Chief Medical Officer's Annual Report 2025

Infections

Simulated HCID exercise

Front cover image: Photograph of a simulation exercise in the Newcastle HCID treatment facility showing clinical staff in personal protective equipment managing a simulated pregnant patient (mannequin) with a high risk infection.

Image courtesy Danny Morland via Brendan Payne, The Newcastle Upon Tyne Hospitals NHS Foundation Trust

Foreword

Infectious diseases are the oldest enemy of human health. The extraordinary improvements in life expectancy over the last 150 years have been built on the ability of medicine, science and public health to prevent and treat infections. Multiple sciences have contributed. Public health engineering including clean water, sanitation and housing, and agricultural and food sciences to improve nutrition played major roles in reducing the impact of diseases such as cholera, typhoid and tuberculosis. Specific medical preventative countermeasures including vaccines have substantially reduced the risk of many of the most feared diseases of history including diphtheria, polio, smallpox, measles and tetanus. Diagnostic tests and antibiotics have allowed us to diagnose and treat previously fatal bacterial infections causing sepsis, meningitis and post-surgical wound infections, and antivirals have reduced the risk of major viral diseases such as HIV.

Infectious diseases have, however, a capacity to evolve around many of our most effective treatments and antimicrobial resistance was highlighted as a major threat by previous Chief Medical Officer (CMO) Dame Sally Davies. New infections previously unknown in humans continue to emerge for which we do not initially have countermeasures, including in the lifetime of most people reading this, diseases such as HIV, SARS (SARS-CoV-1), bovine spongiform encephalopathy (BSE) leading to new variant Creutzfeldt-Jakob disease (nvCJD) and COVID-19 (SARS-CoV-2). Many of these jump from animals, periodically causing epidemics and, much more rarely, pandemics. With international travel other known diseases previously limited to particular geographical areas can spread widely causing major harm to human health; examples in the last 15 years include Ebola in West Africa, Zika in Latin America, MERS in Asia and Mpox globally. Existing human infections can genetically reassort or evolve in response to our existing immunity, in particular influenza. Infectious diseases are therefore a very dynamic threat.

The tools of medical science have repeatedly proved very effective against varied bacteria, viruses, parasites and fungi which cause severe disease but alone they cannot defeat infections. Only if they are delivered to the right people at the right time can they prevent and treat major diseases. This requires actions by doctors and other clinical staff, health services, families, society and governments. One of the greatest threats to effective actions that reduce the predictable, serious and evolving risk multiple infections cause is complacency.

This report considers infections and our countermeasures in England in 2025. It builds on previous CMO reports, in particular *Getting Ahead of the Curve* by Sir Liam Donaldson in 2002. A lot has changed since then, with several new infections, two new pandemics, advances in vaccine science, diagnostics and treatments. Over the same period, a rise of antibiotic, antiviral, antiparasitic and antifungal resistance has increased the threat posed by many infections. Lower levels of vaccination leave the way open for predictable, and entirely preventable, outbreaks of potentially fatal diseases in children such as measles and diphtheria.

This report has several high-level recommendations, and some specific recommendations in the individual chapters. I would, however, like to highlight some key messages for the public, the medical profession and authorities including government.

For the **public**, it is worth celebrating that whenever there is an infectious emergency the public respond remarkably, as they did during COVID-19. Between emergencies it is easy to take for granted the protection from infection that modern medicine invisibly gives us all. The gradual drifting down of rates of vaccination for preventable and potentially severe infections needs to be reversed if we are to provide the best protection from often exceptionally dangerous diseases of children and adults.

For the **medical profession and other healthcare workers**, we know that medical science has repeatedly shown its ability to combat infections, saving large numbers of lives, but I would like to highlight two priorities. The first is to reinforce the need to avoid overprescription of antibiotics and other antimicrobials; antimicrobial resistance remains a major threat. There is often a difficult balance to be struck, but antimicrobial stewardship is a professional responsibility. Secondly, we have as a profession not done enough to reduce the risk of infections in the elderly, the largest growing segment of the medically vulnerable population. This includes having too little research into infections in this age group.

For **authorities, including national and local government**, it has repeatedly been shown that when government takes a lead preventing infections there can be dramatic effects in reducing the infectious risk to all citizens. I would, however, highlight the risk of complacency and de-prioritisation of infectious threats between outbreaks and epidemics. The surges of infection in winter come every year, putting substantial pressure on the NHS. Outbreaks and epidemics occur frequently and pandemics are rare but potentially catastrophic. These are entirely predictable (although their timing is not) and infectious emergencies will happen multiple times during the lifetimes of those reading this report. We need to keep our capacity to prevent and respond to infections up between events rather than wring our hands and wish we had done so when they occur.

Finally, I would like to thank the many chapter authors and others from around the country who helped with this report, and in particular the editor-in-chief Dr. Nileema Patel and editor Dr. Alex Thompson.

Prof Chris Whitty
Chief Medical Officer for England

Executive summary

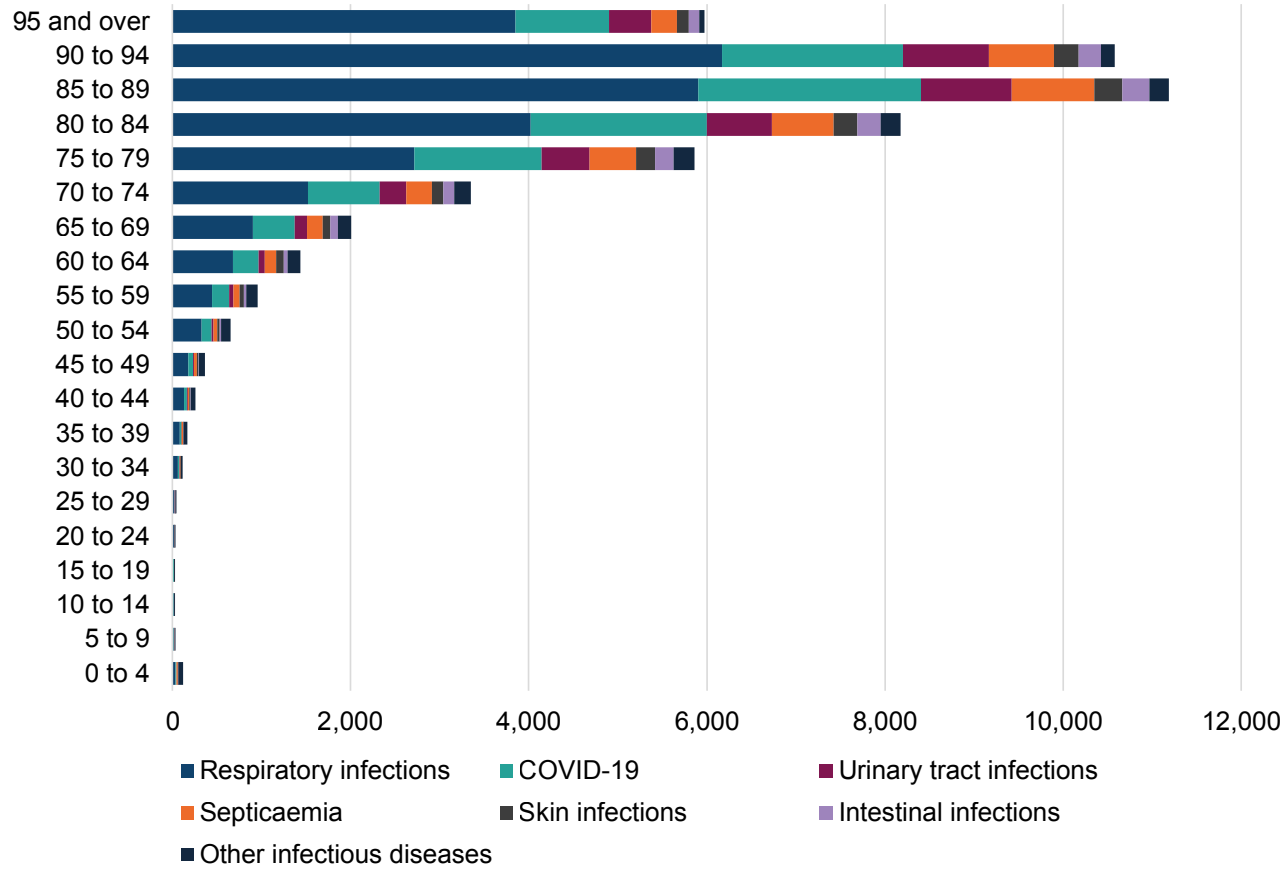
Infectious disease in England

Infections are ubiquitous – over the course of our lifetimes we will all experience multiple episodes of infection. In most healthy people outside the extremes of age these are usually mild illnesses that resolve quickly, often not requiring treatment. This was not the case in the England of 150 years ago, when life-threatening infections and those capable of causing long-term consequences were much more common at all ages. The scale of progress in the prevention and treatment of infections is one of the greatest successes in scientific, medical and public health history, and has led to substantial improvements in life expectancy. Innovations in water, sanitation and hygiene led to large reductions in cases of cholera, typhoid and other faeco-oral diseases which were epidemic in England previously. Diseases such as diphtheria, polio and rubella are now very rarely seen in England because of the development of vaccines and organised efforts to provide them for the whole population in childhood. Medical and wider scientific advances including antibiotics, antiviral, antifungal and antiparasitic drugs as well as improved diagnostics mean that it is now possible to identify and treat many infections earlier, more accurately and rapidly. Infections however evolve in response to this pressure so the threat is never static. In this century the challenges presented by infections are therefore different. This report aims to reflect on more recent trends in infections and changes to the health system, lay out current challenges and consider what comes next.

The following 7 points highlight key themes explored in this report, which also covers wider issues on infections in England.

1. **Preventing infection in older adults can significantly improve overall health and quality of life.** Many infections are at their most dangerous at the extremes of life. This means the impact of infections as we age is increasingly important, especially as the proportion of older adults in the population is projected to increase significantly over the next 20 years in England. Older adults are at higher risk of infection and its severe consequences including indirectly, through increasing risk of other illnesses such as stroke and heart disease. We have historically given much more emphasis to preventing severe illness in children, and that needs to continue, but increasingly the burden of infectious diseases in older adults is dominating (Figure 1). We now need to give it more systematic attention as it can reduce the quality as well as the length of life. Recent advances in vaccine science have shown that we can improve health outcomes from infection in older adults with tailored interventions such as the RSV, COVID-19 and shingles vaccination programmes now available for this age group.

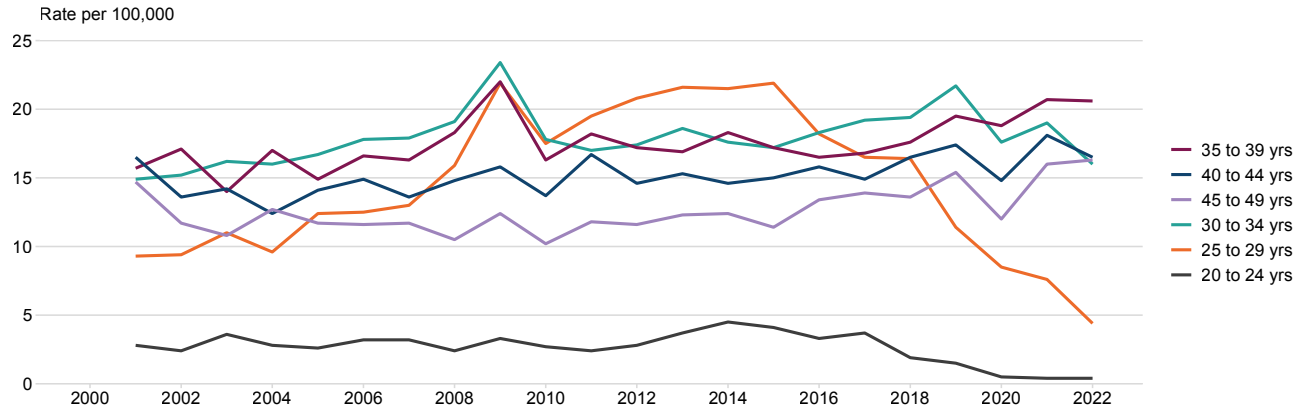
Figure 1: Number of deaths from infectious diseases, by age group, 2023, England



Source: Office for Health Improvement and Disparities, based on mortality data from the Office for National Statistics

2. **Controlling specific infections has proven highly successful in preventing certain cancers.** Vaccination against human papillomavirus (HPV) has significantly reduced new cases of cervical cancer in women under 30 years of age in England, reflecting eligible cohorts since the introduction of the vaccine in 2008 (Figure 2). Provided we achieve consistently high coverage of vaccination (and screening), cervical cancer will become a very rare occurrence in England in the future. Other cancers we have successfully reduced the incidence of include HIV-related lymphoma and Kaposi's sarcoma, and viral hepatitis associated hepatocellular carcinoma. There may be other infections such as Epstein-Barr virus (EBV) which if controlled might reduce cancers further.

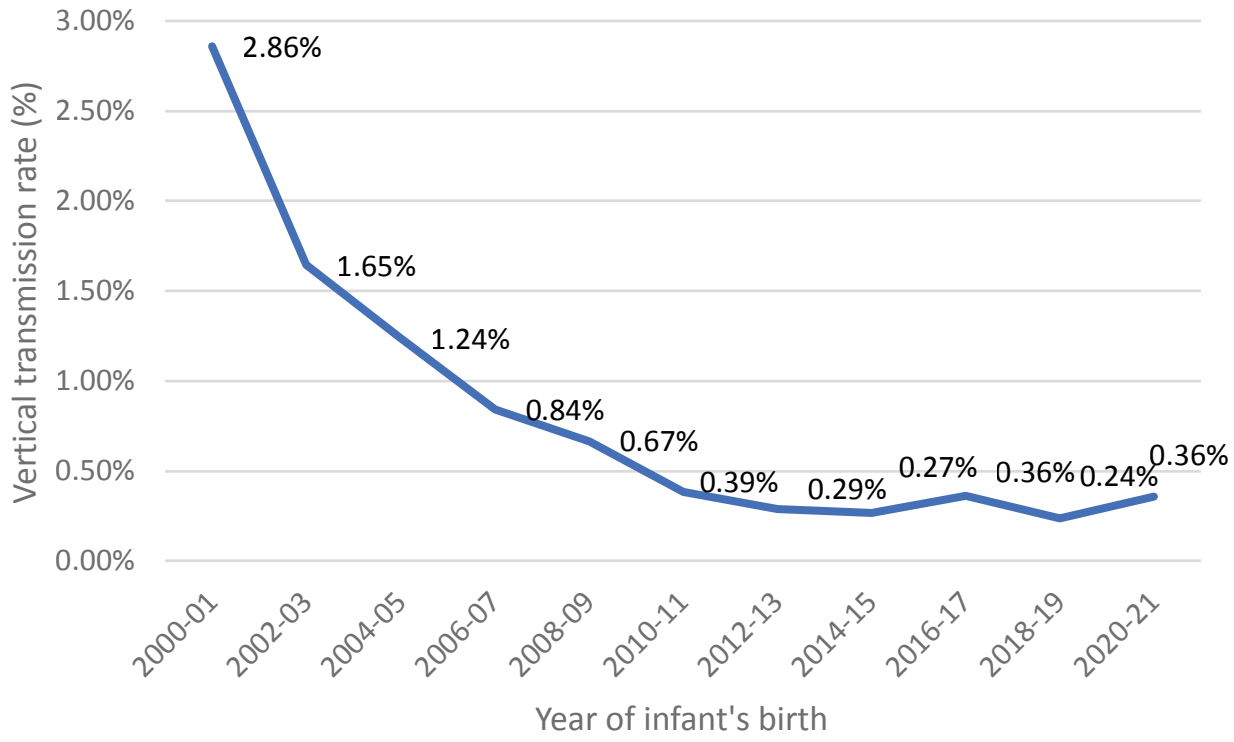
Figure 2: Trend in cervical cancer incidence by age group (age standardised rates per 100,000 population), England, 2001 to 2022



Source: Image from Department of Health and Social Care, Health trends and variation in England, 2025, a Chief Medical Officer report, is licensed under the Open Government Licence v3.0.

3. **Infections in pregnancy and the neonatal period still present significant risks.** Although maternal deaths are rare in the UK, maternal sepsis remains a significant cause of harm especially in some ethnic groups and in areas of deprivation. There has been a major improvement in neonatal mortality from infections over the last 40 years but this has slowed in the last decade. Antenatal screening can reduce risk and improve outcomes as demonstrated by reductions in vertical transmission of HIV (Figure 3), hepatitis and syphilis. Vaccinations such as those against against RSV, influenza and pertussis during pregnancy are effective at preventing fetal and neonatal harm from these infections. However, vaccine uptake amongst pregnant women has sometimes been low relative to the protection provided. Medical advancements in care and improved hygiene practices in high-risk settings such as neonatal units have also contributed to improvements in neonatal mortality from infection. Trials for screening and possibly vaccination against Group B Streptococcus, a common cause of neonatal infection, hold promise for further reductions in the burden of neonatal infection in England.

Figure 3: Vertical transmission rate of HIV by year of birth for infants born to diagnosed women in England

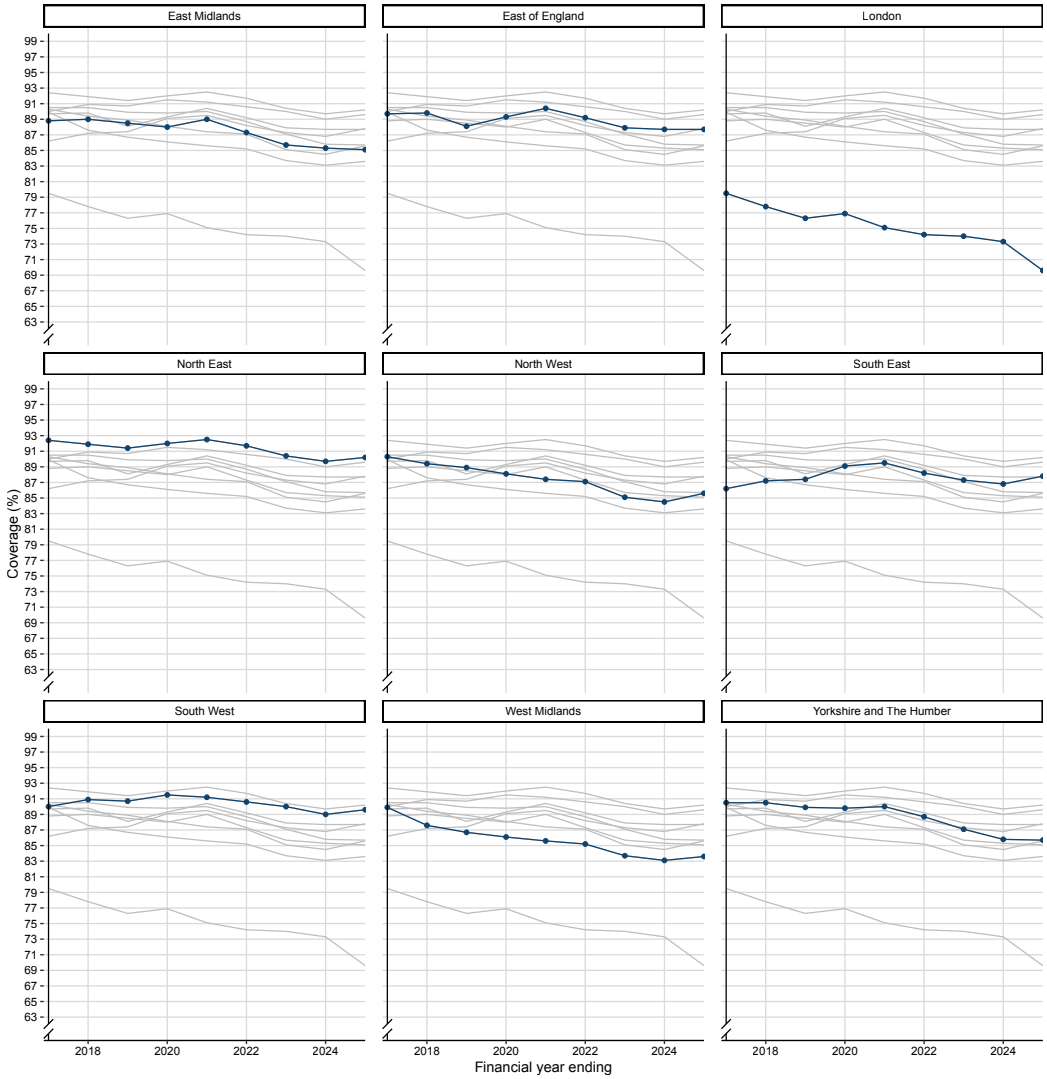


Source: Image from ISOSS HIV report (for pregnancies between 1 April 2021 to 31 March 2022), 2024, is licensed under the Open Government Licence v3.0.

4. **Easily underestimated but potentially very harmful diseases are increasing due to gradually declining coverage of routine vaccinations in children and young adults over the last decade.**

   Overall rates of vaccine uptake in children in England are very high, but they have been drifting down, especially in London (Figure 4). Outbreaks of serious vaccine preventable diseases such as measles are likely to become more frequent, with associated health outcomes including long-term disability and death. Inequalities in vaccination coverage by deprivation, ethnicity and geography lead to unequal distribution of disease. Vaccination has been the keystone in safely and effectively preventing many serious infections such as diphtheria, polio and meningitis in childhood. Barriers to accessing vaccination are important as well as vaccine confidence in contributing to lower uptake. New vaccines against for example varicella zoster (which causes chickenpox and subsequently shingles) for children and RSV in neonates and older adults show continued scientific progress – high levels of uptake are essential to achieve the greatest health impacts from these innovations.

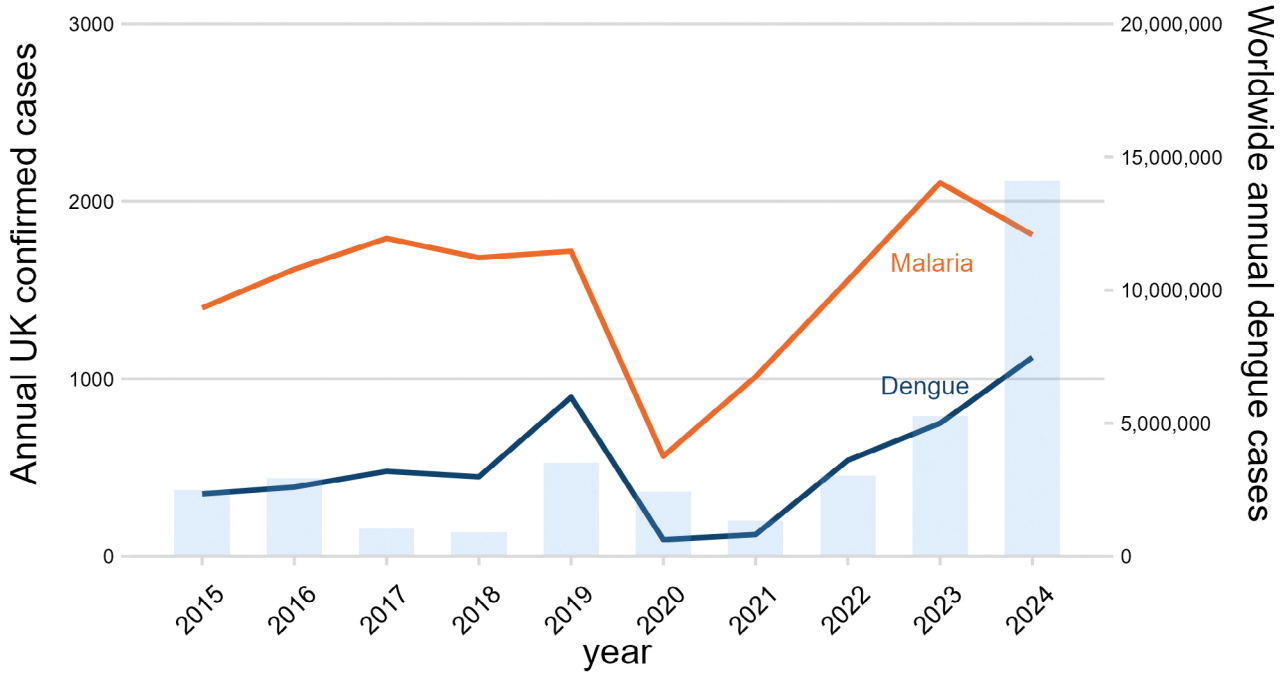
Figure 4: Coverage of the MMR2 vaccine by region in children aged 5 years from financial year ending 2016 to financial year ending 2025



Source: Image from UKHSA, Vaccination coverage statistics for children aged up to 5 years, England (COVER programme) report: April 2024 to March 2025, updated 2 Oct 2025, is licensed under the Open Government Licence v3.0.

5. **The burden and range of infections imported into the UK has increased over the last decade.** The number of imported cases of malaria, enteric fever and dengue has risen and the 2022 outbreak of Mpox demonstrates the potential for novel or emerging imported infections to cause significant ill health (Figure 5). Imported infections have also been increasingly detected in animal and insect vectors of disease in the UK. Travel, trade, increased population density, changes in land usage in response to population growth, migration and climate change are global drivers of this increase. Responding to imported infections involves maintaining surveillance, diagnostic capability, professional expertise in imported infections, healthcare facilities to manage cases and international engagement in research and learning. This also can provide support to other countries.

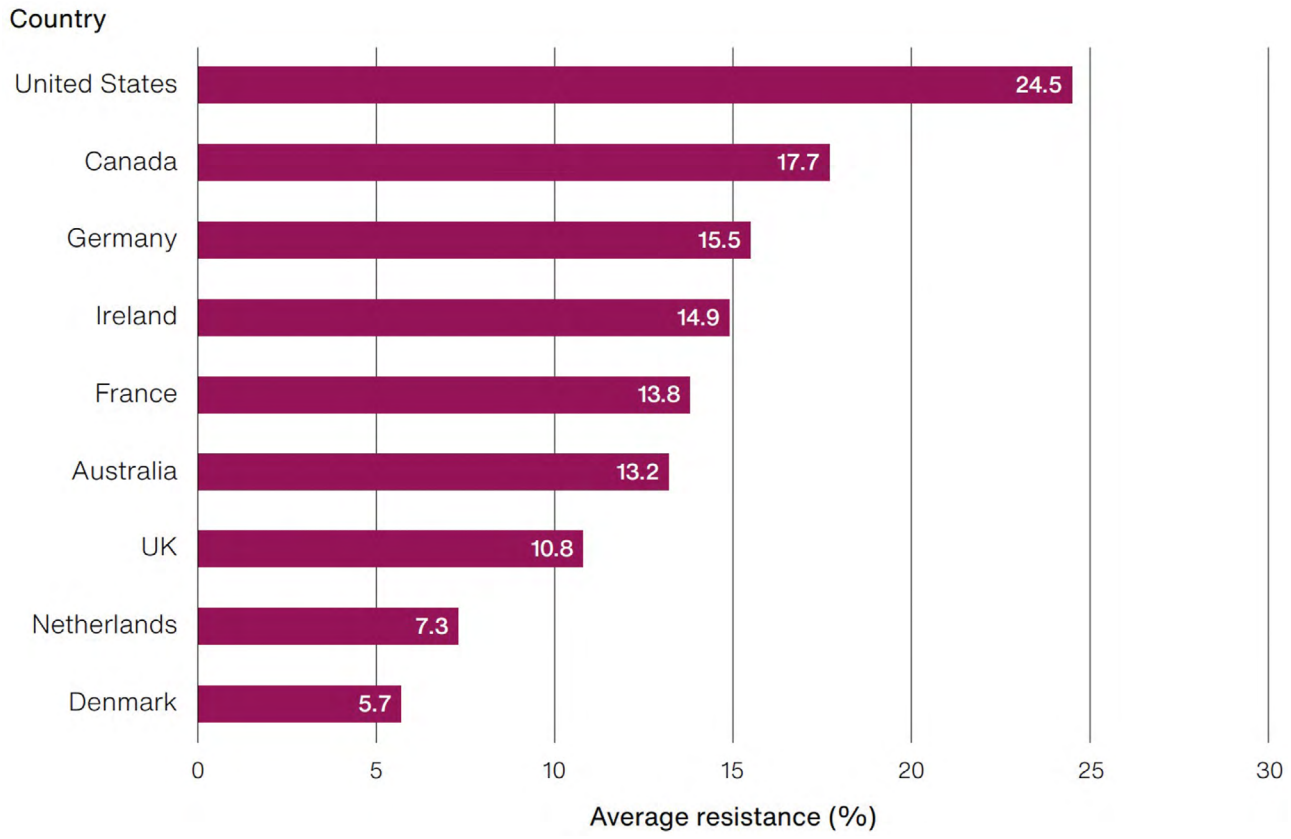
Figure 5: Cases of malaria and dengue diagnosed in the UK, 2015 to 2024



Source: Houlihan, C, Warrell, C, Lalloo, D, Olver, J, Imported infection and zoonosis, chapter 2.2.

6. **Antimicrobial resistance (AMR) continues to be a major risk.** Infections are under evolutionary pressure to adapt around our countermeasures, including antibiotics, antivirals, antiparasitic, antifungals, vaccines and insecticides. Infections are therefore a dynamic threat. As championed by Dame Sally Davies, addressing AMR requires a range of co-ordinated actions to enable more accurate and judicious use of antimicrobials in the presence of infection or possible infection. Prevention of infection in the first instance, through for example vaccines and good hygiene practice, will reduce both the burden of resistant infections from spread and the opportunity for new resistance to develop – this applies to agriculture as it does to human medicine. Infection control measures in hospital and antimicrobial stewardship (reducing overuse of antimicrobials in human and animal health) are both essential. A realistic pipeline of new antimicrobials which can be used in the presence of resistance will mitigate ongoing risk. Whilst England does not yet have as high rates as some countries (Figure 6) this is a significant and growing threat, and we should learn from countries with lower rates than we have.

Figure 6: Prevalence of high-risk antibiotic resistance, 2019



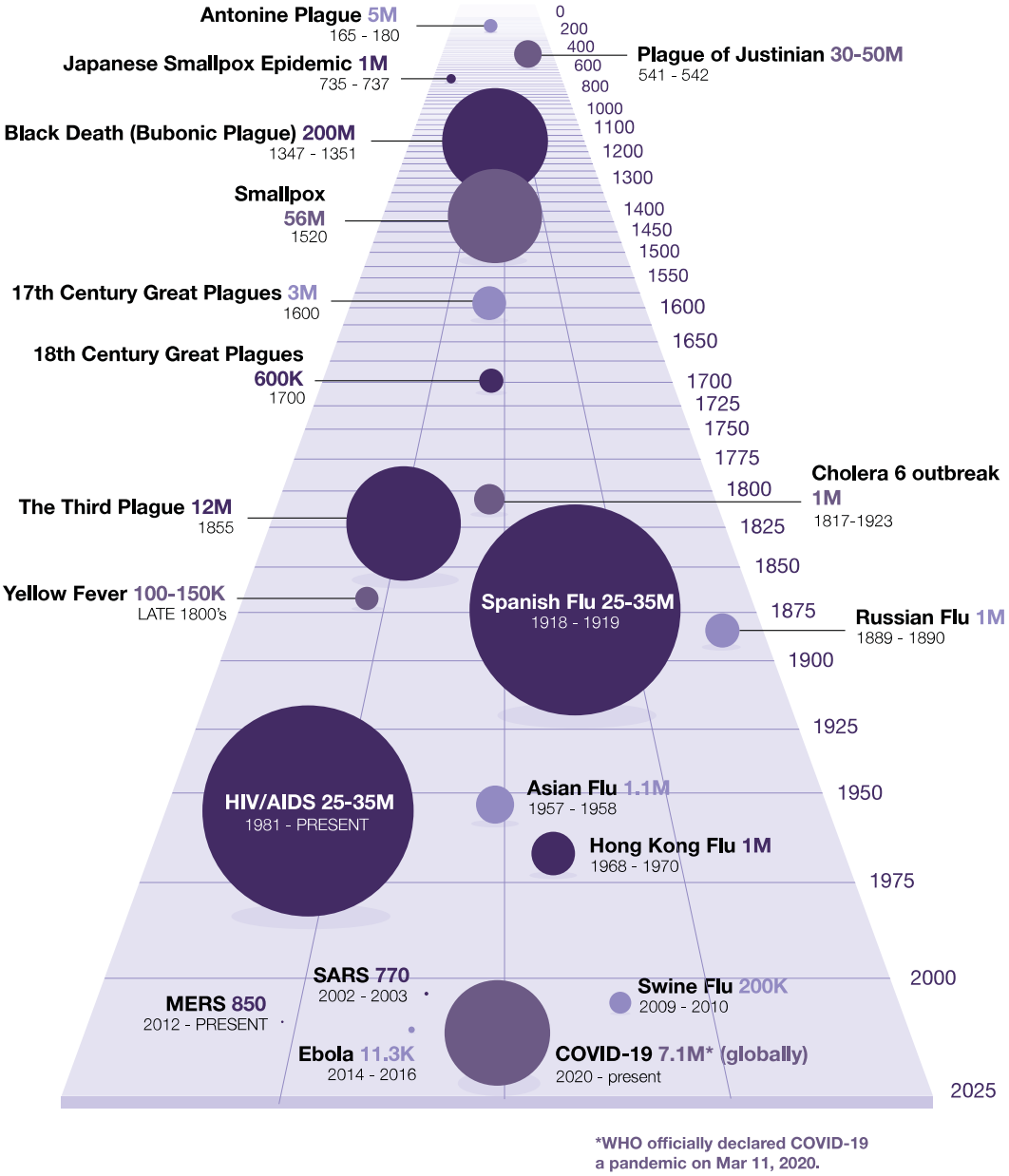
Notes

1. Average resistance is calculated across 12 antibiotic-pathogen combinations that present the highest risks to human health. The 12 priority antibiotic-pathogen combinations included in the analysis are vancomycin-resistant Enterococcus faecalis, vancomycin-resistant Enterococcus faecium, third-generation cephalosporin-resistant Escherichia coli (E. coli), carbapenem-resistant Klebsiella pneumoniae (K. pneumoniae), third-generation cephalosporin-resistant K. pneumoniae, carbapenem-resistant Pseudomonas aeruginosa, meticillin-resistant Staphylococcus aureus, penicillin-resistant Streptococcus pneumoniae, fluoroquinolone-resistant Acinetobacter baumannii (A. baumannii), carbapenem-resistant A. baumannii, fluoroquinolone-resistant E. coll and carbapenem-resistant E. coli.
2. We have compared the UK with a selected group of countries with a similar economic and cultural profile to the UK.

Source: National Audit Office (NAO). Investigation into how government is addressing antimicrobial resistance , page 17. London: NAO, 2025. (accessed 25 August 2025).

7. **The periodic occurrence of significant new epidemics and pandemics as a natural consequence of emerging and evolving infections is predictable, even if the timing of their onset and infection is not.** Five pandemics have affected the UK in the last 75 years: COVID-19 (respiratory), HIV (sexual) and 3 involving influenza (respiratory). Multiple significant epidemics have occurred over the same time period including Ebola and Mpox (touch), Zika (vector), SARS and MERS (respiratory) and BSE/nvCJD (oral). The primary route of transmission (which can be respiratory, sexual, oral, touch or vector-borne) for each of these determined effective control measures ahead of medical countermeasures such as drugs and vaccines being available. Initial control measures at a population level differ by route of transmission. Rapid development of medical countermeasures including diagnostics, drugs and vaccines is essential and depends on a strong science base.

Figure 7: History of pandemics and epidemics.



Estimated numbers of deaths are approximate.

Source: This graphic was adapted by the Cabinet Office from 'Visualizing the History of Pandemics' by Visual Capitalist.

Recommendations

Overall recommendations

This report makes a number of recommendations intended for a range of healthcare, public health, scientific and government departments that each have a role to play in managing the changing burden of infections over time and across the population. More specific recommendations can be found within the individual chapters of this report which reflect the views of their respective authors.

1. **We need to be much more systematic about infections in older age, where the risk is highest.** In managing common infections in elderly patients healthcare professionals should take account both of the higher probability of older patients acquiring many infections, and of infections being more likely to cause severe or recurrent disease in this age group. The difficult balance between over- and underuse of antibiotics is often more tilted towards treatment in older than younger adults in primary care. In secondary care, action to prevent further consequences of infection including sepsis and deconditioning in older patients with infection should be emphasised. The risk that infections precipitate stroke and myocardial infarction in older people is often underappreciated; significant infection should be a prompt to optimise secondary prevention of cardiovascular disease. Vaccines in the elderly have been shown to reduce major or debilitating disease significantly, and their development and deployment needs to be prioritised.

2. **For the NHS and public health system, supporting and tailoring access to vaccines in different population groups will facilitate uptake to improve protection against infections.**

    a. For parents, accessing professional and evidence-based support in decision-making can improve confidence in protecting their children from significant lifelong harm through vaccination. Four things in particular need to be communicated clearly, covering benefits and risks: the dangers of the infections being prevented; the efficacy of the protection; the side effects of the vaccine relative to the risk of disease; and then we need to provide easy access. Some groups in society start with less trust in government and medicine, and this needs to be respected and worked with.

    b. For pregnant women, consistency of advice and access across the range of healthcare professionals and settings they interact with can improve confidence in their decision-making to protect their babies.

    c. Maintaining high levels of HPV vaccine uptake in young girls and boys will work to secure a future where cervical and other HPV driven cancers are very rare.

    d. For older adults, differences in eligibility and repeat schedule can make it harder for people to be aware they can have a vaccine. They may also be uncertain as to when, how

or where to access vaccines. Making this obvious and widely available will support older adults to access care in the community.

   e. Working with underserved communities experiencing specific vaccine concerns or practical difficulty in accessing vaccines to provide culturally acceptable, evidence-based support can improve the health of some of the otherwise most susceptible populations.

3. **Concentric circles of expertise for managing infections within the healthcare system can support effective and timely intervention, including in emergencies.** All clinicians need a baseline level of training and experience in infections. Increasingly, this includes training on providing basic advice to people when they travel. Specialists need to be trained in infections. We also need superspecialists to provide advice on and management of infections including those that are imported or tropical and rarer (such as fungal infections). However, specialists should retain generalist knowledge and capability to manage common complications and co-morbidities, especially as we plan for the future needs of an ageing population.

4. **Antimicrobial resistance (AMR) is everybody's problem.** Reducing infections reduces the need for antimicrobials. Reducing the unnecessary use of antibiotics and other antimicrobials, using older or narrow-spectrum antimicrobials for routine use and reserving more recent antimicrobials for more complex cases will help slow the spread of resistance in England. This must be mirrored in agricultural use. Developing a pipeline of antibiotics, antivirals, antifungals, antiparasitic drugs and insecticides has to be a global endeavour in which the UK has historically played a leadership role – we must continue to keep this a significant priority. Detecting and mapping the spread of antimicrobial resistance globally helps our country and other countries to respond effectively to this threat.

Specific additional recommendations

1. Initial control measures for future epidemics and pandemics should be based on the primary route of transmission until medical countermeasures like drugs and vaccines are developed and made available. We need to maintain our capacity to meet threats from each of the 5 major routes of transmission (respiratory, sexual, oral, touch or vector-borne).

2. Several major cancers caused by infections can be reduced to exceptionally low levels through vaccination, treatment and screening. We should ensure we achieve that by maintaining and improving high uptake, including countering disinformation about vaccines forcefully when necessary.

3. The spread of resistant strains of fungi with the capacity to cause serious human diseases due to the agricultural use of novel fungicides is an issue that requires research and surveillance monitoring. Deployment of novel antifungals in agriculture should consider effects on human health, especially where drug development is happening in parallel so that both human and agricultural health are considered in the round.

4. We are likely to see changes to vector and vector-borne disease distribution in the future, exacerbated by climate change. This is on a background of continued threat from new infectious diseases as they emerge, particularly from domestic and wild animals. Maintaining our preparedness for these includes having a strong and comprehensive surveillance system.

5. Sharing data openly nationally and internationally and integrating UK datasets to enable timely, meaningful and comprehensive surveillance and research for COVID-19 demonstrated it is possible to use data much more effectively than we often do. We should apply this approach to collaboration on data on infections outside of emergencies, including for areas of strength in the UK such as pathogen and human genomics and clinical and biobank data.

6. Research on infections in the UK is an area of strength, however older adults and pregnant women are often underserved. Differences in physiology at these life stages mean the impact of infections differs in these groups, and the way we prevent and manage them should reflect this. Often, it is these groups that are at particular risk who are excluded from studies. A more inclusive and focused approach to key life stages within infectious disease research is possible and necessary as a next strategic step.

7. Infections are global. In order to protect both the UK population and populations more widely, particularly children and vulnerable people, it is necessary to continue supporting the global health architecture including by data sharing, research partnerships and co-development of diagnostics and treatments.

Editor and chapter authors

Christopher J M Whitty, Chief Medical Officer for England

Nileema Patel, Editor-in-Chief

Alex Thompson, Editor

1 The future of preventing and treating infections in England

Christopher J M Whitty

2 Preparing for new and imported infections

2.1 Five routes of transmission in epidemics and pandemics
Christopher J M Whitty and Susan Hopkins

2.2 Imported infection and zoonosis
Catherine Houlihan, Clare Warrell and David Lalloo

3 Infections across the life course

3.1 Infections in older adults
Nileema Patel and Christopher J M Whitty

3.2 Infections in pregnancy
Cordelia E M Coltart, Nicola Vousden and Lucy Chappell

3.3 Neonatal infections in England: current challenges, emerging trends
Simon B Drysdale, Aung Soe and Paul T Heath

3.4 Infections in children
Jolanta Bernatoniene, Elizabeth Whittaker and Andrew Riordan

3.5 Childhood vaccination
Mary Ramsay, Heidi Larson and Andrew Pollard

3.6 Infections in young adults
Thomas Waite

4 Special topics in infection

4.1 Vaccines
Andrew Pollard and Melita Gordon

4.2 Fungal infections
Neil Stone, Andrew Borman, Neil Gow and Tihana Bicanic

4.3 Cancer and infections
Emily Whamond

4.4 Antimicrobial resistance
Jonathan Sandoe and Colin Brown

4.5 Healthcare-associated infections
Russell Hope and Mark Wilcox

5 Responding to infections as a system

5.1 Strengthening infection services for a resilient future health system
Susan Hopkins, David Partridge, Rajeka Lazarus, Martin Llewelyn and Nick Price

5.2 Regional case studies in health protection
Megan Evans, Simon Walker, Tristan Childs and William Welfare

6 Vulnerable populations

6.1 Homelessness and infection
Andrew Hayward and Alistair Story

6.2 Infections and migrant health
Kate Yorke, Lianne Straus and Leonora Weil

7 Wider determinants of infectious disease

7.1 Climate change and infections
Thomas Waite, Jolyon Medlock and Lea Berrang Ford

7.2 Housing and infection
Andrew Hayward

Appendix

A1 Advisory committees: coordination, reform and accountability
Lewis Peake, Carolina Arevalo and Susan Hopkins

Contents

Foreword 1

Executive summary 3

Recommendations 11

Editor and chapter authors 14

1 The future of preventing and treating infections in England 17

2 Preparing for new and imported infections 22

2.1 Five routes of transmission in epidemics and pandemics 22

2.2 Imported infection and zoonosis 28

3 Infections across the life course 37

3.1 Infections in older adults 37

3.2 Infections in pregnancy 51

3.3 Neonatal infections in England: current challenges, emerging trends 81

3.4 Infections in children 108

3.5 Childhood vaccination 132

3.6 Infections in young adults 155

4 Special topics in infection 162

4.1 Vaccines 162

4.2 Fungal infections 180

4.3 Cancer and infections 202

4.4 Antimicrobial resistance 223

4.5 Healthcare-associated infections 245

5 Responding to infections as a system 269

5.1 Strengthening infection services for a resilient future health system 269

5.2 Regional case studies in health protection 288

6 Vulnerable populations 301

6.1 Homelessness and infection 301

6.2 Infections and migrant health 314

7 Wider determinants of infectious disease 333

7.1 Climate change and infections 333

7.2 Housing and infection 344

Appendix: advisory committees: coordination, reform and accountability 358

Acknowledgements 368

1 The future of preventing and treating infections in England

Christopher J M Whitty – Chief Medical Officer for England

Introduction

Over the last two centuries three major groups of diseases have dominated mortality in England and the wider UK: infectious diseases, cardiovascular disease and cancers. Science, public health, clinical medicine and economic development have all played a part in reducing the impacts of infections to a fraction of what they were 150 years ago, and substantially less than they were when the NHS was founded.

The ability of science to combat infections via multiple routes has been shown many times, whether through engineering (cholera, typhoid), treatment (tuberculosis, staphylococcus), vaccination (tetanus, smallpox, polio, diphtheria), vector interventions (malaria, typhus) or wider public health measures (rabies, Ebola). Infections are however always evolving in a way non-communicable diseases do not and we need to be able to respond, rapidly and at scale, to new or emerging threats. A treatment for heart disease which works now will still work in 20 years time, although other treatments will probably supersede it. In 20 years many infections will have evolved around our current countermeasures (prevention or treatment) rendering them ineffective. Meanwhile major new infections, some previously unknown in humans, will have arrived. Recent history with COVID-19 shows these can still cause hundreds of thousands of deaths in England and millions globally. Infectious diseases are therefore both our oldest and our most dynamic health threat.

Six things will drive the changes in the threat of infections over the next few decades: changing demography; new infections (mainly zoonoses); travel-associated spread of disease; evolving antimicrobial and other resistance; public uptake of effective countermeasures, especially vaccines; new science leading to new prevention, diagnosis and treatment options.

Some of these are entirely predictable, and we need to plan for them, especially demographic change. Others are predictable in concept but the timing and level of threat are unpredictable, of which new infections causing pandemics or major epidemics are the most important. The majority of these new infectious threats will be imported from other countries. We therefore need to maintain our capacity to respond to unpredictable infections and to imported disease. Some are trends which we can influence significantly by current policy and practice like antimicrobial resistance. Maintaining public support for some of the most important well-evidenced measures to prevent and cure disease, including vaccination, remains essential and we should never take it for granted. Whilst history suggests we can rely on science to help us get out of major infectious emergencies eventually we cannot assume it will always be quick. Not planning for or investing in an ability to respond to new, emerging or evolving infections because we hope science will turn something up in time is not sensible policy.

Demography

In the next two decades the fastest growing segment of the population of England is older people (over 80 years). Older adults are at substantially greater risk of many serious infections than younger adults or older children. Historically deaths and severe disease were common at both extremes of life. The remarkable strides made to reduce the risk of dangerous infectious diseases of childhood, especially vaccinations for major childhood diseases, mean that child death and major disability from infection, which still occur in some tragic cases, are now rare outside the neonatal period. Increasingly this means that the biggest effects of infections, and the overwhelming majority of infectious deaths, are in older people. The systematic approach we have had in science to address the major diseases in childhood has not yet been replicated in preventing and treating infections of older adults. This needs to change; both the fact that the population is ageing, and that older adults are now much more susceptible to serious infections, are certainties. We explore this more fully in the chapter on ageing, but globally the attention to infections of older people is nowhere near where it needs to be and currently the burden of infection in older people is set to rise.

New and emerging infections

Over the last 50 years we have had two major pandemics from entirely novel pathogens to humans (HIV and COVID-19), one pandemic from a reassorted influenza (the 2009 H1N1 pandemic) which was mercifully mild, and several major epidemics with novel pathogens, one originating in the UK (BSE leading to nvCJD), some in Asia (SARS, MERS) or infections which evolved or spread well outside their original heartlands (Ebola, Mpox, Zika, all originally from Africa). All caused cases in the UK. That we will have more pandemics from new diseases and novel epidemics is a certainty. The great majority of new diseases originate in animals or have an animal reservoir before jumping to, and spreading between, humans – for example HIV from monkeys, Ebola from bats, MERS in camels. Usually they will spread among humans where they emerge and then travel to the UK via humans, but as nvCJD (which emerged in the UK) demonstrated this is not always the case. Some come from domesticated animals, some from wild animals. The human-animal interface is large, varied and always changing.

All major pandemics and epidemics to date have come via one (or more) of 5 routes of transmission with an example of each: oral through food and water (cholera); respiratory (COVID-19); sexual (HIV); touch (Ebola); vector (Zika). Maintaining the capacity to respond to these intermittent, but potentially massive, threats via any of these five routes of transmission looks difficult and expensive between major epidemics, and this tends to lead to disinvestment. Then in the heat of an infectious emergency when society and the economy are badly affected we wring our hands. Maintaining an ability to respond to at least moderate-sized threats is and will always be prudent. This includes the ability to diagnose, isolate and treat early cases, and implement effective public health measures.

Travel-associated disease and international health

England is a trading, international nation, and one of the most heavily networked and multicultural societies in the world. Many diseases common in countries with which we have close links through trade, tourism, family ties and wider travel are rare in England and the other nations of the UK, or are almost never seen except in imported cases. Many of these diseases can be serious, have little or no chance of being transmitted in England (for example serious parasitic diseases), but present a major diagnostic and medical challenge to UK-trained doctors who rarely see them. Global patterns of diseases, and of antimicrobial resistance are constantly shifting and evolving. Travel will also be the route by which most major infections will enter the UK, as laid out in the last section. Historically the UK has been one of the leaders in global science used to combat these diseases internationally. For England and the wider UK, maintaining a specialist ability to diagnose, isolate and manage imported infections will remain important for the foreseeable future.

Antimicrobial resistance, anti-vector resistance and evolving infections

Evolution does not only allow new infections to emerge, it also means that if we put selection pressure on an existing infection via a drug it will often evolve around that. Some do so rapidly, some do so very slowly, but many countermeasures become less effective over time and some become essentially useless rapidly. This is most widely seen with bacteria, and some bacteria (for example the bacteria causing gonorrhoea, and infections in ICUs) have evolved resistance to multiple antibiotic classes. Viral infections such as HIV and influenzas can also evolve resistance to antiviral drugs, parasitic diseases like malaria to antiparasitic drugs, and fungi to antifungals. Mosquitoes and other disease-carrying vectors can evolve insecticide resistance. This can be accelerated if the agent is also widely used in agriculture – for example antifungal and insecticide resistance may come from their use in arable farming and horticulture, and antibiotic resistance from animal use. Widespread use in human health is however the major driver for many of them, and overuse of antibiotics is a very serious global threat.

The speed at which we have developed new antibiotics and other anti-infective agents has often been slower than the speed at which resistance to existing drugs has emerged and spread. It is therefore essential we both maintain a research pipeline, and take steps to limit over-use, or we will end up less able to treat serious infections in the future than we have in the past, in stark contrast to most areas of medicine where each improvement builds on previous science and steady (if sometimes slow) progress is the norm. In infectious diseases it is possible to go backwards.

The position of vaccines is more complex because they stimulate the adaptive immune system, and whilst the infection may evolve, the immune system can also respond to that evolution. Some infections are however evolving and reassorting in such a major way that previously effective vaccines lose their ability to prevent or reduce the severity of disease – influenza and COVID-19 are both examples of this – and need to be updated, in the case of influenza every season. Other infections have to date been unable to evolve around the immune response a

vaccine induces – measles and smallpox are examples of this. For those infections which do rapidly evolve around vaccines however we will need to maintain our ability to adapt our countermeasures.

Because of this evolution we will never reach a steady state with even our existing and known human infections, and maintaining a capacity to slow the emergence of resistance and the science to develop new countermeasures to infections we were once able to prevent or treat will remain essential.

Public uptake of effective countermeasures such as vaccines

In England uptake of vaccines and other medical countermeasures to infection is high; over 93% of babies are for example currently brought by their parents to have the first 6-in-1 vaccine against some of the most dangerous diseases acquired in childhood (diphtheria, tetanus, pertussis (whooping cough), polio, Haemophilus influenzae type b (Hib), and Hepatitis B). We are seeing rapid declines in cervical cancer in young women because of high uptake by girls, and more recently boys, of the HPV vaccine, and childhood meningitis is substantially lower than it was 20 years ago because of vaccination. Pasteurisation of milk, safe water and good animal husbandry all contribute to the general protection against serious infectious diseases.

We cannot however at any point take for granted the trust the public in England and the wider UK rightly have in these extremely important interventions. There has been some waning of uptake even of well-established childhood vaccines, as well as important vaccines pregnant women take to protect their babies. Some of this (often the majority) is due to practical difficulties in accessing vaccines, but there is a movement, often originating outside the UK, to generate distrust of science-based protection against infections in general, and vaccines in particular by way of disinformation and misinformation.

If we as a society lose confidence in the highly effective measures which are, invisibly but effectively, protecting children and adults against infections, we will all be at greater risk. A vaccine, for example, not only protects a child but often all the other children around them. Four things in particular need to be communicated clearly and in a balanced and transparent way, for vaccines in particular: the danger from the infections being prevented; the efficacy of the vaccine; the side effects of the vaccine relative to the risk of disease; and then we need to provide easy access. Some groups in society start with a greater distrust in government and medicine, and this needs to be respected and worked with.

If we start to lose these protections many old infectious enemies which are currently at very low levels will come back. The probability of a collapse in confidence is low, but a gradual erosion of the uptake of these protections is a real risk if we do not respond to it. Everybody loses if we do not maintain this confidence.

Future science

Predicting the future direction of science is never easy as many scientific trends that look revolutionary do not reach their assumed potential, whilst other fields move forward extremely rapidly and unexpectedly. It is certain however that new scientific developments in diagnosis, prevention and treatment will change the risks of many of the infections we currently face. One of the themes of the sections above and the chapters that follow is that in contrast to non-communicable diseases combatting infections needs constant reinvention of many of our countermeasures, or development of novel ones, as new threats emerge and old threats evolve.

At the same time we have been remarkably successful over two centuries in using science to combat major infections, and progress continues against many diseases. The last two decades have shown the continuing power of science to tackle both old and new threats. The new-to-human pandemic with COVID-19 was de-risked by a combination of old science (public health, steroids and other existing drugs) adapted to the new threat, and novel measures such as mass use of rapid diagnostic tests and RNA and virus-vectored vaccines. Meanwhile several new interventions have significantly reduced the risk of existing diseases, including vaccines for RSV (an infection mainly affecting the very young and the old), and HPV (a cancer-causing virus of young adults). New drugs for Hepatitis C, sleeping sickness and other serious infections mean we are able to treat diseases we previously could not.

Of all the future trends laid out in this chapter scientific progress against infections is the least predictable, and the most exciting.

2 Preparing for new and imported infections

2.1 Five routes of transmission in epidemics and pandemics

Christopher J M Whitty – Chief Medical Officer for England, Department of Health and Social Care

Susan Hopkins – Chief Executive Officer, UK Health Security Agency

The five routes

Five routes of transmission have been repeatedly shown to sustain significant epidemics and pandemics. Bacteria, viruses, parasites and fungi with epidemic potential have generally evolved to specialise in using one of these routes, although they may also use one or more secondary routes of transmission. Understanding and identifying the principal route of transmission in epidemics and pandemics is fundamental to implementing effective control or mitigation measures, from sanitation and vaccination to quarantine and vector control.

The 5 routes, with examples of diseases that use them, are:

- **Respiratory** (influenza, measles, smallpox, COVID-19)
- **Sexual** (HIV, Hepatitis B, syphilis)
- **Oral, generally faeco-oral** (cholera, typhoid, bovine spongiform encephalopathy (BSE) to new variant Creutzfeldt–Jakob disease (CJD))
- **Touch** (Ebola, Lassa fever, Mpox)
- **Vector-borne** via mosquitoes, other insects and ticks (malaria, typhus, plague)

Blood-to-blood transmission through needle stick injury, sharing needles or blood transfusion is not a primary route (able to sustain a large epidemic on its own) as a relatively small proportion of the population mix blood with someone else but it is an important secondary route for epidemics of several sexual and touch diseases including HIV, Hepatitis B and Ebola.

In highlighting these 5 routes capable of maintaining a major epidemic, it is important to acknowledge that other routes of transmission can be used by particular diseases. Examples include skin puncture (tetanus), bite by dog (rabies), vertical transmission mother to child (HIV, syphilis, Hepatitis B) and eye splash. None of these routes have however sustained a significant human epidemic on their own.

Since the formation of the NHS in 1948, the UK has been affected by 5 pandemics and of these 4 were respiratory: influenza in 1957, 1968, 2009 and COVID-19. The exception was HIV which was a predominantly sexually transmitted disease with some blood to blood secondary transmission.

Initial approaches to controlling an epidemic almost always depend on the route of transmission identified. Because COVID-19 was transmitted by the respiratory route, effective control measures including keeping physical distance, reducing social contact (especially indoors) and wearing face masks while in close proximity and indoors reduced transmission prior to vaccination being widely available to reduce the severity of the disease. For the last major pandemic on this scale affecting the UK, HIV, a sexually transmitted disease, these interventions would have been ineffective but promoting condoms and reducing the size of sexual networks, as well as reducing needle sharing among people who inject drugs, were important until medical countermeasures including viral suppression and pre-exposure prophylaxis were available. The great faeco-oral cholera pandemics affecting 19th century Britain and repeated epidemics of typhoid were principally addressed by providing safe water and sanitation.

It should be stressed that in all pandemics and epidemics the aim should be to get effective medical countermeasures, in particular vaccines and drugs, as soon as possible and these are much less route dependent. They are also less socially and economically disruptive. Initial actions however have to be guided by the route of transmission.

Respiratory

The understanding of respiratory transmission evolved with diseases such as tuberculosis and smallpox. In the 19th century, germ theory replaced the miasma theory, emphasising respiratory transmission through close range (often colloquially described as droplets) and long range (frequently described as aerosol)[1] particles usually within the same room or building although longer range through the ventilation system has been described.

For high income countries such as the UK, the respiratory route remains the most likely to cause pandemics and significant epidemics. This is in large part because respiratory epidemics and pandemics are more difficult to interrupt since they can be transmitted between people including strangers of all ages, provided they are physically close to one another or in the same enclosed space. While wealthier societies can greatly limit the spread of faeco-oral disease through the provision of safe drinking-water, sanitation and hygiene, as well as fewer overcrowded homes, respiratory transmission continues to pose a threat.

Historical control measures include improved ventilation through opening windows and isolation wards. These types of control measures are still important until there are highly effective medical countermeasures such as vaccines or drugs for a respiratory epidemic. Methods familiar to everybody who experienced COVID-19 include covering coughs and sneezes, social distancing, mask use, ventilation through opening windows (or where that cannot occur through high-efficiency particulate air (HEPA) filtration), temporary closing of higher risk settings such as schools or workplaces where transmission is occurring and at the

extreme social lockdown needs to be considered. All of these have social and economic costs. What is proportionate will depend on the force of transmission (R), the percentage of the population likely to be affected and the severity of health outcomes, in particular mortality. The H1N1 influenza pandemic of 2009, for example, was highly transmissible by the respiratory route but had a very low mortality so the range of measures which were proportionate was much lower than for COVID-19 where the death toll in the UK was potentially in the hundreds of thousands.

Sexual

Sexual transmission has been known since at least the 16th century, with syphilis becoming a major epidemic with significant mortality and morbidity in Europe. Fracastoro proposed the concept of 'contagion' in 1530, describing disease spread through direct sexual contact. Sexual spread of diseases is an extremely effective way for infection to be passed on and is often underestimated; the HIV pandemic has to date killed over 42 million people worldwide. Sexual infections are most likely to be transmitted amongst adults who have regular changes in, or multiple, sexual partners, or have not yet formed a stable relationship; the HIV pandemic was a good example of this, primarily affecting younger adults. HIV also demonstrated that changing sexual behaviours is not straightforward. Where disease is largely passed on by penetrative sex, barrier methods (condoms) of safe sex may significantly reduce the risk of transmission. Some diseases with epidemic potential are also passed on predominantly through extremely close contact and sexual contact is one of the ways this occurs. Mpox is a recent example of this; barrier methods are much less effective in infections passed on by sexual touch rather than only penetrative sex.

Many people have contact details for who they have had sexual contact with so contact tracing and isolation is usually easier than for respiratory infections. However, where contacts are unknown through anonymous or casual sex, reducing the number of sexual contacts and considering how individuals are able to trace prior sexual partners anonymously or through dating apps are important control measures to protect high risk groups until medical countermeasures are available.

Many sexually transmitted infections such as HIV and Hepatitis B and C can also be transmitted through blood as a secondary route of transmission, for example through needle sharing.

Sex education to provide information on how to reduce infection transmission through sex and public health campaigns to reduce stigma from disease and promote testing are important adjunct measures in controlling these infections.

The HIV pandemic provides an example of how initial prevention of disease transmission may rely on social measures (in this case, changes in sexual behaviours), before later moving to a medical management approach as pharmacological treatments are developed.
HIV transmission can now be prevented where people living with HIV take medication regularly and suppress viral load in the blood and sexual fluid to the point they are non-infectious. In addition, where uninfected individuals engage in sexual activity that is known to be higher risk, taking pre-exposure prophylaxis (PrEP) is an effective mechanism for reducing transmission.

Post-exposure doxycycline to reduce syphilis transmission is recommended for specific individuals based on risk factors and available for free within sexual health services.

For some sexually transmitted infections, highly effective vaccinations are available including those against human papillomavirus (HPV) and Hepatitis B, both sexually transmitted causes of cancer (see chapter 4.3). The UK is also implementing a meningococcal vaccine programme to reduce transmission of the closely related bacteria causing gonorrhoea transmission.

Oral

Historically, major infections passed on by the oral route between humans were exceptionally common globally and in the UK. The great majority of these were human faeco-oral diseases where faeces from an infected person contaminated the food or water consumed by others causing the transmission. Cholera is an example where contaminated water is the predominant route of transmission and typhoid one where contamination of food dominates although infected water is also important. The 1854 cholera outbreak in London, investigated by John Snow, marked a milestone in identifying waterborne disease transmission. His work led to reforms in water, sanitation and epidemiological mapping of infection outbreaks. From the middle of the 19th century providing safe water, separating faeces from water supplies and promoting hand washing with soap in high income countries significantly reduced this risk.

Infectious agents carried on or in animals, including fish and birds, to humans through food is also important as part of this transmission route. For this, the combination of refrigeration or freezing (to prevent bacterial propagation), safe preparation through surface and hand cleaning and adequate cooking of food is sufficient to prevent or kill the majority of infections before they are transmitted.

Prion diseases are an exception. Starting in the 1980s, the UK was the epicentre of an epidemic of BSE in cattle which in some tragic cases caused new variant CJD in humans; the prions were not denatured by normal cooking. The critical intervention to eliminate prions in the food chain required the removal of older animals and neurological cattle tissue entering the food chain.

Interventions on epidemics passed on by the oral route therefore need to concentrate on source control from the infected food or water, pasteurization, safe disposal of faeces and adequate freezing, cooling and cooking.

Touch

Historically, contact transmission was one of the earliest recognised forms of disease spread. In the 20th century, hospital-acquired infections spurred further classification into direct and indirect contact routes.

Direct contact involves physical transfer of pathogens through skin-to-skin or mucous membrane contact, as seen with *Staphylococcus aureus* infections. Indirect contact refers to transmission via contaminated objects (fomites), such as medical instruments or bedding. Smallpox, for example, could spread through infected clothing or linens as well as via the respiratory route.[2]

Several major diseases are passed on predominantly by touch, often when an individual touches an infected person and the infection is either introduced through breaks in the skin or because they touch their face. Recently, the most important newly emerging touch epidemics have been Ebola and Mpox. Usually, touch infections occur between people who know one another or are caring for another professionally (including in hospitals). Children, family members and intimate partners are particularly likely to touch one another.

Since there has to be actual contact, contact tracing and isolation for the duration of the incubation period can therefore be highly effective in breaking the chain of transmission in touch diseases.

Where touch is needed (for example in hospital care) transmission can be prevented by ensuring that uninfected people do not touch infected people without a barrier method, such as aprons and gloves. In very high-mortality touch diseases such as Ebola or Marburg disease additional precautions may be needed, but these are the exception. Additional control strategies to prevent transmission of touch pathogens include hand hygiene to remove the organism from the hands between contacts with individuals or with the environment, surface disinfection and isolation procedures.

In healthcare settings, these control strategies are now considered as 'standard precautions' that guide infection control globally, especially in hospitals.

Vector-borne

Vector-borne transmission was conclusively demonstrated in the late 19th and early 20th centuries. Ronald Ross identified mosquitoes as malaria vectors in 1897, while Walter Reed's team confirmed *Aedes* mosquitoes transmitted yellow fever. Vectors such as mosquitoes, ticks and fleas mainly transmit pathogens during or after blood meals.

Vector-borne epidemic diseases, and in particular mosquito borne diseases, are extremely common globally and were historically important in the UK including malaria (eliminated from England around a century ago), typhus (lice) and plague (fleas). Plague, spread via fleas on black rats, was responsible for historical pandemics like the Black Death with massive mortality.[3]

Currently, we have no vector-borne diseases with significant epidemic potential in England but cannot assume that that will remain the case indefinitely. Around the world, the recent reemergence of Zika and ongoing epidemics of dengue and Chikungunya show that *Aedes* mosquitoes remain highly efficient vectors of disease and they are moving through Europe; *Aedes albopictus* has a high likelihood of becoming established in southern England over the next 2 decades, in part because of global warming (see chapter 7.1).

The UK already has tick borne diseases (for example, Lyme) in humans and midge borne diseases (for example, bluetongue) in farmed animals.

In vector-borne diseases for which we do not have a vaccine or other treatment, controlling the vectors is usually the principle aim to reduce the risk of an epidemic. Different vectors require different control measures depending on where they breed, live and come into contact with humans. Control strategies may focus on insecticide use (for example, pyrethroids),

environmental management, bed nets and public education. Integrated Vector Management (IVM) now emphasizes sustainability and community engagement.

Blood-to-blood

Although blood-borne transmission is almost always a secondary route for infections (Hepatitis C is an exception) it remains important to ensure that needles used for injection in one person are not reused on another and that the blood supply is secure from infection through the use of screening questions with those who are donating and testing donated blood products for potential pathogens. Many infections can be passed on blood-to-blood as a secondary route of transmission.

Conclusion

Given the regularity with which significant epidemics and occasionally pandemics emerge for which we do not have existing medical countermeasures such as drugs and vaccines, it is likely we will have to use control measures for epidemics based on the route of transmission many times during the professional lifetimes of current public health and medical practitioners.

Recognising transmission routes is central to designing effective interventions against epidemics. Each mode requires tailored strategies: isolation for contact-based diseases, masks and ventilation for respiratory threats, or vector control for mosquito-borne illnesses.

Historical successes such as cholera or malaria control campaigns demonstrate how knowledge of routes of transmission can guide effective global health policies.

References

1 Randall K., Ewing E. T., Marr L. C., Jimenez J. L. and Bourouiba L. How did we get here: what are droplets and aerosols and how far do they go? A historical perspective on the transmission of respiratory infectious diseases. Interface Focus. 2021;11: 1120210049 doi: 10.1098/rsfs.2021.0049

2 Petersen BW, Harms TJ, Reynolds MG, Harrison LH. Use of Vaccinia Virus Smallpox Vaccine in Laboratory and Health Care Personnel at Risk for Occupational Exposure to Orthopoxviruses — Recommendations of the Advisory Committee on Immunization Practices (ACIP), 2015. MMWR Morb Mortal Wkly Rep 2016;65:257–262. doi: 10.15585/mmwr.mm6510a2

3 World Health Organization. Plague. [Internet] 2022. [Accessed 9 September 2025]. Available from: https://www.who.int/news-room/fact-sheets/detail/plague

2.2 Imported infection and zoonosis

Catherine Houlihan – Consultant in Infection, Rare and Imported Pathogens Laboratory, Porton Down, Consultant Virologist, University College London Hospital

Clare Warrell – Consultant in Infection, Imported Fever Service, Porton Down, Tropical Medicine Consultant, Hospital for Tropical Diseases, London

David Lalloo – Vice Chancellor, Liverpool School of Tropical Medicine

Contributors: Janie Olver, Barry Atkinson, Laura Nabarro

Introduction

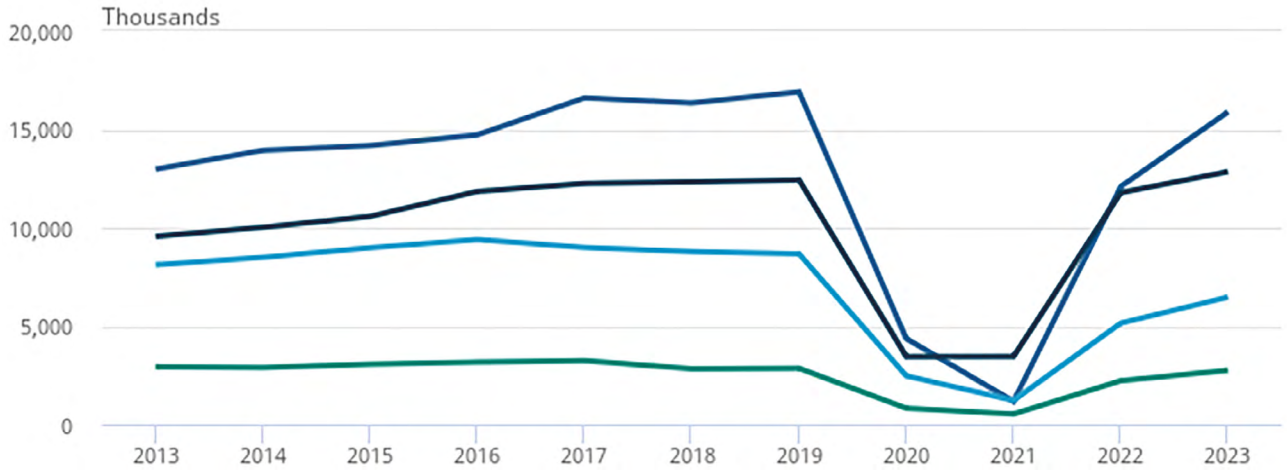
It is over 20 years since the Chief Medical Officer's report, *Getting ahead of the Curve*,[1] focused on the threat that infectious diseases posed to UK public health and highlighted the particular risk of emerging and imported infections. The last 20 years have demonstrated how prescient those warnings were. Increasing globalisation and travel, increasing economic disruption in many countries, changing patterns of migration, and climate change, have all played major roles in increasing the risk that the UK public faces from imported infections and zoonoses. There have been very clear demonstrations of the human and economic impact of such infections ranging from the West African Ebola outbreak in 2014 and Zika in 2016, to the devastation caused by the COVID-19 pandemic from 2020 onwards. Those risks only seem likely to increase; in particular, climate change is altering vector distributions globally, bringing previously 'tropical' conditions ever closer to home. The UK has long been a world leader in research, prevention, diagnosis and management of infectious diseases, across high-, middle- and low-income countries. This expertise and activity will be of even greater importance to UK public health security over the next 20 years.

The increasing threat

Several key factors will continue to influence the increasing number and range of imported infections. Traveller numbers are now almost back at the peak they reached prior to the pandemic, having increased 40% over the preceding 10 years, substantially increasing the risk of imported infection (Figure 1). Global trade augments the opportunities for importation of infections within products and livestock, particularly if animal health standards are poor or disease vectors are directly imported. 60% of emerging infections are zoonoses.[2] Population growth in many countries has meant encroachment on previously undeveloped environments, bringing people into closer contact with animals or insect vectors of disease and increasing the potential for infection of humans by new organisms or new variants of existing infectious agents such as SARS-CoV-2 or influenza. Population distribution is also changing to larger, overcrowded cities where high density living creates the ideal environment for rapid spread of existing or new infections. Economic instability or conflict is altering migration patterns into Europe, potentially changing the burden of imported infections. Finally, climate change has the potential to significantly alter the distribution of infectious diseases, particularly through

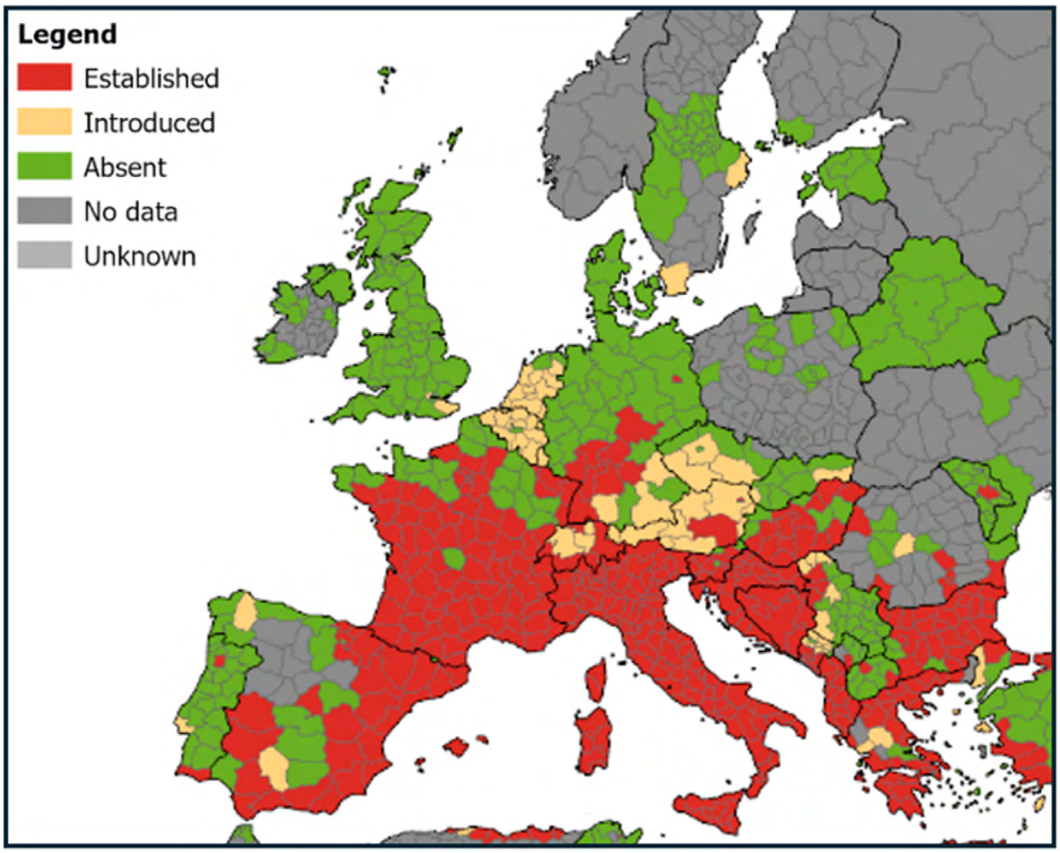
expanding vector distribution. The most striking example is the spread of *Aedes albopictus*, a vector of dengue and chikungunya, which over the last decade has become established in many parts of mainland Europe with the consequent risk of arbovirus transmission (Figure 2).[3] The distribution and behaviour of ticks is also changing.

Figure 1: Travel to the UK, 2013 to 2023[4]



Source: Image from Office for National Statistics (ONS) using International Passenger Survey 2023, Travel trends: 2023, 17 May 2024, is licensed under the Open Government Licence v3.0.

Figure 2: The expanded distribution of *Aedes albopictus* in Europe, May 2024[5]



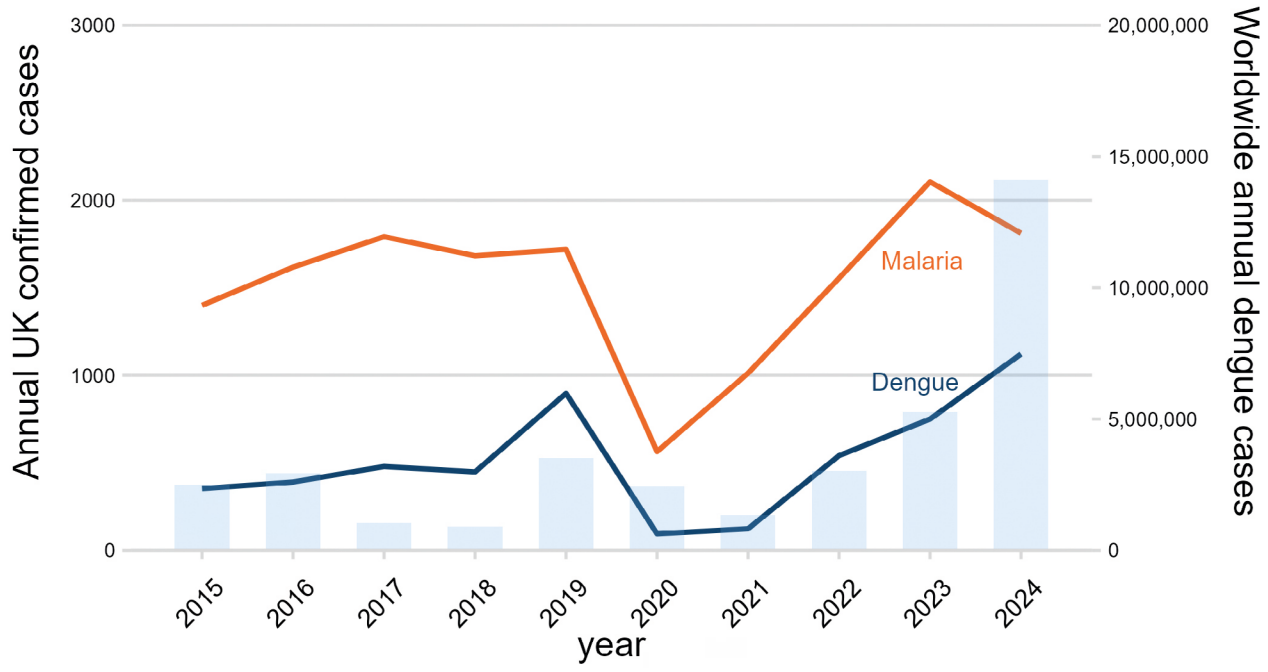
Source: © Eurographics 2025. Based upon the European Centre for Disease Prevention and Control (ECDC) / European Food Safety Authority (EFSA) map. Data collected by VectorNet project. Used with permission from Eurographics.

Imported infections in the UK

The last decade has seen an increased burden of imported infections to the UK through returning travellers, often in waves and sometimes causing onward transmission and/or significant public health disruption.

Imported cases of malaria (approximately 2,000 annually) have returned to levels last seen in the early part of this century, despite declining numbers of cases in endemic countries.[6] The highest number of imported enteric fever cases (645) since 1980 was seen in 2023 and dengue cases have increased over the past decade in line with increased global incidence (Figure 3). Similar introductions of dengue to France in returning travellers have resulted in local outbreaks and sustained chains of transmission, due to the establishment of *Aedes albopictus* (Figure 2). This species has been sporadically detected in England. The identification of viruses related to dengue, including West Nile and Usutu virus, in mosquitoes and birds in the UK, means there is potential for local establishment of transmission and consequent human neurological infection. No locally acquired human cases have been detected, but in around a third of cases of encephalitis in the UK the cause remains undiagnosed.[7]

Figure 3: Cases of malaria and dengue diagnosed in the UK, 2015 to 2024



Source: Created using annual UK confirmed dengue cases from the Rare and Imported Pathogens Laboratory (UK Health Security Agency), annual global dengue cases from the World Health Organisation Global dengue surveillance[8] and annual UK confirmed malaria case data from the Malaria Reference Laboratory and Public Health Scotland via UKHSA, Imported malaria in the UK: statistics[9]

Tick-Borne Encephalitis (TBE) virus also affects the central nervous system and has recently been identified as established in UK tick populations for the first time. The UKHSA Rare and Imported Pathogens Laboratory has confirmed 4 UK-acquired cases since 2019.[10]

Highly pathogenic avian influenza (HPAI) H5N1 has become a significant concern over the past 4 years. The virus is endemic in birds in the UK. Since late 2021, over 7 million UK domestic birds have been culled to control its spread and, as of March 2025, there have been 7 human detections of H5N1.[11] In the United States (US), the virus has infected dairy cattle across several states, demonstrating cross-species transmission and adaption, increasing the risk to humans. There have been 70 human cases and one death in the US.

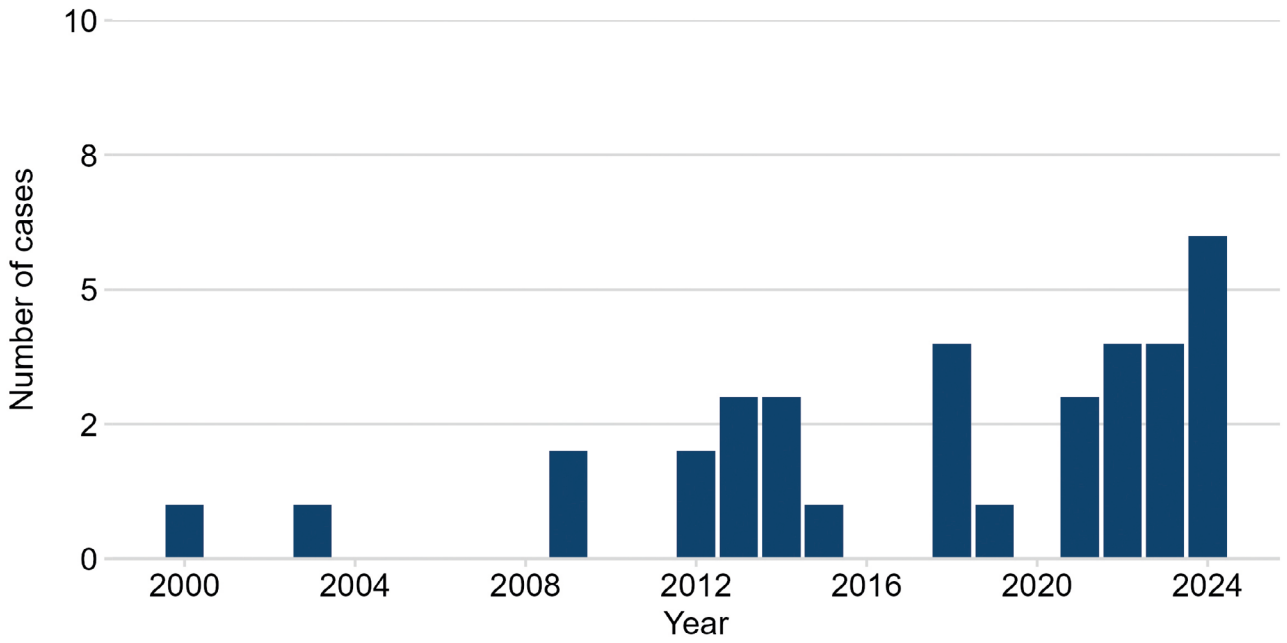
The UK was the first country to detect sustained human-to-human transmission of Mpox (formerly monkeypox) outside endemic areas, as the virus began spreading through sexual networks in 2022. Previously, cases in the UK had been limited to travellers returning from Central and West Africa.[12] In 2022, however, Mpox became primarily a sexually transmitted infection affecting gay, bisexual and men who have sex with men and was declared a Public Health Emergency of International Concern by the World Health Organisation. Prior to 2022, the UK had seen fewer than 15 cases, with little local transmission; since then, over 4,000 UK cases have been reported.

Outbreaks of viral haemorrhagic fevers (VHFs) in West and East Africa have increased in frequency over the past 2 decades. The 2014 to 2016 Ebola outbreak in West Africa, which resulted in over 28,000 cases and 13,000 deaths, directly affected the UK. More than 3,000 UK responders were deployed in a multi-agency response in West Africa that included NHS staff, the UK Armed Forces, UKHSA laboratory staff and equipment and medical teams from UK charities. The burden on public health and NHS authorities in the UK was considerable, despite only 3 patients being treated in the UK.

Diagnoses of high-consequence infectious diseases (HCIDs), defined as those with high mortality, limited treatment or vaccination options, and potential for community and healthcare transmission, have also steadily increased in the UK (Figure 4), requiring admission to contact or respiratory high-level isolation units.

In 2022, a single case of imported Lassa fever was diagnosed in the UK. The individual transmitted the infection to both their partner and unborn child, prompting a major public health response involving over 800 identified healthcare worker contacts, more than 200 of whom were considered "high risk".[13] Multiple UKHSA and NHS England teams were involved in the contact tracing effort. Such co-ordinated multiagency efforts have minimised onward transmission of high consequence imported infections to date. To improve preparedness for future incidents, simulation exercises have been conducted to enhance coordination and response capacity.

Figure 4: High Consequence Infectious Diseases cases managed in the UK, 2000 to 2024[14]



Source: Created using data from Rare and Imported Pathogens Laboratory, UKHSA and Atkinson B, et al J Med Microbiol. 2025[15]

UK capability and response

The UK has made significant and sustained contributions to global health over more than a century. From the discovery of penicillin by Alexander Fleming, to UK-led research on the first successful malaria vaccines and the eradication of smallpox, UK international research leadership supports health security and resilience across nations. It is imperative that the UK continues to invest in scientific innovation, both as a demonstration of its responsibility as a global citizen and to meet international health challenges. Ongoing investment will protect the UK population from emerging threats and will allow the development of a highly skilled specialist workforce that underpins our national health and biosecurity capabilities.

Surveillance

The importance of national and international surveillance of existing or emerging infections cannot be over-emphasised and requires international collaboration and cooperation to be most effective. Open data sharing is key for success. This surveillance should encompass humans and animals, as well as known and potential vectors. The growing number of zoonotic infections underscores the importance of integrated, cross-sectoral surveillance and rapid response across human, animal and environmental health.

The surveillance of ticks and deer in areas where the Tick-Borne Encephalitis (TBE) virus may be endemic is a good example of this integrated approach; targeted case identification and evidence-based prevention measures, including tick avoidance and consideration of TBE vaccination. Similarly integrated approaches to avian influenza surveillance detected the risk and prevented spread, with international data sharing being key.

The ability of public health services to respond to detected threats in an integrated approach is also critical, as illustrated by the Mpox outbreak. Despite increased transmission in Central Africa, the incidence in the UK has rapidly declined thanks to a coordinated strategic response led by UKHSA, the NHS and public health agencies across all 4 nations. The approach focused on reducing transmission through case identification, harm reduction, vaccination and disruption of transmission chains. Strengthening laboratory diagnostics and support services, including guidelines and helplines, also played a critical role in outbreak control.

Diagnostic capability

The relative rarity of many imported and zoonotic infections necessitates a highly specialised diagnostic capability. In the UK, this is concentrated in a limited number of specialised laboratories, primarily within UKHSA. Key facilities include the Rare and Imported Pathogens Laboratory (RIPL), which focuses on diagnosing imported pathogens and includes diagnostics for high-consequence pathogens, the Malaria Reference Laboratory (MRL) which offers malaria diagnosis and national surveillance, and the Respiratory Virus Unit, which handles respiratory viruses associated with zoonotic outbreaks. In addition to the MRL, parasitic infections are diagnosed either at the Clinical Diagnostic Parasitology Laboratory in Liverpool, or the Health Services Laboratory in London. Smaller single-pathogen laboratories such as the Brucella Reference Laboratory offer vital diagnostics but with limited resilience. In response to the increasing frequency of imported infections and emerging zoonotic threats, there is a pressing need to expand diagnostic capabilities across the country, reducing dependence on single laboratories and exploring expanded molecular diagnostic approaches.

RIPL is currently incorporating unbiased next-generation sequencing (metagenomics) into its diagnostic toolkit for febrile returned travellers with no clear diagnosis. This involves the detection and identification of any pathogen through RNA/DNA. This novel diagnostic is also being rolled out in NHS laboratories through NHS England's genomics initiative for use in critically ill respiratory patients on intensive care units, allowing for real-time pathogen detection. A national surveillance system (Mscape) has been developed to support collection and analysis of these metagenomics data from around the country, with the aim of identifying potential emerging infections. As zoonotic and imported infections continue to evolve and pose increasing risks, expanding and integrating diagnostic platforms, and supporting expansion of imported pathogen diagnosis will be critical in safeguarding public health.

Healthcare infrastructure

Training/workforce

A wide range of globally prevalent infectious diseases – parasites, viruses, fungi and bacteria – remain rare or non-endemic in the UK. This means most UK clinicians, including infection doctors, receive limited training or practical experience in their management. Similarly, many standard microbiology labs will only encounter such infections rarely. To ensure national preparedness to prevent, contain and manage the increasing number of imported infections, national and international disease surveillance must be linked with the maintenance of a

small highly trained cadre of tropical disease experts, specialist isolation and treatment facilities, and advanced diagnostic labs. Such experts should include clinicians, parasitologists and laboratory scientists.

Currently, health professionals, including doctors, nurses, researchers and overseas volunteers with experience of working in tropical regions through non-governmental organisations, mission hospitals or academic programmes, make vital contributions to the national pool of clinical expertise. Augmenting this with a small specialist core workforce who have undergone structured tropical medicine training in areas highly endemic for imported pathogens is important to maintain the necessary expertise to address emerging global health threats and to safeguard national health security.

These clinicians can support the development of robust pathways for travel relevant investigations, outbreak awareness in front line services (primary care and emergency departments) and support the management of complex imported infections seen by other infection services. The UK Imported Fever Service 24/7 has been highly successful in providing such clinical and diagnostic support for clinicians.

Facilities

The UK maintains a tiered national infrastructure for the safe management of imported and emerging infectious diseases. The High-Level Isolation Units (HLIUs), based in London and Newcastle, provide secure, negative-pressure environments for the treatment of confirmed or suspected contact HCIDs. There are a further 7 hospitals across England with capacity to manage airborne HCID patients. These units are operated by trained staff with dedicated infection prevention and control protocols and national coordination with UKHSA.

Specialist Regional Infectious Diseases Units (SRIDUs), located in major NHS hospitals across the UK, provide hub and spoke support to local hospitals. These units offer assessment and management of patients with suspected imported, tropical or complex infections. While they do not offer the same level of containment as HLIUs, they provide side-room isolation and essential expertise, bridging frontline care with national systems like the Imported Fever Service.

Diagnostic support for these facilities is offered by the specialist laboratories above, which are additionally supported by UKHSA Containment Level 4 laboratories, based at Porton Down and Colindale. These high-containment laboratories enable the diagnosis and study of the most dangerous pathogens, including viral haemorrhagic fevers, under maximum biosafety conditions. Together, this infrastructure provides the foundation for the UK to safely diagnose, contain and manage imported infectious disease threats.

Research

The UK is a world leader in infectious diseases research and has made a major contribution to reducing the burden and improving the management of many imported and zoonotic diseases. The importance and value of that expertise was most obvious during the COVID-19 pandemic when previous investment in vaccine development led to the rapid production of a COVID-19

vaccine and the UK RECOVERY trial led to the rapid evaluation of lifesaving interventions. The UK has been highly prominent in research efforts to develop and evaluate vaccines and treatments for Ebola since the 2014 West African epidemic. There are many other examples where the substantial portfolio of UK funded research, including that focused in endemic settings, has enabled improved control, prevention and treatment of infectious diseases that have the potential to otherwise threaten UK public health. Health Protection Research Units (HPRU) are partnerships between academic institutions and public health. Several exist, but the Emerging Infections and Zoonoses HPRU aims to contribute knowledge to pandemic preparedness and response to current zoonotic threats. Ongoing investment in such research not only helps to reduce disease burdens in disease endemic countries but also helps develop infectious disease expertise and benefits the UK economy. Maintaining this capacity and supporting access to products in endemic countries is critical to the UK's future global health security.

References

1 Donaldson L. Getting Ahead of the Curve. A strategy for combating infectious diseases (including other aspects of health protection). [Internet] 2002. Available from: https://webarchive.nationalarchives.gov.uk/ukgwa/20120504020310/http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH_4073288

2 Jones KE, Patel NG, Levy MA et al. Global trends in emerging infectious diseases. Nature. 2008;451:990-993 doi: 10.1038/nature06536

3 European Centre for Disease Prevention and Control and European Food Safety Authority. Mosquito maps. [Internet]. 2024. Available from: https://ecdc.europa.eu/en/disease-vectors/surveillance-and-disease-data/mosquito-maps

4 Office for National Statistics. Travel Trends: 2023. [Internet]. 2024. Available from: https://www.ons.gov.uk/peoplepopulationandcommunity/leisureandtourism/articles/traveltrends/2023

5 European Centre for Disease Prevention and Control and European Food Safety Authority. Mosquito maps. [Internet]. 2024. Available from: https://ecdc.europa.eu/en/disease-vectors/surveillance-and-disease-data/mosquito-maps

6 UK Health Security Agency. *Malaria imported into the UK: 2023*. [Internet] 2024. [Accessed 26 April 2025]. Available from: https://www.gov.uk/government/publications/malaria-in-the-uk-annual-report/malaria-imported-into-the-uk-2023

7 Bharucha T, Nashef L, Moran N, Watkins S, Brown D, Zuckerman M. A 9-month retrospective evaluation of the aetiology and management of patients presenting with encephalitis/meningoencephalitis at a South London hospital. Epidemiol Infect. 2020 5;148:e23 doi: 10.1017/S0950268820000047

8 World Health Organisation. Global Dengue Surveillance. [Internet]. 2025. [Accessed 26 April 2025]. Available from: https://worldhealthorg.shinyapps.io/dengue_global/

9 UK Health Security Agency. *Malaria imported into the UK: 2023*. [Internet] 2024. [Accessed 26 April 2025]. Available from: https://www.gov.uk/government/publications/malaria-in-the-uk-annual-report/malaria-imported-into-the-uk-2023

10 UK Health Security Agency. *Infectious diseases impacting England: 2025 report* (Ref: GOV-18375). [Internet] 2025. Available from: https://www.gov.uk/government/publications/infectious-diseases-impacting-england-2025-report

11 UK Health Security Agency. HAIRS risk assessment: influenza of avian origin in lactating livestock. [Internet] 2025. Available from: https://www.gov.uk/government/publications/hairs-risk-assessment-influenza-of-avian-origin-in-lactating-livestock/hairs-risk-assessment-influenza-of-avian-origin-in-lactating-livestock

12 Adler H, Gould S, Hine P et al. Clinical features and management of human monkeypox: a retrospective observational study in the UK. Lancet Infect Dis. 2022;8:1153-1162 doi: 10.1016/S1473-3099(22)00228-6

13 Atkinson B, Beadsworth M, Dunning J. Cases of high-consequence infectious diseases identified in the UK, 1962-2023. *J Med Microbiol*. 2025;74(3):001982 doi: 10.1099/jmm.0.001982

14 Atkinson B, Beadsworth M, Dunning J. Cases of high-consequence infectious diseases identified in the UK, 1962-2023. *J Med Microbiol*. 2025;74(3):001982 doi: 10.1099/jmm.0.001982

15 Atkinson B, Beadsworth M, Dunning J. Cases of high-consequence infectious diseases identified in the UK, 1962-2023. *J Med Microbiol*. 2025;74(3):001982 doi: 10.1099/jmm.0.001982

3 Infections across the life course

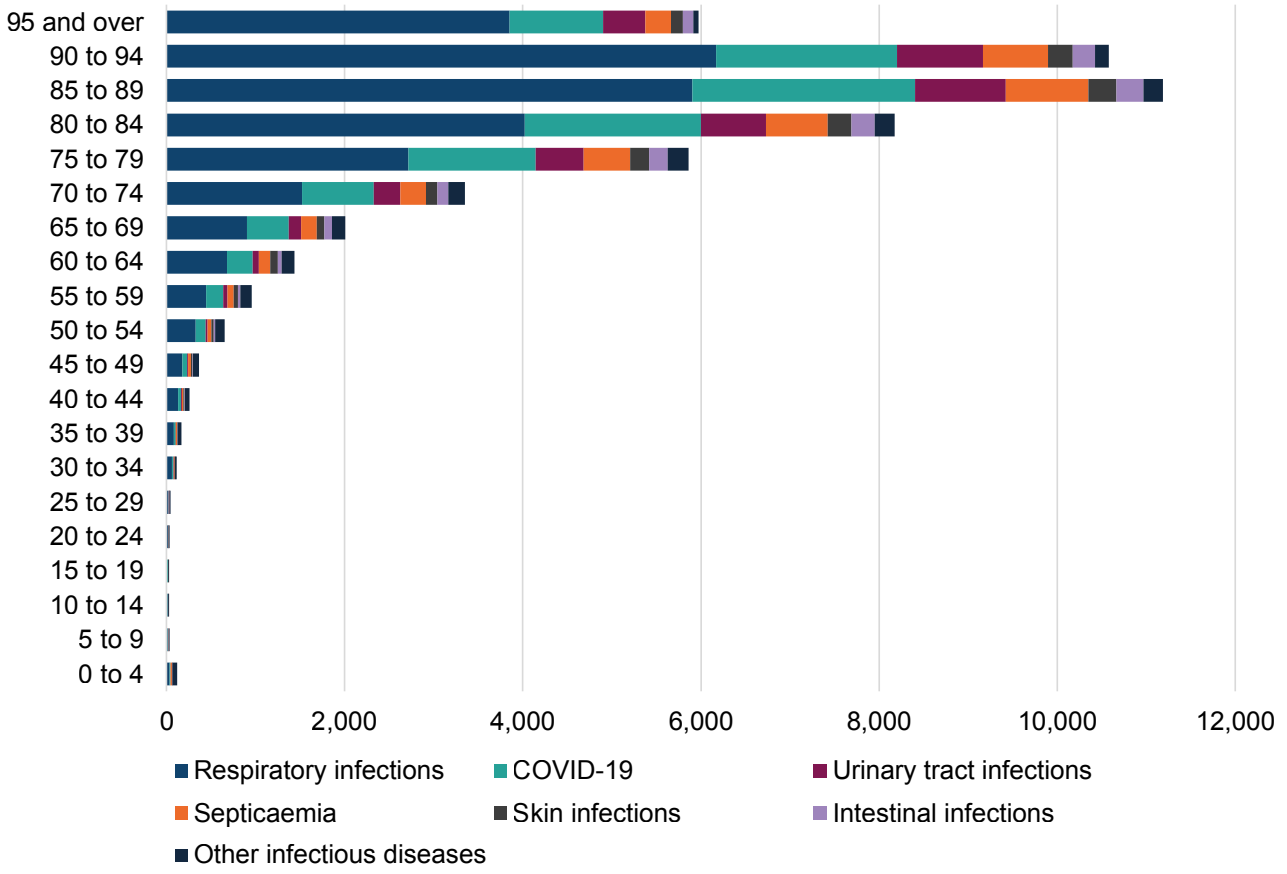
3.1 Infections in older adults

Nileema Patel – Specialty Registrar in Public Health Medicine
Christopher J M Whitty – Chief Medical Officer for England

Introduction

Older adults' overall health and quality of life are on average more affected by infection than any age group except young children, and in terms of mortality the great majority of people who die of infections in England are in older age (Figure 1). As the proportion of older adults in England continues to grow, infections in this age group will increasingly drive avoidable ill health, poor quality of life and death.

Figure 1: Number of deaths from infectious diseases by age group, England, 2023



Source: Office for Health Improvement and Disparities, based on mortality data from the Office for National Statistics (ONS) via Nomis for age groups up to 85 to 89 years. Unpublished ONS data used for the oldest 2 age groups – see data note at end of chapter for counts.

Common respiratory, urinary tract and skin infections tend to affect older adults more severely with increased likelihood of hospital admission and mortality, driven partly by higher prevalence of co-morbidities and in some cases frailty, and in part by impaired immune responses as we age (immunosenescence).

Older people often present with atypical and non-specific symptoms of infection. This also means that they may present to healthcare later. The usual markers of infection such as white cells may also not be as reliable in this age group, and common infections can lead to sepsis more readily in older people from which they also have increased risk of death compared to other age groups.[1]

Infections, episodic and recurrent, can also significantly impair quality of life in older age. The extent to which other major health problems such as acute cardiovascular outcomes including stroke and myocardial infarction (heart attack) in the weeks following an infective episode can be caused by acute infections is often under-appreciated even by doctors.

Certain surgical interventions where infections can lead to poor outcomes are more commonly performed in older people such as hip or heart valve replacements which also make this population more susceptible to complex infection risk.

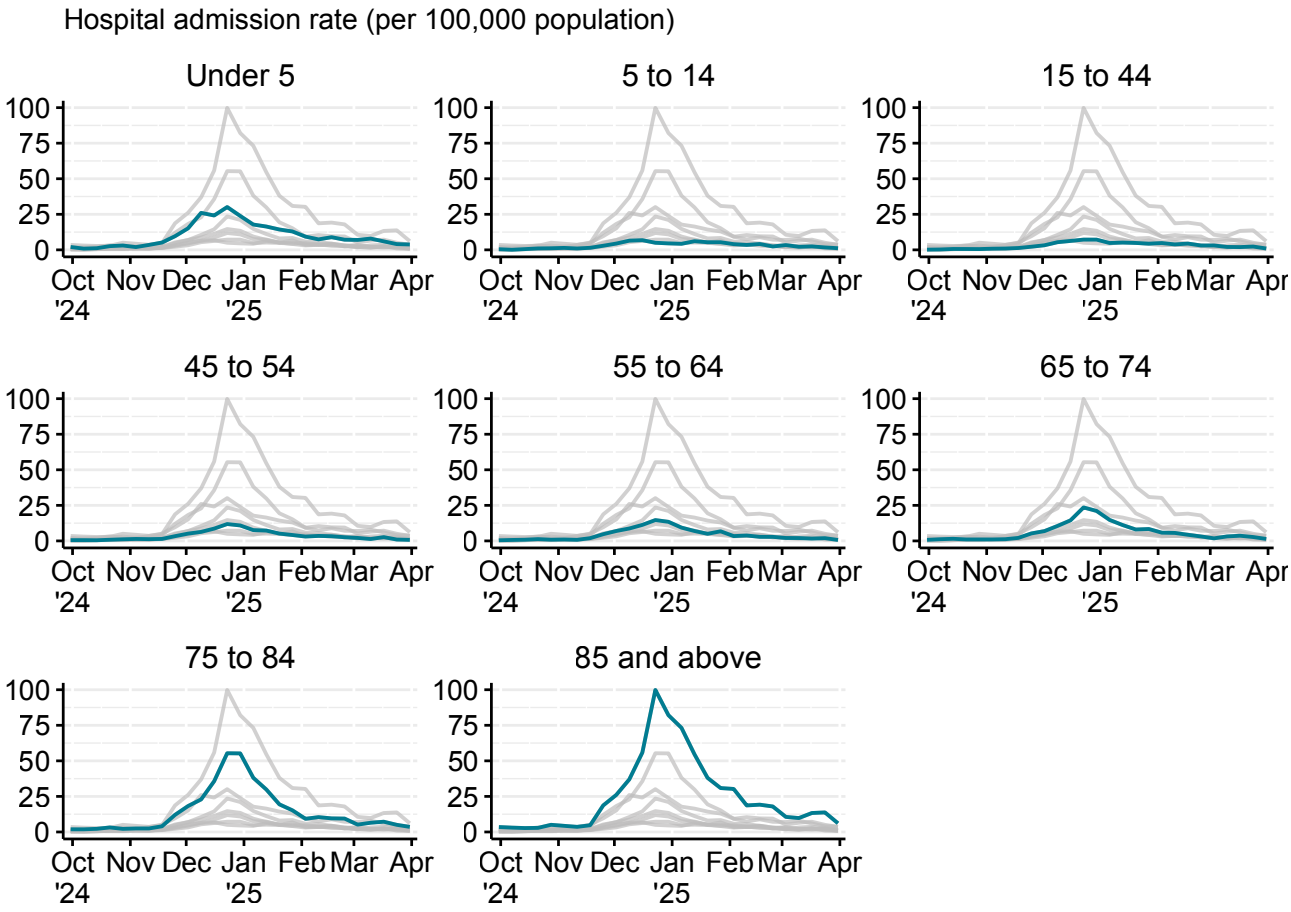
Despite having a large burden of serious disease, infections in older people are often less well researched and less systematically managed than in younger adults.

Mortality and morbidity of infection in older people

The risk of mortality once an infection is acquired is higher in the elderly for many infections, from viral respiratory infections such as influenza or COVID-19, through bacterial infections such as those of the urinary tract or pneumonia, and even parasitic infections such as imported malaria in the UK population.[2,3] Outside the neonatal period and early childhood older age is the biggest predictor of poor outcomes for many common infections.

Older adults are at significantly increased risk of severe disease from respiratory infections, as demonstrated by higher rates of admission to hospital for influenza last winter in 75- to 84-year-olds and people aged 85 and older compared to other age groups (Figure 2).

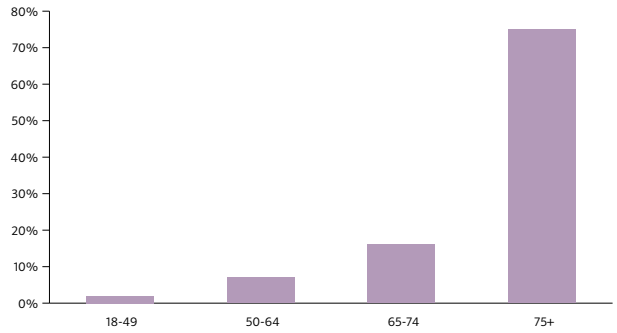
Figure 2: Weekly hospital admission rate by age group for new influenza cases, reported through SARI Watch sentinel surveillance, England, winter 2024 to 2025



Source: UKHSA, Influenza in the UK, annual epidemiological report: winter 2024 to 2025, May 2025, is licensed under the Open Government Licence v3.0.

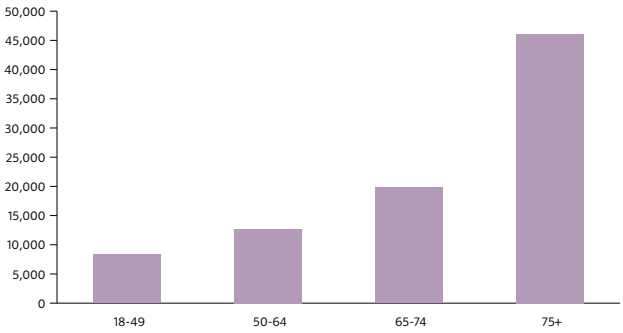
Estimates also show that older adults account for a significantly higher proportion of mortality and morbidity attributable to respiratory syncytial virus (RSV) than younger adults despite incident numbers of RSV infection in the UK being higher in younger adult age groups (Figures 3 and 4).[4] The recently introduced RSV vaccination programme for adults will address some of the burden of ill health from RSV seen in older adults (see below).

Figure 3: Estimated proportion of deaths attributable to RSV (%) by age group, UK[5]



Source: Data from Kevin Herbert, Mark Cabling, Stephen Morris, Fifi Olumogba, Stephanie Stockwell, Anna Louise Todsen and Jon Sussex, The burden of respiratory syncytial virus in adults in the UK. RAND Corporation, 2024.

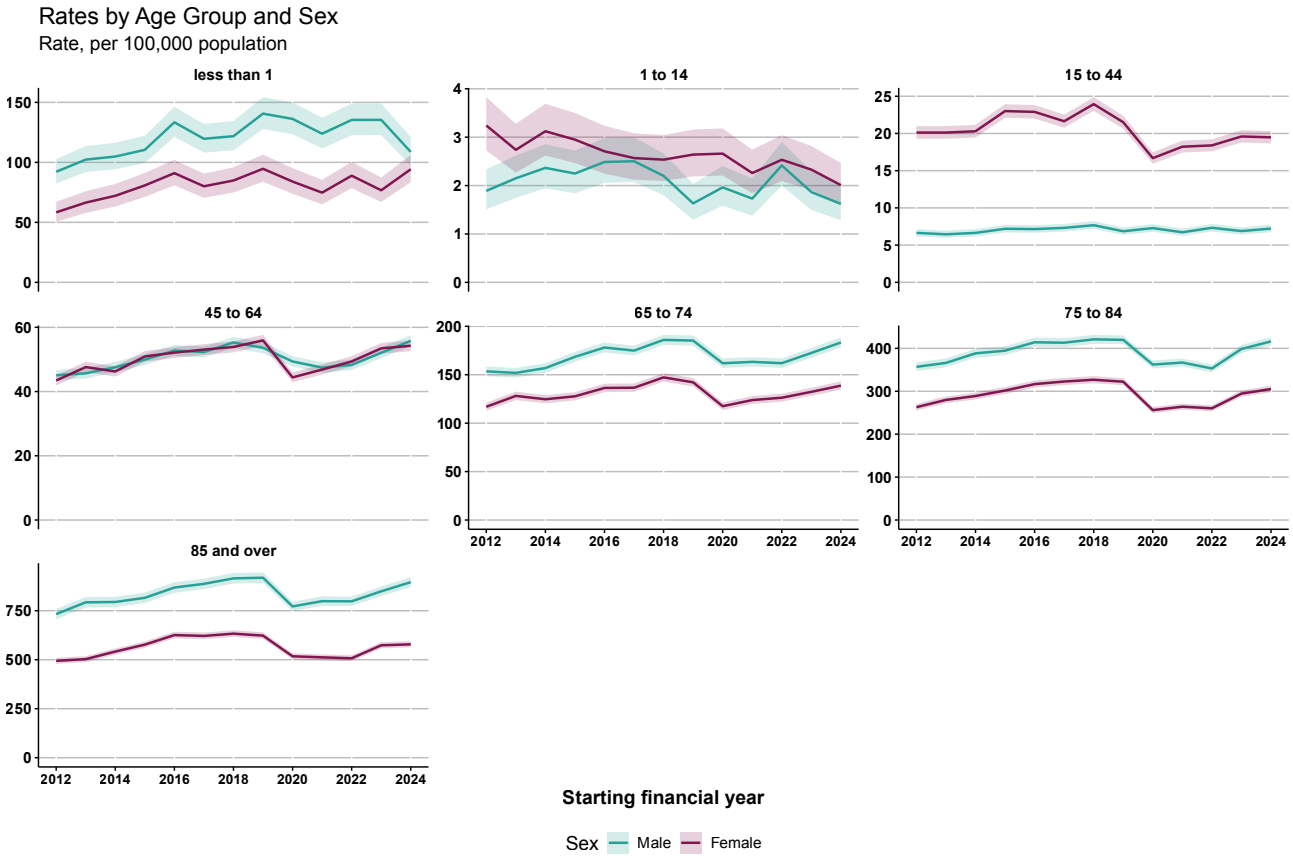
Figure 4: Estimated quality adjusted life years (QALYs) lost to RSV by age group, UK[6]



Source: Data from Kevin Herbert, Mark Cabling, Stephen Morris, Fifi Olumogba, Stephanie Stockwell, Anna Louise Todsen, and Jon Sussex, The burden of respiratory syncytial virus in adults in the UK. RAND Corporation, 2024.

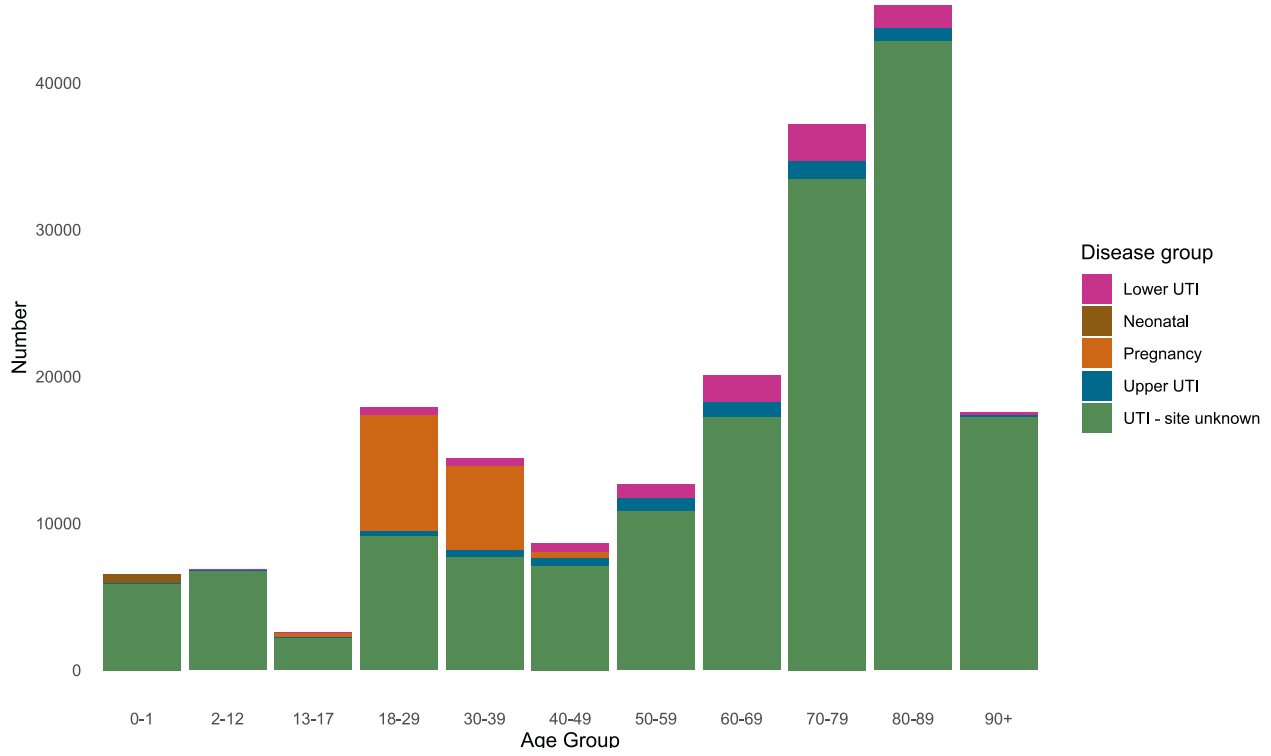
Rates of *E. coli* bacteraemia are significantly higher in older age groups (Figure 5). *E. coli* is a common cause of urinary tract infections (UTIs) for which substantially higher numbers of hospital admissions are seen in older adults, especially women (Figure 6).

Figure 5: Trends in age group and sex rates of E. coli bacteraemia, England, by financial year: April 2012 to March 2025



Source: Image from UKHSA, Annual epidemiological commentary: Gram-negative, MRSA, MSSA bacteraemia and C. difficile infections, up to and including financial year 2024 to 2025, updated 25 September 2025, is licensed under the Open Government Licence v3.0.

Figure 6: UTI admission by age and type, England, financial year 2023 to 2024

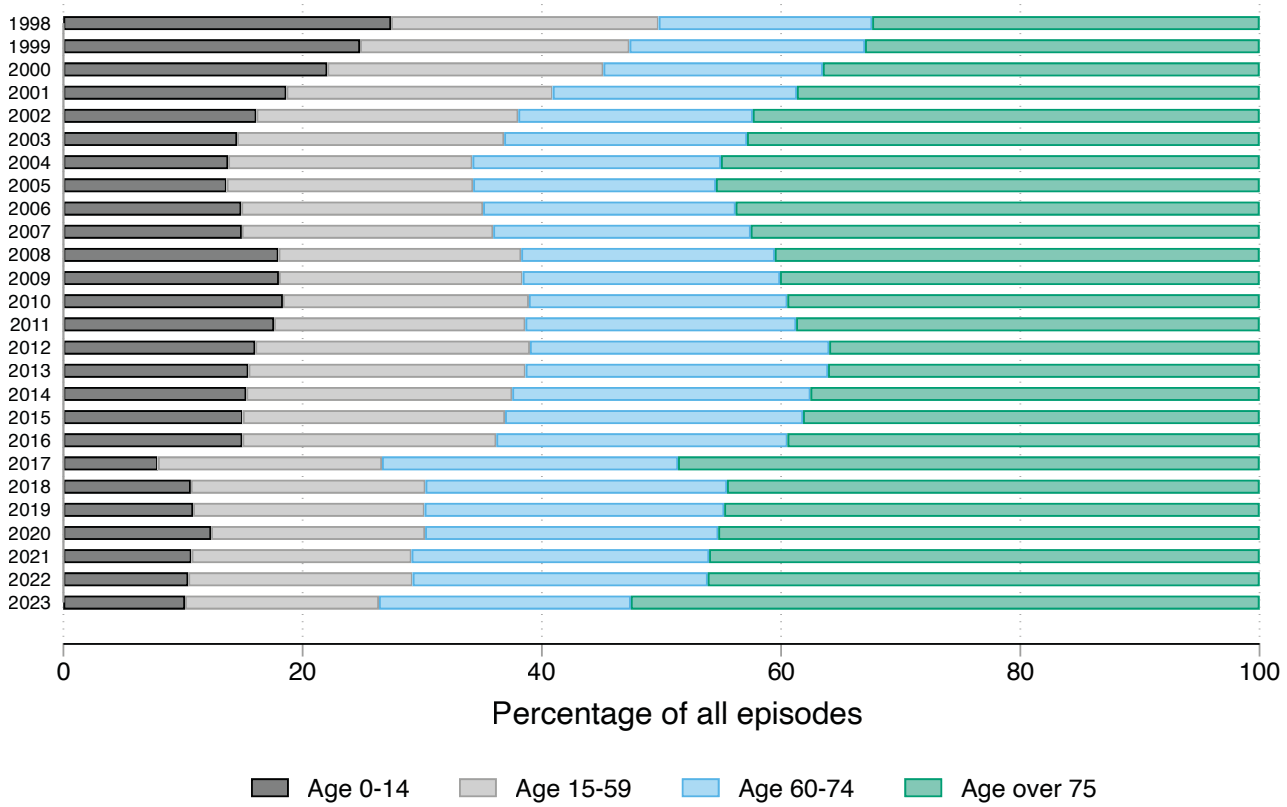


Source: UKHSA, Understanding the burden of UTI hospitalisations in England, July 2025, is available under the Open Government Licence v3.0.

One large cohort study of primary care consultations found that the risk of sepsis was highest for UTIs, followed by skin and then respiratory infections, across all ages.[7] Given these infections are common in older adults who are already at higher risk of sepsis and associated mortality, and this age group is growing in proportion in England, the risk of sepsis in older people should not be underestimated. A recent study showed the proportion of sepsis admissions in people aged 75 and over has increased in recent decades (Figure 7).

Management guidelines for sepsis are often based on research primarily conducted on younger age groups in specialised settings such as critical care, meaning their application to older adults who are often managed on general wards requires adaptation based on clinical judgement rather than data or trials.[8]

Figure 7: Proportion of patients coded as admitted with sepsis by age, 1998 to 2023, England[9]



Source: Image by Allen, V B, Bechman, K, Russell M D, et al., Rising rates of sepsis in England: an ecological study, 2025, Infection is licensed under a Creative Commons Attribution 4.0 International License.

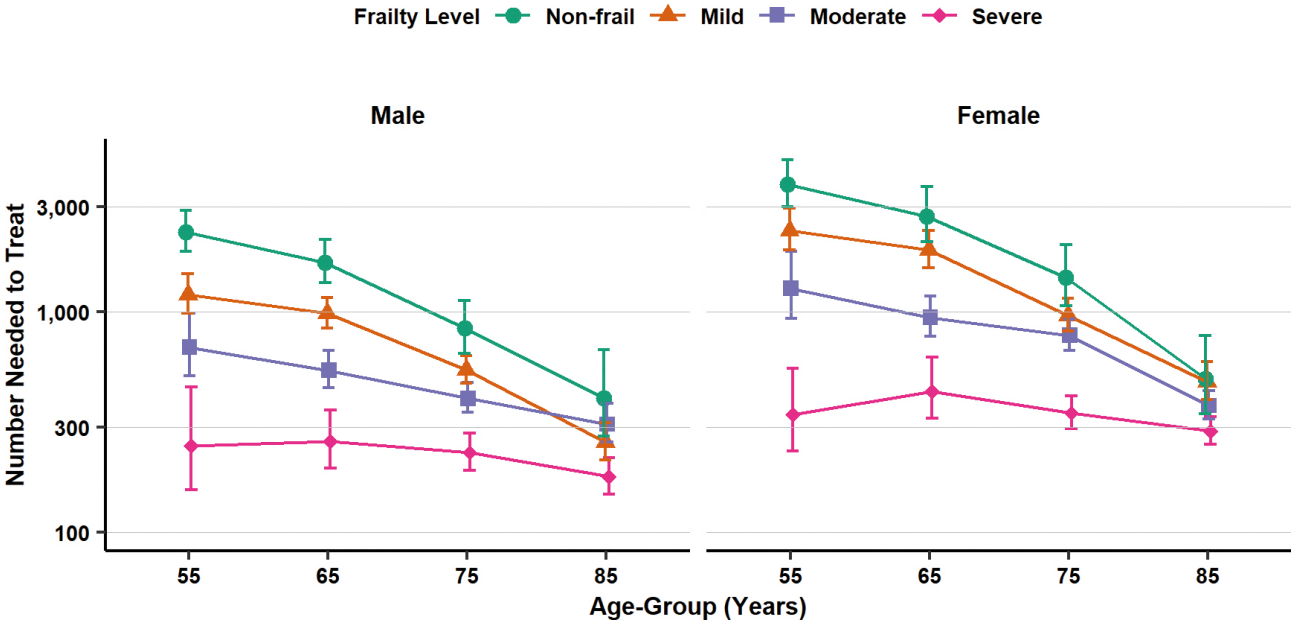
Many infections in older people are managed in the community, but with significant impact on daily functioning for older people. Even less severe infections may have social and mental health implications beyond the direct mortality risk, especially for recurrent infections. For example, cellulitis is a common skin infection usually affecting the legs that can take a protracted period of time to treat.[10,11] During this time, older people are likely to decondition from reduced mobility and may require frequent contact with healthcare services for dressing and antibiotics which can interfere with their physical, social and mental health. Pain from shingles, a skin condition caused by viral infection from varicella zoster that is more common in older people, is an example of an infection which can also limit functional activity such as washing and dressing. In some cases, this pain remains chronic which can go on to affect mental health.

Admission to hospital for infection can cause a significant decline in conditioning and function in older people as they are less mobile, in an unfamiliar environment and often have poorer nutrition which can be a particular challenge during long-term stays both for their recovery from the infection and their longer-term resilience.[12]

Responding to infection in older people

A low threshold for suspecting and treating infection in older people is warranted given they are at higher risk of severe consequences of infection. This includes recognising that the balance point of benefit between antimicrobial treatment and stewardship is more likely to weigh in favour of treatment in older people where there is a higher degree of clinical uncertainty and a significantly greater probability of a poor outcome. This is supported by evidence to show the number of antibiotic prescriptions needed to prevent a case of sepsis is lower in older age groups (Figure 8).[13] Prompt sampling can support antimicrobial stewardship in ongoing care which remains an important priority.

Figure 8: Median estimates of the number of antibiotic prescriptions required to prevent one sepsis event following infection consultations in primary care by frailty level, gender and age group[14]



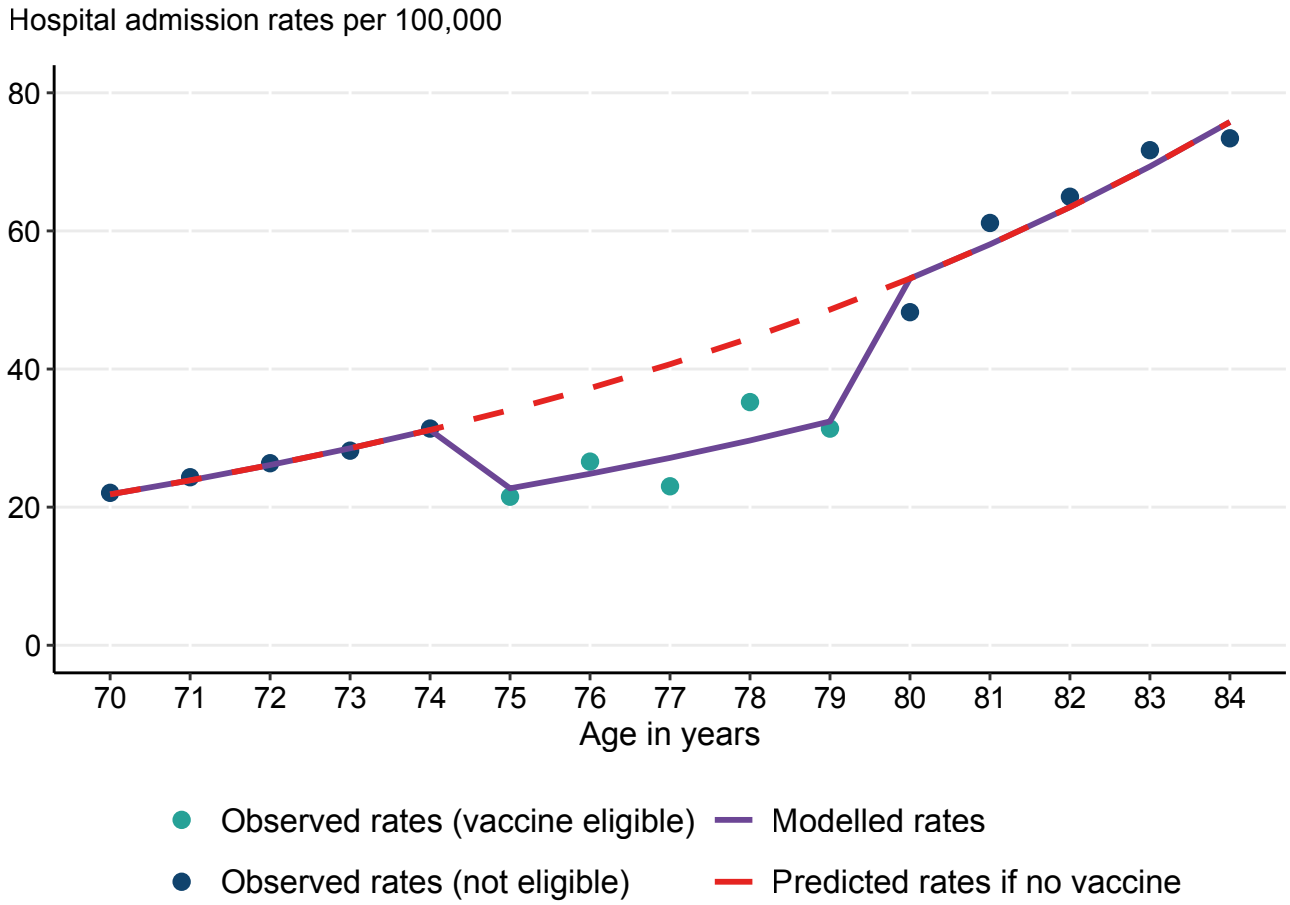
Source: Image by Gulliford M C, Charlton J, Winter J R, et al., Probability of sepsis after infection consultations in primary care in the United Kingdom in 2002–2017: Population-based cohort study and decision analytic model, 2020, PLoS Med, is licensed under Creative Commons Attribution License.

Vaccination

Vaccination in older people has historically been relatively neglected as an opportunity to improve health in older age relative to vaccination in childhood, despite an increasing body of evidence to show it can be a worthwhile strategy. The remarkable effectiveness of the COVID-19 vaccine in older people is a demonstration that despite waning immunity in older life most people still have a capacity to mount an effective immune response when vaccinated against important diseases of later life. Vaccines against influenza, RSV, COVID-19, pneumococcus and shingles have all been shown to be effective.[15]

The RSV vaccination programme is the most recent with early evidence suggesting over 70% vaccine effectiveness.[16] Observed and modelled RSV-associated hospital admission rates in the vaccine eligible group were lower than predicted rates for this group in the absence of a vaccine across winter 2024 to 2025 (Figure 9).

Figure 9: Observed, modelled and predicted RSV-associated hospital admission rates by age, England



Source: Image by Mensah AA, Whitaker H, Andrews NJ, Watson CH. In Cobbold A and colleagues, Surveillance of respiratory syncytial virus: winter 2024 to 2025, UKHSA is licensed under the Open Government Licence v3.0.

Prevention

Some older people can be at greater risk of exposure to respiratory, touch and faeco-oral infectious disease from higher levels of close contact with others who are in a high-risk group or environment such as care homes, hospitals and via domiciliary care. When older people are living at home they will still come into close contact with family members and friends including children and grandchildren who mix in wider environments like the workplace, school and nursery. This highlights the importance of vaccination, not only of older people as above, but also other eligible groups they come into contact with including health and social care staff, to promote indirect protection. For example, vaccination against pneumococcal and influenza infections in children reduces the risk to older adults in addition to protecting the child.

Basic infection prevention and control (IPC) measures such as hand washing and regular cleaning can reduce spread, as the rapid falls in rates of MRSA (touch) and *C. difficile* (faeco-oral) infections in English hospitals when basic infection control measures were enforced show. This and more rigorous IPC measures are especially important in care homes where the majority of residents are older and whose reason for being there is often a risk factor for severe outcomes of infection itself.[17] Some residents may also have individual risk factors related to their care that increase the risk of infection such as the presence of an in-dwelling urinary catheter which increases the risk of UTI. Avoiding unnecessary urinary and intravenous catheterisation remain key interventions to reduce significant infections in older people.

Infection as a risk factor for cardiovascular disease

Stroke

It has been recognised for many years that some chronic infections, such as tertiary syphilis, increase the risk of stroke. Rheumatic fever following streptococcal infection, with subsequent lifelong mitral valve stenosis in the heart, was once one of the major causes of stroke in the UK and still is important in some countries.

There is however now clear evidence from epidemiological, clinical and experimental studies that there is a significantly increased risk of stroke following many acute bacterial and viral infections, generally in older people.[18] Studies have examined bacteraemia (bacteria in the blood), bacterial pneumonia and UTI and in all there is a significantly increased risk, with more severe infections requiring hospitalisation leading to greater and more prolonged risk than milder infections. This risk is most substantial in the first two weeks after infection, with odds ratios for increased risk after severe infections sometimes over 20, but it extends out to at least 90 days and in some studies out to a year with a gradually diminishing risk. Viral infections which have been demonstrated to increase the risk of subsequent stroke include HIV, herpes zoster, influenza and COVID-19. It is likely more infections will be found to increase the risk. The mechanisms by which this increased risk occurs are not fully understood and will vary by infection. Inflammation and a pro-thrombotic (increased clotting) tendency are likely to play a part, but the fact of the association is now certain.

We do not yet have direct evidence that interventions that prevent infection, or reduce its severity, reduce the risk of stroke at a population level, as suitably powered and designed studies have not been conducted, but it would be very surprising if they did not, although the size of the effect cannot yet be determined. As more severe infections (for example those requiring ICU care) are where this has been studied and are more strongly associated with subsequent cardiovascular events, reducing the progression of infection may play an important role in reducing subsequent risk of stroke and other cardiovascular disease.

Stroke also increases the risk of subsequent infections, especially pneumonia and UTI, so the interaction between infection and stroke is a bidirectional one.

It is not yet clear whether specific interventions after an acute infection, such as taking aspirin to reduce platelet activity, would reduce the risk of stroke in higher risk patients including older people or those with pre-existing cardiovascular risks. It is however important to optimise cardiovascular risk factors in elderly patients who have had an infection as a matter of good general medicine. The increased risk of stroke following infection is probably under-appreciated even by many physicians and general practitioners.

Heart disease

There is now reasonable evidence that some common acute infections, including bacterial infections such as pneumonia,[19] and viral infections including influenza are subsequently associated with an increased risk of myocardial infarction.[20] The risk is highest in the first weeks after infection. Since myocardial infarction is much more common in older people, the absolute risk increase is largely in this age group. There are also infections which lead to poor cardiovascular outcomes including valvular heart disease (rheumatic fever, endocarditis) and pericardial constriction (tuberculosis).

Some infections can affect people in any age group, but cardiovascular outcomes may be more severe in older people. The association between some acute viral infections and myocarditis (inflammation of the heart muscle) and pericarditis (inflammation of the pericardial sac around the heart) is well known, and can occur in younger age groups. COVID-19 is the most recent infection where this association has been demonstrated.[21,22]

There is mounting, but not yet conclusive, evidence that vaccinating against common infections of the elderly reduces subsequent cardiovascular risk.[23]

Infection and delirium and dementia in older patients

Delirium

Delirium is an acute change in cognition, often manifesting as altered behaviour and sometimes level of consciousness. Patients who have relatively normal mental capacity normally can become very confused, aggressive or behave strangely. Delirium can be very concerning for patients and their families.

Infections are one of the most common triggers for delirium in older patients. Generally the infection triggering delirium is not in or around the brain (meningitis, encephalitis) but rather a generalised infection of another organ such as UTI or pneumonia, or sepsis.[24] Most commonly after the infection resolves on treatment the delirium also resolves with people returning to or near to their pre-infection state. There are probably a range of causes of delirium triggered by infection so it should not be treated as a single disease, but rather a syndrome.

There is a clear association between delirium and subsequent (in the next few years) dementia, although many people who develop delirium do not go on to develop dementia. The extent to which delirium and the infection which triggers it accelerate the path to dementia, if at all, is

not yet clear. In some people delirium probably represents an acute change in the context of a brain with early dementia which is not yet apparent, and may not be for some years.

Infection and dementia

In the UK in 2025 the great majority of dementia is caused by Alzheimer's disease, Lewy body dementia and vascular dementia. Historically however infections caused a lot of dementia, including in young people. Syphilis was a major cause of dementia a century ago in the UK, and advanced HIV/AIDS became a significant cause of dementia in young people before we had highly active antiretroviral treatment (HAART). The UK was the place of origin of new variant CJD, a specific form of rapid and fatal dementia caused by prions from cattle with bovine spongiform encephalopathy (BSE). In countries with tropical climates there are other infectious causes of dementia, such as African sleeping sickness passed on by tsetse flies, once very common but now fortunately rare and usually treatable.

These causes of dementia caused by infection are now uncommon mainly due to effective prevention, treatment (syphilis, HIV) and removal of risks from the food chain (BSE), although infections should still be considered in younger people with dementia.

The role of common infections in triggering or accelerating Alzheimer's and Lewy body dementia remains unclear. There is certainly an association between dementia and prior severe infections including pneumonia, urinary tract infection and sepsis and dementia.[25] Whether this is causal, or solely because people living with early dementia are more prone to many infections (causality in the other direction), is not yet settled. Several specific infections have been considered as possibly causal – for example recent studies imply *Chlamydia pneumoniae*, a cause of atypical pneumonia, may be associated with dementia, although this remains controversial.[26] There is also plausible data suggesting a role for herpes viruses such as *Herpes simplex* and CMV in some dementia.[27] *H. pylori* has been associated with dementia[28] and there is some weak evidence that *H. pylori* treatment reduces the risk.

It is also logically likely that since infections increase the risk of vascular events, including stroke, they may accelerate vascular or multi-infarct dementia.

Those with dementia are also prone to an increased risk of repeated infections, some of which are preventable and most of which are treatable which can significantly reduce their quality of life.

Research and infections in the elderly

Given the scale of the burden infections place on many older people, including on their quality of life, there has been relatively a much smaller interest shown in their prevention and treatment than in children and younger adults. Immune senescence, where our immune systems get less effective with age underlies much of the increased risk.[29] As a result there has often been an unspoken assumption that vaccines for the elderly are likely to be relatively ineffective. Recent successful vaccines against pneumococcal infection, COVID-19,[30] shingles and RSV[31] in the elderly show that it is possible to prevent or significantly reduce the effect of

varied infections by vaccination in older people. Further extending protection from infection to older people could have a substantial effect on mortality and quality of life, and should be seen as a major research priority in our view.

Given the scale of dementia, stroke and heart disease, their serious and sometimes devastating effects, and the fact that we have repeatedly shown medical science can prevent or treat infections including known infectious cases of dementia, if even a small proportion of dementia and cardiovascular cases can be stopped or slowed down by anti-infective measures this would be a big win. The evidence of association is now strong enough that a move to testing the effects on cardiovascular disease and dementia by prevention of infection at scale is justified. Research to test which if any methods of reducing infections alone or in combination can reduce dementia and cardiovascular disease should be examined seriously.

References

1 Goodacre S, Fuller G, Conroy S, Hendrikse C. Diagnosis and management of sepsis in the older adult. BMJ. 2023;382:e075585 doi:10.1136/bmj-2023-075585

2 Checkley A M, Smith A, Smith V et al. Risk factors for mortality from imported falciparum malaria in the United Kingdom over 20 years: an observational study. BMJ. 2012;344:e2116 doi:10.1136/bmj.e2116

3 Cromer D, Van Hoek AJ, Jit M, Edmunds WJ, Fleming D, Miller E. The burden of influenza in England by age and clinical risk group: a statistical analysis to inform vaccine policy. J Infect. 2014;68(4):363-71. doi: 10.1016/j.jinf.2013.11.013

4 Herbert, Kevin, Mark Cabling, Stephen Morris et al. The burden of respiratory syncytial virus in adults in the UK. Santa Monica, CA: RAND Corporation, 2024. https://www.rand.org/pubs/research_reports/RRA3133-1.html.

5 Herbert, Kevin, Mark Cabling, Stephen Morris et al. The burden of respiratory syncytial virus in adults in the UK. Santa Monica, CA: RAND Corporation, 2024. https://www.rand.org/pubs/research_reports/RRA3133-1.html.

6 Herbert, Kevin, Mark Cabling, Stephen Morris et al. The burden of respiratory syncytial virus in adults in the UK. Santa Monica, CA: RAND Corporation, 2024. https://www.rand.org/pubs/research_reports/RRA3133-1.html.

7 Gulliford MC, Charlton J, Winter JR et al. Probability of sepsis after infection consultations in primary care in the United Kingdom in 2002–2017: Population-based cohort study and decision analytic model. PLOS Medicine 2020;17(7): e1003202. doi: 10.1371/journal.pmed.1003202

8 Goodacre S, Fuller G, Conroy S, Hendrikse C. Diagnosis and management of sepsis in the older adult. BMJ. 2023;382:e075585 doi:10.1136/bmj-2023-075585

9 Allen, V.B., Bechman, K., Russell, M.D. et al. Rising rates of sepsis in England: an ecological study. Infection. 2025. doi: 10.1007/s15010-025-02601-0

10 Waite, T., Drake, H., Preventing infections in older adults, Chief Medical Officer's Annual Report 2023: Health in an Ageing Society. [Internet] 2023. [Accessed 6 November 2025] Available from: https://www.gov.uk/government/publications/chief-medical-officers-annual-report-2023-health-in-an-ageing-society

11 Laube S. Skin infections and ageing. Ageing Res Rev. 2004;3(1):69-89. doi: 10.1016/j.arr.2003.08.003.

12 Arora, A., Time to move: Get up, get dressed, keep moving [Internet] 2017. [Accessed 16 October 2025] Available from: https://www.england.nhs.uk/blog/amit-arora/

13 Gulliford MC, Charlton J, Winter JR et al. Probability of sepsis after infection consultations in primary care in the United Kingdom in 2002–2017: Population-based cohort study and decision analytic model. PLOS Medicine 2020;17(7): e1003202. doi: 10.1371/journal.pmed.1003202

14 Gulliford MC, Charlton J, Winter JR et al. Probability of sepsis after infection consultations in primary care in the United Kingdom in 2002–2017: Population-based cohort study and decision analytic model. PLOS Medicine 2020;17(7): e1003202. doi: 10.1371/journal.pmed.1003202

15 Andrews N, Stowe J, Kuyumdzhieva G, et al. Impact of the herpes zoster vaccination programme on hospitalised and general practice consulted herpes zoster in the 5 years after its introduction in England: a population based study. BMJ Open 2020;10:e037458. doi:10.1136/ bmjopen-2020-037458

16 Mensah AA, Whitaker H, Andrews NJ, Watson CH. Early impact of RSV vaccination in older adults in England. Lancet. 2025;405(10485):1139-40.

17 Office for National Statistics. Older people living in care homes in 2021 and changes since 2011. [Internet] 2023. [Accessed 6 November 2025] Available from: https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/ageing/articles/olderpeoplelivingincarehomesin2021andchangessince2011/2023-10-09

18 Elkind MS, Boehme AK, Smith CJ, Meisel A, Buckwalter MS. Infection as a stroke risk factor and determinant of outcome after stroke. Stroke. 2020 Oct;51(10):3156-68. doi: 10.1161/STROKEAHA.120.030429.

19 Pedersen EM, Yonis H, Egelund GB et al. Severe infections as risk factors for acute myocardial infarction: a nationwide, Danish cohort study from 1987 to 2018. Eur J Prev Cardiol. 2025;32(8):661-70. doi: 10.1093/eurjpc/zwae344.

20 Warren-Gash C, Smeeth L, Hayward AC. Influenza as a trigger for acute myocardial infarction or death from cardiovascular disease: a systematic review. Lancet Infect Dis. 2009;9(10):601-10. doi: 10.1016/S1473-3099(09)70233-6.

21 Fairweather D, Beetler DJ, Di Florio DN, Musigk N, Heidecker B, Cooper Jr LT. COVID-19, myocarditis and pericarditis. Circulation research. 2023;132(10):1302-19. doi: 10.1161/CIRCRESAHA.123.321878.

22 Sampri A, Shi W, Bolton T et al. Vascular and inflammatory diseases after COVID-19 infection and vaccination in children and young people in England: a retrospective, population-based cohort study using linked electronic health records. Lancet Child Adolesc Health. 2025;9:837-47.

23 Addario A, Célarier T, Bongue B, Barth N, Gavazzi G, Botelho-Nevers E. Impact of influenza, herpes zoster, and pneumococcal vaccinations on the incidence of cardiovascular events in subjects aged over 65 years: a systematic review. Geroscience. 2023 Dec;45(6):3419-47. doi: 10.1007/s11357-023-00807-4

24 Wilson JE, Mart MF, Cunningham C et al. Delirium. Nat Rev Dis Primers. 2020;6(1):90. doi: 10.1038/s41572-020-00223-4.

25 Sipilä PN, Heikkilä N, Lindbohm JV et al. Hospital-treated infectious diseases and the risk of dementia: a large, multicohort, observational study with a replication cohort. Lancet Infect Dis. 2021;21(11):1557-67. doi: 10.1016/S1473-3099(21)00144-4

26 Chacko A, Delbaz A, Walkden H et al. Chlamydia pneumoniae can infect the central nervous system via the olfactory and trigeminal nerves and contributes to Alzheimer's disease risk. Sci Rep. 2022;12(1):2759. doi: 10.1038/s41598-022-06749-9.

27 Warren-Gash C, Forbes HJ, Williamson E et al. Human herpesvirus infections and dementia or mild cognitive impairment: a systematic review and meta-analysis. Sci Rep. 2019;9(1):4743. doi: 10.1038/s41598-019-41218-w.

28 Liu NY, Sun JH, Jiang XF, Li H. Helicobacter pylori infection and risk for developing dementia: an evidence-based meta-analysis of case-control and cohort studies. Aging (Albany NY). 2021;13(18):22571. doi: 10.18632/aging.203571

29 Lee KA, Flores RR, Jang IH, Saathoff A, Robbins PD. Immune senescence, immunosenescence and aging. Front Aging. 2022;3:900028. doi: 10.3389/fragi.2022.900028

30 Bernal JL, Andrews N, Gower C et al. Effectiveness of the Pfizer-BioNTech and Oxford-AstraZeneca vaccines on covid-19 related symptoms, hospital admissions, and mortality in older adults in England: test negative case-control study. BMJ. 2021;373. doi: 10.1136/bmj.n1088

31 Mensah AA, Whitaker H, Andrews NJ, Watson CH. Early impact of RSV vaccination in older adults in England. Lancet. 2025;405(10485):1139-40.

Data note

Unpublished counts for Figure 1, deaths from infectious diseases for ages 90 and above, England, 2023 from ONS

Age group	Respiratory infections	COVID-19	Urinary tract infections	Septicaemia	Skin infections	Intestinal infections	Other infectious diseases
90 to 94	6,168	2,034	966	727	280	251	150
95+	3,851	1,050	475	288	132	119	58

3.2 Infections in pregnancy

Cordelia E M Coltart – Associate Professor, UCL & Honorary Consultant in Infectious Diseases, Royal Free Hospital NHS Trust

Nicola Vousden – Public Health Registrar, DHSC & Clinical Lecturer in Maternal and child population health, National Perinatal Epidemiology Unit, University of Oxford

Lucy Chappell – Chief Scientific Adviser, DHSC & Professor of Obstetrics, Kings College London

Contributors: Alison Rodger, Kate Duhig, Harindra Amarasinghe, Allison Felkner

Introduction

Infections in pregnancy refer to the group of diseases caused by a pathogen infecting a woman during pregnancy or the peripartum period. Most maternal infections are not serious but physiological and immunological changes that happen during pregnancy can increase the severity of some infections with a potentially significant impact on the woman, her unborn baby or both. Some pathogens can be transmitted from the woman to the fetus during pregnancy, delivery or through breastfeeding, known as vertical transmission. Infections related to the neonatal infant (including some infections derived from childbirth) are covered in chapter 3.3.

Table 1: Definitions of infections in pregnancy

Term	Definition
Infection	A condition caused by the presence of a pathogen (bacteria, virus, fungi or parasite) in the body – this often leads to symptomatic disease but can be asymptomatic.
Sepsis[1] including life-threatening severe sepsis	The most severe form of infection is sepsis, a life-threatening condition. This can lead to organ dysfunction due to the body's immune system triggering an extreme response to the infection causing damage to the tissues and organs sometimes leading to shock, organ failure and death. This is preventable[2] if recognised and treated early. Women who are pregnant, have given birth or had a termination or miscarriage in the past 6 weeks are at higher risk of sepsis compared to non-pregnant women.[3]
Puerperal infection/sepsis	Also known as peri or postpartum infection (within 42 days of birth), it refers to infections occurring during or after childbirth or miscarriage. Most commonly this is infection of the female reproductive tract (for example, chorioamnionitis or endometritis). Puerperal sepsis is the more severe end of the spectrum but is often used interchangeably with puerperal infection in the literature.

Term	Definition
Direct and indirect causes of infection related maternal deaths[4]	Direct causes of death are those due to infection that directly relate to pregnancy and childbirth, such as genital tract sepsis (for example, chorioamnionitis, sepsis related to preterm prelabour rupture of membranes, sepsis following caesarean section, urinary tract sepsis, sepsis following feticide). Indirect causes of death are related to deaths from other infections which may be exacerbated by the physiological effects of pregnancy, for example, influenza, pneumonia, meningitis, viral infections, TB.
Vertical transmission	Transmission of a pathogen or infection from woman to fetus or infant during pregnancy, at birth or through breastfeeding.

Pregnancy is associated with major physiological changes across all body systems (including cardiovascular, respiratory, gastrointestinal and renal). The immune system also changes, allowing the body to support the fetus and not reject it, despite the contribution of paternal genetic material to the fetus which could trigger an immune response. The immune system also increases white blood cell counts, which increase further during the physiological stress of labour and birth. These collective changes can mean that:

- **pregnant women are at increased risk of acquiring some infections**. For example, the immunological and pathophysiological changes in pregnancy can lead to women being more susceptible to acquiring infections such as urinary tract infections, listeriosis and malaria.
- **pregnant women are at risk of severe outcomes from infection**. For example, pregnant women are at 2.4-fold increased risk of being hospitalised with influenza than non-pregnant patients with influenza[5] and pregnant women with influenza are more likely to be admitted to intensive care, and their babies to neonatal intensive care, than pregnant women without influenza.[6] During the height of the COVID-19 pandemic, pregnant women with SARS-CoV-2 infection had a 7.7-fold increased risk of maternal death and a 3.8-fold increased risk of intensive care admission compared to pregnant women without SARS-CoV-2.[7]
- **signs and symptoms of infection may be obscured, resulting in delays to recognising infection or its severity**. For example, an elevated heart rate in labour may be observed as a normal physiological response (given the altered range of normal heart rate in pregnancy).[8] Additionally, younger people (including pregnant women) compensate physiologically to infection/sepsis (for example, increase in heart rate to maintain blood pressure) until the point of collapse; there should be a higher degree of suspicion for sepsis in these groups. Reviews have consistently found that failure to recognise sepsis and late, inadequate or inappropriate treatment contributes to maternal deaths in the UK and there is a need to improve early detection and appropriate treatment of sepsis (including antibiotics and good source control).[9]

- **infections that are associated with minimal symptoms in the non-pregnant individual can have serious consequences in pregnancy**. For example, *Listeria monocytogenes* infection is a rare infection from eating contaminated food (for example, cold meats or fish, mould-ripened or blue-veined cheeses, unpasteurised milk products, pate, prepared sandwiches and salads). The infection is usually not serious for most people and can cause no or mild symptoms for a pregnant woman, but on rare occasions it can cause chorioamnionitis, preterm labour and/or spread across the placenta leading to severe or even fatal consequences for the fetus including miscarriage and stillbirth.

Furthermore, childbirth and obstetric interventions can lead to increased risk of infections. A national case control study of severe maternal sepsis in the UK in 2011 to 2012 identified key risk factors for developing sepsis, including obesity, pre-existing comorbidity and obstetric risks such as prolonged rupture of membranes, any operative delivery (operative vaginal and caesarean section after the onset of labour) or vaginal trauma.[10]

The global impact of infections in pregnancy

There have been considerable advances in maternal mortality globally. Between 2000 and 2023, the number of maternal deaths per 100,000 live births dropped by about 40% worldwide (to approximately 260,000 deaths globally in 2023).[11] Over 90% of these deaths occured in lower- and middle- income countries (LMIC), with 70% in sub-Saharan Africa. This reduction is at least in part due to improved infection prevention and control practices (such as sanitation) aimed to reduce the spread of infections, the use of aseptic techniques during birth interventions, changes in wider health practices such as availability of safe terminations of pregnancy and improved quality of care such as earlier identification of infection and appropriate treatment with antibiotics.[12]

Despite these advances, infections in pregnancy remain a major cause of morbidity and mortality. Global estimates suggest that sepsis contributes approximately 6.6% of all maternal deaths.[13] Accurate assessment of the true burden of infections to maternal deaths is challenging given different case definitions and reporting mechanisms but is likely to be much higher when considering deaths primarily attributed to other causes such as termination of pregnancy,[14] infections aggravated by pregnancy such as influenza or infections that are globally underreported such as HIV.[15] The World Health Organization (WHO) Global Maternal Sepsis Study identified that more than half of maternal deaths in hospital were related to infection. Whilst the burden was highest in LMIC,[16] a study from the USA identified that 23% of all maternal deaths were related to sepsis.[17]

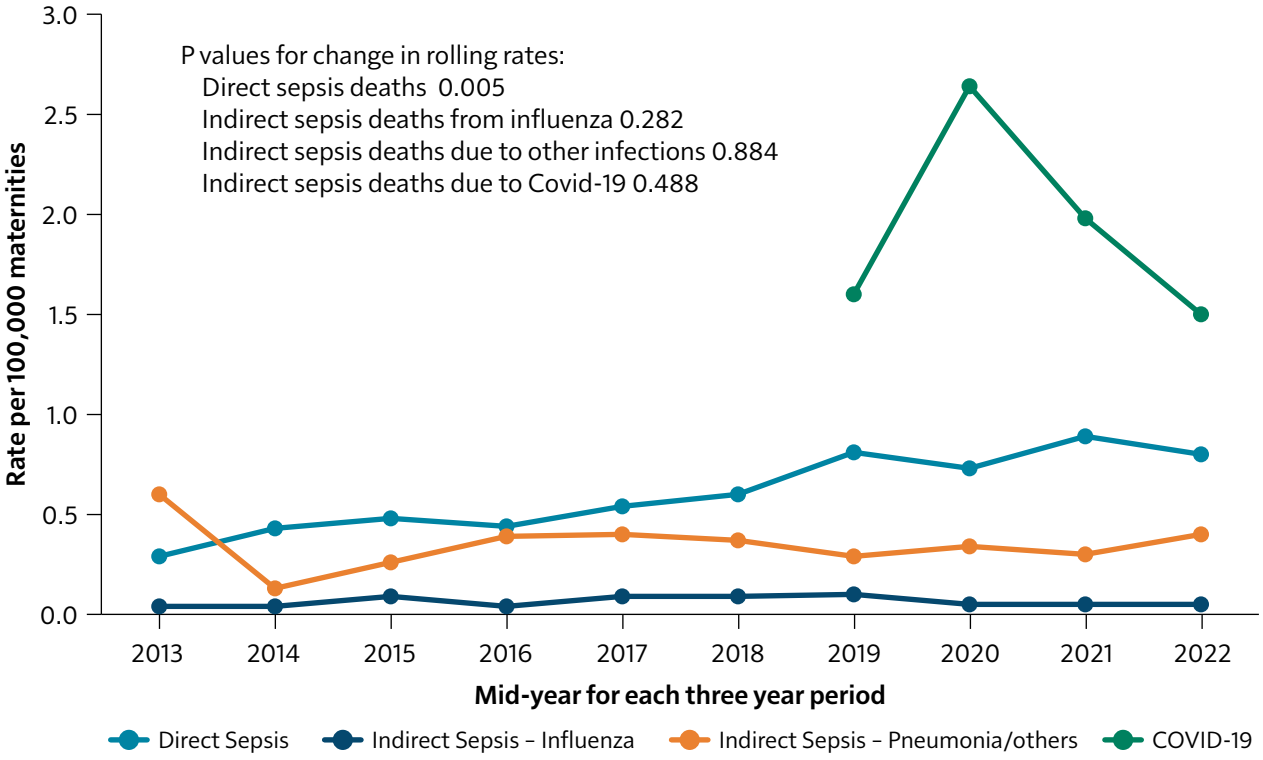
Although maternal deaths represent the most severe adverse outcome, there is also a considerable burden of morbidity from infections and sepsis. Globally, it is estimated that for every 1,000 women who have a live birth, 70 require hospital treatment for infection and 11 have severe maternal outcomes relating to infection.[18] This figure will vary across different settings and is largely driven by the burden in LMIC. In high income countries, in every 1,000 women who have a live birth, 39 require hospital admission for infection and less than one has a severe outcome.[19] Survivors of severe sepsis may have long-term consequences to mental, physical

health and quality of life, although the quality of evidence following sepsis in pregnancy is poor.[20]

The impact of infections in pregnancy in England

In 2023, there were 649,153 maternities (live births and still births) in the UK.[21,22,23] Sepsis has persisted as a leading cause of maternal deaths (in the broadest sense as death from a primary infective cause) in the UK since 1985, when comparable data recording began.[24] Whilst indirect causes of death related to sepsis have remained stable over time, there has been an increase in the rate of deaths from direct sepsis, even without considering the stark impact of the recent COVID-19 pandemic (Figure 1). In the most recent triennial surveillance report from Mothers and Babies: Reducing Risk through Audits and Confidential Enquiries across the UK (MBRRACE-UK), sepsis was the fifth most common cause of maternal death between 2020 to 2022 (9%; n=25).[25] COVID-19, also a primary infective cause, led to 38 maternal deaths* (14%), the second most common cause of maternal deaths during this period.[26] In the UK, surveillance of COVID-19 in pregnancy from the start of the pandemic was feasible due to rapid research funding, established maternal case cohort methodology (MBRRACE) and advanced planning (including hibernated studies) for how to handle unexpected outbreaks years in advance.

Figure 1: Trend in maternal deaths from sepsis from 2013 to 2022 in the UK



Source: Data supplied by Mothers and Babies: Reducing Risk through Audits and Confidential Enquiries across the UK (MBRRACE-UK), Maternal, Newborn and Infant Clinical Outcome Review Programme, National Perinatal Epidemiology Unit, University of Oxford

* This includes only women that died directly as a result of complications of COVID-19, not all women that had COVID-19 at the time of death and died from other causes or whose care was impacted by the burden of the pandemic on health services.

While maternal deaths in the UK are rare, hospital admissions with infections or sepsis are more common. In 2023 to 2024, approximately 0.5% of births in England were complicated by a hospital admission where the main diagnosis was recorded as 'puerperal sepsis' (n=2,536) and 2% with a hospital admission for 'puerperal infection' (n=12,047).[27] Infections were the second most common cause of maternity admission to intensive care in 2015 to 2016, most commonly for pneumonia (44%) or complications arising from urinary tract infections (20%).[28] A national study of sepsis in pregnancy identified that for every death from sepsis in pregnancy in the UK, approximately 50 women developed life threatening severe sepsis (4.7 per 10,000 maternities, 2011 to 2012).[29] If rates remained the same, this would equate to 305 women with life threatening severe sepsis during pregnancy in 2023. Routine surveillance data on non-fatal infections in pregnancy in the UK and more recent data are not currently available.

Inequalities

It is well documented that socio-economic factors impact health outcomes.[30] This is also the case for risk factors for infection in pregnancy.

MBRRACE reports have shown that maternal mortality rates in the UK are higher in women from Black and other ethnic minority groups, several of which did not have English as their preferred language.[31] A national case-control study in the UK (2011 to 2012) also identified Black and other minority ethnicity as a risk factor for severe sepsis.[32] There is also a social deprivation gradient such that women living in the most deprived areas are at 6.5-fold higher risk of severe maternal sepsis morbidity and mortality compared with women living in the most affluent areas.[33] Socioeconomic deprivation and being from an ethnic minority background are documented risk factors for adverse pregnancy outcomes across many country settings, including England,[34,35] often associated with poorer access to antenatal care.[36]

In 2023, 1 in 3 births in England and Wales are to women born outside the UK.[37] For women that have recently arrived in the UK, confidential enquiries have identified that there can be challenges in accessing appropriate care pathways and provision of interpreters during antenatal care.[38] Indeed, lack of good interpretation and not having English as the preferred language were key factors identified in a number of maternal death reviews. High quality interpretation is essential to understanding and communicating with women, especially as communication difficulties can be magnified as women become more unwell and are unable to express themselves or misinterpreted by healthcare workers due to cultural differences.[39] These same groups are also the least likely to receive antenatal vaccinations.[40]

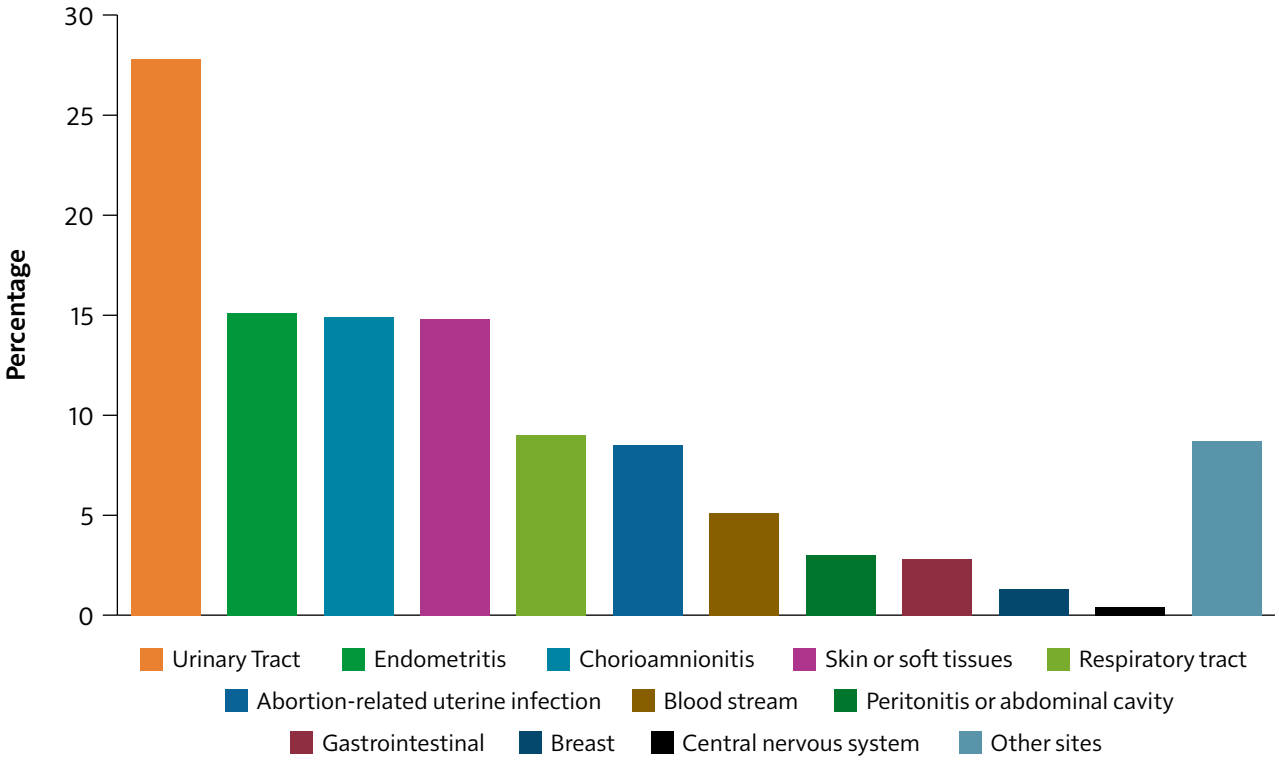
Health promotion messaging and engagement regarding maternal health service provision, usage and antenatal vaccination must focus on reaching these higher risk groups. Additionally, ensuring appropriate communication is key, involving high-quality interpreter services, rather than relying on family members.

Common infections in pregnancy

Globally, the most common source of infection in pregnancy is from the urinary tract (Figure 2).[41] A UK case-control study for maternal sepsis also found the largest proportion of

cases were due to genitourinary infections (specifically *Escherichia coli* (*E. coli*)) and an Irish review of pregnancy-related sepsis reported similar results with *E. coli* causing the highest proportion of cases (37.3%), followed by Group B streptococcus (20.6%).[42,43] Genitourinary tract infections are associated with several adverse consequences for the pregnant woman and her baby including maternal sepsis and postnatal morbidity for the mother.[44] Physiological urinary tract changes during pregnancy make mild (for example, asymptomatic bacteriuria) and severe (for example, pyelonephritis, endometritis, chorioamnionitis) infections more likely.

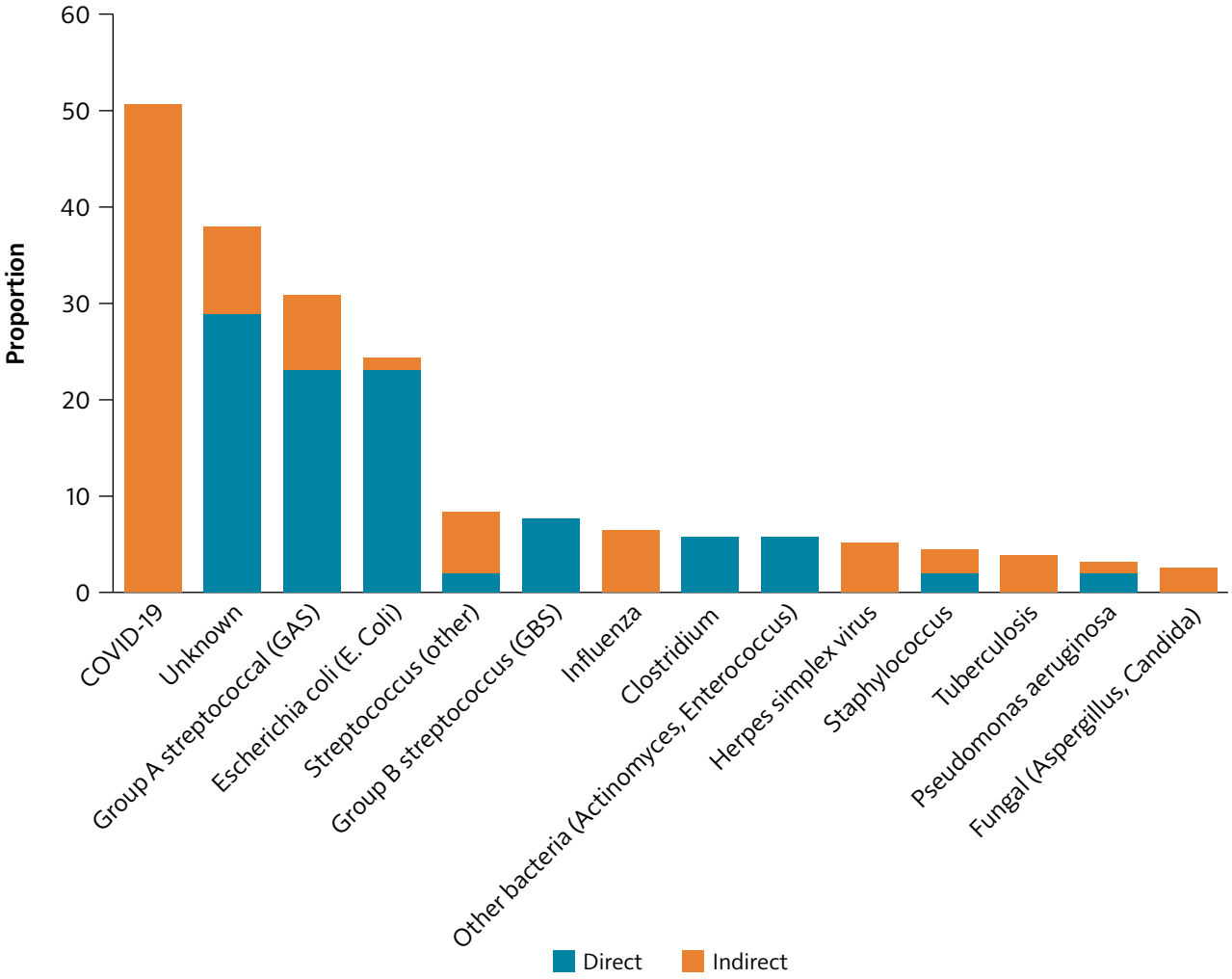
Figure 2: Primary sources of global maternal infections leading to sepsis[45]



Source: Produced from published data from WHO Global Maternal Sepsis Study (GLOSS) Research Group. Frequency and management of maternal infection in health facilities in 52 countries (GLOSS): a 1-week inception cohort study. Lancet Glob Health 8, e661-e671 (2020).

However, the organisms that contributed to the highest proportion of maternal deaths in England from 2012 to 2023 (Figure 3) were COVID-19 (50.6%), Group A Streptococcus (30.9%) and *E. coli* (22.5%), with over a third of infections caused by unidentified organisms. Invasive Group A Streptococcal (iGAS) infections are more common in postpartum women than in non-pregnant populations. The morbidity is significant and it can progress from the first signs of a non-specific inflammatory response to toxic shock syndrome and death in hours.[46, 47] There is limited evidence regarding the cause of infections that result in hospital admission during pregnancy or the postnatal period in England, outside of those causing maternal deaths.

Figure 3: The leading infectious organisms that caused direct and indirect maternal deaths from 2012 to 2023 in the UK



Source: Unpublished data supplied by Mothers and Babies: Reducing Risk through Audits and Confidential Enquiries across the UK (MBRRACE-UK), Maternal, Newborn and Infant Clinical Outcome Review Programme, National Perinatal Epidemiology Unit, University of Oxford

Skin rashes in pregnancy are common and may not be harmful but can also be a sign of an infection, such as rubella, measles or varicella (chickenpox), which can cause neonatal infection. Any new rash in pregnancy should be discussed with a healthcare professional to rule out potential infections.

The UK Health Security Agency (UKHSA) reported a 23.8% increase in sexually transmitted infection (STI) diagnoses in 2022 compared to 2021, including increases for chlamydia (24.3%), gonorrhoea (50.3%) and syphilis (15.2%). Syphilis infections in England further increased by 29% among women in the general population between 2022 to 2023.[48] This rise is focused in specific groups (not including pregnant women), but pregnant women are a risk group for STIs. STIs can impact not only the pregnant woman, but also the fetus and infant through congenital abnormalities and/or neonatal infection, for example, ophthalmia neonatorum from chlamydia and gonorrhoea, congenital syphilis and congenital herpes. Data suggest that the number of congenital syphilis cases in England is small but has increased (from 15 cases between 2015 to 2018 to 25 between 2020 to 2023).[49]

Human Immunodeficiency Virus (HIV) is another infection of particular concern in pregnancy for both mother and baby, especially if unrecognised and/or uncontrolled (Case study 1).

This chapter does not cover the full range of possible infections seen in pregnancy in England. We have aimed to highlight infections which are common, increasing, or have particular significance in pregnant women. With an increasingly globalised world, it is becoming more common to see pregnant women who have been born abroad and/or travelled peri-partum. Table 2 summarises some key infections to consider in relation to the implications of travel, imported and other infections. Box 1 highlights the need to consider pregnant women as a priority in respiratory virus outbreaks or other pandemic infections.

Table 2: Imported, travel and other related infections to consider and impact on pregnant population

Infection	How it differs in pregnancy
Malaria[50,51]	Malaria is a parasitic infection caused by the protozoan parasite, *Plasmodium* spp., transmitted by *Anopheles* mosquitoes. There are 5 species of malaria that infect humans, 2 of which are mainly associated with adverse consequences in pregnancy – *P. falciparum* and *P. vivax*. *P. falciparum* causes the most severe disease and accounts for the highest burden of cases seen in the UK.[52] Malaria is endemic in 85 countries in Africa, Asia and Central/South America. However, the prevalence of imported malaria in pregnancy in the UK is unknown.[53] Pregnant women are more likely to be bitten by mosquitoes (compared to non-pregnant women) and are therefore at higher risk of infection.[54] Pregnant women also have a 3-fold higher risk of severe malaria than non-pregnant women[55,56] which is associated with higher mortality rates. There are also potential adverse consequences for the pregnancy, especially as *Plasmodium*-infected erythrocytes can accumulate in the placenta leading to fetal growth restriction, preterm delivery, low birthweight and stillbirth.[57] National guidelines recommend avoiding bites and travel to malarious regions during pregnancy if possible. Chemoprophylaxis is also recommended but depends on area of travel and stage of pregnancy.[58]

Infection	How it differs in pregnancy
Zika[59,60]	Zika virus is transmitted by *Aedes* mosquitoes but it can also be sexually transmitted. There was a large outbreak in 2015 to 2016 particularly across Latin America. It is endemic across South and Central America, parts of Africa and Asia, the Caribbean and the Pacific Islands. Most cases are asymptomatic or cause mild symptoms, but in pregnancy infection can result in congenital Zika virus syndrome with cranial defects (microcephaly), fetal growth restriction, oligohydramnios and talipes. The earlier the infection within pregnancy, the more likely fetal complications are severe. To mitigate these risks, UKHSA advises that women should avoid travel to Zika endemic regions during pregnancy and avoid conception for 2 to 3 months after travel, while men should wait for 6 months before trying to conceive after travel and/or use barrier contraception throughout pregnancy due to prolonged persistence of virus in seminal fluid.[61] Surveillance should be offered to women exposed to Zika infection during pregnancy via fetal medicine units.
Chagas disease[62]	Chagas disease is increasingly reported in Latin American migrants who have settled in Europe, although it is not routinely tested for in the UK. A vector-borne disease caused by the parasite *Trypanosoma cruzi* (American trypanosomiasis), it is transmitted to people by the infected faeces of a blood-sucking triatomine bug (at the site of the bite or via another skin breach, mucous membranes or contaminated food). Traditional transmission only occurs in endemic areas of Latin America, but further onward human-to-human transmission can occur via other routes — including vertical transmission, blood transfusion and transplantation (although current routine donor screening would prevent transmission from transfusion and transplantation in the UK). Chronic infection can lead to cardiac or gastrointestinal manifestations in 20% to 30%, decades later. Infection can be detected via serology testing of those from high-risk areas (including pregnant women). It is estimated that <5% of those infected in the UK have been identified.
Other travel related	There are many other travel-related viral infections which can be transmitted from the mother to baby during delivery, including dengue and chikungunya infection.
Travel vaccines	Pregnant women can consider some travel vaccinations where the benefit outweighs any risk. Specialist advice should be sought.

Box 1: Special considerations – pandemics in pregnancy?

Pandemic infections remain high on the global public health agenda, especially for respiratory viruses. Of the viral pandemics in the last 2 decades (Severe Acute Respiratory Syndrome, Middle Eastern Respiratory Syndrome, COVID-19, influenza A H1N1 2009 (swine flu), Ebola and Zika), pregnant women were disproportionately affected with adverse consequences for the woman and fetus, including higher mortality rates in pregnant women than non-pregnant women. In some infections, pregnant women are one of the highest risk groups, whereas in others they feature lower down in the list of vulnerability; but in all cases, these pandemic infections were serious in pregnancy. For example, in the 2009 H1N1 swine flu epidemic, pregnant women and young children were disproportionately affected. Pregnant women in the US accounted for 1.0% of infections, but 5.8% of deaths associated with H1N1.[63,64]

Therefore, in any emerging, re-emerging or novel infection, evaluating the impact on pregnant women and related protections should be considered a priority to inform policies at pace, including in emergency situations.[65]

Preventing infections in pregnancy

Good hygiene and sanitation measures provide the greatest protection from many infections, particularly around the time of delivery. The simple measures of hand washing, good food hygiene, avoiding exposure to high-risk foods/activities or recognised infectious diseases form the mainstay of advice to pregnant women in preventing infections. Healthcare related hygiene measures stem from the work of Dr Semmelweiss, a Hungarian physician in the 1860s, who was the pioneer of antiseptic procedures, promoting hand disinfection by healthcare workers in obstetrics to prevent puerperal infections, leading to significant reductions in maternal mortality rates.[66] These measures remain important in healthcare today and infection after childbirth can be eliminated if good hygiene is practised and early signs of infection are recognised and treated in a timely manner.

Vaccination also plays an important role in preventing some diseases. During pregnancy, healthcare professionals should check that women are fully immunised according to the UK vaccination schedule; both from routine childhood vaccines which can have an impact on the pregnant women or fetus as well as from those in the antenatal vaccination programme (below). For example, rubella vaccination has been part of the UK's routine childhood immunisation schedule for over 30 years, with high uptake and rubella immunity in the UK population. However, vaccination rates for rubella and other infections may be lower in women who have been born abroad, a growing population. The UK achieved elimination of rubella in 2016. However, between 2003 and 2016, 31 rubella infections (0.23 per 100,000 pregnancies) were identified through surveillance, of which 26 were in women born abroad and 5 led to congenital rubella syndrome in the child.[67]

Antenatal vaccination programmes in England

Maternal vaccination in pregnancy is recommended for 2 main reasons:

- primarily for maternal benefit with some infant co-benefit (for example, influenza)
- primarily for infant benefit via passive immunity transfer of antibodies across the placenta such as pertussis (whooping cough), respiratory syncytial virus (RSV)

Accurate estimates of vaccination uptake in pregnancy in the UK can be challenging because vaccines can be delivered by primary care or hospital based antenatal care providers and the records may not transition between these 2 entities accurately.

Vaccination against influenza, pertussis and RSV are recommended in pregnancy because they are safe and reduce the risk of infection to the woman and the baby in their first months of life.[68] Vaccination against COVID-19 was also recommended by the Joint Committee for Vaccination and Immunisation (JCVI) in recent years but, from spring 2025, pregnant women are no longer eligible for routine COVID-19 vaccination due to the lack of cost-effectiveness as the risk of severe outcomes to mothers and babies since the Omicron period is low.[69] This may be due to higher levels of natural or vaccine-induced immunity in women of reproductive age compared to the first wave contributing to less severe disease, as well as no maternal deaths from COVID-19 in the last 2 years.

Influenza

There has been a vaccination programme for pregnant women against influenza since 2010. This is a seasonal programme, with pregnant women (and others who meet the criteria for vaccination) being offered vaccination any time between September and March each year. Influenza virus has the capability to change year on year and thus the vaccine is updated ahead of each season to target the most likely circulating strains.[70]

Vaccinating pregnant women against flu protects:

- the pregnant woman herself
- the baby during pregnancy from the impact of the woman becoming unwell
- the baby in the first few months of life via passively transferred antibodies

Pregnant women are at higher risk of complications and admission to intensive care from influenza than non-pregnant women. Influenza infection during pregnancy may be associated with perinatal mortality, prematurity and lower birth weight in the infant.[71] Babies under 6 months of age are at risk of serious illness and complications from influenza.[72] Passive immunity passed from a vaccinated pregnant mother to her unborn child can give protection to babies in this age group.

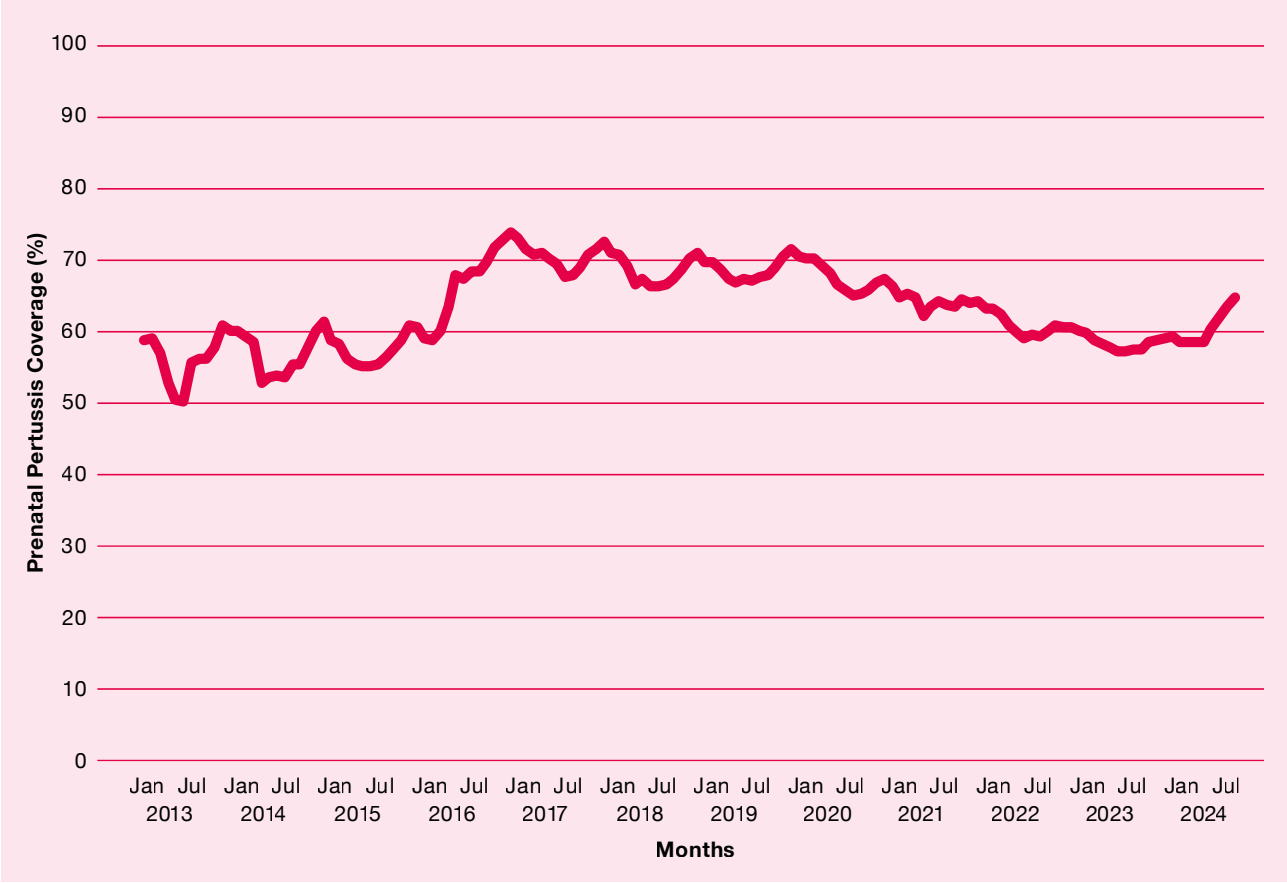
Seasonal flu vaccination uptake in pregnant women in England remains persistently low. Having declined year on year from 2018 to 2024, vaccination rates increased slightly to 35% in the 2024 to 2025 flu season, although the true proportion may be lower due to the challenge in

identifying the proportion of eligible pregnant women from primary care data.[73] There are ethnic inequalities in vaccine uptake with proportions varying from 45.2% in women of Chinese ethnicity to 36.6% in White British women to 12.7% in Black or Black British-Caribbean women.[74]

Pertussis

Maternal vaccination is very effective at protecting against pertussis disease and hospitalisation, and is primarily for the infant's benefit. It passively protects infants from birth, with an estimated 90% effectiveness until infants are due their first dose of primary vaccinations at 8 weeks of age (in the UK). Since the introduction of pertussis vaccination in pregnancy in 2013 until the end of November 2024, there have been 31 deaths in babies with confirmed pertussis, all of whom were too young to be eligible for infant vaccination; 25 had mothers who were not vaccinated in pregnancy.[75] Vaccinating in pregnancy offers the best protection against severe pertussis disease in young babies and in those that do get infected after maternal vaccination, they typically have a less severe disease course.[76] Pertussis vaccine coverage was 65.9% in September 2024, following a recent increase after years of gradual decline (Figure 4).[77]

Figure 4: Prenatal pertussis vaccine coverage in England from January 2013 to September 2024

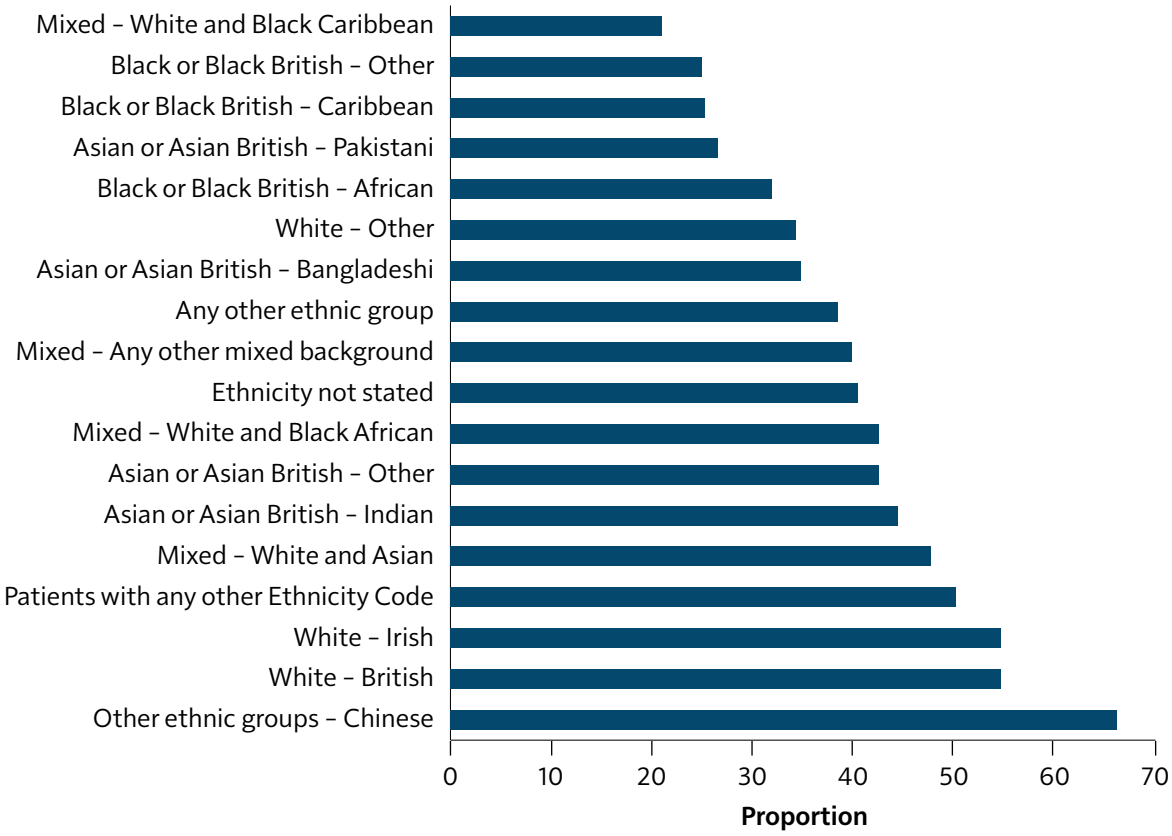


Source: Image from UK Health Security Agency, Vaccine update: issue 354, January 2025, maternity special is licensed under the Open Government Licence v3.0.

Respiratory syncytial virus (RSV)

RSV is a common cause of acute respiratory tract infections. Most infections cause mild illness but in infants under 6 months, more severe disease such as bronchiolitis and pneumonia can occur. The JCVI advises that pregnant women should routinely be offered vaccination as they reach 28 weeks of pregnancy to enable antibodies to be passed onto the infant to protect them from infection. Pregnant women who do not receive the vaccination at this time are still eligible up until delivery as it will protect them from infection and, therefore, reduce the risk of spreading infection to the newborn baby.[78] The vaccination programme was launched in the UK in September 2024. The aim is to reduce incidence and severity of RSV-associated disease in infants. In December 2024 (the fourth month of the programme), 47.6% of women had received an RSV vaccine (Figure 5). Ethnic and socioeconomic inequalities were similar to other vaccination types.

Figure 5: RSV vaccine coverage (%) in pregnant women, measured in December 2024, by ethnicity. Data from 40.4% of general practices across England[79]



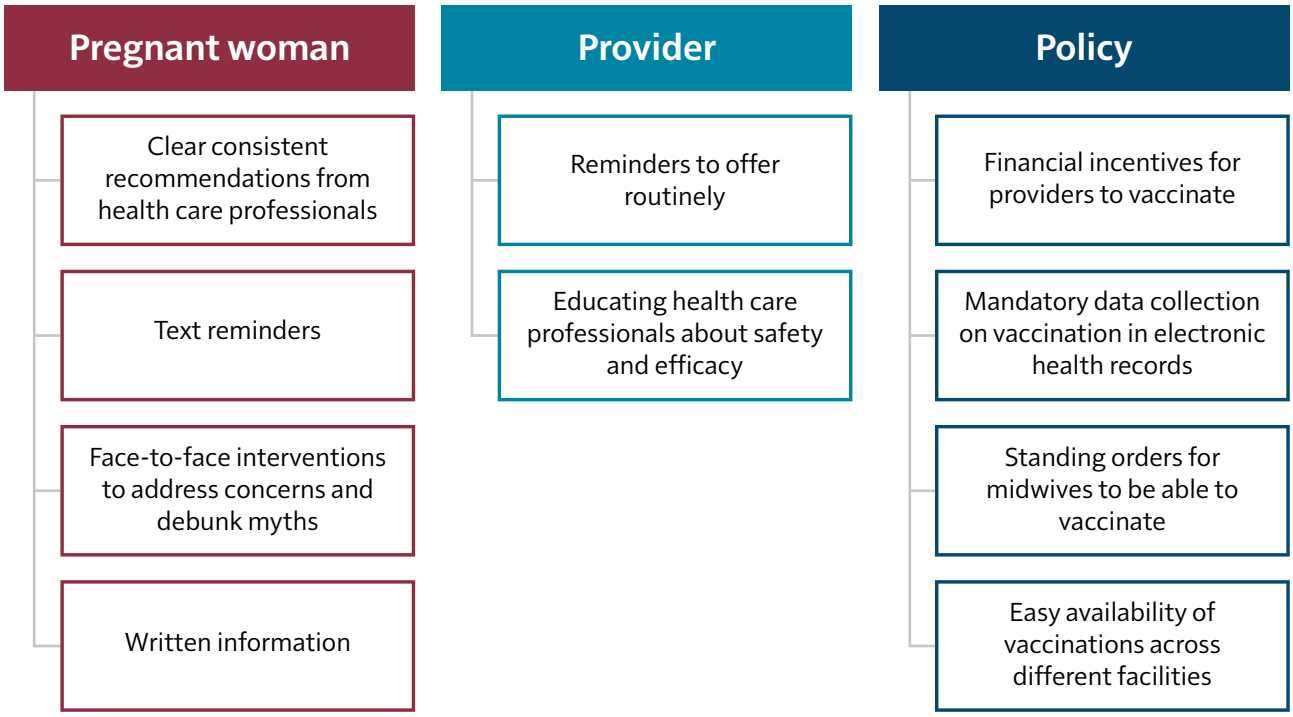
Source: UK Health Security Agency, RSV maternal vaccination coverage in England: December 2024, updated 31 July 2025.

Reasons for low vaccine uptake in pregnancy and implications

Despite well-established data on the benefits of vaccination, uptake of vaccination in pregnancy remains below optimal levels. Concerns over long term safety, side effects and efficacy, inconsistent guidance from health care professionals and practical challenges such as inconvenience of appointments have all been cited.[80,81]

Recommendation of vaccination from a health care professional can increase uptake, with women receiving a recommendation being 10 to 12 times more likely to receive a pertussis or influenza vaccination than those who did not.[82] A review of interventions to promote vaccination in pregnancy identified further interventions which may have a small but beneficial impact on increasing influenza vaccine uptake (Figure 6).[83] Lower vaccination rates in pregnancy are associated with younger age, lower socioeconomic status, certain ethnic minority groups and migrant status.[84,85,86,87,88] Evidence suggests that interventions could increase uptake in disadvantaged both non-pregnant and pregnant populations,[89] such as healthcare professional recommendation, improving accessibility, group antenatal care and culturally diverse information sources, that may be beneficial at improving vaccination uptake in Black pregnant women.[90]

Figure 6: Evidence of interventions that may increase uptake of vaccination in pregnancy, generated from evidence from a systematic review[91]



Source: Adapted from evidence described in a systematic review by Razai MS, Mansour R, Goldsmith L, et al. Interventions to increase vaccination against COVID-19, influenza and pertussis during pregnancy: a systematic review and meta-analysis.[92]

The MBRRACE confidential enquiries into deaths of women from infections in pregnancy have reported that access to clear messaging about the benefits and risks of medication and vaccination in pregnancy may improve outcomes. For example, the UK teratology information service provides 'Best Use of Medicines in Pregnancy' (BUMPS) information.[93] Dissemination of regularly updated advice and data concerning new vaccines and treatments to women and their clinicians, including key opinion leaders and representatives of communities at risk, is likely to support vaccine uptake, particularly if there is strong community engagement. Furthermore, the inclusion of pregnant women in vaccine clinical trials would improve evidence-based decision-making and support credible health promotion messaging.

Antenatal screening for infections

The antenatal screening programme opportunistically screens every pregnant woman at their first antenatal appointment for blood-borne viruses. Screening consent for HIV, Hepatitis B and syphilis has remained consistently high at 99.8% from 2021 to 2024.[94] It allows for early diagnosis and initiation of treatment, avoiding complications of late presentation. The implementation of HIV screening and success in preventing mother-to-child HIV transmission in the UK is outlined in Case study 1.

In 2021 to 2022:

- 0.92 per 1,000 women screened positive for HIV[95]
- 1.64 per 1,000 screened positive for syphilis[96]

In 2022 to 2023:

- 3.33 per 1,000 screened positive for hepatitis B[97]

Whilst the numbers of women that screen positive for Hepatitis B are relatively small, the proportion of women attending post-natal specialist follow-up is consistently lower than the target threshold of 75%. Follow up is vital for neonatal vaccination to prevent transmission to the baby. Without this, transmission can be as high as 90% from mothers with high infectivity and 10% to 40% from mothers with lower infectivity.[98] Of babies infected at birth or during the first year of life, around 90% go on to develop chronic infection.[99] NHS England and UKHSA are currently investigating all reports of vertical transmission of Hepatitis B virus from mother to baby from 2021 onwards.[100]

Pregnant women may test negative for syphilis in the first trimester and become infected later in pregnancy, resulting in congenital syphilis in the infant. Between 2015 to 2023, there were 55 cases of congenital syphilis; nearly half of these infants (24) were born to women who screened negative in antenatal screening, suggesting infection later in the pregnancy.[101] Current guidance is to repeat screening for syphilis in pregnancy only where risk of infection is identified, such as in people with genital infections, new/multiple partners, and/or adverse social circumstances.

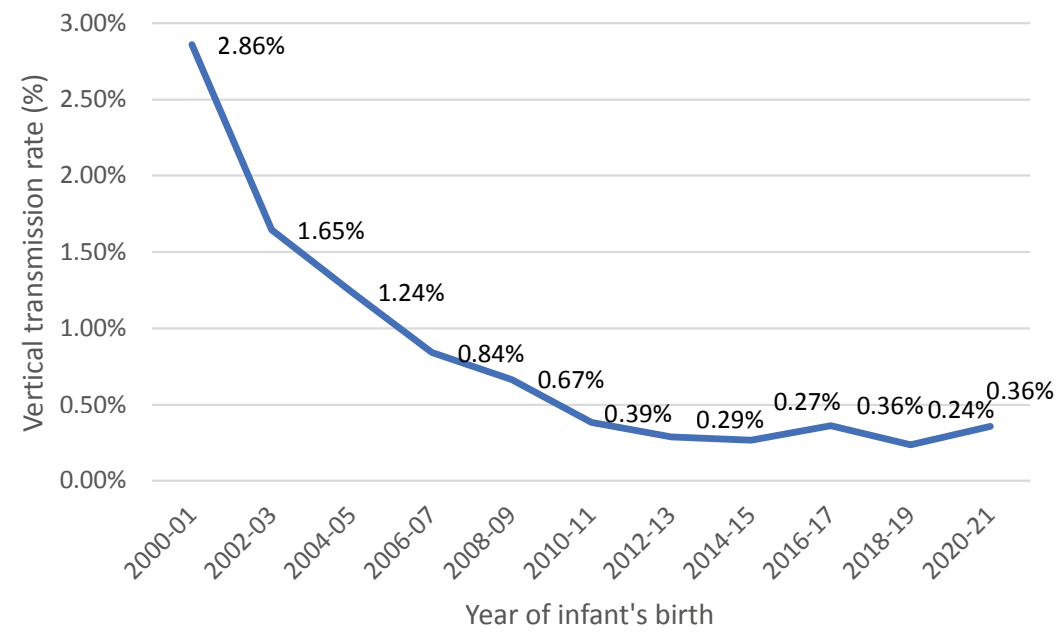
Case study 1: Mother-to-Child Transmission (MTCT) of HIV in the UK – a success story[102] *

The reduction of vertical transmission of HIV in the UK is a success story for public health and the UK antenatal HIV programme is an exemplar of how active screening, prompt diagnosis and treatment can have a substantial impact.

In 1993, vertical transmission rates among diagnosed women with HIV were 25.6% and there were no national intervention programmes[103]. This figure represents only a subset of MTCT cases as only about one third of pregnant women living with HIV were diagnosed and most of these were aware of their status prior to pregnancy, with very few diagnosed in the antenatal period. By the late 1990s, the value of risk reduction interventions became clear and the pivotal role of antenatal screening and early detection was recognised. This led to the introduction of a universal antenatal HIV testing programme in England in 2000 and throughout the UK by 2002. Uptake rates increased year on year and have exceeded 97% since 2011.[104] Since 2012, the number of diagnosed women (pregnant and non-pregnant) have generally declined.

With widespread implementation of routine antenatal screening for HIV, vertical transmission is now rare, with a rate below 0.4% in England since 2012, reducing from 2.86% in 2000 to 2001 (Figure 7). This equates to 3 known vertical transmissions among 841 infants born during the 2 calendar years 2020 to 2021, where infection status was known in the mother (a vertical transmission rate of 0.36% (95% CI 0.07%-1.0%).[105]

Figure 7: Vertical transmission rate by year of birth for infants born to diagnosed women in England



Source: Image from ISOSS HIV report (for pregnancies between 1 April 2021 to 31 March 2022), 2024, is licensed under the Open Government Licence v3.0.

*Data reported in this case study is taken from the relevant year of the ISOSS HIV report unless otherwise stated.

The British HIV Association (BHIVA) produces national guidelines on the management of HIV in pregnancy and postpartum and reports trends on new MTCT in the UK each year. The antenatal HIV programme has shown success.

Prevalence

- Of 578,562 maternity deliveries in NHS hospitals in England in 2021 to 2022,[106] 574 pregnancies were to women with HIV[107]
- 89% of these women were known to be living with HIV before pregnancy (the remaining women diagnosed during pregnancy), compared to approximately 40% in the early 2000s

Not included in these figures, however, are those not diagnosed, who are of particular concern due to the risk of uncontrolled disease, potentially increasing susceptibility to other infections and making other infections more complicated to treat, especially in pregnancy.

New diagnoses (screening year 2021 to 2022)

- 0.11 eligible pregnant women per 1,000 tested received a new HIV diagnosis (downward trend from 0.16 in 2017 to 2018)
- Women diagnosed with HIV during pregnancy in 2019 were diagnosed earlier (median gestational age 12 weeks) than in 2019 (13 weeks)

Antiretroviral therapy (ART)

- Women diagnosed with HIV during pregnancy in 2019 started ART earlier (median 16 weeks) than in 2010 (21 weeks), reflecting improved clinical guidelines and care pathways
- In 2021 to 2022, 98.5% of women were on ART during pregnancy, with the majority conceiving on ART (95.1%, an increase from 70.5% in 2015), 4.9% commencing ART during pregnancy (half of these during the first trimester) and 0.02% receiving no treatment
- 91.1% of pregnancies delivered with an undetectable viral load (equal or less than 50 copies per millilitre), reflecting high coverage of ART in pregnancy

Mode of delivery

- The proportion of women with HIV delivering vaginally steadily increased from 2003 to 2014 and has remained stable at nearly half of deliveries since 2015 (given the achievement of undetectable viral loads prior to birth)

Breastfeeding

- BHIVA guidelines recommend formula-feeding for infants born to women living with HIV, eliminating the risk of postnatal transmission; however, since 2012, it also states that 'women who are virologically suppressed on combination ART… who choose to breast feed should be supported to do so, but should be informed about the low risk of transmission'
- Between 2012 to 2021, there were 267 reports (3.1% of 8,526 deliveries) of breastfeeding with an increasing trend over time

Treating infections in pregnancy

Pregnant women usually die from undertreatment of an infection, not from overtreatment, often because of infections not being recognised. Treatment for infections in pregnancy should be considered as for non-pregnant women, with adaptations for pregnancy, which may require specialist advice or training. Pregnant women should receive prompt and safe care including appropriate escalation pathways. It is essential that healthcare workers 'Think Sepsis', use a multi-disciplinary team approach with senior clinical leadership, consider prompt imaging and act on the results, utilise an early warning system for monitoring, follow a sepsis bundle guideline and avoid assumptions about the safety of routine care, which may need to be tailored to pregnancy. Wherever possible, healthcare professionals should use evidence and guidance specifically developed for pregnant women, which has considered any mitigations needed such as shielding during radiological investigations or optimal drug choice in pregnancy. Healthcare professionals in maternity regularly balance the benefits and risks when presenting choices to pregnant women, accessing relevant guidance and/or expertise. Table 3 summarises the sources of current English guidance. Furthermore, appropriate treatment includes good source control (alongside antimicrobial therapy) to remove the origin of the infection, for example by draining an infected collection or debridement. Failure to achieve source control has been implicated in some maternal deaths in the UK.[108]

Table 3: Summary of sources of current English guidance relevant to both diagnosing and managing infections in pregnancy

National Institute for Health and Care Excellence (NICE)[109]	Pregnancy specific national guidance using the best available evidence to develop recommendations that guide decisions in health, public health and social care. For example, NICE guideline 51 "Suspected sepsis: recognition, diagnosis and early management".[110]

Royal College of Obstetrics and Gynaecology (RCOG) Guidelines[111]	Green-top Guidelines provide systematically developed recommendations to assist clinicians and patients in making decisions about appropriate treatment for specific conditions. For example, RCOG Green Top Guideline 64 "Identification and management of maternal sepsis during and following pregnancy".[112]
NHS England's maternal and neonatal safety improvement programme[113]	National policy to improve the prevention, identification, escalation and response to maternal and neonatal deterioration through the Maternity Early Warning Score (MEWS) tool and the Newborn Early Warning Trigger and Track (NEWTT2) tool.
Specialist infection societies guidance	For example: British Association for Sexual Health and HIV (BASH)[114] British Infection Association (BIA)[115]
Drug treatment safety information	UK Teratology Information Service (UKTIS) provides evidence-based safety information about medication, vaccine, chemical and radiological exposures in pregnancy.[116] LactMed, the Drugs and Lactation Database, contains information on drugs and other chemicals to which breastfeeding mothers may be exposed. It includes information on the levels of such substances in breast milk and infant blood, and the possible adverse effects in the breastfed infant. Suggested therapeutic alternatives to those drugs are provided, where appropriate.[117] BUMPS (Best Use of Medicines in Pregnancy) provides freely available, reliable, evidenced-based and accurate information about the use of medicines in pregnancy.[118]
Accessible lay information for pregnant women	For example: NHS pregnancy information.[119] National Childbirth Trust (NCT) information including on infections and vaccines.[120]
Travel infections advice	National Travel Health Network and Centre (NaTHNaC) was set up by the Department of Health in 2002 with the broad aim of *Protecting the Health of British Travellers*. It also provides pregnancy specific advice.[121]

Moving forwards: how to enable high-quality care for infections in pregnancy

Enhancing prevention

Healthcare professionals who care for pregnant women should have access to up-to-date educational resources about vaccination in pregnancy. Improved access to vaccinations across a variety of settings (such as within antenatal services) and provision by midwives can offer an effective alternative to provision of vaccines in primary care.[122] This requires regional pathways and commissioning.

Improving prompt recognition

When women first detect any symptoms of infection there needs to be a clear accessible pathway for timely assessment by a health care professional and prompt recognition of infection by the healthcare workers. For this to occur, women need to understand which signs and symptoms need assessment, where to access specialist assessment and be able to get there.

Getting the right expertise

While the management of infections in pregnancy is routine in every maternity unit, complex cases including those with sepsis, atypical presentations, unusual or resistant organisms or women with co-morbidities, may need more specialist expertise and there is a need for clear escalation pyramids to facilitate this. This includes routine escalation from primary to secondary care, but further escalation to tertiary care and more specialist expertise may be needed. This may be particularly needed with rising complexity in the obstetric population, including increased maternal age, rising numbers of multiple long-term conditions and higher rates of complex pregnancies compared to the maternity population in previous decades. Furthermore, there are more women giving birth who were born outside the UK or who have travelled and may be at risk of imported infections.

Obstetric specific national tools to support assessment, such as the Maternity Early Warning Score, should be implemented as standard. Complex cases should be managed by a multi-disciplinary team, with obstetric leadership and a shared care model between medical, anaesthetic, intensive care, infection, microbiology and other relevant services. With increasing specialisation within our medical workforce from an early stage in careers, there may be a loss of some generalism and expertise of healthcare professionals who can confidently care for unwell pregnant women including infection issues. All health care professionals should be aware of the signs and symptoms and response to deterioration in pregnancy. The growth of maternal medicine networks across the country provides a clear opportunity for the provision of advice to hospitals across secondary care. At a national level, there is a need to grow and maintain a small body of experts within the field of infection in pregnancy.

There is also a need for consistent implementation of existing pathways for non-acute infections, for example improving the follow-up of women that are diagnosed with Hepatitis B in pregnancy to prevent transmission of infection to their infant.

Data, research, innovation and implementation factors

Whilst there has been an active portfolio of research in pregnancy in the UK over many decades, substantial barriers remain. Whilst there is a requirement from the European Medical Agency for a Paediatric Investigational Plan for new entry drugs to be evaluated in children and young persons,[123] there is no such requirement for pregnancy and breast-feeding, despite calls for a similar Maternity Investigation Plan.[124] As a result, new entry vaccines and antimicrobials are not routinely evaluated for consideration in pregnancy.

There is precedent for effective research on infections and related interventions in pregnancy, including designing and delivering vaccine studies.

For example, a range of research methodologies have been used across several countries to develop national strategies for maternal pertussis vaccination in the third trimester with the aim of reducing infant mortality.[125, 126] In contrast, pregnant women were excluded from COVID-19 vaccine trials in the initial stages of development in 2020. COVID-19 vaccination commenced in the United States in early 2021, particularly as the Alpha wave caused severe disease in some unvaccinated pregnant women. This was supported by careful ongoing scrutiny of safety data and pregnancy outcomes, supported by a vaccine data registry. COVID-19 vaccines were then offered in the UK initially for highest risk pregnant women and then more widely, with similar data linkage established in England and Scotland to ascertain and report on safety and other outcomes. Investment in data infrastructure and linkage to enable such analyses has been critical to enabling timely outputs of particular importance in a pandemic and in the absence of research data garnered through clinical trials.

There is a need for a triple approach to addressing the inequalities in outcomes for pregnant and breastfeeding women with infections:

- improved routine data collection, curation, linkage and analysis
- greater opportunities for research participation across diagnostics, therapeutics, vaccines and socio-behavioural science
- appropriate implementation of evidence, with consideration of how research findings from non-pregnant populations may need to be adapted in pregnancy.

Conclusion

Infections in pregnancy pose a significant and sometimes under-recognised risk. While most infections in pregnancy are straightforward with no adverse outcomes for mother or baby, immunological and physiological changes in pregnancy can mean that some infections cause more severe disease. Infections in pregnancy can have significant consequences for both the woman and her baby with some infections primarily affecting the woman, others the fetus via vertical transmission (while causing little or no symptoms to the mother), and some may impact both the woman and baby. All infections require early recognition and prompt effective treatment, and some are preventable through vaccination.

Infections in pregnancy are likely to continue to be prevalent, due to travel trends, emerging patterns of diseases and increased threats of antimicrobial resistance. Our health structures around maternity care (including workforce) need to develop to meet these demands, with engagement from a wide number of stakeholders including maternity professionals, midwives, primary care and other physicians, and patient groups.

Mitigation strategies will be based on reinforcing current guidance including improved prevention (including increased vaccine uptake), earlier detection, access to specialist networks included shared care with infection experts and maternity networks via maternal medicine networks, centred around the needs of the pregnant woman and her baby.

References

1 Singer M, Deutschman CS, Seymour CW et al. The Third International Consensus Definitions for Sepsis and Septic Shock (Sepsis-3). JAMA. 2016 Feb 23;315(8):801-10. doi: 10.1001/jama.2016.0287.

2 World Health Organisation. Global Report on the Epidemiology and Burden of Sepsis: Current evidence, identifying gaps and future directions. [Internet] 2020. [Accessed 11 April 2025] Available from: https://www.who.int/publications/i/item/9789240010789

3 National Institute for Health and Care Excellence. Guideline NG51, 2016, Suspected sepsis: recognition, diagnosis and early management. [Internet] 2024. [Accessed 11 July 2025] Available from: https://www.nice.org.uk/guidance/ng51

4 Felker A, Patel R, Kotnis R et al. on behalf of MBRRACE-UK. Saving Lives, Improving Mothers' Care. [Internet] 2024. [Accessed 11 July 2025] Available from: https://www.npeu.ox.ac.uk/mbrrace-uk/reports/maternal-reports/maternal-report-2020-2022

5 Mertz D, Geraci J, Winkup J et al. Pregnancy as a risk factor for severe outcomes from influenza virus infection: A systematic review and meta-analysis of observational studies. Vaccine. 2017;35(4):521-528 doi: 10.1016/j.vaccine.2016.12.012

6 Vousden N, Bunch K, Knight M; UKOSS Influenza Co-Investigators Group. Incidence, risk factors and impact of seasonal influenza in pregnancy: A national cohort study. PLoS One. 2021;16(1):e0244986. doi: 10.1371/journal.pone.0244986.

7 Smith ER, Oakley E, Grandner GW et al. Adverse maternal, fetal, and newborn outcomes among pregnant women with SARS-CoV-2 infection: an individual participant data meta-analysis. BMJ Glob Health. 2023;8(1):e009495. doi: 10.1136/bmjgh-2022-009495.

8 Green LJ, Mackillop LH, Salvi D et al. Gestation-Specific Vital Sign Reference Ranges in Pregnancy. Obstet Gynecol. 2020;135(3):653-664. doi: 10.1097/AOG.0000000000003721.

9 Knight M, Bunch K, Felker A et al. on behalf of MBRRACE-UK. Saving Lives, Improving Mothers' Care Core Report – Lessons learned to inform maternity care from the UK and Ireland Confidential Enquiries into Maternal Deaths and Morbidity 2019-21. [Internet] 2023. Available from: https://www.npeu.ox.ac.uk/mbrrace-uk/reports/

10 Acosta CD, Kurinczuk JJ, Lucas DN, Tuffnell DJ, Sellers S, Knight M; United Kingdom Obstetric Surveillance System. Severe maternal sepsis in the UK, 2011-2012: a national case-control study. PLoS Med. 2014 8;11(7):e1001672. doi: 10.1371/journal.pmed.1001672.

11 World Health Organisation. Maternal mortality factsheet. [Internet] 2025. [Accessed 17 July 2025] Available from: https://www.who.int/news-room/fact-sheets/detail/maternal-mortality

12 World Health Organisation. Global Report on the Epidemiology and Burden of Sepsis: Current evidence, identifying gaps and future directions. [Internet] 2020. [Accessed 11 April 2025] Available from: https://iris.who.int/bitstream/handle/10665/334216/9789240010789-eng.pdf

13 Cresswell JA, Alexander M, Chong MYC et al. Global and regional causes of maternal deaths 2009-20: a WHO systematic analysis. Lancet Glob Health. 2025;13(4):e626-e634 doi: 10.1016/S2214-109X(24)00560-6

14 WHO Global Maternal Sepsis Study (GLOSS) Research Group. Frequency and management of maternal infection in health facilities in 52 countries (GLOSS): a 1-week inception cohort study. Lancet Glob Health. 2020;8(5):e661-e671. doi: 10.1016/S2214-109X(20)30109-1.

15 Say L, Chou D, Gemmill A et al. Global causes of maternal death: a WHO systematic analysis. *Lancet Glob Health.* 2014;2(6):e323-33 doi: 10.1016/S2214-109X(14)70227-X

16 WHO Global Maternal Sepsis Study (GLOSS) Research Group. Frequency and management of maternal infection in health facilities in 52 countries (GLOSS): a 1-week inception cohort study. Lancet Glob Health. 2020;8(5):e661-e671. doi: 10.1016/S2214-109X(20)30109-1.

17 Hensley MK, Bauer ME, Admon LK, Prescott HC. Incidence of Maternal Sepsis and Sepsis-Related Maternal Deaths in the United States. JAMA. 2019;322(9):890–892. doi:10.1001/jama.2019.9818.

18 WHO Global Maternal Sepsis Study (GLOSS) Research Group. Frequency and management of maternal infection in health facilities in 52 countries (GLOSS): a 1-week inception cohort study. Lancet Glob Health. 2020;8(5):e661-e671. doi: 10.1016/S2214-109X(20)30109-1.

19 WHO Global Maternal Sepsis Study (GLOSS) Research Group. Frequency and management of maternal infection in health facilities in 52 countries (GLOSS): a 1-week inception cohort study. Lancet Glob Health. 2020;8(5):e661-e671. doi: 10.1016/S2214-109X(20)30109-1.

20 Daoud AK, Oxford-Horrey C. Long-term sequelae and management following obstetric sepsis. Semin Perinatol. 2024;48(7):151981 doi: 10.1016/j.semperi.2024.151981.

21 Office for National Statistics. Births in England and Wales: birth registrations. [Internet] 2025. [Accessed 11 July 2025] Available from: https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/livebirths/datasets/birthsinenglandandwalesbirthregistrations

22 Director-General Health and Social Care. Women's health plan 2021 to 2024: data landscape review. [Internet] 2024. [Accessed 11 July 2025]. Available from: https://www.gov.scot/publications/womens-health-plan-review-data-landscape/pages/3/

23 Northern Ireland Statistics and Research Agency. Registrar General Annual Report. [Internet] 2024. [Accessed 11 July 2025] Available from: https://view.officeapps.live.com/op/view.aspx?src=https%3A%2F%2Fwww.nisra.gov.uk%2Fsystem%2Ffiles%2Fstatistics%2FSection%25203%2520-%2520Births_Tables_2023.xlsx&wdOrigin=BROWSELINK

24 Confidential Enquiry into Maternal and Child Health. Saving Mothers Lives: Reviewing maternal deaths to make motherhood safer – 2003-2005. [Internet] 2007. Available from: https://www.publichealth.hscni.net/sites/default/files/Saving%20Mothers%27%20Lives%202003-05%20Executive%20Summary.pdf

25 Felker A, Patel R, Kotnis R et al. on behalf of MBRRACE-UK. Saving Lives, Improving Mothers' Care: Surveillance findings and lessons learned to inform maternity care from the UK and Ireland Confidential Enquiries into Maternal Deaths from thrombosis and thromboembolism, malignancy and ectopic pregnancy 2020-2022, and morbidity findings for recent migrants with language difficulties. [Internet] 2024. Available from: https://www.npeu.ox.ac.uk/mbrrace-uk/reports/maternal-reports/maternal-report-2020-2022

26 Felker A, Patel R, Kotnis R et al. on behalf of MBRRACE-UK. Saving Lives, Improving Mothers' Care: Surveillance findings and lessons learned to inform maternity care from the UK and Ireland Confidential Enquiries into Maternal Deaths from thrombosis and thromboembolism, malignancy and ectopic pregnancy 2020-2022, and morbidity findings for recent migrants with language difficulties. [Internet] 2024. Available from: https://www.npeu.ox.ac.uk/mbrrace-uk/reports/maternal-reports/maternal-report-2020-2022

27 NHS Digital. Hospital admitted patient care activity 2023-2024. [Internet] 2024. [Accessed 11 July 2025] Available from: https://digital.nhs.uk/data-and-information/publications/statistical/hospital-admitted-patient-care-activity

28 J. Jardine, H. Aughey, NMPA Project Team, et al., Maternity Admissions to Intensive Care in England, Wales and Scotland in 2015/16: A Report From the National Maternity and Perinatal Audit (London, UK: RCOG, 2019). [Internet] 2019. [Accessed 11 July 2025] Available from: https://www.hqip.org.uk/resource/national-maternity-and-perinatal-audit-intensive-care-report/

29 Acosta CD, Kurinczuk JJ, Lucas DN, Tuffnell DJ, Sellers S, Knight M; United Kingdom Obstetric Surveillance System. Severe maternal sepsis in the UK, 2011-2012: a national case-control study. PLoS Med. 2014 8;11(7):e1001672. doi: 10.1371/journal.pmed.1001672

30 Marmot M, Allen J, Goldblatt P, et al. Fair society, healthy lives. Strategic review of health inequalities in England, 2010. [Internet] 2010. Available from: http://www.instituteofhealthequity.org/resources-reports/fair-society-healthy-lives-the-marmot-review

31 Felker A, Patel R, Kotnis R et al. on behalf of MBRRACE-UK. Saving Lives, Improving Mothers' Care Core Report – Lessons learned to inform maternity care from the UK and Ireland Confidential Enquiries into Maternal Deaths and Morbidity 2020-22. [Internet] 2024. Available from: https://www.npeu.ox.ac.uk/mbrrace-uk/reports/maternal-reports/maternal-report-2020-2022

32 Acosta CD, Kurinczuk JJ, Lucas DN, Tuffnell DJ, Sellers S, Knight M; United Kingdom Obstetric Surveillance System. Severe maternal sepsis in the UK, 2011-2012: a national case-control study. PLoS Med. 2014 8;11(7):e1001672. doi: 10.1371/journal.pmed.1001672

33 Acosta CD, Harrison DA, Rowan K, Lucas DN, Kurinczuk JJ, Knight M. Maternal morbidity and mortality from severe sepsis: a national cohort study. BMJ Open. 2016: 23;6(8):e012323. doi: 10.1136/bmjopen-2016-012323.

34 Kim MK, Lee SM, Bae SH et al. Socioeconomic status can affect pregnancy outcomes and complications, even with a universal healthcare system. Int J Equity Health. 2018 5;17(1):2. doi: 10.1186/s12939-017-0715-7.

35 Jardine J, Walker K, Gurol-Urganci I et al. Adverse pregnancy outcomes attributable to socioeconomic and ethnic inequalities in England: a national cohort study. The Lancet. 2021;398(10314):1905-1912

36 Kapaya, H., Mercer, E., Boffey, F. et al. Deprivation and poor psychosocial support are key determinants of late antenatal presentation and poor fetal outcomes-a combined retrospective and prospective study. BMC Pregnancy Childbirth 2015;15(309) doi: 10.1186/s12884-015-0753-3

37 Office for National Statistics. Births by parents country of birth in England and Wales: 2023. [Internet] 2024. Available from: https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/.

38 Felker A, Patel R, Kotnis R et al. on behalf of MBRRACE-UK. Saving Lives, Improving Mothers' Care Core Report – Lessons learned to inform maternity care from the UK and Ireland Confidential Enquiries into Maternal Deaths and Morbidity 2020-22. [Internet] 2024. Available from: https://www.npeu.ox.ac.uk/mbrrace-uk/reports/maternal-reports/maternal-report-2020-2022

39 Felker A, Patel R, Kotnis R et al. on behalf of MBRRACE-UK. Saving Lives, Improving Mothers' Care Core Report – Lessons learned to inform maternity care from the UK and Ireland Confidential Enquiries into Maternal Deaths and Morbidity 2020-22. [Internet] 2024. Available from: https://www.npeu.ox.ac.uk/mbrrace-uk/reports/maternal-reports/maternal-report-2020-2022

40 Walker JL, Rentsch CT, McDonald HI et al. Social determinants of pertussis and influenza vaccine uptake in pregnancy: a national cohort study in England using electronic health records. BMJ Open. 2021; 11(6):e046545. doi: 10.1136/bmjopen-2020-046545

41 WHO Global Maternal Sepsis Study (GLOSS) Research Group. Frequency and management of maternal infection in health facilities in 52 ountries (GLOSS): a 1-week inception cohort study. Lancet Glob Health 2020;8(5):e661-e671 doi: 10.1016/S2214-109X(20)30109-1

42 S. J. Knowles, N. P. O'Sullivan, A. M. Meenan, R. Hanniffy, and M. Robson. Maternal Sepsis Incidence, Aetiology and Outcome for Mother and Fetus: A Prospective Study. BJOG. 2015;122(5):663-71 doi: 10.1111/1471-0528.12892

43 Acosta CD, Harrison DA, Rowan K, Lucas DN, KurinczukJJ, Knight M. Maternal morbidity and mortality from severe sepsis: a national cohort study. BMJ Open. 2016: 23;6(8):e012323. doi: 10.1136/bmjopen-2016-012323.

44 Hay P. Genito-urinary infections in pregnancy. Women's Health Med 2005;2:47-50 doi: 10.1383/wohm.2.2.47.63058

45 WHO Global Maternal Sepsis Study (GLOSS) Research Group. Frequency and management of maternal infection in health facilities in 52 countries (GLOSS): a 1-week inception cohort study. Lancet Glob Health 2020;8(5):e661-e671 doi: 10.1016/S2214-109X(20)30109-1

46 Lissauer, D., Morgan, M., Banerjee, A., Plaat, F., Pasupathy, D. and the Royal College of Obstetrics and Gynaecology. Identification and Management of Maternal Sepsis During and Following Pregnancy: Green-top Guideline No. 64. BJOG. 2025;132(4):e61-e85 doi: 10.llll/1471-0528.18009

47 Leonard A, Wright A, Saavedra-Campos M, et al.. Severe group A streptococcal infections in mothers and their newborns in London and the South East, 2010-2016: assessment of risk and audit of public health management. BJOG. 2019 Jan;126(1):44-53. doi: 10.1111/1471-0528.15415.

48 UK Health Security Agency. Sexually transmitted infections (STIs): annual data. [Internet] 2025. Available from: https://www.gov.uk/government/statistics/sexually-transmitted-infections-stis-annual-data-tables

49 NHS England. ISOSS Syphilis report (for pregnancies between 1 April 2021 to 31 March 2022). [Internet] 2024. Available from: https://www.gov.uk/government/publications/idps-isoss-syphilis-outcome-report-2023/isoss-syphilis-report-2023#summary-and-next-steps

50 Royal College of Obstetricians and Gynaecologists. The Diagnosis and Treatment of Malaria in Pregnancy (Green-top Guideline No. 54b). [Internet] 2010. [Accessed 11 July 2025] Available from: https://www.rcog.org.uk/guidance/browse-all-guidance/green-top-guidelines/the-diagnosis-and-treatment-of-malaria-in-pregnancy-green-top-guideline-no-54b/

51 UK Health Security Agency. Guidelines for malaria prevention in travellers from the United Kingdom, 2024. [Internet] 2024. [Accessed 11 July 2025] Available from: https://www.gov.uk/government/publications/malaria-prevention-guidelines-for-travellers-from-the-uk

52 UK Health Security Agency. Guidelines for malaria prevention in travellers from the United Kingdom, 2024. [Internet] 2024. [Accessed 11 July 2025] Available from: https://assets.publishing.service.gov.uk/media/67f7c23ac6046b50261bc7f3/guidelines-for-malaria-prevention-in-travellers-from-the-UK-2024.pdf

53 Royal College of Obstetricians and Gynaecologists. The Diagnosis and Treatment of Malaria in Pregnancy (Green-top Guideline No. 54b). [Internet] 2010. [Accessed 11 July 2025] Available from: https://www.rcog.org.uk/guidance/browse-all-guidance/green-top-guidelines/the-diagnosis-and-treatment-of-malaria-in-pregnancy-green-top-guideline-no-54b/

54 Lindsay S, Ansell J, Selman C, Cox V, Hamilton K, Walraven G. Effect of pregnancy on exposure to malaria mosquitoes. Lancet. 2000; 3;355(9219):1972. doi: 10.1016/S0140-6736(00)02334-5.

55 Luxemburger C, Ricci F, Nosten F, Raimond D, Bathet S, White NJ. The epidemiology of severe malaria in an area of low transmission in Thailand. Trans R Soc Trop Med Hyg. 1997;91(3):256-62. doi: 10.1016/s0035-9203(97)90066-3.

56 Steketee RW, Nahlen BL, Parise ME, Menendez C. The burden of malaria in pregnancy in malaria-endemic areas. Am J Trop Med Hyg 2001;64:28–35. doi: 10.4269/ajtmh.2001.64.28.

57 Royal College of Obstetricians and Gynaecologists. The Diagnosis and Treatment of Malaria in Pregnancy (Green-top Guideline No. 54b). 28 April 2010. Available from: https://www.rcog.org.uk/guidance/browse-all-guidance/green-top-guidelines/the-diagnosis-and-treatment-of-malaria-in-pregnancy-green-top-guideline-no-54b/ (accessed 11/7/2025)

58 UK Health Security Agency. Guidelines for malaria prevention in travellers from the United Kingdom, 2024. [Internet] 2024. [Accessed 11 July 2025] Available from: https://www.gov.uk/government/publications/malaria-prevention-guidelines-for-travellers-from-the-uk

59 UK Health Security Agency. Zika virus (ZIKV): clinical and travel guidance. [Internet] 2025. [Accessed 11 July 2025] Available from: https://www.gov.uk/government/collections/zika-virus-zikv-clinical-and-travel-guidance

60 Lindsay S, Ansell J, Selman C, Cox V, Hamilton K, Walraven G. Effect of pregnancy on exposure to malaria mosquitoes. Lancet. 2000;3;355(9219):1972. doi: 10.1016/S0140-6736(00)02334-5.

61 UK Health Security Agency. Zika virus (ZIKV): clinical and travel guidance. [Internet] 2025. Available from: https://www.gov.uk/government/collections/zika-virus-zikv-clinical-and-travel-guidance#zika-and-pregnancy

62 UK Health Security Agency. Chagas disease: migrant health guide. [Internet] 2025. [Accessed 11 July 2025] Available from: https://www.gov.uk/guidance/chagas-disease-migrant-health-guide

63 Siston AM, Rasmussen SA, Honein MA et al. Pandemic 2009 influenza a(H1N1) virus illness among pregnant women in the United States. JAMA. 2010;303(15):1517–25. doi: 10.1001/jama.2010.479.

64 Creanga AA, Johnson TF, Graitcer SB et al. Severity of 2009 pandemic influenza a (H1N1) virus infection inpregnant women. Obstet Gynecol. 2010;115(4):717–26. doi: 10.1097/AOG.0b013e3181d57947.

65 World Health Organisation. Guiding maternal and perinatal health research during global pandemics. [Internet] 2025. Available from: https://www.who.int/news/item/14-02-2025-guiding-maternal-and-perinatal-health-research-during-global-pandemics

66 Semmelweiss, IP. Etiology, Concept and Prophylaxis of Childbed Fever. 1861.

67 Bukasa A, Campbell H, Brown K et al. Rubella infection in pregnancy and congenital rubella in United Kingdom, 2003 to 2016. Euro Surveill. 2018;23(19):17-00381. doi: 10.2807/1560-7917.ES.2018.23.19.17-00381.

68 UK Health Security Agency. Vaccine update issue 354, January 2025, maternity special. [Internet] 2025. Available from: https://www.gov.uk/government/publications/vaccine-update-issue-354-january-2025-maternity-special/vaccine-update-issue-354-january-2025-maternity-special

69 Department of Health and Social Care. JCVI statement on COVID-19 vaccination in 2025 and spring 2026. [Internet] 2024. [Accessed 11 July 2025] Available from: https://www.gov.uk/government/publications/covid-19-vaccination-in-2025-and-spring-2026-jcvi-advice/jcvi-statement-on-covid-19-vaccination-in-2025-and-spring-2026

70 UK Health Security Agency. Vaccine update issue 354, January 2025, maternity special. [Internet] 2025. Available from: https://www.gov.uk/government/publications/vaccine-update-issue-354-january-2025-maternity-special/vaccine-update-issue-354-january-2025-maternity-special

71 UK Health Security Agency. Vaccine update issue 354, January 2025, maternity special. [Internet] 2025. Available from: https://www.gov.uk/government/publications/vaccine-update-issue-354-january-2025-maternity-special/vaccine-update-issue-354-january-2025-maternity-special

72 UK Health Security Agency. Vaccine update issue 354, January 2025, maternity special. [Internet] 2025. Available from: https://www.gov.uk/government/publications/vaccine-update-issue-354-january-2025-maternity-special/vaccine-update-issue-354-january-2025-maternity-special

73 UK Health Security Agency. Seasonal influenza vaccine uptake in GP patients: monthly data, 2024 to 2025. [Internet] 2025. Available from: https://www.gov.uk/government/statistics/seasonal-influenza-vaccine-uptake-in-gp-patients-monthly-data-2024-to-2025

74 UK Health Security Agency. Vaccine update issue 354, January 2025, maternity special. [Internet] 2025. Available from: https://www.gov.uk/government/publications/vaccine-update-issue-354-january-2025-maternity-special/vaccine-update-issue-354-january-2025-maternity-special

75 UK Health Security Agency. Vaccine update issue 354, January 2025, maternity special. [Internet] 2025. Available from: https://www.gov.uk/government/publications/vaccine-update-issue-354-january-2025-maternity-special/vaccine-update-issue-354-january-2025-maternity-special

76 UK Health Security Agency. Whooping cough vaccination in pregnancy guide. [Internet] 2024. [Accessed 11 July 2025] Available from: https://www.gov.uk/government/publications/resources-to-support-whooping-cough-vaccination/whooping-cough-vaccination-in-pregnancy-guide

77 UK Health Security Agency. Vaccine update issue 354, January 2025, maternity special. [Internet] 2025. Available from: https://www.gov.uk/government/publications/vaccine-update-issue-354-january-2025-maternity-special/vaccine-update-issue-354-january-2025-maternity-special

78 UK Health Security Agency. Vaccine update issue 354, January 2025, maternity special. [Internet] 2025. Available from: https://www.gov.uk/government/publications/vaccine-update-issue-354-january-2025-maternity-special/vaccine-update-issue-354-january-2025-maternity-special

79 UK Health Security Agency, RSV maternal vaccination coverage in England: December 2024. [Internet] 2025. Available from: https://www.gov.uk/government/publications/rsv-immunisation-for-older-adults-and-pregnant-women-vaccine-coverage-in-england/rsv-maternal-vaccination-coverage-in-england-december-2024#:~:text=Overall%2C%20the%20monthly%20RSV%20maternal,for%20December%202024%20was%2047.6%25.

80 Kilich E, Dada S, Francis MR et al. Factors that influence vaccination decision-making among pregnant women: A systematic review and meta-analysis. PLoS One. 2020;15(7):e0234827. doi: 10.1371/journal.pone.0234827

81 Razai MS, Mansour R, Ravindran P et al. Facilitators and barriers to vaccination uptake in pregnancy: A qualitative systematic review. PLoS One. 2024;19(4):e0298407. doi: 10.1371/journal.pone.0298407

82 Kilich E, Dada S, Francis MR et al. Factors that influence vaccination decision-making among pregnant women: A systematic review and meta-analysis. PLoS One. 2020;15(7):e0234827. doi: 10.1371/journal.pone.0234827.

83 Razai MS, Mansour R, Goldsmith L et al. Interventions to increase vaccination against COVID-19, influenza and pertussis during pregnancy: a systematic review and meta-analysis. J Travel Med. 2023;30(8):taad138. doi: 10.1093/jtm/taad138.

84 Skirrow H, Barnett S, Bell S, Mounier-Jack S, Kampmann B, Holder B. Women's views and experiences of accessing pertussis vaccination in pregnancy and infant vaccinations during the COVID-19 pandemic: A multi-methods study in the UK. Vaccine. 2022;40(34):4942-4954. doi: 10.1016/j.vaccine.2022.06.076. Epub 2022 Jul 1. PMID: 35811204; PMCID: PMC9247266.

85 Woodcock T, Novov V, Skirrow H et al. Characteristics associated with influenza vaccination uptake in pregnancy: a retrospective cohort study. Br J Gen Pract. 2023;73(727):e148-e155. doi: 10.3399/BJGP.2022.0078.

86 Skirrow H, Barnett S, Bell S et al. Women's views on accepting COVID-19 vaccination during and after pregnancy, and for their babies: a multi-methods study in the UK. BMC Pregnancy Childbirth. 2022;22(1):33. doi: 10.1186/s12884-021-04321-3.

87 Ihenetu G, Aylin P, Novov V et al. Uptake of COVID-19 vaccines and association with hospitalisation due to COVID-19 in pregnancy: Retrospective cohort study. Vaccine. 2024;42(25):126214. doi: 10.1016/j.vaccine.2024.126214.

88 Walker JL, Rentsch CT, McDonald HI, et al. Social determinants of pertussis and influenza vaccine uptake in pregnancy: a national cohort study in England using electronic health records. BMJ Open 2021;**11:**e046545. doi: 10.1136/bmjopen-2020-046545

89 Norman G, Kletter M, Dumville J. Interventions to increase vaccination in vulnerable groups: rapid overview of reviews. BMC Public Health. 2024;24(1):1479. doi: 10.1186/s12889-024-18713-5.

90 Callahan, AG., Coleman-Cowger, VH. Schulkin, J. et al. Racial disparities in influenza immunization during pregnancy in the United States: A narrative review of the evidence for disparities and potential interventions. Vaccine. 2021;39(35):4938-4948 doi: 10.1016/j.vaccine.2021.07.028.

91 Razai MS, Mansour R, Goldsmith L et al. Interventions to increase vaccination against COVID-19, influenza and pertussis during pregnancy: a systematic review and meta-analysis. J Travel Med. 2023;30(8):taad138. doi: 10.1093/jtm/taad138.

92 Razai MS, Mansour R, Goldsmith L et al. Interventions to increase vaccination against COVID-19, influenza and pertussis during pregnancy: a systematic review and meta-analysis. J Travel Med. 2023;30(8):taad138. doi: 10.1093/jtm/taad138.

93 Bumps. Best use of medicines in pregnancy. [Internet] [Accessed 11 July 2025] Available from: https://www.medicinesinpregnancy.org/

94 NHS England. ISSOS hepatitis B report (for pregnancies between 1 April 2021 to 31 March 2022). [Internet] 2025. Available from: https://www.gov.uk/government/publications/idps-isoss-hepatitis-b-outcome-report-2023/isoss-hepatitis-b-report-for-pregnancies-between-1-april-2022-to-31-march-2023

95 NHS England. ISOSS HIV report (for pregnancies between 1 April 2021 to 31 March 2022). [Internet] 2025. Available from: https://www.gov.uk/government/publications/idps-isoss-hiv-outcome-report-2023/isoss-hiv-report-2023

96 NHS England. ISOSS Syphilis report (for pregnancies between 1 April 2021 to 31 March 2022). [Internet] 2024. Available from: https://www.gov.uk/government/publications/idps-isoss-syphilis-outcome-report-2023/isoss-syphilis-report-2023

97 NHS England. ISSOS hepatitis B report (for pregnancies between 1 April 2021 to 31 March 2022). [Internet] 2025. Available from: https://www.gov.uk/government/publications/idps-isoss-hepatitis-b-outcome-report-2023/isoss-hepatitis-b-report-for-pregnancies-between-1-april-2022-to-31-march-2023

98 UK Health Security Agency. Guidance on the hepatitis B antenatal screening and selective neonatal immunisation pathway. [Internet] 2025. Available from https://www.gov.uk/government/publications/hepatitis-b-antenatal-screening-and-selective-neonatal-immunisation-pathway/guidance-on-the-hepatitis-b-antenatal-screening-and-selective-neonatal-immunisation-pathway--2

99 UK Health Security Agency. Guidance on the hepatitis B antenatal screening and selective neonatal immunisation pathway. [Internet] 2025. Available from https://www.gov.uk/government/publications/hepatitis-b-antenatal-screening-and-selective-neonatal-immunisation-pathway/guidance-on-the-hepatitis-b-antenatal-screening-and-selective-neonatal-immunisation-pathway--2

100 NHS England. ISOSS hepatitis B report (for pregnancies between 1 April 2021 to 31 March 2022). [Internet] 2025. Available from: https://www.gov.uk/government/publications/idps-isoss-hepatitis-b-outcome-report-2023/isoss-hepatitis-b-report-2023#pregnancy-outcome

101 Peters H, Francis, K., Smeaton, L., Thorne C. Congenital syphilis among women with a negative screen in pregnancy, England 2015-23. BASH conference, 2024. [Internet] 2024. Available from: https://www.ucl.ac.uk/integrated-screening-outcomes-surveillance/sites/integrated_screening_outcomes_surveillance/files/peters_o1_isoss_congenital_syphilis_negative_in_pregnancy.pdf

102 NHS England. Guidance ISOSS HIV report. [Internet] 2024.

103 British HIV Association (BHIVA). BHIVA guidelines for the management of HIV in pregnancy and postpartum 2018. [Internet] 2020. Available from: https://www.bhiva.org/wp-content/uploads/2024/10/BHIVA-Pregnancy-guidelines-2020-3rd-interim-update.pdf

104 Public Health England. Health Protection Report. Antenatal screening for infectious diseases in England: summary report for 2015. [Internet] 2017. Available from: www.gov.uk/government/uploads/system/uploads/attachment_data/file/583576/hpr0217_naism.pdf

105 NHS England. ISOSS HIV report (for pregnancies between 1 April 2021 to 31 March 2022). [Internet] 2024. Available from: https://www.gov.uk/government/publications/idps-isoss-hiv-outcome-report-2023/isoss-hiv-report-2023

106 NHS Digital: NHS Maternity Statistics, England – 2021-22. [Internet] 2022. [Accessed 16 July 2025] Available from: https://digital.nhs.uk/data-and-information/publications/statistical/nhs-maternity-statistics/2021-22

107 NHS England. ISOSS HIV report (for pregnancies between 1 April 2021 to 31 March 2022). [Internet] 2024. [Accessed 16 July 2025] Available from: https://www.gov.uk/government/publications/idps-isoss-hiv-outcome-report-2023/isoss-hiv-report-2023

108 Knight M, Bunch K, Cairns A et al. on behalf of MBRRACE-UK. Saving Lives, Improving Mothers' Care Rapid Report 2021: Learning from SARS-CoV-2-related and associated maternal deaths in the UK June 2020- March 2021. [Internet] 2024. Available from: https://www.npeu.ox.ac.uk/mbrrace-uk/reports/maternal-reports/covid-rapid-report-2021

109 National Institute for Health and Care Excellence. Pregnancy. [Internet] [Accessed 11 July 2025] Available from: https://www.nice.org.uk/Guidance/Conditions-and-diseases/Fertility--pregnancy-and-childbirth/Pregnancy

110 National Institute for Health and Care Excellence. Suspected sepsis: recognition, diagnosis and early management NICE guideline. [Internet] 2024. [Accessed 11 July 2025] Available from: https://www.nice.org.uk/guidance/ng51

111 Royal College of Obstetricians & Gynaecologists. Green-top Guidelines. [Internet] [Accessed 11 July 2025] Available from: https://www.rcog.org.uk/guidance/browse-all-guidance/green-top-guidelines/

112 Lissauer D, Morgan M, Banerjee A, Plaat F, Pasupathy D; Royal College of Obstetrics and Gynaecology. Identification and Management of Maternal Sepsis during and following Pregnancy: Green-top Guideline No. 64. BJOG. 2025;132(4):e61-e85. doi: 10.1111/1471-0528.18009.

113 NHS England. Maternity and Neonatal Safety Improvement Programme. [Internet] [Accessed 11 July 2025] Available from: https://www.england.nhs.uk/mat-transformation/maternal-and-neonatal-safety-collaborative/

114 British Association for Sexual Health and HIV. Guidelines. [Internet] [Accessed 11 July 2025] Available from: https://www.bashh.org/resources/guidelines

115 British Infection Association. Published and Reference Guidance. [Internet] [Accessed 11 July 2025] Available from: https://britishinfection.org/guidance/published-guidelines

116 UK teratology information service. Evidence-based safety information about medication, vaccine, chemical and radiological exposures in pregnancy. [Internet] [Accessed 11 July 2025] Available from: https://uktis.org/

117 Drugs and Lactation Database (LactMed®) [Internet]. Bethesda (MD): National Institute of Child Health and Human Development; 2006-. [Accessed 11 July 2025] Available from: https://www.ncbi.nlm.nih.gov/books/NBK501922/

118 Bumps. Best use of medicines in pregnancy. [Internet] [Accessed 11 July 2025] Available from: https://www.medicinesinpregnancy.org/ (accessed 11/7/2025)

119 NHS, Pregnancy [Internet, no date]. [Accessed 24 November 2025] Available from: https://www.nhs.uk/pregnancy/

120 National Childbirth Trust. Recognising and treating infections in pregnancy. [Internet] 2025. [Accessed 2 May 2025] Available from: https://www.nct.org.uk/information/pregnancy/body-pregnancy/infections-during-pregnancy

121 Travelhealthpro. Pregnancy. [Internet] [Accessed 2 May 2025] Available from: https://travelhealthpro.org.uk/factsheet/45/pregnancy

122 Skirrow H, Holder B, Meinel A et al. Evaluation of a midwife-led, hospital based vaccination service for pregnant women. Hum Vaccin Immunother. 2021;17(1):237-246. doi: 10.1080/21645515.2020.1770515.

123 European Medicines Agency. Paediatric investigation plans. [Internet] Available from: https://www.ema.europa.eu/en/human-regulatory-overview/research-development/paediatric-medicines-research-development/paediatric-investigation-plans

124 Chappell LC, David AL. Improving the Pipeline for Developing and Testing Pharmacological Treatments in Pregnancy. PLoS Med. 2016;13(11):e1002161 doi: 10.1371/journal.pmed.1002161

125 Saso A, Kampmann B. What Is the Impact of Maternal Pertussis Immunization in Pregnancy on the Quantity, Quality and Longevity of Infant Vaccine Responses?: A Review of the Current Evidence. Pediatr Infect Dis J. 2025;44(2S):S49-S55 doi: 10.1097/INF.0000000000004692

126 De Weerdt L, Herzog SA, Van Damme P, Maertens K. Timing of pertussis vaccination during pregnancy: Evidence and implementation – A systematic review. Vaccine. 2024;42(21):126152 doi: 10.1016/j.vaccine.2024.07.053

3.3 Neonatal infections in England: current challenges, emerging trends

Simon B Drysdale – Associate Professor, University of Oxford and Consultant in Paediatric Infectious Diseases and Immunology, Children's Hospital, Oxford

Aung Soe – Consultant Neonatologist, Medway NHS Foundation Trust, Gillingham

Paul T Heath – Professor of Paediatric Infectious Diseases, City St George's, University of London, London

Introduction

Neonatal infections represent a critical challenge in modern perinatal medicine, significantly affecting neonatal outcomes and placing considerable demands on healthcare resources. Compared with children and adults, neonates demonstrate differences in nearly all aspects of immunity and this, compounded by their exposure to invasive procedures and the hospital environment, accounts for their increased susceptibility to infections.

Over recent decades, improvements in neonatal intensive care have increased survival rates. However, this progress has been accompanied by a rising incidence of infection-related complications. The challenges of managing evolving patterns of antibiotic resistance and emerging pathogens underscore the necessity for an integrated approach that combines clinical vigilance, robust infection control and innovative preventive strategies.

Recent highlights in the prevention of neonatal infections include the routine implementation of an effective respiratory syncytial virus (RSV) vaccine for pregnant women together with a complementary RSV monoclonal antibody programme for high-risk infants. A large cluster randomised controlled trial (GBS3) will soon clarify whether a universal swab-based screening intrapartum antibiotic prophylaxis (IAP) programme, or the current risk-based screening programme, is most clinically and cost effective in preventing early onset Group B Streptococcus (GBS) infections, while forthcoming trials of GBS vaccines for pregnant women offer the potential for more comprehensive prevention of GBS infections in babies. Screening and vaccination programmes have shown success against rubella and Hepatitis B infections while policies on improved hygiene during pregnancy have reduced neonatal listeria infections and allowed simplification of empiric antibiotic regimens for infants with sepsis and meningitis.

This chapter is structured to first review the epidemiological burden of neonatal infections and then detail the underlying microbiological agents and transmission dynamics. Subsequent sections address risk factors, clinical presentations and current diagnostic, management and preventative strategies.

Definition of a "neonate"

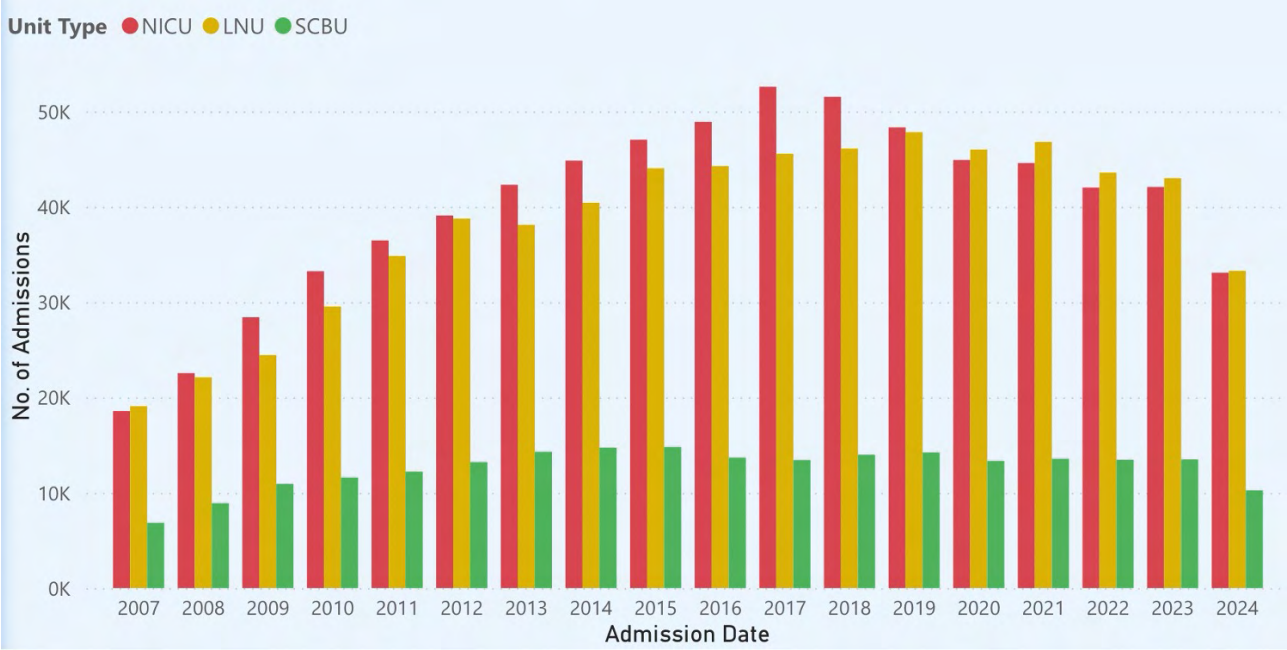
In this chapter, the term "neonate" will include infants from birth up to 90 days (3 months) of age, encompassing the typical neonatal period (first 28 days) and extending to capture late-onset infections. This definition acknowledges that infections can manifest beyond the classical 28-day window, especially in infants born prematurely and who are cared for on neonatal units (NNUs).

Defining "term" versus "preterm"

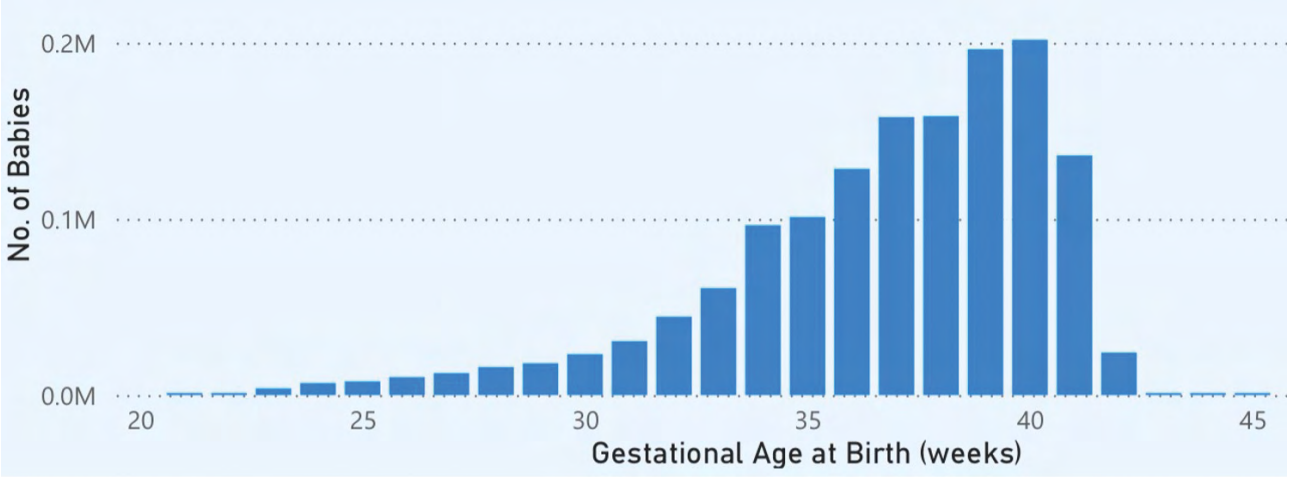
In neonatal medicine, "term" infants are those born at 37 to 42 weeks of gestation, having completed full *in utero* development. "Preterm" infants are born before 37 weeks, with further categorisation: "late preterm" (34 to 36 weeks), "moderate preterm" (32 to 33 weeks), "very preterm" (28 to 31 weeks), and "extremely preterm" (less than 28 weeks). "Post-term" are those infants born after 42 weeks of gestation. Each preterm category reflects increasing immaturity, with lower gestational ages correlating with higher risks of infections and complications. This classification is essential for determining appropriate clinical interventions, long-term support and optimal outcomes for these vulnerable infants. It underpins targeted research, informs public health strategies globally and improves overall care. Figure 1 shows the number of babies admitted to NNUs in England and Wales overall from 2007 to 2024 and how many of these were born at different gestations (point of pregnancy).[1] It should be emphasised that most babies who receive neonatal care are born full term and that, overall, approximately 1 in 7 babies are admitted to a NNU.[2]

Figure 1: Number of admissions to NNUs (a), and breakdown by gestational age (b), in England and Wales, 2007 to 2024[3]

(a)



(b)



NICU: neonatal intensive care unit; LNU: local neonatal unit; SCBU: special care baby unit.

Source: The UK National Neonatal Research Database, a UK Health Research Authority approved national data asset, developed and managed at Imperial College London; https://www.imperial.ac.uk/neonatal-data-analysis-unit/neonatal-data-analysis-unit/. Open access under the Creative Commons BY license.

Understanding early versus late onset sepsis and congenital infection

In neonates, sepsis is classified as early or late onset based on timing and likely source. Early onset sepsis (EOS) occurs within the first 72 hours of life and is usually due to vertical transmission around the time of birth, with pathogens colonising the birth tract such as Group B Streptococcus and *Escherichia coli* being most common. Late onset sepsis (LOS) appears after 72 hours, often resulting from hospital-acquired or community sources. LOS is associated with prolonged hospitalisation, invasive procedures and environmental exposures. The most

common pathogens are coagulase-negative staphylococci and *Staphylococcus aureus*. A congenital infection is acquired *in utero* (before birth) that may result in clinical signs of disease in the newborn period or may remain asymptomatic initially but cause complications later in life (see section below).

Recognising clinical or culture-negative sepsis

It is well recognised that many neonates with clinical features compatible with sepsis may in fact have negative blood (and other sterile site) cultures. This is a significant problem for clinicians and as a result most neonates who receive antibiotics do not have a proven bacterial infection. Possible explanations include the small volumes of blood obtained for culture from neonates, the absence of a bacteraemia with some infections (such as pneumonia) or the presence of non-culturable pathogens (such as viruses). The non-specific nature of clinical signs in neonates, however, means that a non-infectious cause for the presentation of "sepsis" is also possible.

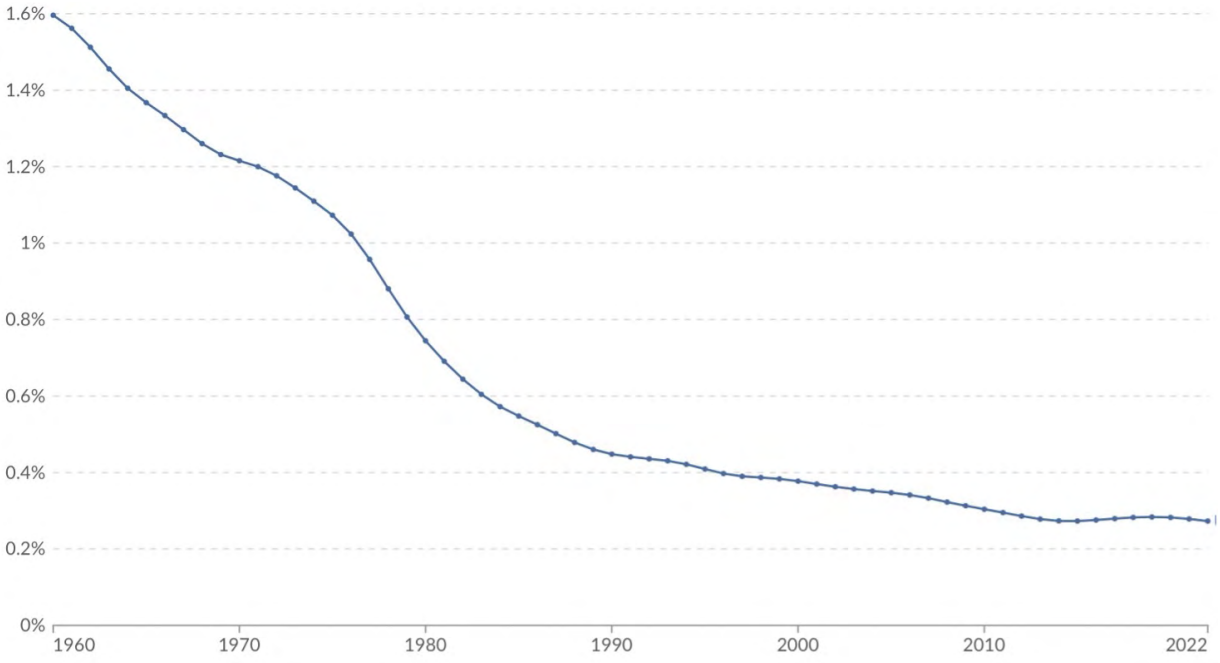
Highlighting the routes of presentation to healthcare for neonates with infection

Neonatal infections may present via 2 distinct pathways. First, some infants develop infection soon after birth while still in hospital and will be cared for on the NNU or postnatal ward by neonatal teams. Second, some infants may initially appear well and be discharged, only to later present to the hospital via the emergency department or via their General Practitioner. These infants are typically managed on general paediatric wards, where infections – whether congenital, community-acquired or nosocomial – are identified and treated. Recognising these 2 patterns of referral is crucial in understanding the various routes data can be captured and in planning diagnostic and management strategies.

Epidemiology and burden of neonatal infections

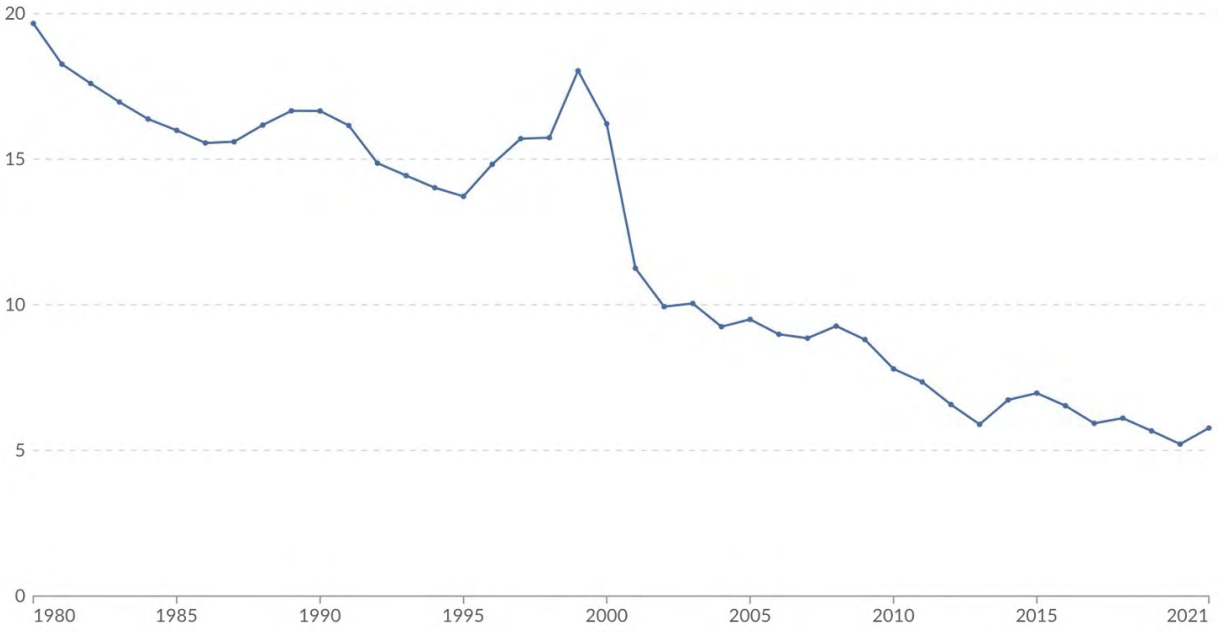
Infections are a leading cause of morbidity and mortality in neonates in England. Surveillance systems – such as those run by UKHSA, the UK Neonatal Collaborative and the neonatal infection surveillance network (neonIN) – provide valuable data on the incidence, epidemiology and regional variations in infection rates. The burden of neonatal infections also imposes significant economic costs on the NHS due to extended hospital stays, intensive treatments and long-term follow-up care. Moreover, the societal and familial impacts, including chronic health conditions and neurodevelopmental impairments, emphasise the need for effective intervention strategies. Over the last 60 years, there has been a substantial reduction in neonatal mortality in the UK (Figure 2).[4] The specific mortality due to neonatal infections (Figure 3)[5] has also declined significantly over the last 30 years, although has plateaued in the last 10 years.

Figure 2: Estimated percentage of newborns who die before reaching 28 days in the UK, 1960 to 2022[6]



Source: Image by United Nations Inter-agency Group for Child Mortality Estimation (2024) – with major processing by Our World in Data. "Neonatal mortality rate" [dataset]. United Nations Inter-Agency Group for Child Mortality Estimation, "United Nations Inter-Agency Group for Child Mortality Estimation"; Various sources, "Population" [original data]. Retrieved March 28, 2025 from https://ourworldindata.org/grapher/neonatal-mortality-wdi. Open access under the Creative Commons BY license.

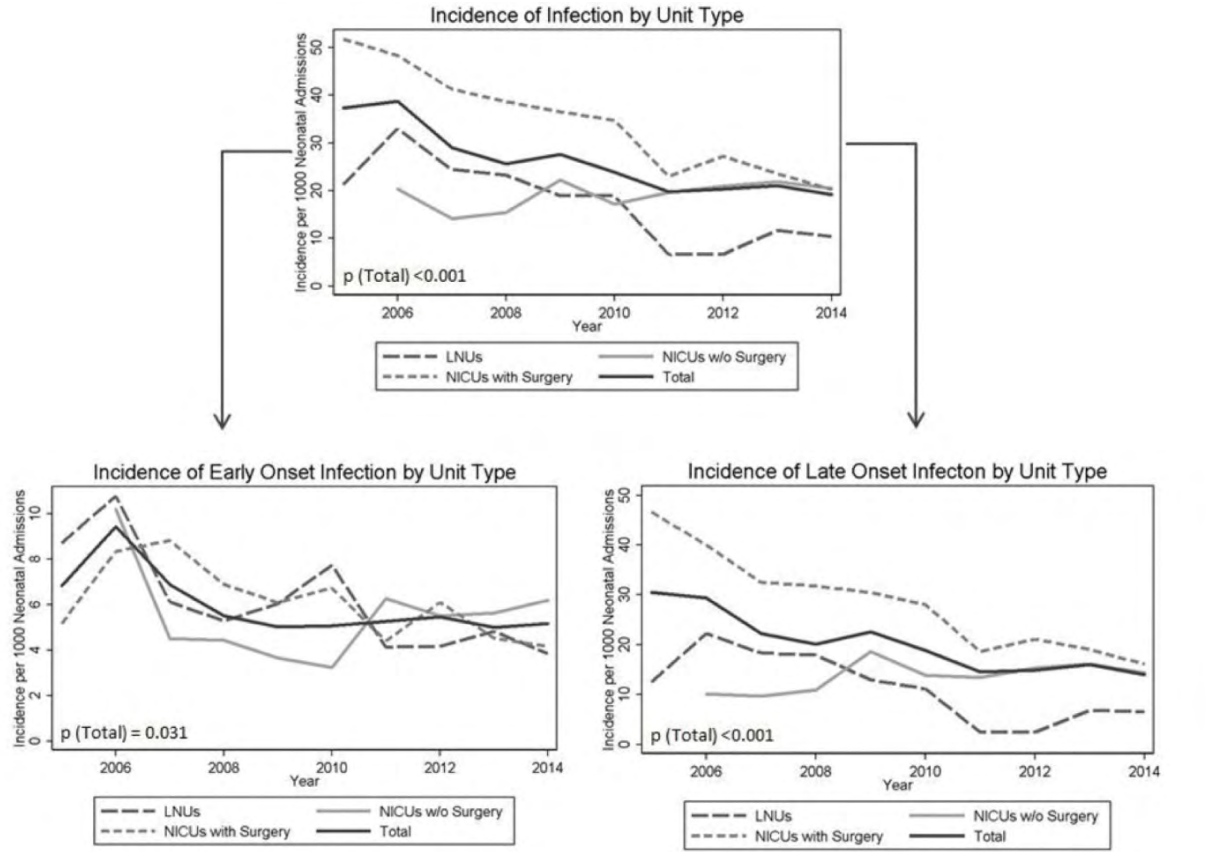
Figure 3: Estimated deaths from neonatal sepsis and other neonatal infections, among individuals <1 year old, per 100,000 people, in the UK, 1980 to 2021[7]



Source: Image by IHME, Global Burden of Disease (2024) – with minor processing by Our World in Data. "Neonatal sepsis and infection death rate in infants" [dataset]. IHME, Global Burden of Disease, "Global Burden of Disease – Child Mortality" [original data]. Retrieved March 28, 2025 from https://ourworldindata.org/grapher/neonatal-sepsis-and-infection-death-rate-in-infants. Open access under the Creative Commons BY license.

There is some evidence of a decreasing trend in the incidence of infections (blood culture confirmed) in babies on NNUs, over time (Figure 4), particularly for late onset sepsis. This may reflect the implementation of infection, prevention and control (IPC) measures.

Figure 4: Incidence of infections over the neonIN study period, by type of NNU[8]

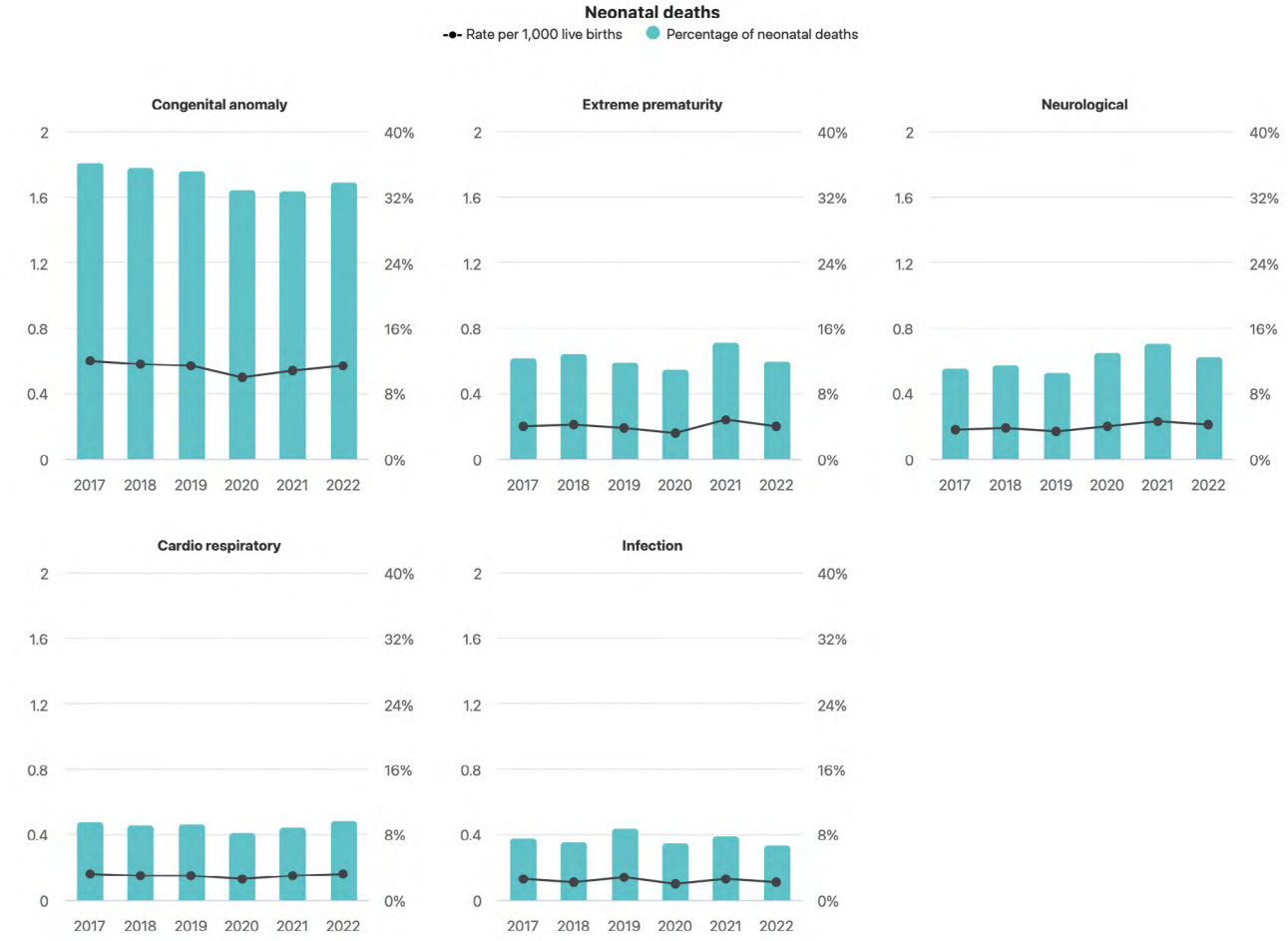


Incidences calculated per 1000 neonatal admissions. LNU – local neonatal unit; NICU – neonatal intensive care unit

Source: Image reproduced from Cailes B, Kortsalioudaki C, Buttery J, Pattnayak S, Greenough A, Matthes J, Bedford Russell A, Kennea N, Heath PT; neonIN network. Epidemiology of UK neonatal infections: the neonIN infection surveillance network. Arch Dis Child Fetal Neonatal Ed. 2018 Nov;103(6):F547-F553 with permission from BMJ Publishing Group Ltd.

Different data sets are available for evaluating the association between infection and neonatal deaths. MBRRACE-UK provides comprehensive information about each UK neonatal death (including late fetal losses, stillbirths, neonatal deaths) to allow detailed examination of the risk factors for perinatal mortality (Figure 5). The most recent neonatal mortality rates available are for 2022: 1.69 per 1000 live births (UK); 1.67 (England); 1.59 (Scotland); 1.91 (Wales); and 2.29 (Northern Ireland); a total of 1,151 neonatal deaths in 2022. Infection is among the common causes of neonatal death, accounting for 6.6% of deaths (0.11 per 1000 live births), with relatively little change noted between 2017 and 2022.

Figure 5: Data on neonatal deaths in the UK from MBRRACE-UK, 2017 to 2022[9]



Data sources: MBRRACE-UK, PDS, ONS, NRS, PHS, NIMATS, States of Guernsey, States of Jersey.

Source: Image by Gallimore ID, Matthews RJ, Page GL, Smith LK, Fenton AC, Knight M, Smith PW, Redpath S, Manktelow BN, on behalf of the MBRRACE-UK Collaboration. MBRRACE-UK Perinatal Mortality Surveillance, UK Perinatal Deaths of Babies Born in 2022: State of the Nation Report. Leicester: The Infant Mortality and Morbidity Studies, Department of Population Health Sciences, University of Leicester. 2024. Open access under the Creative Commons BY license at: https://timms.le.ac.uk/mbrrace-uk-perinatal-mortality/surveillance/

Further detail on the relationship between infections and deaths is provided by a review of death certificate classifications.[10] This shows a higher incidence in preterm and especially extremely preterm infants (<28 weeks) compared with term infants, and a higher incidence of early onset infection-related deaths compared with late onset-related deaths in both term and preterm infants, but of equivalent incidence in extremely preterm infants. It is worth emphasising that the total number of infection-related neonatal deaths in term infants is equivalent to the total number in preterm infants (200 term versus 76 preterm plus 119 extremely premature) (Tables 1 and 2). There was no significant change in the infection-related mortality rates in term and preterm infants between 2003 to 2005 and 2013 to 2015 but there was a significant decline in rates for extremely preterm infants and in overall infection-related rates.

Table 1: Early and late onset infection-related neonatal deaths and neonatal mortality rate in term, preterm and extremely preterm neonates in England and Wales, 2013 to 2015[11]

Neonatal deaths related to infection	Term (≥37 weeks)	Preterm (28–36 weeks)	Extremely Preterm (<28 weeks)	All deaths
Early-onset infection (<7 days)				
Number of deaths (%)	200 (29.9%)	76 (11.4%)	119 (17.8%)	395 (59%)
Deaths per 1000 live births	0.10	0.51	14.2	0.91
Late-onset infection (7–28 days)				
Number of deaths (%)	96 (14.3%)	57 (8.5%)	121 (18.1%)	274 (41%)
Deaths per 1000 live births	0.05	0.38	14.5	0.31

Source: Table adapted from Oligbu G, Ahmed L, Ferraras-Antolin L, Ladhani S. Retrospective analysis of neonatal deaths secondary to infections in England and Wales, 2013-2015. Arch Dis Child Fetal Neonatal Ed. 2021 Jul;106(4):363-369.

Table 2: Infection-related neonatal deaths and neonatal mortality rate in term, preterm and extremely preterm neonates in England and Wales, 2013 to 2015 compared with 2003 to 2005[12]

Infection-related neonatal deaths	2013 to 2015	2003 to 2005	Significant difference between periods?
Term (≥37 weeks)			
Number of deaths (%)	296 (44.2%)	280 (36.5%)	No
Deaths per 1000 live births	0.15	0.16	
Preterm (28–36 weeks)			
Number of deaths (%)	133 (19.9%)	129 (16.8%)	No
Deaths per 1000 live births	0.90	0.97	
Extremely preterm (<28 weeks)			
Number of deaths (%)	240 (35.9%)	359 (46.7%)	Yes
Deaths per 1000 live births	28.7	37.7	
All deaths (overall)			
Number of deaths (%)	669 (100%)	768 (100%)	Yes
Deaths per 1000 live births	0.32	0.40	

Source: Table adapted from Oligbu G, Ahmed L, Ferraras-Antolin L, Ladhani S. Retrospective analysis of neonatal deaths secondary to infections in England and Wales, 2013-2015. Arch Dis Child Fetal Neonatal Ed. 2021 Jul;106(4):363-369.

Causative pathogens

Understanding the microbiological profile of neonatal infections is essential for effective management. The most commonly encountered bacterial pathogens include GBS, *Escherichia coli* (*E. coli*) and Coagulase negative staphylococci (CoNS) (Table 3). In addition, viral (for example, herpes simplex virus (HSV), cytomegalovirus (CMV), respiratory syncytial virus (RSV)) and fungal pathogens (for example, *Candida* species) contribute to the overall burden. Antimicrobial resistant pathogens, especially Gram-negative bacteria such as *E. coli*, are becomingly increasingly common and are associated with worse outcomes than susceptible strains.

Table 3: Common neonatal pathogens and their characteristics

Pathogen	Type	Mode of Transmission	Typical Outcome	Comments
Group B Streptococcus	Bacteria	Typically, vertical for EO infection (via maternal colonization) and horizontal for LO infection	EO: sepsis and pneumonia; LO: sepsis, meningitis and focal infections	IAP is effective against EO infection. Risk-based or swab screening-based IAP strategies are used. See Case study 1.
Escherichia coli	Bacteria	Vertical / Horizontal	Both EO and LO infections: sepsis, meningitis	Resistance concerns, especially in preterm infants.
Coagulase Negative Staphylococcus (CoNS)	Bacteria	Horizontal, often line-related	Usually LO infections. Usually relatively mild sepsis presentation with insidious onset but can be severe.	Very common but lower mortality risk. With increasing use of matrix-assisted laser desorption/ ionisation time-of-flight mass spectrometry (MALDI-TOF), CoNS are increasingly being speciated.

Pathogen	Type	Mode of Transmission	Typical Outcome	Comments
Herpes Simplex Virus	Virus	Vertical / Horizontal	Classified as disseminated, central nervous system (CNS) or skin/eye/mouth (SEM) disease.	High mortality and long-term morbidity. Requires rapid antiviral therapy but diagnosis often delayed.
Cytomegalovirus	Virus	Vertical / Horizontal	Only 10% are symptomatic in the neonatal period but CMV is the most common cause of acquired sensorineural deafness in children. May also result in significant neurodevelopmental sequelae.	Congenital infection (vertical transmission) may require treatment, postnatally acquired (horizontal transmission) is usually a self-limiting illness in term born neonates. See Case study 2.
Respiratory viral infections (for example RSV, influenza)	Virus	Horizontal	Upper respiratory tract infection, bronchiolitis, pneumonia, apnoeas.	Common over the winter months. See Case study 3.
Candida spp.	Fungal	Horizontal	Systemic candidiasis	Most common in preterm infants and associated with prolonged antibiotic use.

EO: early onset; LO: late onset; IAP: intrapartum antibiotic prophylaxis

Bacterial pathogens

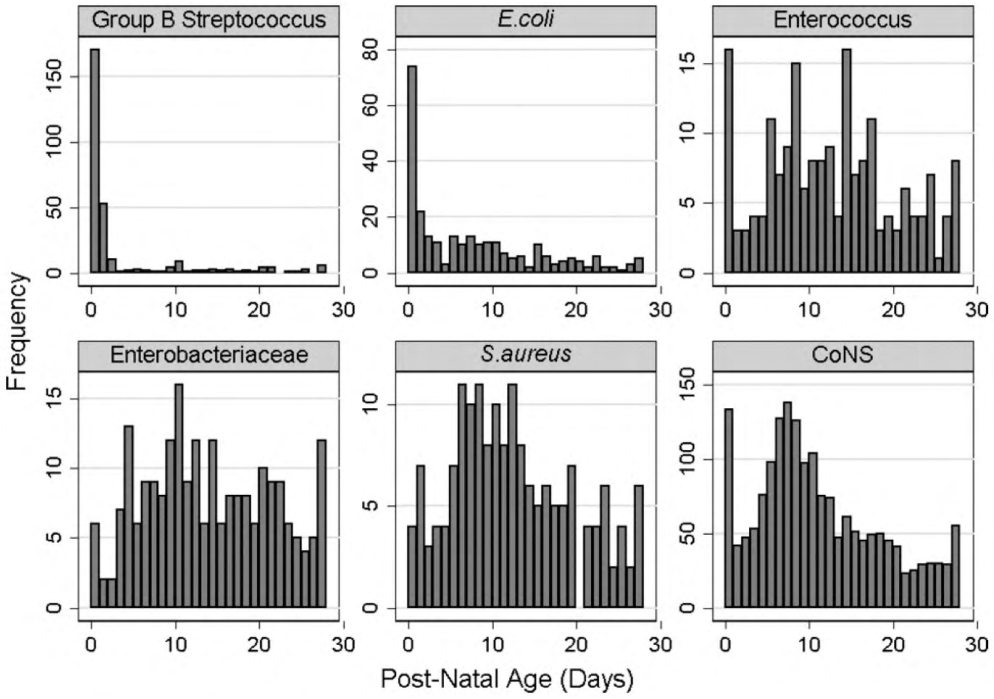
GBS remains the leading cause of EOS despite maternal screening programs (Case study 1). *Escherichia coli*, notably strains resistant to first-line antibiotics, pose a significant challenge among preterm infants as do other Gram-negative bacteria (GNB). Table 4 shows the numbers of significant GNB blood stream infections identified in infants <3 months old from 2015 to 2024 through routine laboratory surveillance.[13] Figure 6 shows the variation in frequency of pathogens according to day of life over the first 28 days. CoNS are the most commonly identified pathogens causing LOS.[14]

Case study 1: Group B Streptococcus (GBS)

In infants less than 3 months of age, GBS is the most common cause of early onset infection (including sepsis and pneumonia) and the most common cause of meningitis. There is an increasing incidence of GBS infections in England, highlighting the need for effective prevention strategies. One potential strategy is development of a maternal vaccine, and the other potential strategy is a better approach to screening and use of intrapartum antibiotics (IAP). Screening pregnant women is based on the presence of risk factors (such as having had a previous baby with GBS) or on the presence of GBS on a rectal-vaginal swab taken in late pregnancy. Either approach results in a significant number of women (and thus babies) being exposed to antibiotics. A large-scale clinical trial, GBS3, funded by the National Institute for Health and Care Research Health Technology Assessment (NIHR HTA), will determine which type of screening programme is most clinically and cost effective. Its outcomes will allow the UK National Screening Committee (NSC) to decide on the optimal screening approach.

A GBS vaccine given to pregnant women has the potential advantages of preventing both early and late infections (including meningitis), as IAP will only prevent early infections, and reducing antibiotic use. Vaccines may also prevent infections in pregnant women as well as preventing stillbirths and premature births due to GBS. As of 2025, there are 2 candidate GBS vaccines that have completed phase 2 trials in pregnant women. Phase 3 trials will begin in 2025, and it is anticipated that phase 4 studies will then be needed to support licensure of such vaccines. The UK provides an ideal setting for phase 4 studies and for early adoption of effective and safe GBS vaccines.

Figure 6: Incidence of common pathogens and timing of infections (by postnatal age over the neonatal period (28 days)) in 30 NNUs in the neonIN network[15]



CoNS: Coagulase negative staphylococci.

Source: Image reproduced from Cailes B, Kortsalioudaki C, Buttery J, Pattnayak S, Greenough A, Matthes J, Bedford Russell A, Kennea N, Heath PT; neonIN network. Epidemiology of UK neonatal infections: the neonIN infection surveillance network. Arch Dis Child Fetal Neonatal Ed. 2018 Nov;103(6):F547-F553 with permission from BMJ Publishing Group Ltd.

Table 4: Numbers of significant Gram-negative bloodstream infections identified in infants <3 months old from 2015 to 2024 through routine laboratory surveillance, England[16]

	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
E. coli	489	607	610	565	595	597	486	565	553	551
Klebsiella spp	NA	NA	102	126	142	133	157	161	170	173
Pseudomonas aeruginosa	NA	NA	36	39	35	35	48	34	45	39

Source: Unpublished data from the Mandatory Surveillance of Healthcare Associated Infections Antimicrobial Resistance and Healthcare Associated Infections Division, Epidemic & Emerging Infections Directorate, UKHSA.

Listeria monocytogenes was previously recognised as a common pathogen in neonates and associated with severe clinical outcomes, but is now very rare, with only 27 cases described in infants <90 days old over a 2-year period (2017 to 2019) in England, Wales, Scotland and Ireland.[17] The significant decline over time is likely a reflection of the dietary advice provided by the NHS for pregnant woman, which recommends avoiding eating unpasteurised dairy products, chilled ready-to-eat foods like prepacked sandwiches and pâté. A recent increase among pregnant women from ethnic minority groups in England suggests that targeted health education among such mothers is still needed.[18]

Viral and fungal infections

Viral pathogens (for example, HSV, CMV, varicella zoster virus (VZV)) and fungal agents (for example, *Candida* species) present an increasing burden over time. The number of cases of congenital viral infections leading to hospitalisation has increased over the last few years,[19] though this may also reflect increased use of better diagnostic tests rather than a change in the epidemiology. Of note, congenital rubella syndrome is now rare in the UK, highlighting the success of the measles, mumps and rubella (MMR) vaccine programme but also emphasising the need to maintain high coverage.

Case study 2 highlights a typical CMV case seen in the neonatal/paediatric setting.

The best prospect for prevention of congenital CMV (cCMV) is a vaccine administered to women either before or during pregnancy. Unfortunately, the most recent vaccine trial, of an mRNA vaccine, was stopped because it did not meet its primary efficacy endpoint. This emphasises the need to develop other strategies for prevention. Prevention of acquisition of CMV in pregnancy through hygiene-based behavioural interventions may also have an important role.[20] A national enhanced (British Paediatric Surveillance Unit (BPSU)) study of congenital and hospitalised neonatal VZV has recently been completed and will define this current burden. The anticipated introduction of a routine childhood VZV vaccine programme in the UK in 2026 is expected to reduce these VZV infections over time. Similarly, a recently completed BPSU study on HSV will define this burden. Improved recognition and treatment in pregnant women coupled with better diagnostics and earlier antiviral therapy in affected infants hold most promise for improving outcomes while a candidate HSV-2 mRNA vaccine aimed at prevention of recurrent genital herpes may also have an important role.[21]

Case study 2: Congenital cytomegalovirus (cCMV)

A baby girl was born at term after an uncomplicated pregnancy and delivery. Routine newborn hearing screening performed on day 2 of life yielded abnormal auditory responses, prompting further follow-up. At 14 days old she had a formal audiology assessment and was found to have bilateral mild-to-moderate sensorineural hearing loss. A urine test confirmed cCMV as the cause. She went on to have further tests, including MRI brain and eye review which were normal, and she proceeded to have 6 months of treatment with oral valganciclovir. At follow up at 2 years of age she had no progression of the hearing loss but remained under follow up with the audiology and neurodevelopment teams.

cCMV affects approximately 1 in 200 births, although recent data are lacking. It is the most common non-genetic cause of sensorineural hearing loss (SNHL). Prompt treatment of infants, starting in the first month of life, with the antiviral medication valganciclovir, has been shown to reduce the risk of progression of SNHL. However, many infants are diagnosed with cCMV outside this optimal treatment window and thus miss out on the best available management options. At present, infants are not screened for cCMV in England. It has been shown that it could be cost-effective to do so and there is evidence of the benefit of universal screening of infants for cCMV using routinely obtained dried blood spots on day 5 of life (for example, in Ontario, Canada).[22] The UK National Screening Committee most recently (2022)[23] indicated "that screening for congenital CMV (cCMV) is not recommended because:

- we are not sure if tests reliably show which babies with cCMV will suffer long-term health problems
- it is likely that screening will find a larger number of babies with the infection who will not have problems from it than those who will
- there is a lack of evidence that early treatment following screening leads to better outcomes than later treatment after symptoms
- currently, it is not clear what is the best way of treating children who do not have symptoms".

More research is needed to address these gaps.

In addition, neonates who have been discharged home after birth, especially those born prematurely, will commonly be readmitted to hospital due to infection with winter viruses (for example, RSV, influenza and human metapneumovirus (HMPV)) which are associated with clinical syndromes such as bronchiolitis or pneumonia. The most important cause of viral lower respiratory tract infections in young infants is RSV. Case study 3 demonstrates the impact of RSV on healthcare services and the potential impact of the new maternal RSV vaccine programme.

Case study 3: Respiratory syncytial virus (RSV)

RSV is the leading global cause of viral lower respiratory tract infections in children under 5 years of age, with a specific burden in young infants. In the UK, it has been estimated that there are 270,000 symptomatic cases, 108,000 GP consultations, 74,000 emergency department visits, 20,000 hospitalisations, 900 ICU admissions and 22 deaths in infants <1 year old every year. Although certain underlying conditions such as prematurity are associated with an increased risk of severe infection, the majority (~80%) of hospitalised children are otherwise healthy. Up until now, the only available preventative approach has been with the use of a short-acting monoclonal antibody called palivizumab. This has been reserved for those at highest risk as it is expensive and needs to be given by monthly intramuscular injection over the RSV season. The recent licensures of an RSV vaccine for pregnant women (Abrysvo) and a long-acting monoclonal antibody (nirsevimab) for young infants has allowed the possibility of a strategy that can prevent RSV in all infants for the first time. The UK Joint Committee on Vaccination and Immunisation (JCVI) considered both products to be suitable for a universal programme and the maternal vaccine programme was implemented in September 2024 following a competitive tender. Early data suggest high vaccine effectiveness (Table 6). The JCVI has also recommended that the current palivizumab programme for high-risk infants is replaced by nirsevimab and this will begin in 2025.

Modes of transmission

Vertical transmission

Early-onset infections primarily arise from vertical transmission of pathogens during labour and delivery with maternal genital and gastrointestinal tract colonisation a major risk factor.

Congenital infections, acquired *in utero* or during the perinatal period, represent a critical subset of neonatal infections with profound short- and long-term implications for infant health. These infections, which include *Toxoplasma gondii*, rubella virus, CMV, HSV, syphilis, HIV, Hepatitis B and C, collectively referred to as SCORTCH (previously TORCH) infections, can cause a range of clinical manifestations from asymptomatic disease to severe multisystem involvement. Infants affected by congenital infections may present with growth restriction, neurologic deficits, sensory impairments and cardiac anomalies, among other complications. Early detection is paramount; timely diagnosis can facilitate targeted interventions that may mitigate adverse outcomes, including permanent disabilities. Preventative strategies, such as maternal screening programmes, vaccination (Hepatitis B, rubella) and public health initiatives to reduce exposure risks, are essential to reducing and potentially eliminating these infections. For example, the rubella immunisation programme has substantially reduced congenital rubella syndrome in England, to the extent that screening of pregnant women has not been needed since April 2016. Continued emphasis on hygiene and screening during pregnancy helps identify and manage infections like toxoplasmosis, CMV and syphilis. The integration of robust surveillance systems also enables healthcare providers to monitor trends in congenital infection

rates and adjust clinical protocols accordingly. Recognising the complex interplay between maternal health, prenatal care and neonatal outcomes is key to developing comprehensive strategies that address not only the clinical management of these infections but also their broader social and economic impacts.

Horizontal transmission

Nosocomial infections acquired in NNUs are predominantly due to horizontal transmission – from contaminated equipment, healthcare workers, parents, carers or environmental sources. Reducing horizontal transmission is important in improving outcomes for neonates who are hospitalised for prolonged periods and are therefore at higher risk of developing a nosocomial infection. Recent outbreaks of *Staphylococcus capitis*, antibiotic resistant *E. coli* and methicillin-resistant *Staphylococcus aureus* (MRSA) have been observed on English NNUs. Combating these infections requires robust infection prevention and control practices and procedures, and implementing and reinforcing these in a timely manner when there are concerns about an outbreak.[24]

Risk factors and clinical presentation

The multifactorial risk profile for early onset neonatal infections spans maternal, perinatal and neonatal factors. At birth, early recognition of these risk factors enables prompt intervention (Table 5).

Table 5: Key risk factors for early onset sepsis[25]

Risk Factor
Suspected or confirmed infection in another baby in the case of a multiple pregnancy
Invasive GBS infection in a previous baby
Prolonged rupture of membranes
Maternal GBS colonisation, bacteriuria or infection in the current pregnancy
Prelabour rupture of membranes
Preterm birth following spontaneous labour
Intrapartum fever due to suspected or confirmed bacterial infection
Clinical diagnosis of chorioamnionitis

Source: Table adapted from © NICE (2024). Neonatal infection: antibiotics for prevention and treatment. Available from: https://www.nice.org.uk/guidance/ng195 All rights reserved. Subject to Notice of rights.

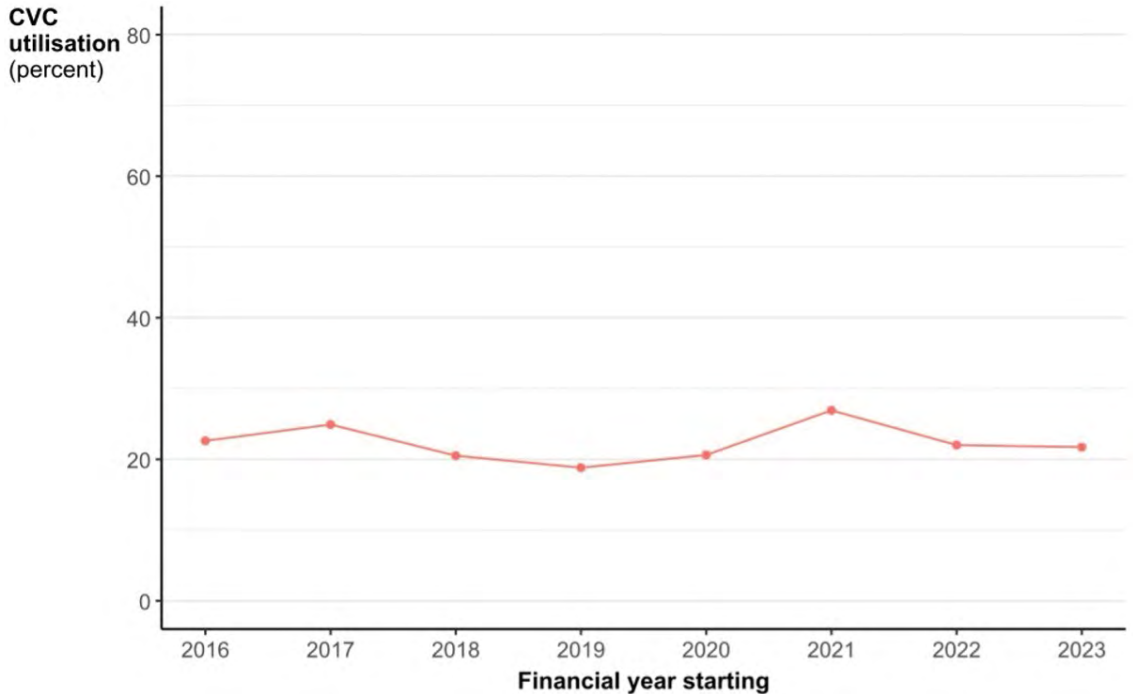
Maternal and perinatal risk factors

In the case of a multiple pregnancy, infection in one baby is associated with a high risk of infection in other babies, reflecting a common source. Invasive GBS infection in a previous baby is known to be a risk factor for GBS infection in subsequent babies, likely due to persistent GBS colonisation and/or non-protective antibody levels in the mother. While maternal colonisation with GBS is a pre-requisite for vertical transmission of GBS from mother to baby (occurring just before or during delivery), colonisation is common (20% to 25% of pregnant UK women), yet invasive disease in babies is rare (around 1% to 2% of babies born to colonised women). This is one reason why there is a debate as to the optimal screening programme for the UK: risk-based or universal swab-based. This issue is being addressed by the UK GBS3 trial (case study 1). Chorioamnionitis may be due to different pathogens and may even be polymicrobial, which has an implication for antibiotic choice. National guidelines (the Royal College of Obstetrics and Gynaecology guideline on preventing early-onset GBS) have been developed (and are currently being updated) with the aim of reducing early onset sepsis in neonates.[26] In addition, there are guidelines and scoring systems (NICE neonatal infection: antibiotics for prevention and treatment guideline[27] and the Kaiser Permanente neonatal sepsis calculator[28]) that are used by neonatal teams in the UK to help predict the likelihood of a neonate having an infection and requiring antibiotics.

Neonatal risk factors

Neonates with low birth weight or prematurity are at a higher risk of invasive infections, partly because of their need for intensive supportive care. Invasive devices such as central venous catheters (CVC) or endotracheal tubes can serve as conduits for infection, especially when biofilm formation occurs. Data from the UKHSA surveillance of bloodstream infections in critical care report (2024)[29] demonstrate that in NNUs, among patients with at least one positive blood culture, CVC use was common, varying between 18.8% and 26.9% from 2016 to 2023 (Figure 7).

Figure 7: Central venous catheter (CVC) utilisation in NNUs, England, 2016 to 2023[30]



Source: Image by UKHSA, Supplementary results for paediatric and neonatal units, England: May 2016 to March 2024, is licensed under Open Government Licence v3.0.

Clinical signs, diagnostic challenges and management

Neonatal infections often present with nonspecific signs such as temperature instability, poor feeding and respiratory distress. The subtlety of these symptoms in the early stages of infection can delay diagnosis. Laboratory markers such as C-reactive protein (CRP) and procalcitonin, while useful, have limitations in specificity when interpreted against the backdrop of normal neonatal physiology. The diagnostic process is complicated by the limited blood volume available for testing in neonates. Newer biomarkers (for example, transcriptomic profiles) that need small blood volumes and give rapid results are required to improve diagnostic accuracy, particularly in relation to bacterial infections and the need for antibiotics. It is extremely common to empirically treat infants for infection prior to a pathogen being detected and in many cases no pathogen is identified. This results in diagnostic uncertainty and many infants being treated with antimicrobials unnecessarily. Nevertheless, this practice reflects the relative frequency of infection in this population and the potential for poor outcomes if antibiotics are started late.

Empirical antibiotic therapy

First-line treatments typically include combinations such as benzylpenicillin and gentamicin (in NNUs or postnatal wards – case study 4) or cefotaxime and amoxicillin (in emergency departments or on general paediatric wards) with consideration of other antimicrobials (for example, antivirals and antifungals) depending on the history, clinical features and route of presentation to healthcare. Antibiotic resistance is an escalating concern and thus therapy is adjusted based on culture sensitivities and clinical response. Ongoing surveillance is vital for

informing optimal empiric therapies. For example, recent enhanced national surveillance for invasive listeria infection in infants <3 months old showed that it was now rare, and that guidelines which previously recommended the additional use of amoxicillin for treating listeria in cases of possible sepsis and meningitis in this period could instead be restricted to the first month of life.[31] In addition, pharmacokinetic differences in neonates require careful dosing to avoid toxicity while ensuring therapeutic efficacy. Alongside antimicrobial therapy, supportive measures (fluid management, respiratory support, thermoregulation) are essential in stabilising unwell neonates.

Case study 4: Management of suspected early onset sepsis (EOS) in neonates

EOS refers to culture proven bloodstream infection in live born neonates within the first 72 hours after birth. It is a systemic bacterial, viral or fungal infection that poses a potentially fatal threat or significant morbidity to both term and preterm infants. Whilst the identification and treatment of symptomatic babies is relatively straightforward, defining the management of asymptomatic infants with risk factors is a challenge, particularly in the absence of reliable tests that can exclude sepsis. In 2012, the National Institute for Clinical Excellence (NICE) early onset guideline (CG149) provided recommendations for the management of infants with risk factors for EOS, aiming to prioritise the treatment of sick babies, to minimise antibiotic exposure in infants without EOS and to promote antibiotic stewardship to avoid the development of resistant organisms. Despite this, marked differences in practice between NNUs persisted, leading to differing thresholds for screening asymptomatic infants. An updated guideline (NG195) was published in 2021 with modified criteria. This guideline also provides an option for clinicians to use a different strategy, the Kaiser Permanente (KP) neonatal sepsis calculator. This was developed and initially validated in the US but was already being used by many UK NNUs because of its perceived simplicity and reduction in babies starting antibiotics, without an increase in 'missed' cases of sepsis. Validation of the KP calculator and a comparison of its use with the current NICE guidance is now required in order to determine potential differences in patient, clinical and cost outcomes and to inform evidence-based practice change.

Recent advancements have enabled some NHS trusts to incorporate genetic testing into neonatal care to identify infants susceptible to hearing loss caused by aminoglycoside antibiotics (for example, gentamicin), particularly those with mutations such as m.1555A>G in mitochondrial 12S rRNA.[32] Aminoglycosides, although vital for treating severe neonatal infections, can cause irreversible hearing impairment in genetically predisposed infants. Early genetic screening allows clinicians to select safer alternative treatments, reducing the risk of ototoxicity and long-term morbidity. Genetic testing also informs families about inheritance risks and aids informed decision-making. Increasingly affordable and rapid genomic technologies such as this promise wider adoption of personalised medicine, significantly improving outcomes for vulnerable neonates.

Prevention and infection control measures

Preventative strategies play a pivotal role in reducing the incidence of neonatal infections. Effective prevention encompasses both antenatal interventions and rigorous infection control within hospital settings. As noted above, administration of intrapartum antibiotics can prevent early-onset GBS sepsis. Enhanced obstetric practices, including timely management of maternal infections and judicious antibiotic use, help reduce vertical transmission risks.

Strict adherence to infection prevention and control practices such as hand hygiene, use of personal protective equipment (PPE), and routine cleaning and/or sterilisation of medical equipment are essential in minimising nosocomial (late onset) infections on NNUs. Regular cleaning protocols and staff training further reinforce infection control measures. Parents and carers, as well as staff, all have a role to play.

Vaccination strategies for neonatal infection prevention

As vaccination remains one of the most effective public health interventions, its role in reducing neonatal infections is receiving increased attention. Although direct neonatal vaccination is limited by the immaturity of the neonatal immune system, maternal immunisation represents a promising strategy for conferring passive immunity to the infant.

Maternal immunisation

Maternal immunisation not only protects the mother but also allows for the transfer of antibodies across the placenta as well as through breast milk, offering neonates early-life protection. This is important for infections that can be acquired by infants in the neonatal period (for example pertussis, RSV, influenza, SARS-CoV-2). The maternal vaccine programme in the UK is detailed in Table 6. Current guidelines recommend that pregnant women receive the seasonal influenza vaccine and year-round RSV and pertussis vaccines. Uptake in maternal vaccines varies by region and demographics and there has been a recent overall trend to declining uptake. This poses a significant issue for pregnant women and their infants and is discussed further in chapter 3.2.

Research is underway for vaccines specifically targeting other pathogens such as GBS, CMV (see case studies) and HSV, which currently have a direct impact on maternal and neonatal health. Their development should be prioritised.

Neonatal vaccination

Direct vaccination of neonates is challenging as immune responses may be suboptimal, especially in infants born prematurely. Studies continue to explore strategies for early-life immunisation that could safely and effectively protect against key pathogens without compromising immune development. Both active (for example, BCG and Hepatitis B vaccines) and passive (for example, nirsevimab) are available for high-risk neonates in the UK (Table 6).

Ongoing research into novel vaccine platforms and adjuvants offers the potential for the development of safe and effective vaccines which are tailored to neonates.

Table 6: Maternal and neonatal immunisations in England and their impact on neonatal infection outcomes

Vaccine	Target population	Current UK Coverage (%)	Recent data on impact	Comments
Pertussis	All pregnant women	66%*	Vaccine effectiveness (VE) 93% against laboratory-confirmed cases in infants < 8 weeks (UK)[33]	Recommended year round in each pregnancy; ideally from 16-32 weeks gestation
Influenza	All pregnant women	~39%**	VE 64% against laboratory-confirmed cases in infants < 6 months of age (Canada)[34]	Recommended annually; any gestation
Respiratory syncytial virus (RSV)	All pregnant women	~48%***	VE 72% against hospitalisations in infants < 3 months of age (UK)[35]	Recommended year round in each pregnancy; from 28 weeks gestation
BCG	Eligible Infants	N/A+	VE 90% against severe tuberculosis (meningeal and miliary) in trials of neonatal vaccination[36] (systematic review)	Given to high-risk infants at birth
Hepatitis B vaccine	Eligible Infants	N/A+	VE 72% against Hepatitis B in newborn infants of HBsAg-positive mothers[37] (systematic review)	Given to neonates at high-risk at birth, 4 weeks and 12 months. Given to all infants as part of the 6 in 1 vaccine in national immunisation programme at 2,3,4 months.

Vaccine	Target population	Current UK Coverage (%)	Recent data on impact	Comments
Hepatitis B immunoglobulin	Eligible Infants	N/A+	Compared with vaccine alone, vaccine plus Hepatitis B immunoglobulin further reduced Hepatitis B occurrence (RR 0.54)[38] (systematic review)	Given to neonates at very high-risk at birth along with Hepatitis B vaccine
Palivizumab (short-acting RSV monoclonal antibody)	Eligible Infants	N/A+	VE 82% against RSV-related hospitalisation in otherwise healthy preterm infants (33 to 35 weeks and less than 6 m of age) (Netherlands).[39]	Passive monoclonal antibody. Only very high-risk infants are eligible to receive this. To be replaced by Nirsevimab from Autumn 2025.
Nirsevimab (long-acting RSV monoclonal antibody)	Eligible Infants	N/A+	VE 82% against hospitalisation for RSV-related lower respiratory tract infection in all infants (Spain)[40]	Passive monoclonal antibody. Only high-risk infants are eligible to receive this in the UK from Autumn 2025

*Estimated coverage rates for the financial year 2024/25[41]

**Estimated coverage rates for 1st Sept 2024 to 31st January 2025[42]

***Programme started in England on 1st September 2024. Data for November 2024[43]

+Only given to high-risk infants, universal coverage data not applicable

Future research directions and challenges

Future research must address the gaps in our current understanding of neonatal infections. Key areas include a better understanding of the basis for neonatal susceptibility to infections, of the risk factors and clinical indicators of infection and in the development of next-generation diagnostic methods. A number of other research recommendations have been highlighted in the NICE guideline: Neonatal infection: antibiotics for prevention and treatment.[44] Overcoming ethical and logistical challenges in neonatal clinical trials is essential for translating research findings into clinical practice. Collaborative research initiatives, supported by robust funding, will be critical to driving progress in these areas.

Conclusion

Neonatal infections continue to pose a significant threat to infant health in England, demanding a comprehensive approach that integrates clinical excellence with proactive public health strategies. This chapter has examined the epidemiological burden, underlying microbiological mechanisms, clinical challenges, current management practices and prevention strategies for neonatal infections. By enhancing surveillance, standardising protocols and investing in research and workforce training, England can make substantial strides in safeguarding the health of its most vulnerable population.

References

1 The UK National Neonatal Research Database. NNRD data visualisations. [Internet] Available from: https://www.imperial.ac.uk/neonatal-data-analysis-unit/neonatal-data-analysis-unit/nnrd-data-visualisations/

2 Bliss. Statistics about neonatal care. [Internet] Available from: https://www.bliss.org.uk/research-campaigns/neonatal-care-statistics/statistics-about-neonatal-care

3 The UK National Neonatal Research Database. Neonatal Data Analysis Unit. [Internet] [Accessed 21 May 2025] Available from: https://www.imperial.ac.uk/neonatal-data-analysis-unit/neonatal-data-analysis-unit/

4 United Nations Inter-agency Group for Child Mortality Estimation (2024) – with major processing by Our World in Data. Neonatal mortality rate. [Internet] 2025. [Accessed 4 March 2025] Available from: https://ourworldindata.org/grapher/neonatal-mortality-wdi?tab=line&country=~GBR

5 Institute for Health Metrics and Evaluation., Global Burden of Disease (2024) – with minor processing by Our World in Data. Neonatal sepsis and infection death rate in infants. [Internet] 2024. [Accessed 4 March 2025] Available from: https://ourworldindata.org/grapher/neonatal-sepsis-and-infection-death-rate-in-infants

6 United Nations Inter-agency Group for Child Mortality Estimation (2024) – with major processing by Our World in Data. Neonatal mortality rate. [Internet] 2025. [Accessed 28 March 2025] Available from: https://ourworldindata.org/grapher/neonatal-mortality-wdi

7 Institute for Health Metrics and Evaluation. Global Burden of Disease (2024) – with minor processing by Our World in Data. Neonatal sepsis and infection death rate in infants. [Internet] 2024. [Accessed 28 March 2025] Available from: https://ourworldindata.org/grapher/neonatal-sepsis-and-infection-death-rate-in-infants

8 Cailes B, Kortsalioudaki C, Buttery J et al. neonIN network. Epidemiology of UK neonatal infections: the neonIN infection surveillance network. Arch Dis Child Fetal Neonatal Ed. 2018;103(6):F547-F553. doi: 10.1136/archdischild-2017-313203.

9 Gallimore ID, Matthews RJ, Page GL et al., on behalf of the MBRRACE-UK Collaboration. MBRRACE-UK Perinatal Mortality Surveillance, UK Perinatal Deaths of Babies Born in 2022: State of the Nation Report. [Internet] 2024. Available from: https://timms.le.ac.uk/mbrrace-uk-perinatal-mortality/surveillance/

10 Oligbu G, Ahmed L, Ferraras-Antolin L, Ladhani S. Retrospective analysis of neonatal deaths secondary to infections in England and Wales, 2013-2015. Arch Dis Child Fetal Neonatal Ed. 2021;106(4):363-369. doi: 10.1136/archdischild-2020-319093.

11 Oligbu G, Ahmed L, Ferraras-Antolin L, Ladhani S. Retrospective analysis of neonatal deaths secondary to infections in England and Wales, 2013-2015. Arch Dis Child Fetal Neonatal Ed. 2021;106(4):363-369. doi: 10.1136/archdischild-2020-319093.

12 Oligbu G, Ahmed L, Ferraras-Antolin L, Ladhani S. Retrospective analysis of neonatal deaths secondary to infections in England and Wales, 2013-2015. Arch Dis Child Fetal Neonatal Ed. 2021;106(4):363-369. doi: 10.1136/archdischild-2020-319093.

13 UK Health Security Agency. Antimicrobial Resistance and Healthcare Associated Infections Division, Epidemic & Emerging Infections Directorate. Unpublished data from the Mandatory Surveillance of Healthcare Associated Infections.

14 UK Health Security Agency. Surveillance of bloodstream infections in critical care, England. [Internet] 2025. Available from: https://www.gov.uk/government/statistics/surveillance-of-bloodstream-infections-in-critical-care-england/supplementary-results-for-pediatric-and-neonatal-units-england-may-2016-to-march-2024

15 Cailes B, Kortsalioudaki C, Buttery J et al. neonIN network. Epidemiology of UK neonatal infections: the neonIN infection surveillance network. Arch Dis Child Fetal Neonatal Ed. 2018;103(6):F547-F553. doi: 10.1136/archdischild-2017-313203.

16 UK Health Security Agency. Antimicrobial Resistance and Healthcare Associated Infections Division, Epidemic & Emerging Infections Directorate. Unpublished data from the Mandatory Surveillance of Healthcare Associated Infections.

17 Vergnano S, Godbole G, Simbo A et al. Listeria infection in young infants: results from a national surveillance study in the UK and Ireland. Arch Dis Child. 2021;106(12):1207-1210. doi: 10.1136/archdischild-2021-321602.

18 Jalava K, Amar C, McLauchlin J, Godbole G. Increased incidence of listeriosis among pregnant women belonging to ethnic minorities in England. J Infect. 2021;82(6):276-316. doi: 10.1016/j.jinf.2021.03.024.

19 Kadambari S, Pollard AJ, Goldacre MJ, Goldacre R. Congenital viral infections in England over five decades: a population-based observational study. Lancet Infect Dis. 2020;20(2):220-229. doi: 10.1016/S1473-3099(19)30416-5.

20 Barber V, Calvert A, Vandrevala T et al. Prevention of Acquisition of Cytomegalovirus Infection in Pregnancy Through Hygiene-based Behavioral Interventions: A Systematic Review and Gap Analysis. Pediatr Infect Dis J. 2020 Oct;39(10):949-954. doi: 10.1097/INF.0000000000002763.

21 ModernaTX. A Study of mRNA-1608, a Herpes Simplex Virus -2 (HSV-2) Therapeutic Candidate Vaccine, in Healthy Adults 18 to 55 Years of Age With Recurrent HSV-2 Genital Herpes. [Internet] 2025. Available from: https://clinicaltrials.gov/study/NCT06033261?rank=1

22 Dunn JKE, Chakraborty P, Reuvers E et al. Outcomes of a Population-Based Congenital Cytomegalovirus Screening Program. JAMA Pediatr. 2025;179(3):332-339. doi: 10.1001/jamapediatrics.2024.5562.

23 UK National Screening Committee. Antenatal screening programme: Cytomegalovirus. [Internet] 2022. Available from: https://view-health-screening-recommendations.service.gov.uk/cytomegalovirus/#:~:text=Cytomegalovirus%20(CMV)%20is%20a%20common,called%20congenital%20CMV%20(cCMV).

24 Anthony M, Bedford-Russell A, Cooper T et al. Managing and preventing outbreaks of Gram-negative infections in UK neonatal units. Arch Dis Child Fetal Neonatal Ed. 2013;98(6):F549-53. doi: 10.1136/archdischild-2012-303540.

25 National Institute for Health and Care Excellence. Neonatal infection: antibiotics for prevention and treatment. NICE guideline NG195. [Internet] 2024. Available from: https://www.nice.org.uk/guidance/ng195/chapter/recommendations#ID0EUMAC

26 Royal College of Obstetricians & Gynaecologists. Prevention of Early-onset Group B Streptococcal Disease (Green-top Guideline No. 36). [Internet] 2017. Available from: https://www.rcog.org.uk/guidance/browse-all-guidance/green-top-guidelines/prevention-of-early-onset-group-b-streptococcal-disease-green-top-guideline-no-36/

27 National Institute for Health and Care Excellence. Neonatal infection: antibiotics for prevention and treatment. NICE guideline NG195. [Internet] 2024. Available from: https://www.nice.org.uk/guidance/ng195/chapter/recommendations#ID0EUMAC

28 Kaiser Permanente. Neonatal Early-Onset Sepsis Calculator (2024 Update). [Internet] 2024. Available from: https://neonatalsepsiscalculator.kaiserpermanente.org

29 UK Health Security Agency. Surveillance of bloodstream infections in critical care, England. [Internet] 2025. Available from: https://www.gov.uk/government/statistics/surveillance-of-bloodstream-infections-in-critical-care-england/supplementary-results-for-pediatric-and-neonatal-units-england-may-2016-to-march-2024

30 UK Health Security Agency. Supplementary results for pediatric and neonatal units, England: May 2016 to March 2024.[Internet] 2025. Available from: https://www.gov.uk/government/statistics/surveillance-of-bloodstream-infections-in-critical-care-england/supplementary-results-for-pediatric-and-neonatal-units-england-may-2016-to-march-2024

31 UK Health Security Agency. Antimicrobial Resistance and Healthcare Associated Infections Division, Epidemic & Emerging Infections Directorate. Unpublished data from the Mandatory Surveillance of Healthcare Associated Infections.

32 National Institute for Health and Care Excellence. Genedrive MT-RNR1 ID Kit for detecting a genetic variant to guide antibiotic use and prevent hearing loss in babies: early value assessment. Health technology evaluation HTE6. [Internet] 2023. [Accessed 28 March 2025] Available from: https://www.nice.org.uk/guidance/hte6

33 Dabrera G, Amirthalingam G, Andrews N et al. A case-control study to estimate the effectiveness of maternal pertussis vaccination in protecting newborn infants in England and Wales, 2012-2013. Clin Infect Dis. 2015;60(3):333-7 doi: 10.1093/cid/ciu821

34 Fell DB, Russell M, Fung SG et al. Effectiveness of Influenza Vaccination During Pregnancy Against Laboratory-Confirmed Seasonal Influenza Among Infants Under 6 Months of Age in Ontario, Canada. J Infect Dis. 2024;230(1):e80-e92. doi: 10.1093/infdis/jiad539.

35 Williams TC, Marlow R, Cunningham S et al. PERUKI & BronchStart Collaboration. Bivalent prefusion F vaccination in pregnancy and respiratory syncytial virus hospitalisation in infants in the UK: results of a multicentre, test-negative, case-control study. Lancet Child Adolesc Health. 2025;S2352-4642(25)00155-5.

36 Mangtani P, Abubakar I, Ariti C et al. Protection by BCG vaccine against tuberculosis: a systematic review of randomized controlled trials. Clin Infect Dis. 2014;58(4):470-80. doi: 10.1093/cid/cit790

37 Lee C, Gong Y, Brok J, Boxall EH, Gluud C. Effect of hepatitis B immunisation in newborn infants of mothers positive for hepatitis B surface antigen: systematic review and meta-analysis. BMJ. 2006 ;332(7537):328-36. doi: 10.1136/bmj.38719.435833.7C

38 Lee C, Gong Y, Brok J, Boxall EH, Gluud C. Effect of hepatitis B immunisation in newborn infants of mothers positive for hepatitis B surface antigen: systematic review and meta-analysis. BMJ. 2006 ;332(7537):328-36. doi: 10.1136/bmj.38719.435833.7C

39 Blanken MO, Rovers MM, Molenaar JM et al. Dutch RSV Neonatal Network. Respiratory syncytial virus and recurrent wheeze in healthy preterm infants. N Engl J Med. 2013;368(19):1791-9. doi: 10.1056/NEJMoa1211917.

40 Ares-Gómez S, Mallah N, Santiago-Pérez MI et al.; NIRSE-GAL study group. Effectiveness and impact of universal prophylaxis with nirsevimab in infants against hospitalisation for respiratory syncytial virus in Galicia, Spain: initial results of a population-based longitudinal study. Lancet Infect Dis. 2024;24(8):817-828.

41 UK Health Security Agency. Prenatal pertussis vaccination coverage in England from January to March 2025, and annual coverage for 2024 to 2025. [Internet] 2025. Available from: https://www.gov.uk/government/publications/pertussis-immunisation-in-pregnancy-vaccine-coverage-estimates-in-england-october-2013-to-march-2014/prenatal-pertussis-vaccination-coverage-in-england-from-january-to-march-2025-and-annual-coverage-for-2024-to-2025

42 UK Health Security Agency. Seasonal influenza vaccine uptake in GP patients: monthly data, 2024 to 2025. [Internet] 2025. Available from: https://www.gov.uk/government/statistics/seasonal-influenza-vaccine-uptake-in-gp-patients-monthly-data-2024-to-2025

43 UK Health Security Agency. RSV maternal vaccination coverage in England: November 2024. [Internet] 2025. Available from: https://www.gov.uk/government/publications/rsv-immunisation-for-older-adults-and-pregnant-women-vaccine-coverage-in-england/rsv-maternal-vaccination-coverage-in-england-november-2024

44 Dunn JKE, Chakraborty P, Reuvers E et al. Outcomes of a Population-Based Congenital Cytomegalovirus Screening Program. JAMA Pediatr. 2025;179(3):332-339. doi: 10.1001/jamapediatrics.2024.5562.

3.4 Infections in children

Jolanta Bernatoniene – Consultant in Paediatric Infectious Diseases, Bristol Royal Hospital for Children, University Hospitals Bristol & Weston NHS Foundation Trust

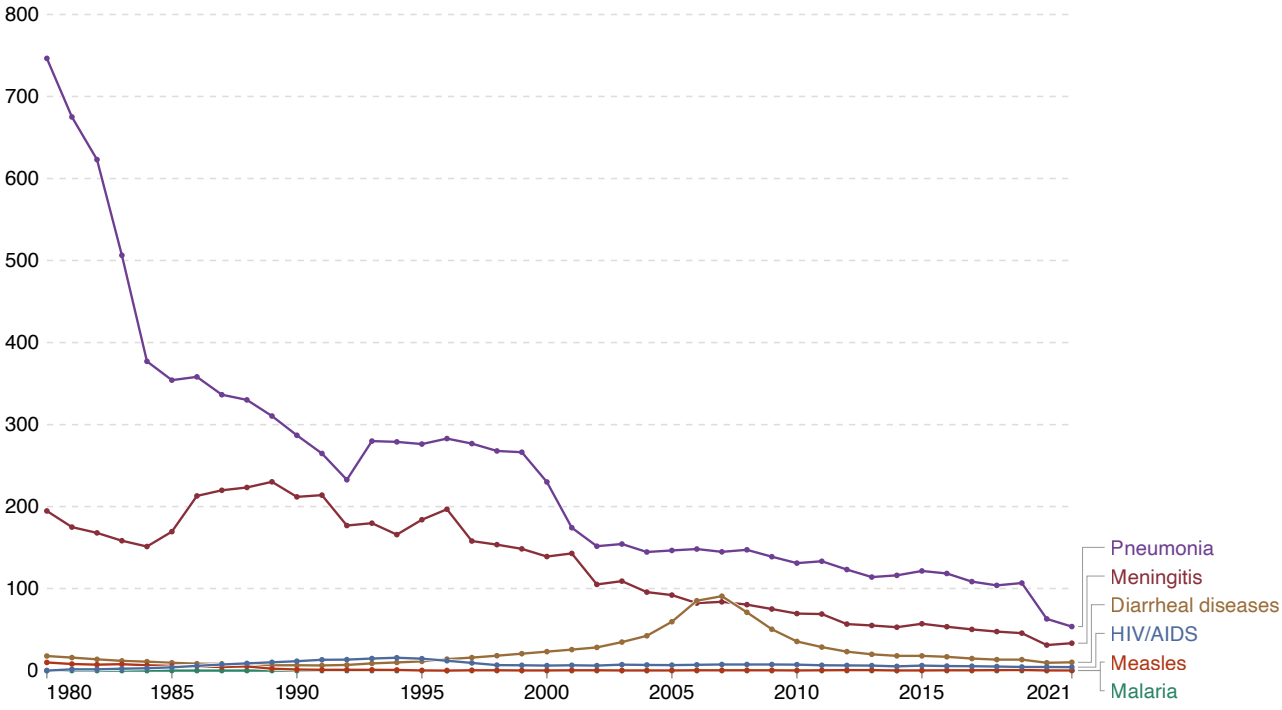
Elizabeth Whittaker – Professor of Practice, Paediatric Infectious Disease and Immunology, West London Children's Healthcare, Imperial College Healthcare NHS Trust and Imperial College London

Andrew Riordan – Consultant in Paediatric Infectious Diseases and Immunology, Alder Hey Children's NHS Foundation Trust, Liverpool

Introduction

Child health has improved over the last 20 years, with the child mortality rate in England and Wales (1 to 15 years) falling from 16 deaths per 100,000 in 2001 to 9 per 100,000 in 2023.[1] Much of this overall improvement is related to the sustained implementation of advancements in the prevention and treatment of infectious diseases which were, historically, a leading cause of death in children. The reduction in child mortality from infectious diseases can be seen most markedly in children under 5 years (Figure 1).

Figure 1: Estimated annual deaths from major infectious diseases in children under 5 years old, United Kingdom, 1980 to 2021[2]



Source: Image by IHME, Global Burden of Disease (2024) – with minor processing by Our World in Data, Childhood deaths from the most lethal infectious diseases, United Kingdom is licensed under CC-BY.

However, infection continues to be common in childhood and a major reason for acute morbidity and healthcare use in these age groups. Although absolute numbers of child deaths in England are low, infections were responsible for 15% of these between 1 April 2019 and 31 March 2022.[3]

While no infectious diseases are exclusive to children, many are much more common in children than in adults due to immature immunity, vaccination gaps (until they complete the childhood immunisation schedule), differing exposures related to childhood behaviours (for example, play leading to touch infections) and reduced ability to maintain personal hygiene at younger ages. A number of changing factors influence susceptibility to infection in childhood such as uptake of childhood immunisations and nutritional states (including obesity).

Common infections in childhood are often mild, such as viral upper respiratory tract infections and hand foot and mouth disease. Some of these can pose more serious risks to health in adulthood, such as Epstein-Barr Virus (EBV), chickenpox and mumps. However, some infections pose a more significant risk to child health and that of other vulnerable population groups through spread. Here, we outline changing epidemiology and responses to examples of serious infections in children.

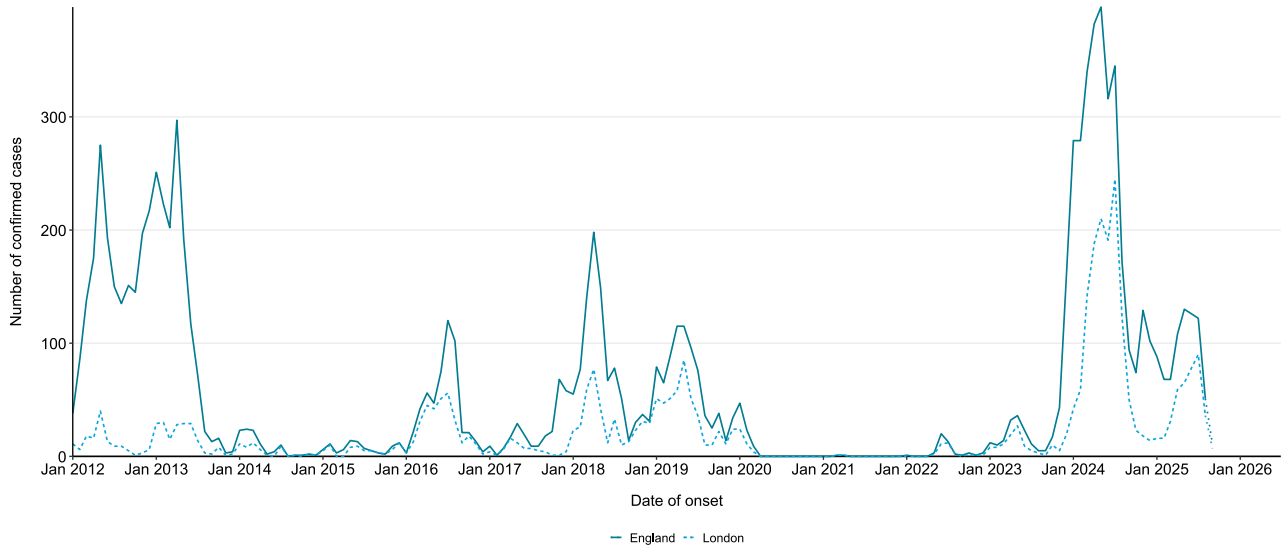
Changing epidemiology

Childhood infections have changed with resurgence of vaccine preventable diseases (measles, pertussis), outbreaks of established infections (Group A streptococcus) and emergence of new pathogens (SARS-CoV-2, Zika, Mpox).

Measles – a continuing threat

Measles, a vaccine preventable acute viral illness, is one of the most highly infectious diseases. Most cases are in unimmunised children and severe disease and complications are more common in poorly nourished and/or chronically ill children, including those who are immunosuppressed. Measles can cause blindness and hearing loss and, in some cases, death can occur years after the initial infection from a complication known as subacute sclerosing pan-encephalitis (SSPE). Prior to introduction of a vaccine, measles accounted for approximately 100 deaths per year.[4] Incidence and mortality from measles fell after vaccination was introduced. Despite achieving endemic measles elimination in 2016 in the UK, by 2018, measles transmission was re-established, at a time when large epidemics were seen in other countries. Further international outbreaks in 2024 were mirrored in England when 2,911 confirmed measles cases were recorded, the highest since 2012 (Figure 2).[5] The rise comes as vaccination rates for 2 doses have fallen below 90%, which could lead to more outbreaks. A national incident was declared with the launch of a catch-up vaccination campaign.

Figure 2: Laboratory confirmed cases of measles by month of onset of rash or symptoms reported, London and England: 1 January 2012 to 7 April 2025



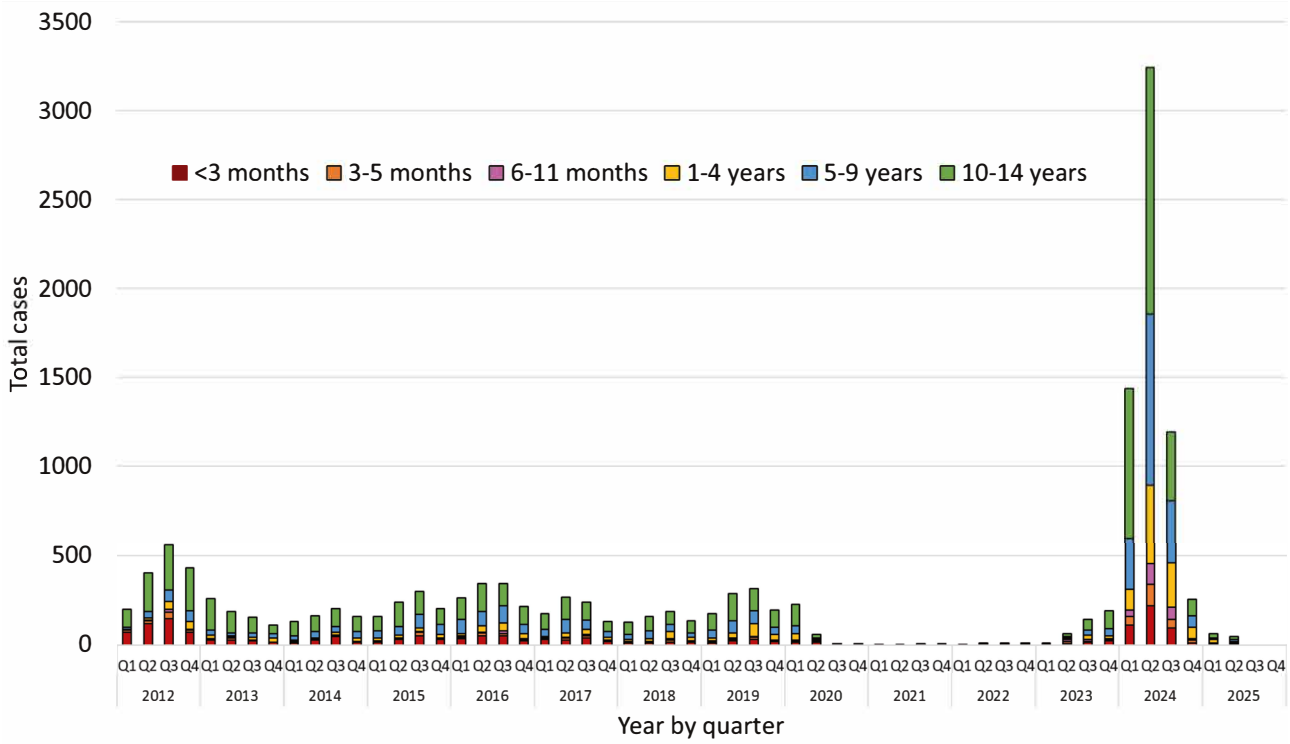
Source: Image from UKHSA, Confirmed cases of measles in England by month, age, region and upper-tier local authority: 2025 is licensed under the Open Government Licence v3.0.

Pertussis on the rise again

Pertussis is a vaccine preventable bacterial infection that causes whooping cough. Most hospitalisations and fatal cases of pertussis occur in unimmunised or incompletely immunised infants under 6 months of age. Before the introduction of a vaccine, over 100,000 people were suspected to have pertussis on average each year and over 2,000 people died from pertussis in some years.[6] Forty-eight babies aged less than one year old died from pertussis between 2001 and 2011 in England.[7] The introduction of pertussis vaccination in pregnancy in 2012 provided protection to babies before they could be directly protected by the infant vaccine programme.

Non-pharmaceutical interventions (NPI) implemented to help control the spread of SARS-CoV-2 between March 2020 and July 2021 had an impact on other infectious diseases, including pertussis (Figure 3). Consequently, pertussis activity was exceptionally low across England from April 2020 until summer 2023 when cases increased. High levels of pertussis activity were observed across all age groups and in every region in England in 2024. Vaccine uptake in pregnant women, babies and young children has fallen in recent years across England. Maternal vaccine uptake fell from 74.7% in December 2017 to 58.6% in 2023 to 2024.[8]

Figure 3: Total cases of laboratory-confirmed pertussis in children aged under 15 years by age group and by quarter each year, England, between Q1 2012 and Q2 2025

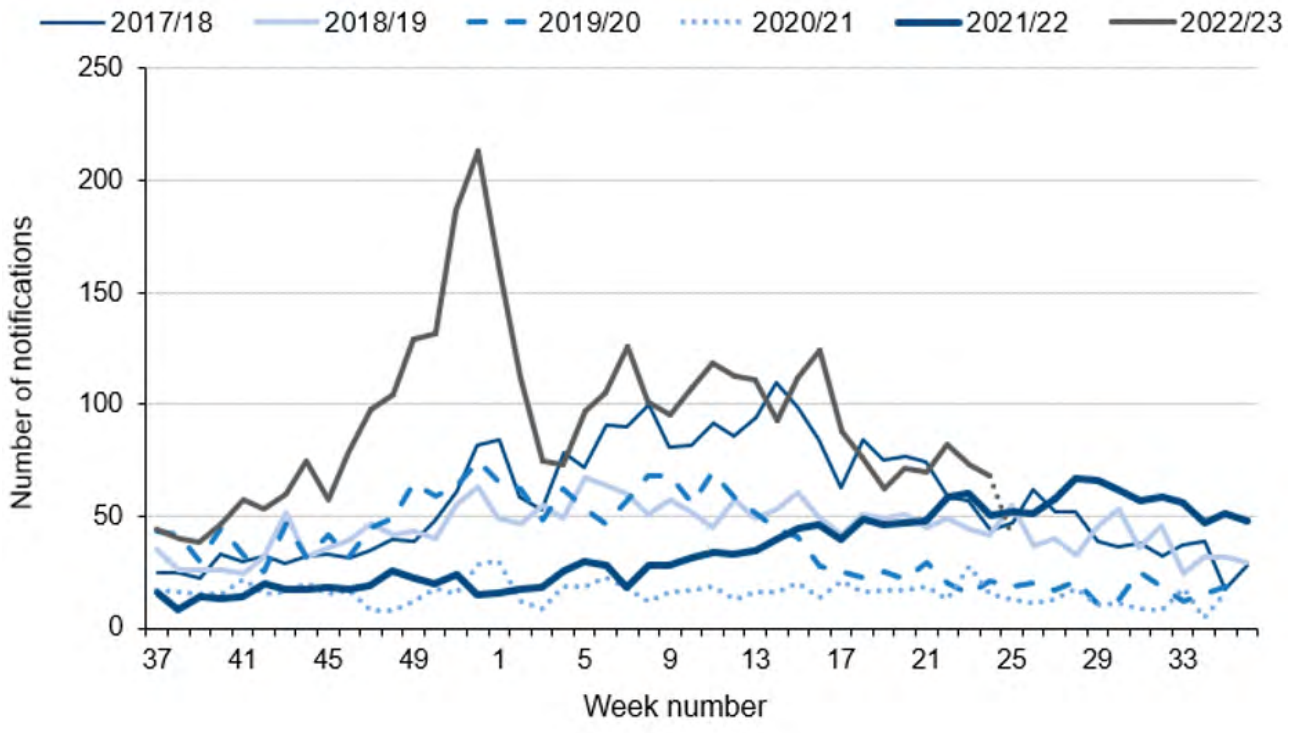


Source: UKHSA Immunisations team

Resurgence of Group A Streptococcal (GAS) disease

Group A streptococcus (GAS) is a bacterium that can cause a wide range of diseases including tonsilitis, scarlet fever, necrotizing fasciitis, rheumatic fever and toxic shock syndrome. Following a low incidence of invasive group A streptococcal (iGAS) infections during the COVID-19 pandemic, marked increases were noted in many countries including England during 2022, particularly in children (Figure 4). Pleural empyema accounted for a larger than usual number of cases of iGAS in children, putting stress on inpatient paediatrics and highlighting the importance of planning for paediatric critical care surge capacity.

Figure 4: Weekly laboratory notifications of invasive GAS, England, by season, 2017 to 2018 to 2022 to 2023



Source: Image from UKHSA, Group A streptococcal infections: 15th update on seasonal activity in England, updated 29 June 2023, is licensed under the Open Government Licence v3.0

This outbreak was associated with relatively high mortality. A change in typical seasonality (autumn rather than spring) may have resulted in both a lower suspicion of bacterial infection in children with typical winter respiratory viruses and a higher rate of pleural empyema. This highlighted the need for earlier detection and distinction of bacterial versus viral infections.

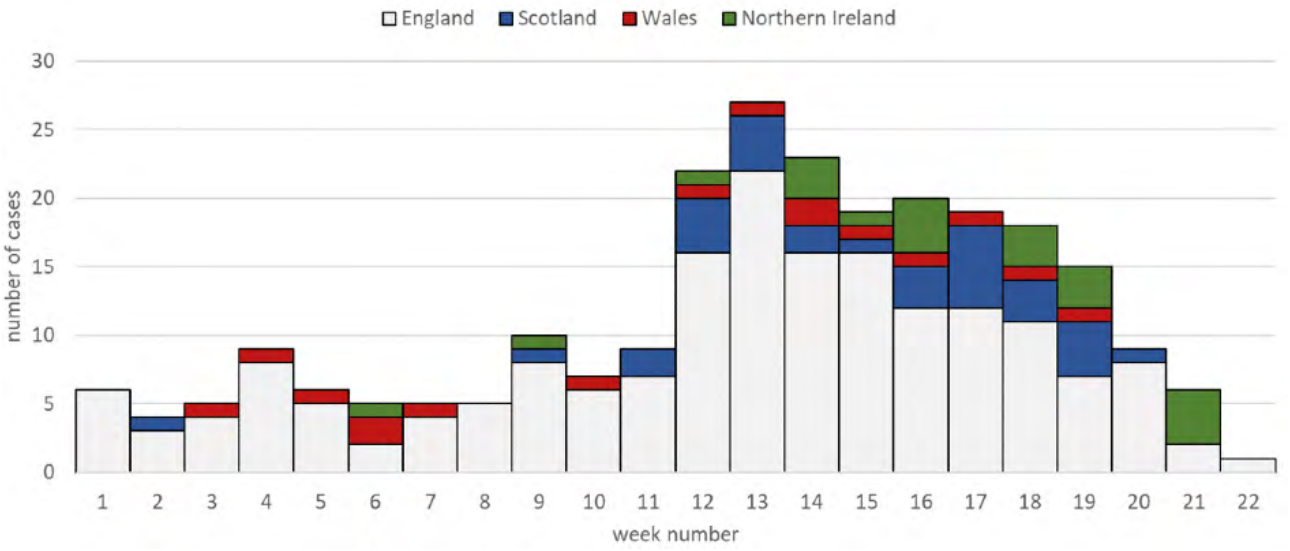
Shortages of liquid antibiotic preparations were seen nationally highlighting the need for robust antibiotic distribution pathways. In response, alternative antibiotic suspensions were sourced and resources to help young children swallow pills were shared.[9] The value of paediatric networks such as the British Paediatric Allergy Infection and Immunity Group (BPAIIG) and UK paediatric antimicrobial stewardship (UK-PAS) came to the fore, producing treatment guidance and a Short Supply Protocol for alternative antibiotics if penicillin suspension was unavailable.

Children are more likely to develop iGAS following chickenpox. The Joint Committee on Vaccination and Immunisation (JCVI) have recommended a universal varicella vaccination programme using the combined MMRV (measles, mumps, rubella and varicella) vaccine. Despite the increasing burden on global health caused by GAS, there is currently no licensed vaccine available. However, research on GAS vaccine development is ongoing.

Novel hepatitis

Between January and June 2022, 260 cases of acute non-A-to-E hepatitis were identified in children under 16 years old in England (Figure 5). There were no deaths, but 12 children required liver transplantation.

Figure 5: Novel hepatitis cases by week of presentation, 1 January to 13 June 2022



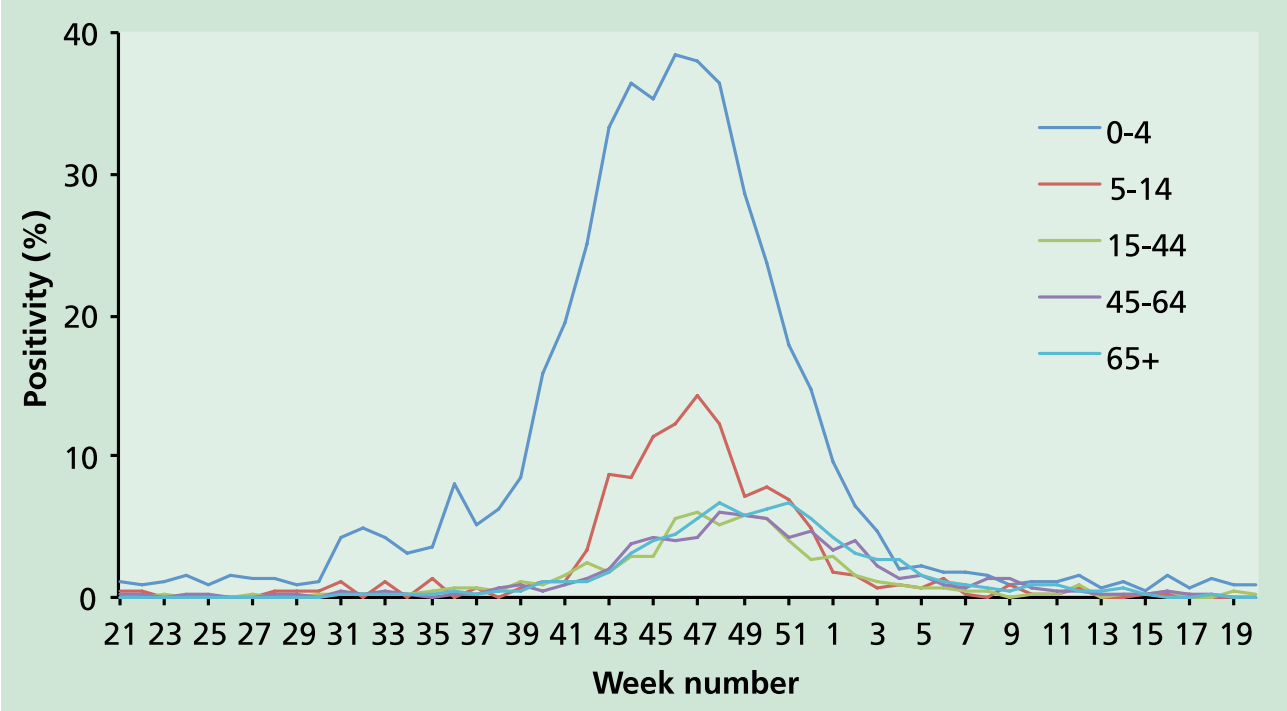
Source: Image from UKHSA, Investigation into acute hepatitis of unknown aetiology in children in England: case update, 2023 is licensed under the Open Government Licence v3.0.

A co-ordinated response between the UK Health Security Agency (UKHSA), NHS England (NHSE) and colleagues in paediatric hepatology, paediatric infectious diseases and virology provided a case definition and a mechanism for advice on investigation and management options to support clinical teams. Subsequently, a link between adenovirus and adenovirus associated virus (AAV) and specific Human Leukocyte Antigen (HLA) types were found in this cohort, using existing research studies.[10]

Respiratory syncytial virus (RSV) – a new vaccine

RSV infects up to 90% of children within the first 2 years of life and frequently reinfects older children and adults. RSV causes bronchiolitis in infants leading to significant breathing difficulties and hospitalisation, with an average annual admission rate of 35.1 per 1000 infants under one year of age. This significant burden of RSV illness in children every winter has a considerable impact on NHS services (33,500 hospitalisations per year in children under 5 years[11] and 20 to 30 child deaths per year)[12] (Figure 6).

Figure 6: Weekly swab positivity for RSV (%) by age group and date of specimen, Respiratory DataMart 2023/2024



Source: Image from UKHSA, Respiratory syncytial virus: the green book, chapter 27a, last updated 14 July 2025, is licensed under the Open Government Licence v3.0.

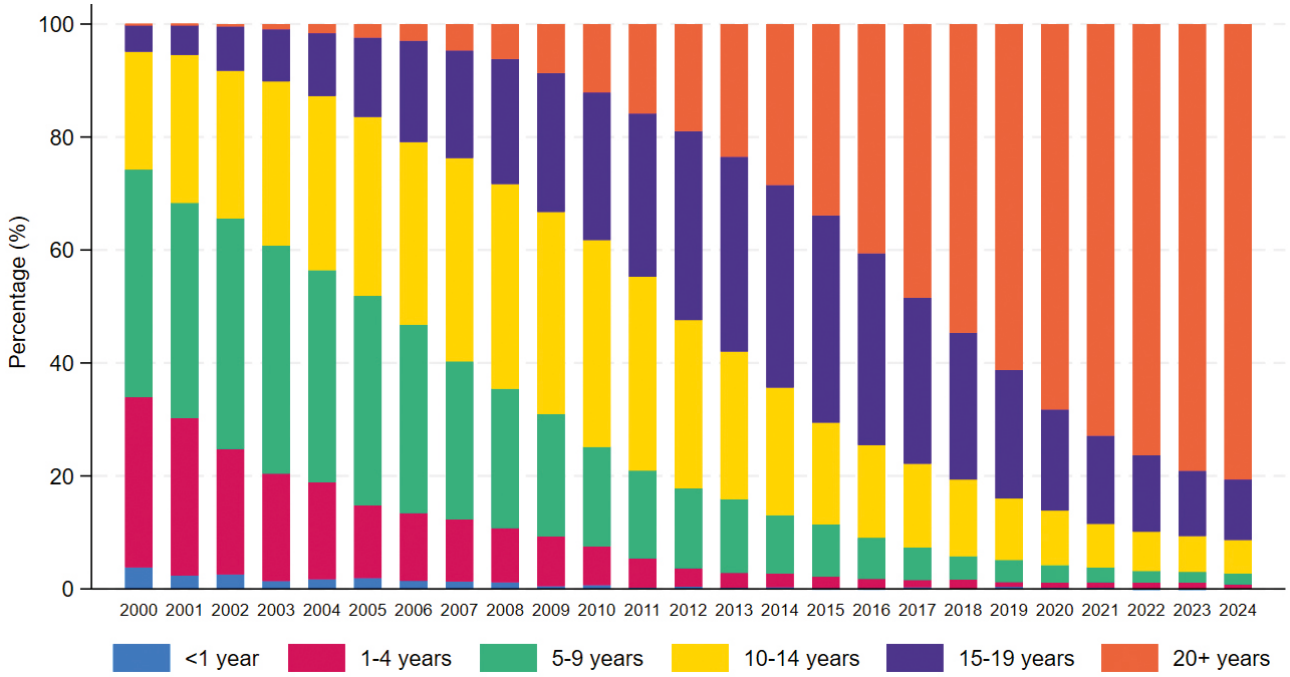
Although most RSV admissions are in healthy children, risk factors for severe RSV disease include chronic lung disease, congenital heart disease, chromosomal abnormalities, neuromuscular disorders, large airway abnormalities and immunodeficiency, particularly from multimorbidity.[13]

A universal programme to vaccinate pregnant women against RSV was introduced in England in September 2024 with the expectation that this will significantly reduce hospitalisation for infants with RSV over time. In July 2025, the provision of monoclonal RSV antibody for preterm infants born at less than 32 weeks gestation was introduced. This bridged the gap for these infants born before a maternal vaccination could be given; hence protecting this extremely vulnerable group.

Achievements in paediatric HIV

Effective treatment for HIV became available for children in 1996. Since then the risk of dying from HIV has decreased 5-fold.[14] The risk of mother to child transmission for HIV also decreased with treatment from 24% to 0.2%. Children with HIV are now expected to reach adulthood, leading to increasing numbers moving to adult HIV services.[15] The increasing number and complexity of HIV treatments are managed by a Children's HIV National Network allowing expert advice for all children, irrespective of where they live in the UK.

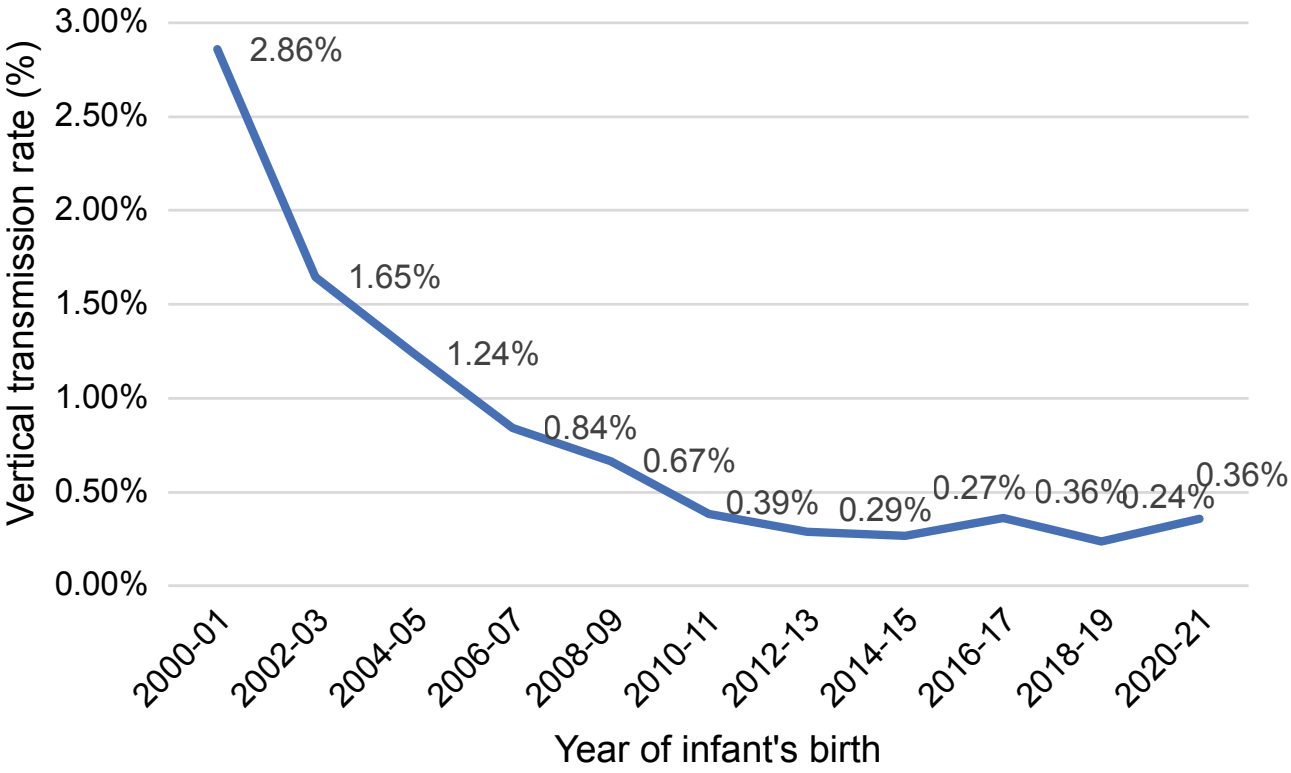
Figure 7: Age distribution of people in England with HIV diagnosed in childhood by year (n=1,569), 2000-2024



Data are for all children and young people who ever presented to medical services in England, including children who have since transferred to adult care. CHARS does not collect outcome data (e.g. deaths or lost to follow-up) for those who have transferred to adult care. All paediatric patients are included, from date of first presentation to paediatric HIV services in the UK, regardless of mode of HIV acquisition. Those who died or moved abroad while in paediatric care are included up until the year of death or year they left the country. Data for 2024 to 2025 are incomplete as subject to reporting delay.

Source: Image from Children's HIV and AIDS Reporting System (CHARS), Annual Report 2023-25 (data reported 1st July 2023 – 31st January 2025), with permission.

Figure 8: Vertical transmission rate by year of birth for infants born to diagnosed women in England



Source: Image from NHS England, ISOSS HIV report (for pregnancies between 1 April 2021 to 31 March 2022), 2024, is licensed under the Open Government Licence v3.0.

Changing populations and health inequalities

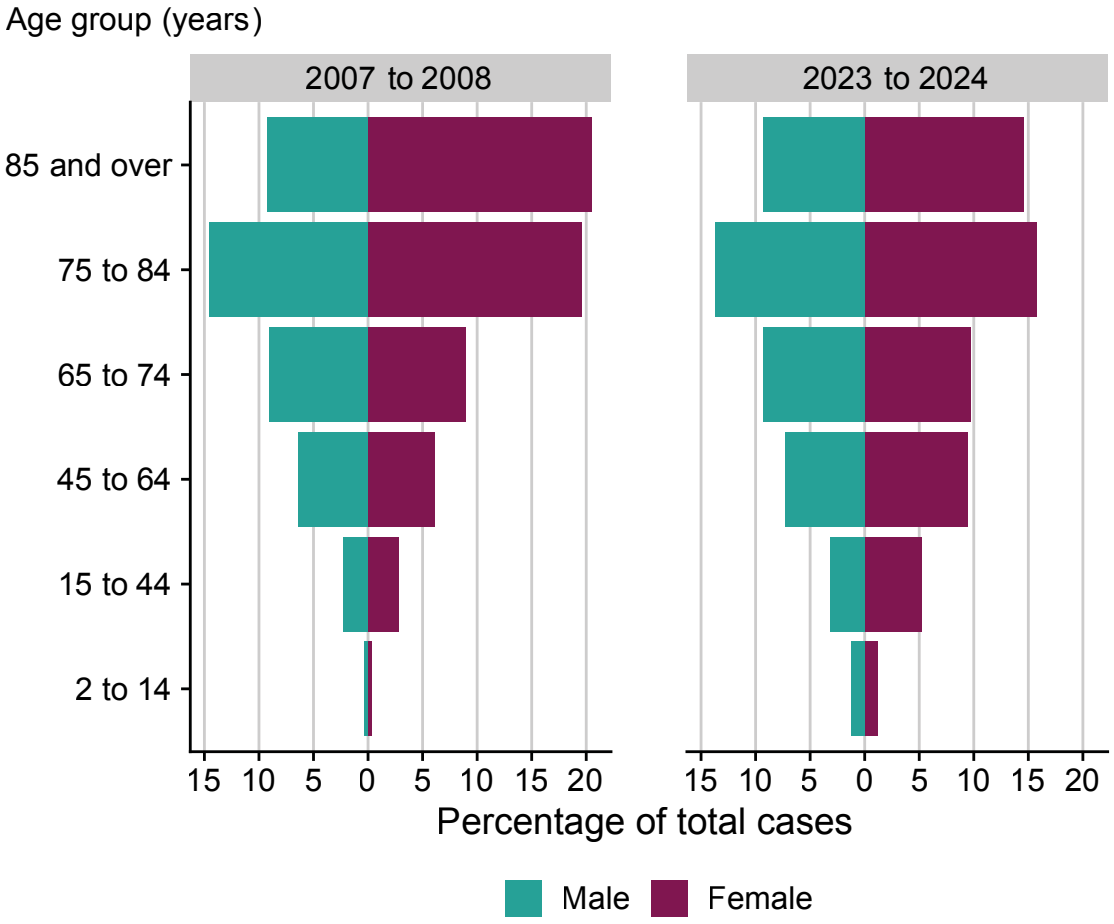
Children with complex needs, including immunocompromise

Advances in medical technology have led to increased survival of children with complex needs and life limiting conditions (for example, from complications of preterm delivery, genetic conditions, primary immunodeficiencies, immunodeficiencies secondary to novel treatments, chronic organ support technologies). These children have high healthcare need; they are more likely to have an unscheduled paediatric critical care unit (PCCU) admission than previously well children and are at higher risk of complex infections, prolonged hospital stay, frequent readmission and mortality.[16,17] From the National Child Mortality Database (NCMD) report in 2023, 90% of infection related deaths are in children with an underlying health condition.[18] Assessing and managing infection in children with complex needs is difficult and they are at increased risk of healthcare associated infection.

Healthcare associated infection in children

The prevalence of healthcare associated infection (HCAI) in children in 2011 to 2012 (3.6%) was lower than in adults.[19] The most common sites of HCAI in children are bloodstream infections (45%), followed by lower respiratory tract infections (22%) many of which are viral (such as RSV). The prevalence of infections is highest in PCCUs (15%). Trends of bloodstream infections in PCCUs differ considerably from those described in adult critical care units. This is likely due in part to the small event counts in PCCUs (leading to greater variability in rates) and lower participation of PCCUs in national surveillance. Children may have higher rates due to line sites (difficult to site subclavian lines in children). Enterobacteriaceae are the most frequently found micro-organisms in HCAI in children (15%). Some organisms that are important causes of HCAI in adults are much less common causes of HCAI in children for example *C. difficile* (Figure 9).

Figure 9: Age and sex distribution of C. *difficile* infections by percentage, England, by financial years: April 2007 to March 2008 and April 2023 to March 2024

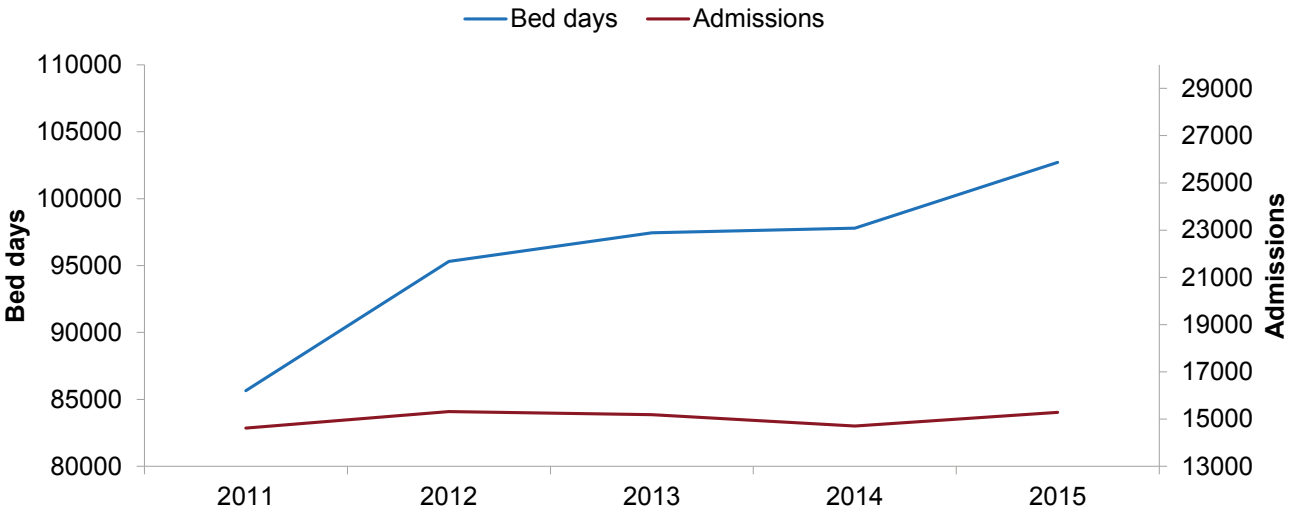


Source. Image from UKHSA, Annual epidemiological commentary: Gram-negative, MRSA, MSSA bacteraemia and C. difficile infections up to and including financial year 2023 to 2024, updated 15 May 2025, licensed under the Open Government Licence v3.0.

Paediatric critical care capacity

Despite a reduction in vaccine preventable disease, the demand for PCCUs increased 5% year on year from 2000 to 2020 (Figure 10).

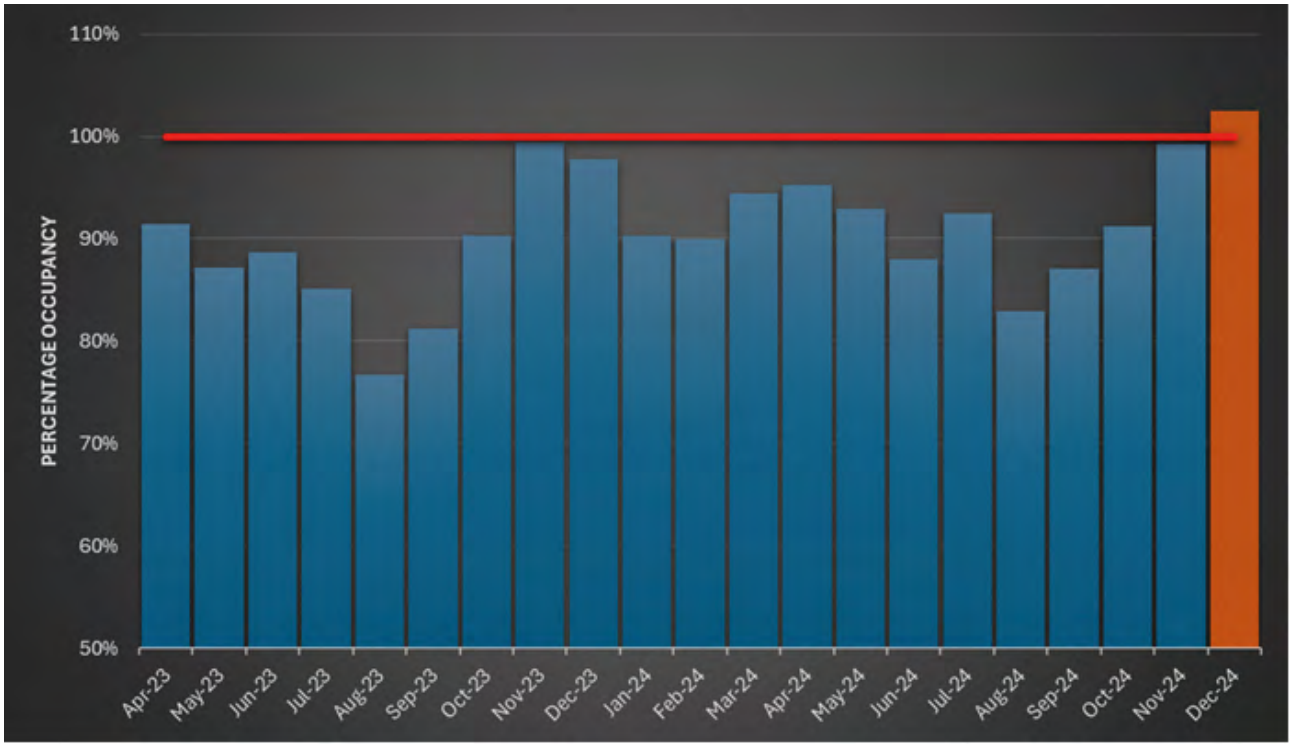
Figure 10: Increase in bed days and admissions to PCCUs, 2011 to 2015



Source: Image from NHS England. Paediatric Critical Care and Specialised Surgery in Children Review, November 2017.

This fell during the first year of the COVID-19 pandemic but has increased over the last 2 years, with PCCUs across England over 95% capacity every winter (Figure 11).

Figure 11: PCCU occupancy in England as a percentage of NHSE funded capacity, April 2023 to December 2024



Source: Data collated from the paediatric intensive care audit network data dashboard.

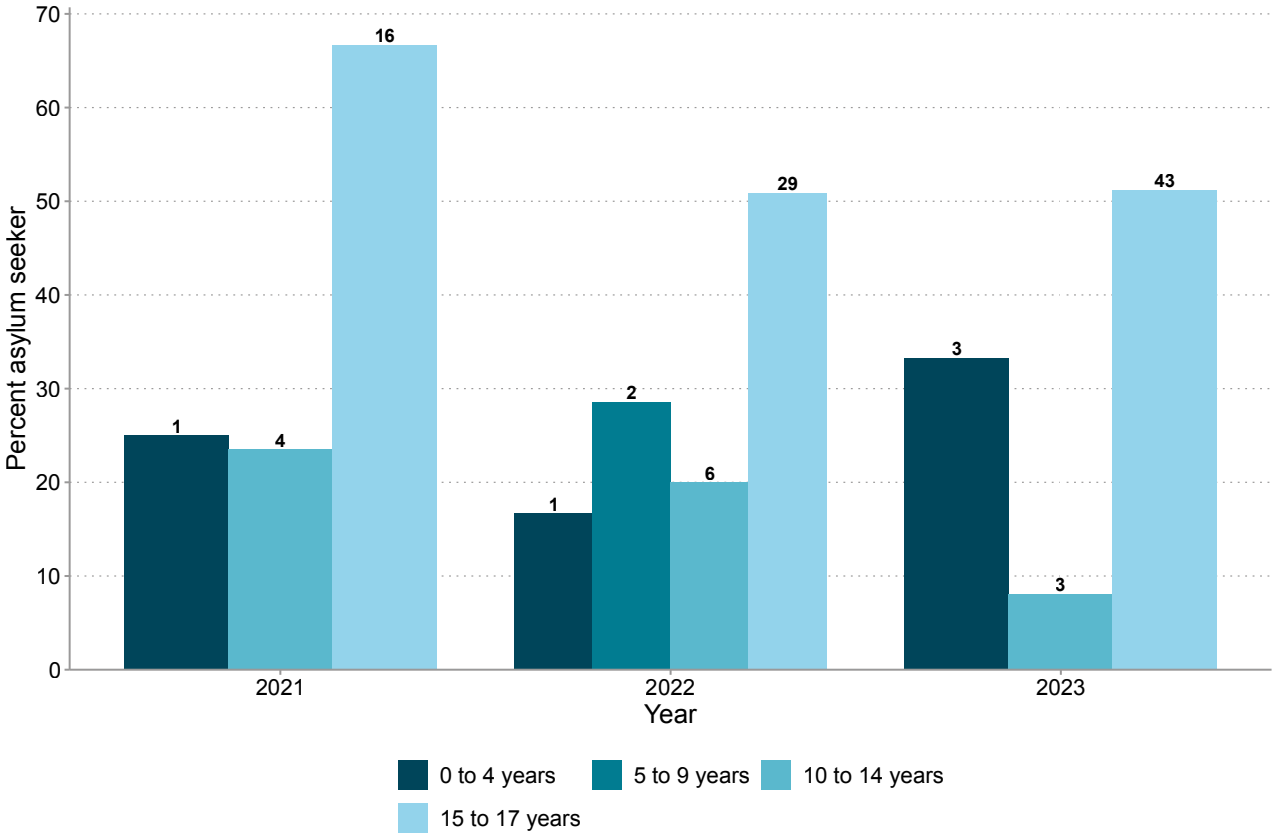
Increasing centralisation of PCC services and a reduction in the number of children cared for in adult critical care units over the last 15 to 20 years has led to improved outcomes in serious infections in children. In addition, specialist transport services provide access to co-ordinated, specialist consultant advice on patient management from the point of first contact. Paediatric infectious diseases services are an essential part of this pathway and all PCCUs should be linked with paediatric infection services, available around the clock. The provision of round-the-clock rapid review from critical care outreach teams prevents unplanned PCCU admission and/or readmission and the roll out of Martha's rule is anticipated to contribute positively to early recognition of the deteriorating child and prevention of need for critical care. The COVID-19 pandemic demonstrated that capacity is not just about beds or ventilators, but reliant on the presence of highly skilled nurses.

Refugees

Children and young people seeking asylum and refugees (CYPSAR) have complex social, physical and mental health needs, including a high prevalence of many infectious diseases such as tuberculosis (TB), parasitic infection and Hepatitis B. Many will have incomplete or uncertain vaccination status.

The UK received 26,903 asylum applications in the year ending March 2021, of which 2,044 were for children and young people seeking asylum and refugees who were unaccompanied. The number of children reported as asylum seekers has increased since 2021. The majority of these children were in the 15 to 17 year age group. In one cohort, 22.7% of these young people had TB infection (defined as a positive TB interferon gamma release assay (IGRA)).[20]

Figure 12: Proportion and number of asylum seekers in all TB notifications in non-UK born children by age group in children aged less than 18 years, England, 2021 to 2023



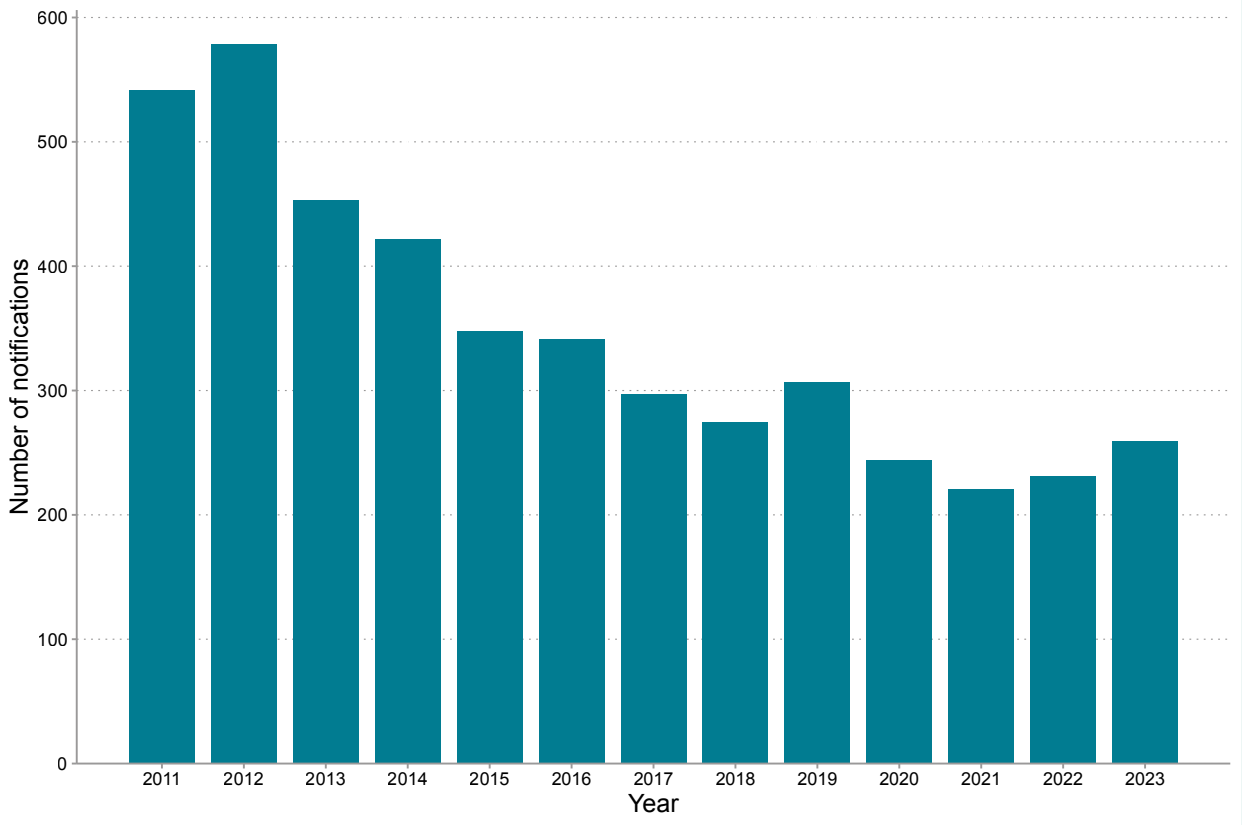
Source: Image from UKHSA, Tuberculosis in children aged 0 to 17 years, England, 2023 – GOV.UK, updated 29 May 2025, is licensed under the Open Government Licence v3.0.

In 2023, 20.5% of all children notified with TB were reported to be asylum seekers.[21] Young age, previous experiences, separation from family and language and cultural barriers impede access to appropriate healthcare once symptomatic for this population group.

Case study: Tuberculosis (TB) and the action plan 2021 to 2026

Children are particularly vulnerable to TB, especially those aged under 5 years who are at greatest risk of developing severe TB disease such as TB meningitis. The BCG vaccine can significantly reduce the risk of severe TB in young children. In 2023, there was a 12.1% increase in the number of children with TB compared with 2022 (Figure 13).[22] Over half (60.6%) of children with TB had pulmonary disease. In 2023, 9.6% of children under 18 years old with TB were reported to have a history of homelessness, rising to 19.2% of children aged 15 to 17 years (20 out of 104), compared with all people notified with TB (6.4%).

Figure 13: Overall number of TB notifications in children aged under 18 years, England, 2011 to 2023



Source: Image from UKHSA, Tuberculosis in children aged 0 to 17 years, England, 2023 – GOV.UK, updated 29 May 2025, is licensed under the Open Government Licence v3.0.

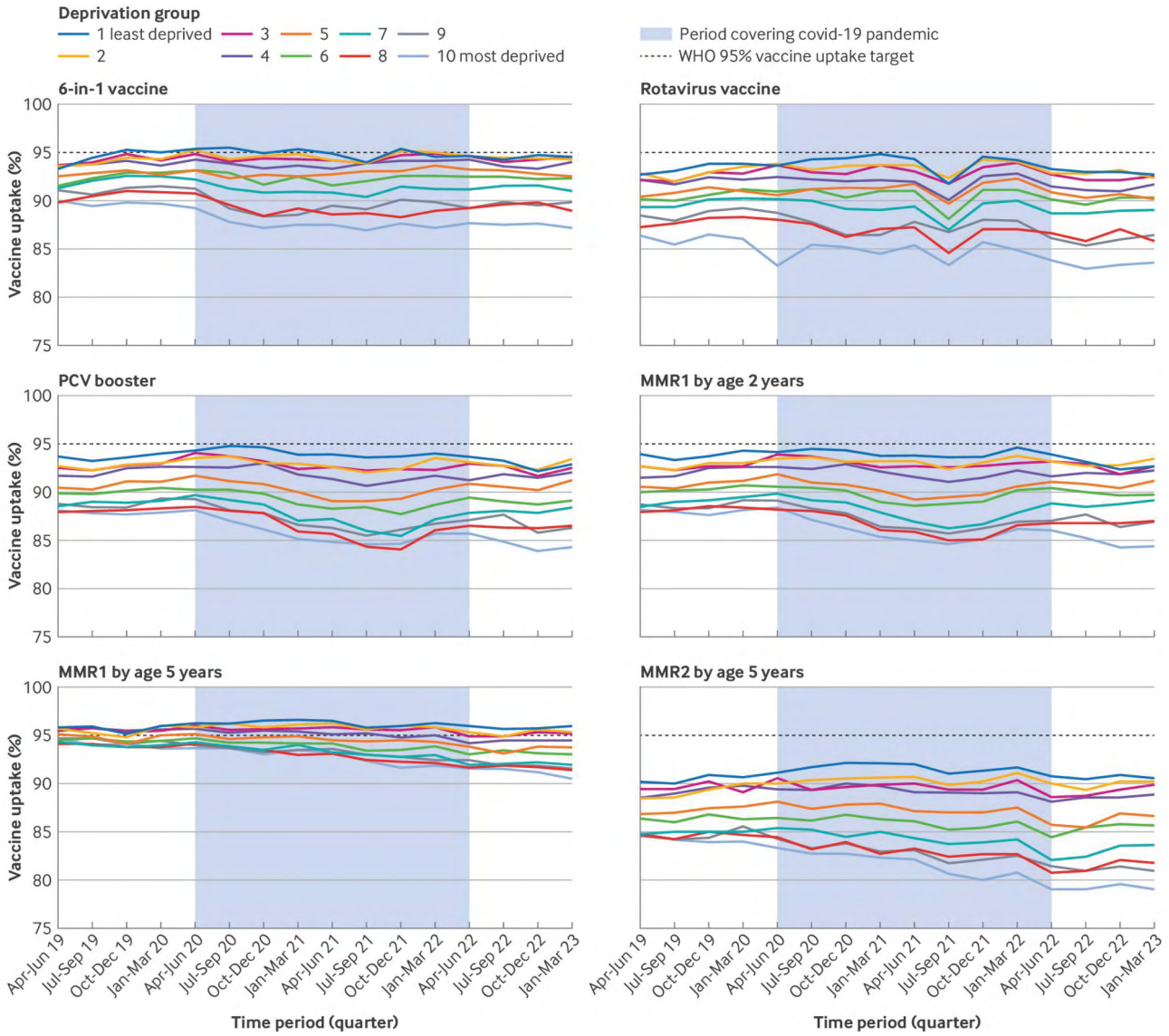
Although young children usually acquire TB from infected adults, the epidemiology, care pathways and management of children with TB should be distinct from (but linked with) those for adults. Children are identified as a specific population group requiring actions in the joint UKHSA and NHSE collaborative TB action plan 2021 to 2026.

New entrant screening programmes have typically focused on those over 16 years of age, despite the increased susceptibility of children to TB infection and the risk of more severe disease than adults.

Deprivation

Children living in the most deprived areas are twice as likely to be admitted to hospital for respiratory diseases and 6 times more likely for measles than children living in the least deprived areas.[23,24] Children living in the most deprived areas also have longer lengths of hospital stay than those living in the least deprived areas. Respiratory infection is associated with social inequalities in all age groups, but the greatest effect was in the under 4 years age group with admission rates 91% higher in the most deprived children compared to the least deprived.[25] These inequalities are linked to various factors, including poverty, housing conditions and access to healthcare. Furthermore, children born to families living in more deprived areas are also less likely to be vaccinated (Figure 14).[26]

Figure 14: Population weighted uptake of each vaccination studied over time, stratified by index of multiple deprivation group in England[27]



Source: Image from Flatt, A., et al., Inequalities in uptake of childhood vaccination in England, 2019-23: longitudinal study *BMJ* 2024 is licensed under CC by 4.0.

The risk of dying from infection is greatest in children from the most deprived families, with those most deprived having a risk of 5.73 per 100,000 children per year and those least deprived having a risk of 2.65 per 100,000 children per year.[28]

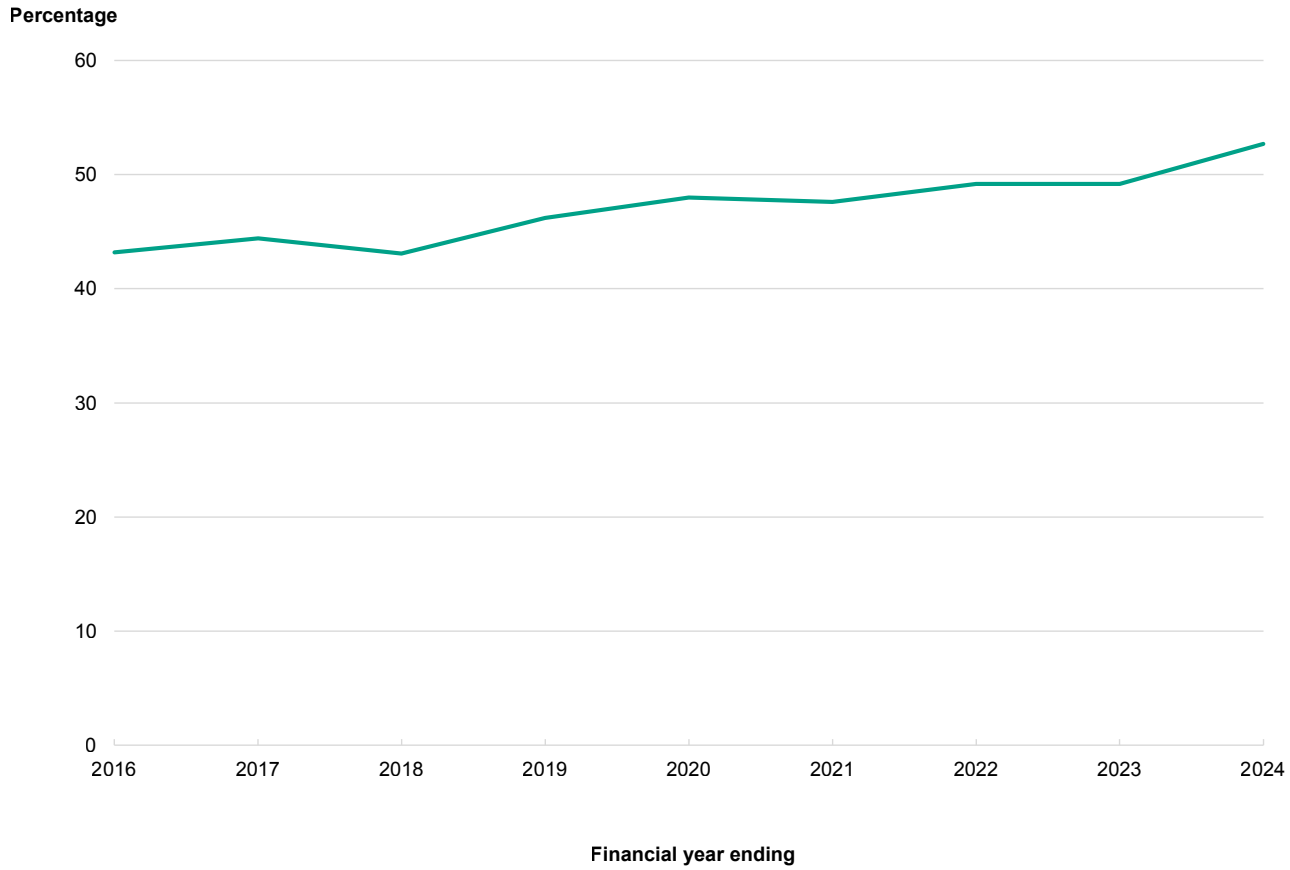
The risk of dying from infection also varies by the ethnicity of the child. Children from an Asian or Asian British (7.02 per 100,000 children per year) or Black or Black British ethnic background (6.11 per 100,000 children per year) were at higher risk than those from a White ethnic background (3.48 per 100,000 children per year). Children from a Pakistani ethnic background were at the highest risk of all (9.33 per 100,000 children per year).[29]

Responding to infections in children

Breastfeeding

Breastfeeding is important in promoting child health and is linked with fewer hospital admissions of infants for diarrhoea, vomiting and respiratory infections. The prevalence of breastfeeding at 6 to 8 weeks in England increased to 52.7% in 2023 to 2024 (Figure 15).[30] This is the highest prevalence of breastfeeding at 6 to 8 weeks reported since 2015 to 2016 when the current data collection commenced. However, there is wide variation in breastfeeding rates; mothers living in affluent areas are more likely to breastfeed than mothers living in more deprived areas.

Figure 15: Prevalence of breastfeeding at 6 to 8 weeks in England, 2015 to 2016 to 2023 to 2024



Source: Image by Office for Health Improvement and Disparities, Breastfeeding at 6 to 8 weeks, 2023 to 2024 statistical commentary, 2024, is licensed under the Open Government Licence v3.0.

UK childhood immunisation schedule

Vaccination is one of the best ways of preventing infection, particularly in young children. A number of new vaccines have been introduced to the UK childhood vaccination schedule over the past 20 years. These include Hepatitis B, pneumococcal conjugate vaccine, meningococcal conjugate vaccine, rotavirus, human papilloma virus (HPV) vaccine and seasonal influenza vaccination. Currently, seasonal influenza, HPV, MenACWY, Td/IPV (final dose) and MMR vaccines are offered to children in schools.[31] School settings provide an opportunity for systematic population-level vaccination, facilitating high coverage. Teachers and school nurses play an important role in providing information and access. Recent trends in childhood vaccine uptake and associated challenges are discussed in chapter 3.5.

Antimicrobial resistance

Most antibiotic prescribing in England occurs in primary care. Children are at risk of unnecessary exposure to antibiotics, particularly for viral respiratory tract infection. Antimicrobial resistance (AMR) in children is primarily caused by inappropriate use of antibiotics and poor infection prevention and control practices, and perpetuated by a lack of new antimicrobial drugs being developed.

Children are vulnerable to the threat of AMR in ways that are distinct from adults because of immature immune systems, higher rates of infection and long-term consequences (for example, from meningitis). In 2019, an estimated one in 5 deaths caused by bacterial AMR occurred in children younger than 5 years.[32] Children also have fewer treatment options with delayed access to newer antibiotics to treat these resistant organisms as trials are first completed in adults and the market incentives to do paediatric studies are less attractive to pharmaceutical companies. Increasing antibiotic use in children has contributed substantially to the rise in global antibiotic consumption over the past 2 decades.[33] This is due to high rates of infection and empiric antibiotic prescribing in children. Good quality antibiotic prescribing for children in primary care is key to controlling antibiotic resistance. More precise prescribing guidelines, decision support tools and better diagnostics in primary care could reduce unnecessary antibiotic prescribing for children and thus reduce AMR.

There is a lack of paediatric-specific data to benchmark the use of antimicrobial agents and the incidence of HCAI in order to guide local and national interventions. This lack of data leads to marked variability in the management of paediatric infections. Improved paediatric data on antimicrobial use is required.

Few new antibiotic agents or formulations have been developed or licensed for use in children in recent years; those that have been developed do not always adequately address the specific needs of children in terms of efficacy for relevant pathogens, dosing and optimal formulations.[34] Paediatric investigation plans for new antimicrobials need to include young children and run in parallel with adult studies to prevent the delay in newer agents being available for children.

Improvement in diagnostics

Fever in children is the most common presentation to primary care and emergency departments and often treated unnecessarily with antibiotics. This is because distinguishing severe infections from those that are self-limiting is challenging, both in terms of specimen collection (for example, adequate blood culture volume, logistics of biopsy or endoscopy under general anaesthetic) and because co-infection with respiratory viruses is common. Advances in infection diagnostics for children include the development of rapid, point-of-care tests and multiplex syndromic panels, which allow for broader testing of pathogens associated with clinical presentations. These tests allow quicker and more accurate pathogen detection, facilitating earlier use of targeted antimicrobial agents and improved patient outcomes. Novel diagnostics to complement molecular testing such as host-RNA signatures (looking at the immune response in the patient) can identify bacterial infections with a 95% to 100% accuracy and validation of point-of-care tests for use in paediatric emergency departments are underway.

Establishment of national networks

Improvements in treating and preventing infection in children have led to fewer but more complex serious infections which require specialist management (such as HIV, TB, Hepatitis C). A number of paediatric collaborative networks have been created to promote high quality, patient centred care in paediatric infectious diseases so that children can access expert care

wherever they live in England. These networks link with adult services where needed and require support to maintain the expert guidance they provide. The following are examples of such networks:

- UK Paediatric Antimicrobial Stewardship (UK-PAS) multidisciplinary network was launched in June 2019 to address the unmet need for coordinated paediatric efforts in dealing with antimicrobial resistance and improving antimicrobial use in the UK
- Congenital CMV Network (CCMVNET) is a European initiative promoting international collaboration, research and educational activities for congenital cytomegalovirus (cCMV). In 2020, the network established the European cCMVNET registry of children collecting data on epidemiology, clinical characteristics, long term sequelae, and treatment of infants born with cCMV
- British Association of Paediatric Tuberculosis (BAPT) was developed in 2017 to promote the health of children in the UK who have been exposed to or infected with tuberculosis by supporting and training relevant healthcare professionals and providing evidence based paediatric specific guidelines
- Children's HIV National Network (CHINN) is a network established in the UK to reduce inequalities in access to specialist paediatric HIV outpatient care. It was set up in 2005 and provides every hospital in the UK caring for children with HIV with direct access to advice from larger centres in London
- The Hepatitis C Operational Delivery Network (ODN) for paediatrics is a national network in England that provides specialised care and treatment for children and young people with Hepatitis C

Research trials

The UK is a global leader in supporting vaccine clinical trials, contributing to a number of the successes summarised in this report, including RSV, meningococcal and pneumococcal vaccine introduction and their impact on changing epidemiology. Other paediatric infection research trials include:

- RECOVERY trial (Randomised Evaluation of COVID-19 Therapy) recruited children into the first randomised controlled trial of management of Paediatric Inflammatory Multisystem Syndrome. This resulted in the first evidence-based guidelines for treatment of this emerging condition[35]
- CAP-IT trial of antibiotic use in young children with pneumonia, showing that length of treatment can safely be reduced from 7 to 3 days[36]
- BATCH (Biomarker-guided duration of Antibiotic Treatment in Children Hospitalised with confirmed or suspected bacterial infection) aims to tackle antibiotic overuse in hospitalised children and reduce the spread of antimicrobial resistance[37]

Pandemic planning and lessons learnt from recent outbreaks

Over the last 20 years, there have been a number of emerging infections including Zika, H1N1 swine influenza, H5N1 avian influenza, Mpox, SARS-CoV-2, all of which have specific relevance for children.

Influenza

Influenza (flu) is an acute viral infection of the respiratory tract. The risk of serious illness from influenza is higher amongst children under 6 months of age, older people, those with underlying health conditions such as respiratory or cardiac disease, chronic neurological conditions, immunosuppression and in pregnant women.

Influenza viruses cause outbreaks most years and they are the usual cause of epidemics. Children, particularly those under 5 or with underlying health conditions, are more vulnerable to severe outcomes. Influenza vaccination has been recommended in the UK since the late 1960s, with the aim of directly protecting those in clinical risk groups who are at a higher risk of influenza associated morbidity and mortality.

During the 2009 to 2010 H1N1 influenza virus (swine flu) pandemic, a higher proportion of children experienced infection and hospitalisation compared to adults, and severe disease and mortality was seen both in healthy children and those with pre-existing conditions. Seventy deaths were recorded, with higher mortality rates in children of Bangladeshi and Pakistani ethnic background than children of White British ethnic background. The childhood mortality rate was 6 per million, and highest in infants under one year of age at 14 per million.[38]

Seasonal influenza vaccination is protective against H1N1 virus and is offered to all children aged 2 to 16 years as well as at risk children from 6 months of age. Importantly, it is offered to pregnant women, providing passive protection to young infants, although uptake is poor. The higher rate of severe disease in children with H1N1 influenza raised concerns about the emergence of H5N1 avian influenza in recent years and the impact on children in the event of a subsequent pandemic. There has yet to be demonstrated human-to-human transmission of avian flu despite extensive recent surveillance but increasing cases in poultry and more recently bovine farm animals internationally is of concern.

At this time, pandemic planning for children is focused on influenza as the best example of a virus with pandemic potential that is most likely to impact young children, based on experience in 2009. Strategies include addressing vaccine hesitancy for seasonal influenza vaccination, both antenatal and in children, particularly in those at greatest risk, integrating data collection across primary and secondary care, improved diagnostics and improved access to diagnostics at the frontline including primary care.

COVID-19

SARS-CoV-2 infection in children predominantly results in asymptomatic or mild infections. Over 10,500 hospitalisations with primary COVID-19 disease were recorded between February 2020 and February 2022 in children aged under 17 in England; 62% in children less than 5 years of age. Children from deprived neighbourhoods and those who were of Asian, Black or mixed ethnicity were overrepresented in hospitalisations and 44% had medical co-morbidities. Four percent required PCCU admission, lowest in those less than 5 years of age. Forty-eight children died within 28 days of hospitalisation with primary COVID-19 disease, 91.7% had comorbidities affecting 2 or more body systems and 59% had life-limiting disability.[39]

England was the first to describe Paediatric Inflammatory Multisystem Syndrome associated with SARS-CoV-2 (PIMS-TS), a post infectious inflammatory condition with cardiac involvement.[40] This was possible due to well-established networks in paediatric infection services. There were 997 hospitalisations with PIMS-TS, peaking in February 2021. Forty-four percent required PICU admission.

A small proportion (~1%) of children developed 'long COVID' or post-COVID condition. NHS England commissioned 15 services to support children with post-COVID-condition in 2021 and CLoCK (Long COVID in children and young people), an NIHR funded research study, described the prevalence and impact of persistent symptoms in children and young people associated with SARS-CoV-2 infection.[41]

High Consequence Infectious Disease (HCID)

The increased risk of these emerging infections in children and young people highlights the value of the HCID paediatric network and the importance of inclusion of children in pandemic planning, in particular in research to develop preventative and therapeutic strategies.

England is unique in commissioning specific paediatric HCID centres as part of a national network. These centres managed the first paediatric HCID cases seen in the UK (including SARS-CoV-2 and Mpox) allowing child-centred care with isolation and containment within appropriately developed frameworks.[42,43] Close working relationships with national bodies (NHSE, UKHSA, Royal College of Paediatrics and Child Health, Royal College of Obstetrics and Gynaecology) supported policy and guideline development which was then adopted internationally and contributed to the UK as a global leader during these outbreaks and the COVID-19 pandemic.

References

1 Office for National Statistics. Child and infant mortality (by year of death), England and Wales. [Internet] 2025. Available from: https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/deaths/datasets/childmortalitystatisticschildhoodinfantandperinatalchildhoodinfantandperinatalmortalityinenglandandwales

2 Institute for Health Metrics and Evaluation. Global Burden of Disease (2024) – with minor processing by Our World in Data. "HIV/AIDS" [dataset]. IHME, Global Burden of Disease, "Global Burden of Disease - Deaths and DALYs" [original data]. [Internet] [Accessed 16 July 2025] Available from: https://ourworldindata.org/grapher/childhood-deaths-from-the-five-most-lethal-infectious-diseases-worldwide?country=~GBR

3 National Child Mortality Database. Infection related deaths of children and young people in England. [Internet] 2023. [Accessed 18 July 2025] Available from: https://www.ncmd.info/publications/child-death-infection/

4 UK Health Security Agency. Measles: the green book, chapter 21. [Internet] 2019. [Accessed 18 July 2025] Available from: https://www.gov.uk/government/publications/measles-the-green-book-chapter-21 Accessed 18th July 2025

5 UK Health Security Agency. UKHSA data dashboard, Measles. [Internet] 2025. [Accessed 3 October 2025] Available from: https://ukhsa-dashboard.data.gov.uk/vaccine-preventable-diseases/measles

6 University of Oxford. Vaccine Knowledge Project. Pertussis (Whooping Cough). [Internet] 2024. [Accessed 18 July 2025] Available from: https://vaccineknowledge.ox.ac.uk/pertussis-whooping-cough#More-information-about-the-disease

7 UK Health Security Agency. Pertussis: the green book, chapter 24. [Internet] 2025. [Accessed 18 July 2025] Available from: https://www.gov.uk/government/publications/pertussis-the-green-book-chapter-24

8 UK Health Security Agency. Research and Analysis: Confirmed cases of pertussis in England by month, 2025. [Internet] 2025. [Accessed 18 July 2025] Available from: https://www.gov.uk/government/publications/pertussis-epidemiology-in-england-2024/confirmed-cases-of-pertussis-in-england-by-month-2025

9 NHS. Healthier Together Advice on Swallowing Pills. [Internet] [Accessed 18 July 2025] Available from: https://www.what0-18.nhs.uk/parentscarers/worried-your-child-unwell/teaching-your-child-swallow-tablets

10 Morfopoulou S, Buddle S, Montaguth O et al. Genomic investigations of unexplained acute hepatitis in children. Nature. 2023;617(7961):564-573 doi: 10.1038/s41586-023-06003-w

11 Reeves R, Hardelid P, Gilbert R et al. Estimating the burden of respiratory syncytial virus (RSV) on respiratory hospital admissions in children less than five years of age in England, 2007-2012 Influenza Other Respir Viruses. 2017;11(2):122-129 doi: 10.1111/irv.12443

12 Cromer D, van Hoek A, Newall A, Pollard A and Jit M. Burden of paediatric respiratory syncytial virus disease and potential effect of different immunisation strategies: a modelling and cost-effectiveness analysis for England. Lancet Public Health 2017;2(8):e367-e374 doi: 10.1016/S2468-2667(17)30103-2

13 Thorburn K. Pre-existing disease is associated with a significantly higher risk of death in severe respiratory syncytial virus infection. Arch Dis Child 2009;94(2):99-103 doi: 10.1136/adc.2008.139188.

14 Gibb D, Doung T, Tookey A et al. National Study of HIV in Pregnancy and Childhood Collaborative HIV Paediatric Study. Decline in mortality, AIDS, and hospital admissions in perinatally HIV-1 infected children in the United Kingdom and Ireland. BMJ. 2003;327(7422):1019. doi: 10.1136/bmj.327.7422.1019.

15 Foster C, Ayers S, Fidler S. Antiretroviral adherence for adolescents growing up with HIV: understanding real life, drug delivery and forgiveness. Ther Adv Infect Dis. 2020;7:2049936120920177. doi: 10.1177/2049936120920177

16 Fraser LK, Parslow R. Children with life-limiting conditions in paediatric intensive care units: a national cohort, data linkage study. Arch dis Child 2018;103:540-547 doi: 10.1136/archdischild-2017-312638

17 Kanthimathinathan H, Plunkett A, Scholefield B, Pearson G and Morris K. Trends in long-stay admissions to a UK paediatric intensive care unit. Arch Dis Child 2020;105:558-562. doi: 10.1136/archdischild-2019-317797

18 National Child Mortality Database. Infection related deaths of children and young people in England. [Internet] 2023. [Accessed 18 July 2025] Available from: https://www.ncmd.info/publications/child-death-infection/

19 Zingg W, Hopkins S, Gayet-Ageron A, et al; ECDC PPS study group. Health-care-associated infections in neonates, children, and adolescents: an analysis of paediatric data from the European Centre for Disease Prevention and Control point-prevalence survey. Lancet Infect Dis. 2017;17(4):381-389. doi: 10.1016/S1473-3099(16)30517-5

20 Pinto A, Seery P and Foster C. Infectious disease screening outcomes and reducing barriers to care for unaccompanied asylum-seeking children: a single-centre retrospective clinical analysis. BMJ Paediatr Open. 2022;6(1):e001664. doi: 10.1136/bmjpo-2022-001664.

21 UK Health Security Agency. Research and analysis: Tuberculosis in children aged 0 to 17 years, England, 2023. [Internet] 2025. [Accessed 18 July 2025] Available from: https://www.gov.uk/government/publications/tuberculosis-in-england-2024-report/tuberculosis-in-children-aged-0-to-17-years-england-2023

22 UK Health Security Agency. Research and analysis: Tuberculosis in children aged 0 to 17 years, England, 2023. [Internet] 2025. [Accessed 18 July 2025] Available from: https://www.gov.uk/government/publications/tuberculosis-in-england-2024-report/tuberculosis-in-children-aged-0-to-17-years-england-2023

23 Hawker J, Olowokure B, Sufi F, Weinberg J, Gill N and Wilson R. Social deprivation and hospital admission for respiratory infection: an ecological study. Respiratory Medicine 2003;97(11): 1219-1224 doi: 10.1016/s0954-6111(03)00252-x

24 UK Health Security Agency. Research and analysis: Health inequalities in health protection report 2025. [Internet] 2025. [Accessed 18 July 2025] Available from: https://www.gov.uk/government/publications/health-inequalities-in-health-protection-report/health-inequalities-in-health-protection-report-2025

25 Hawker J, Olowokure B, Sufi F, Weinberg J, Gill N and Wilson R. Social deprivation and hospital admission for respiratory infection: an ecological study. Respiratory Medicine 2003;97(11): 1219-1224 doi: 10.1016/s0954-6111(03)00252-x

26 Flatt A, Vivancos R, French N et al. Inequalities in uptake of childhood vaccination in England, 2019-23: longitudinal study. BMJ 2024; 387 doi: 10.1136/bmj-2024-079550.

27 Flatt A, Vivancos R, French N et al. Inequalities in uptake of childhood vaccination in England, 2019-23: longitudinal study. BMJ. 2024; 387 :e079550 doi:10.1136/bmj-2024-079550

28 National Child Mortality Database. Infection related deaths of children and young people in England. [Internet] 2023. Available from: https://www.ncmd.info/publications/child-death-infection/

29 National Child Mortality Database. Infection related deaths in children and young people in England. [Internet] 2023. [Accessed 18 July 2025] Available from: https://www.ncmd.info/wp-content/uploads/2023/12/Infection-related-deaths-of-children-and-young-people-in-England.pdf

30 Office for Health Improvement and Disparities. Official Statistics: Breastfeeding at 6 to 8 weeks, 2023 to 2024 statistical commentary. [Internet] 2024. [Accessed 18 July 2025] Available from: https://www.gov.uk/government/statistics/breastfeeding-at-6-to-8-weeks-after-birth-annual-data-april-2023-to-march-2024/breastfeeding-at-6-to-8-weeks-2023-to-2024-statistical-commentary

31 UK Health Security Agency. Guidance: Supporting Immunisation programmes. [Internet] 2025. [Accessed 18 July 2025] Available from: https://www.gov.uk/government/publications/health-protection-in-schools-and-other-childcare-facilities/supporting-immunisation-programmes#vaccines-offered-in-schools

32 GBD 2021 Antimicrobial Resistance Collaborators. Global burden of bacterial antimicrobial resistance 1990-2021: a systematic analysis with forecasts to 2050. Lancet. 2024;404(10459):1199-1226 doi: 10.1016/S0140-6736(24)01867-1

33 Browne A, Chipeta M, Haines-Woodhouse G et al. Global antibiotic consumption and usage in humans, 2000-18: a spatial modelling study. Lancet Planet Health. 2021;5 (12) doi: 10.1016/S2542-5196(21)00280-1

34 Bamford A, Masini T, Williams P et al. Tackling the threat of antimicrobial resistance in neonates and children: outcomes from the first WHO-convened Paediatric Drug Optimisation exercise for antibiotics. Lancet Child Adolesc Health. 2024;8(6):456-466 doi: 10.1016/S2352-4642(24)00048-8.

35 RECOVERY Collaborative Group. Immunomodulatory therapy in children with paediatric inflammatory multisystem syndrome temporally associated with SARS-CoV-2 (PIMS-TS, MIS-C; RECOVERY): a randomised, controlled, open-label, platform trial. Lancet Child Adolesc Health. 2024;8(3):190-200. doi: 10.1016/S2352-4642(23)00316-4.

36 Bielicki J, Stohr W, Barratt S et al. Effect of Amoxicillin Dose and Treatment Duration on the Need for Antibiotic Re-treatment in Children With Community-Acquired Pneumonia: The CAP-IT Randomized Clinical Trial. JAMA. 2021;326(17):1713-1724. doi: 10.1001/jama.2021.17843.

37 Waldron CA, Pallman P, Schoenbuchner S et al; BATCH trial team. Effectiveness of biomarker-guided duration of antibiotic treatment in children hospitalised with confirmed or suspected bacterial infection: the BATCH RCT. Health Technol Assess. 2025;29(16):1-125. doi: 10.3310/MBVA3675.

38 Sachedina N and Donaldson L. Paediatric mortality related to pandemic influenza A H1N1 infection in England: an observational population-based study. Lancet. 2010;376(9755):1846-52 doi: 10.1016/S0140-6736(10)61195-6

39 Ward J, Harwood R, Kenny S et al. Pediatric Hospitalizations and ICU Admissions Due to COVID-19 and Pediatric Inflammatory Multisystem Syndrome Temporally Associated With SARS-CoV-2 in England. JAMA Pediatr. 2023;177(9):947–55 doi: 10.1001/jamapediatrics.2023.2357

40 Whittaker E, Bamford A, Kenny J et al. Clinical Characteristics of 58 Children With a Pediatric Inflammatory Multisystem Syndrome Temporally Associated With SARS-CoV-2. JAMA. 2020;324(3):259-269. doi: 10.1001/jama.2020.10369

41 Stephenson T, Pereira S, Shafran R et al. Physical and mental health 3 months after SARS-CoV-2 infection (long COVID) among adolescents in England (CLoCk): a national matched cohort study. Lancet Child Adolesc Health. 2022;6(4):230-239. doi: 10.1016/S2352-4642(22)00022-0.

42 Alonso A, Cohen J, Cole J et al; NHS England HCID Networks. Clinical Management of Hospitalized Patients With High-Consequence Infectious Diseases in England. Health Secur. 2024;22(S1):S50-S65. doi: 10.1089/hs.2023.0167

43 Whittaker E, Sinha R, Riordan A et al. Ethical and legal considerations in the care of children and young people with high consequence infectious diseases (HCIDs): an approach to decision making. Lancet Child Adolesc Health. 2025;9(3):205-210. doi: 10.1016/S2352-4642(24)00353-5.

3.5 Childhood vaccination

Mary Ramsay – Director Public Health Programmes, UK Health Security Agency; Professor of Vaccine Policy, London School of Hygiene and Tropical Medicine

Heidi Larson – Professor of Anthropology, Risk and Decision Science, Director, The Vaccine Confidence Project and Chair, The Global Listening Project, London School of Hygiene & Tropical Medicine; Visiting Professor, Centre for Evaluation of Vaccines, University of Antwerp, Belgium; Clinical Professor, Institute of Health Metrics & Evaluation, University of Washington, Seattle

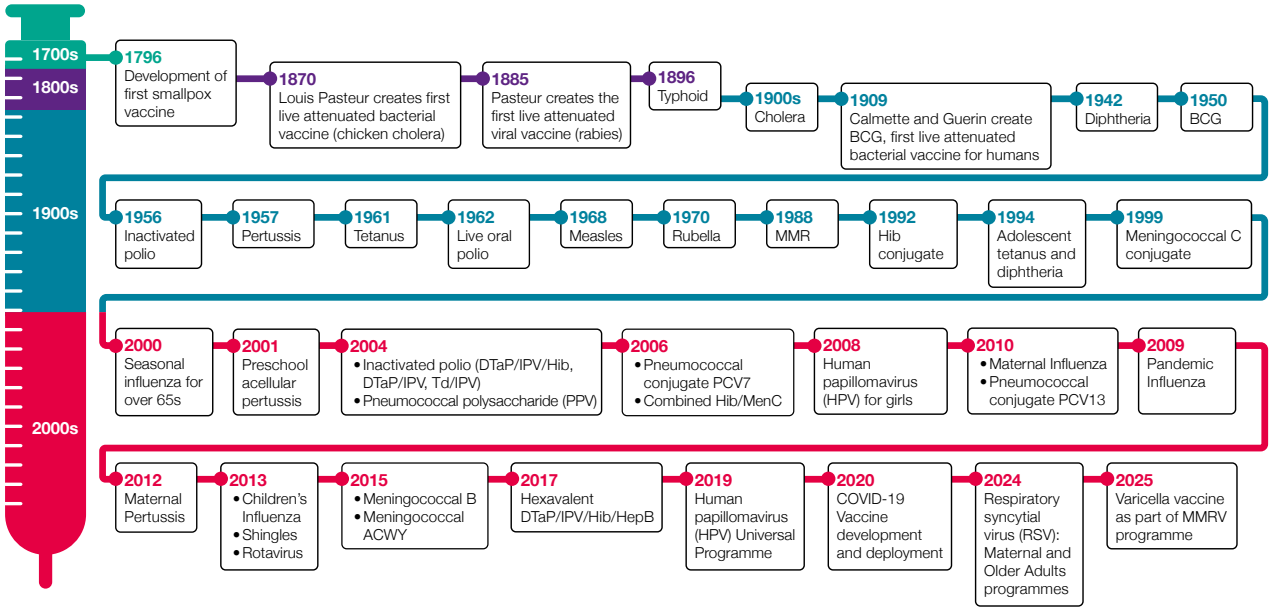
Andrew Pollard – Ashall Professor of Infection and Immunity, University of Oxford and Chair of the Joint Committee on Vaccination and Immunisation 2013 to 2025

Introduction

Successful childhood vaccination programmes have been in place in the UK for more than 80 years, with the introduction of vaccines against diphtheria in 1940, tuberculosis in 1953 and whooping cough (pertussis) in 1961.[1] Following large outbreaks of poliomyelitis in the 1950s, it was recognised that national coordination of the programmes was required and, in 1963, the Joint Committee on Vaccination and Immunisation (JCVI) was formed to provide advice on a consistent immunisation schedule across the whole of the NHS. This aimed to improve childhood health by ensuring an equitable programme across the country to achieve higher levels of vaccine uptake. The creation of local immunisation coordinators in the late 1980s, inclusion of vaccination in the GP contract from April 1990, and making the schedule consistent across all local health authorities were part of a range of measures introduced to improve access and reduce the risk of missed doses for children who move between areas. Improving vaccine coverage to sufficiently high levels can reduce circulation of targeted infections to levels low enough to also indirectly protect people unable to be vaccinated or in whom vaccines may be less effective. This is known as herd immunity. Achieving this safely is a key advantage of mass vaccination programmes.[2]

The national programme has since been further enhanced to offer population-level vaccination against many more infections for children and, more recently, to older adults and pregnant women (Figure 1). The routine childhood schedule now includes vaccines which protect against 17 infections, including measles, rotavirus, the main causes of bacterial meningitis, and 2 infections that can cause cancer (Hepatitis B and human papilloma virus – discussed further in chapter 4.3). Adult and maternal vaccinations are discussed in chapters 4.1 and 3.2, respectively.

Figure 1: Historical vaccine development and introduction of routine vaccine programmes in the UK[3]

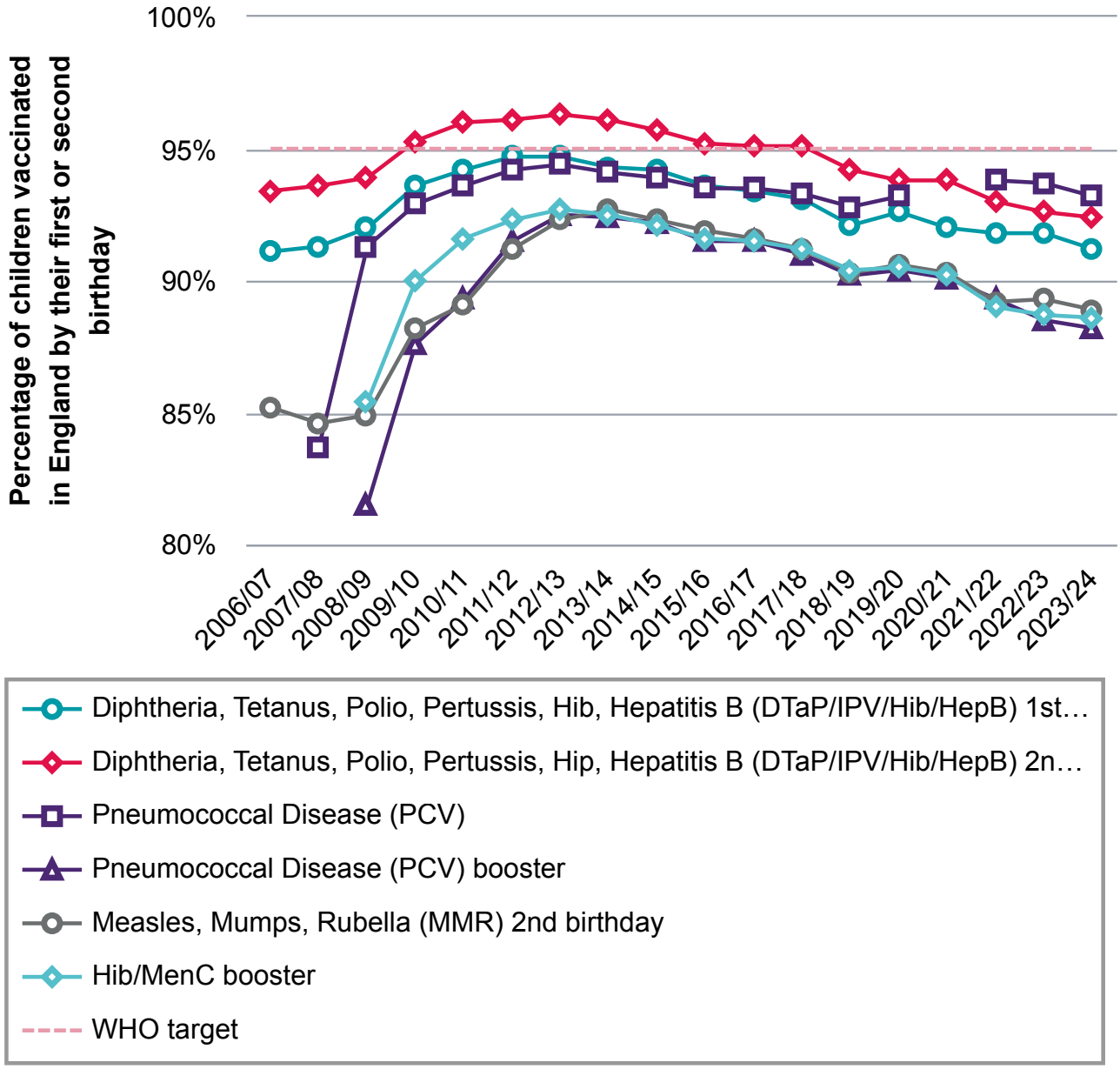


© Crown copyright 2025. UK Health Security Agency gateway number: 2025503

Source: UK Health Security Agency (UKHSA) Immunisation Programmes Publications team

However, over the last decade coverage has been slowly but steadily declining for vaccination programmes across the childhood schedule (Figure 2).

Figure 2: Percentage of children vaccinated in England by their first or second birthday[4]



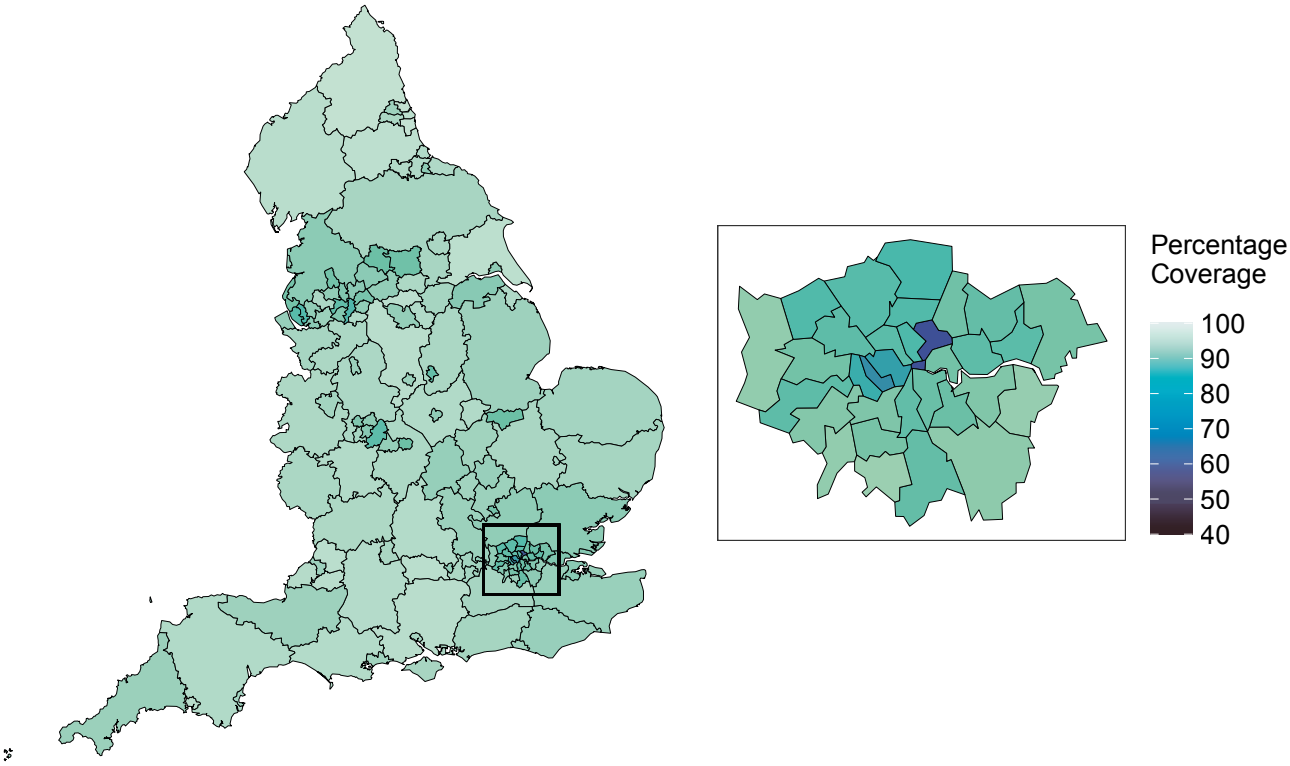
Copyright Nuffield Trust & The Health Foundation

Source: Image by Nuffield Trust and The Health Foundation, Vaccination coverage for children and mothers, 2025, with permission.

Coverage for the 3 primary doses of hexavalent vaccine (covering diphtheria, tetanus, polio, pertussis, *Haemophilus influenzae* type B and Hepatitis B), given at 8, 12 and 16 weeks is measured at one year of age, and again at 2 and 5 years. When measured at one year of age, peak coverage of 3 doses was 94.7% in 2012 to 2013, but by 2023 to 2024, had declined to 91.2% in England.

The overall fall in coverage has also been seen in the other UK countries, although Scotland and Wales have maintained higher coverage overall, with Scotland still achieving coverage of over 95% for the primary course of the hexavalent vaccine by age 5 years. England tends to have the lowest coverage of the four nations, driven primarily by lower coverage within London (Figure 3).

Figure 3: Coverage of the 6-in-1 vaccine in children aged 12 months in England for 2024 to 2025 by Upper-tier Local Authority[5]



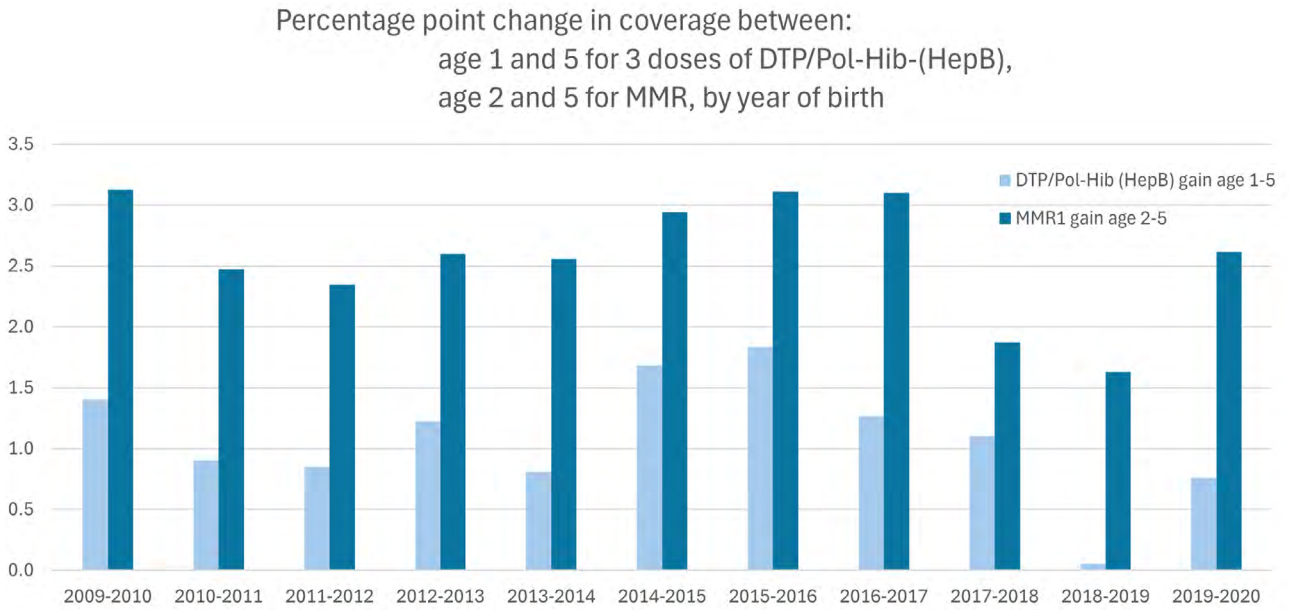
Source: Image from UKHSA, Vaccination coverage statistics for children aged up to 5 years, England (COVER programme) report: April 2024 to March 2025, 2025, is licensed under the Open Government Licence v3.0.

National coverage of the second dose of the measles-mumps-rubella vaccine (MMR2), normally given at 3 years and 4 months of age, has declined by more percentage points than vaccines given earlier in life. Coverage of primary vaccination by age 5 years is expected to be higher than for the same number of doses measured at earlier ages, reflecting the longer time between vaccination and the point of measurement, and therefore the opportunity for catch-up. MMR coverage measured at 5 years of age has declined from 87.7% in 2012 to 2013 to 83.9% in 2023 to 2024.[6]

Analysis of coverage by year of birth can be used as a proxy for the extent of catch-up vaccination being undertaken. Disappointingly, as well as the decline in timely coverage at one year of age for third dose of the hexavalent diphtheria, tetanus, pertussis, polio, *Haemophilus influenzae* type b and Hepatitis B vaccine and at 2 years of age for first dose of MMR vaccine, the percentage point change in coverage by the age of 5 years is sub-optimal. The increase in coverage between these ages fell to very low levels for children born in 2017 to 2018 and 2018 to 2019 (Figure 4). Children in these 2 cohorts would have reached 3 years and 4 months during the early COVID-19 pandemic years (2020 and 2021) when there was the greatest disruption to routine immunisation services in primary care, combined with higher parental anxiety.[7] The low extent of catch-up at this age is consistent with lower coverage seen for the pre-school booster doses and suggests that vaccination of older children is prioritised lower than that of infants - something that was particularly evident during the pandemic. In recognition of this and its contribution to an increase in cases of measles, a national campaign was launched to catch-up children with the MMR vaccine in 2023 and 2024. The evaluation suggested that an additional

180,000 doses were delivered and coverage increased more in deprived and ethnic minority communities.[8]

Figure 4: Estimated extent of primary vaccination catch-up by 5 years of age by year of birth, England, 2009 to 2010 to 2018 to 2019



DTP/Pol-Hib-(HepB): vaccine covering diphtheria, tetanus, polio, pertussis, *Haemophilus influenzae* type B and Hepatitis B

MMR: measles, mumps, rubella vaccine

Source: Data from UKHSA, Vaccination coverage statistics for children aged up to 5 years, England (COVER programme) report: April 2024 to March 2025, updated 2 October 2025.

Additionally, there are geographical differences in vaccine coverage across England, with London consistently demonstrating lower levels than the rest of the country. Furthermore, vaccine coverage is usually lower in more deprived areas and there is also evidence of widening ethnic inequalities in routine childhood vaccination in England.[9]

Barriers to access to healthcare and changing attitudes to vaccines in some population groups are contributing to the decline in childhood vaccine coverage and the subsequent resurgence of vaccine preventable diseases such as measles.

Although vaccination coverage measured for the financial year 2024 to 2025 is consistent with the broad trend of decline over the last decade, it has remained stable or increased from the previous year for some vaccines.[10]

Modern examples of success from childhood vaccination

Vaccination programmes against common causes of invasive disease

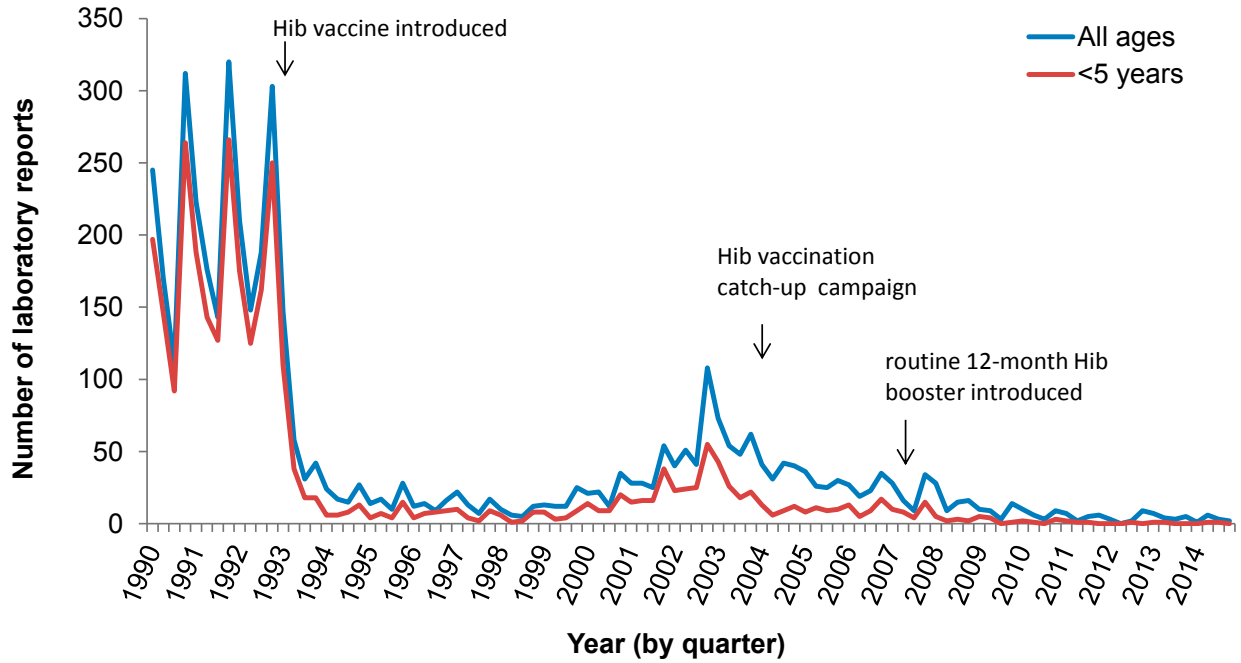
Conjugate vaccines against the most common causes of invasive disease, including meningitis and sepsis in children, were introduced between 1992 and 2006. These were the Hib vaccine for *Haemophilus influenzae* type b, the MenC vaccine for serogroup C meningococcal disease and

the pneumococcal conjugate vaccine targeting 7, and then 13, different pneumococcal serotypes. All 3 organisms are commonly carried in the nasopharynx of healthy people,[11] but can invade the blood stream to cause serious infections. All have a high case-fatality ratio and high rate of long-term sequelae.

As well as reducing severe disease in people who become infected, conjugate vaccines are effective at blocking transmission by reducing asymptomatic nasopharyngeal carriage of the organisms that cause infection. Doses are therefore offered at ages when children are most susceptible to disease, usually in infancy, and then again just before the prevalence of nasopharyngeal carriage of the target organisms is highest – toddlers for the Hib and pneumococcal conjugate vaccines and teenagers for the MenC vaccine. Targeting carriage has proven to be a highly effective means of controlling infection through herd immunity.

A resurgence of Hib occurred between 1999 and 2005, showing that a booster dose at an older age was needed to sustain low carriage rates in toddlers (Figure 5). A Hib booster vaccine campaign was therefore conducted in 2003. In 2006, a booster dose of combined Hib and MenC was added to the routine schedule. These lessons informed the implementation of the MenC and pneumococcal conjugate vaccines.

Figure 5: *Haemophilus influenzae* type b laboratory reports by quarter, England, 1990 to 2014[12]

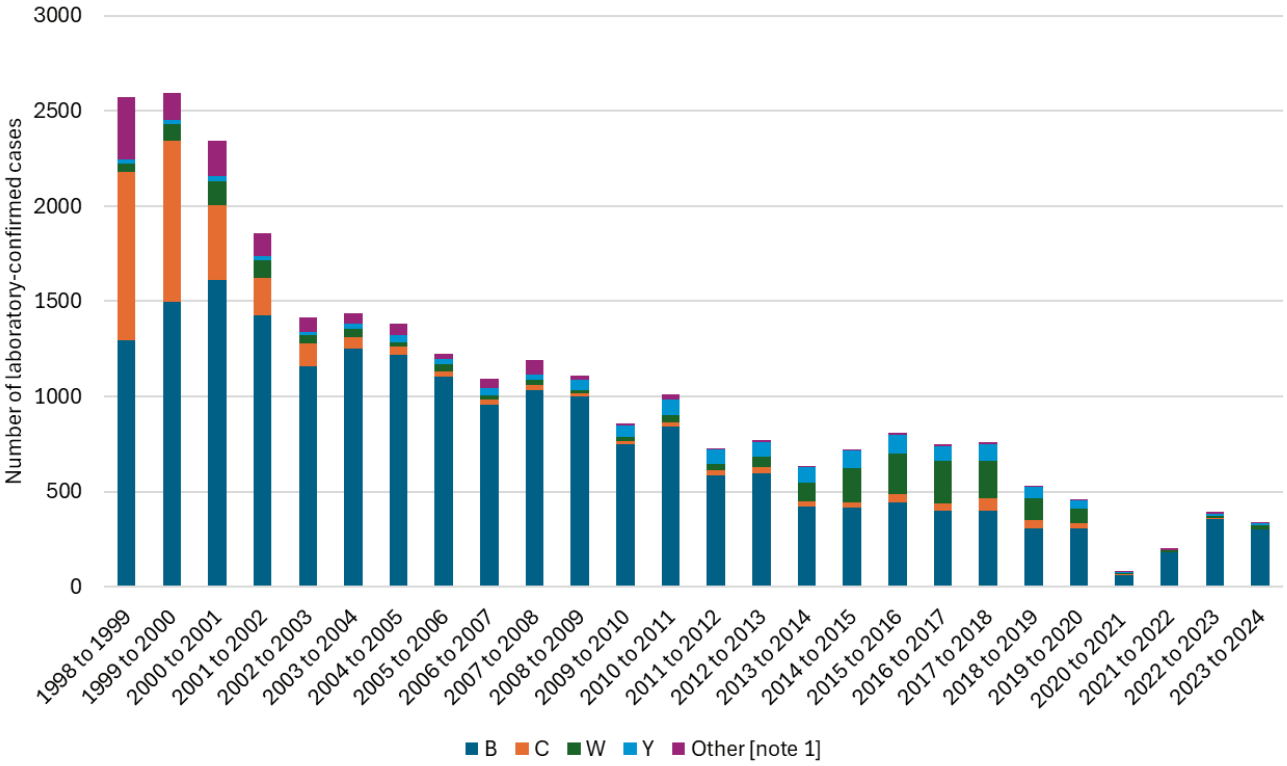


Source: Public Health England, Graph showing Haemophilus influenzae type b laboratory reports 1990 to 2014 is licensed under the Open Government Licence v3.0

In November 1999, a routine programme for infants to receive the MenC conjugate vaccine, alongside a catch-up programme for all children up to 18 years completed over the following year, was introduced in response to an increase in cases and deaths from invasive meningococcal disease (IMD) driven by expansion of a hyperinvasive MenC strain. A rapid fall in MenC cases in the age groups targeted for vaccination was subsequently observed, followed by a reduction in cases across the whole population due to the vaccine preventing acquisition of

MenC carriage and reducing transmission across all age groups. By 2014 to 2015, only approximately 30 MenC cases on average were confirmed each year (Figure 6).

Figure 6: Invasive meningococcal infections laboratory reports in England by capsular group and epidemiological year, 1998 to 1999, to 2023 to 2024



Note: Other includes capsular groups: A, X, E, Z, ungroupable and ungrouped. Ungroupable refers to invasive clinical meningococcal isolates that were non-groupable, while ungrouped cases refers to culture-negative but polymerase chain reaction (PCR) screen (ctrA) positive and negative for the four genogroups [B, C, W and Y] routinely tested for.

Source: Data from UKHSA, Meningococcal disease: laboratory-confirmed cases in England 2023 to 2024, Last updated 20 January 2025.

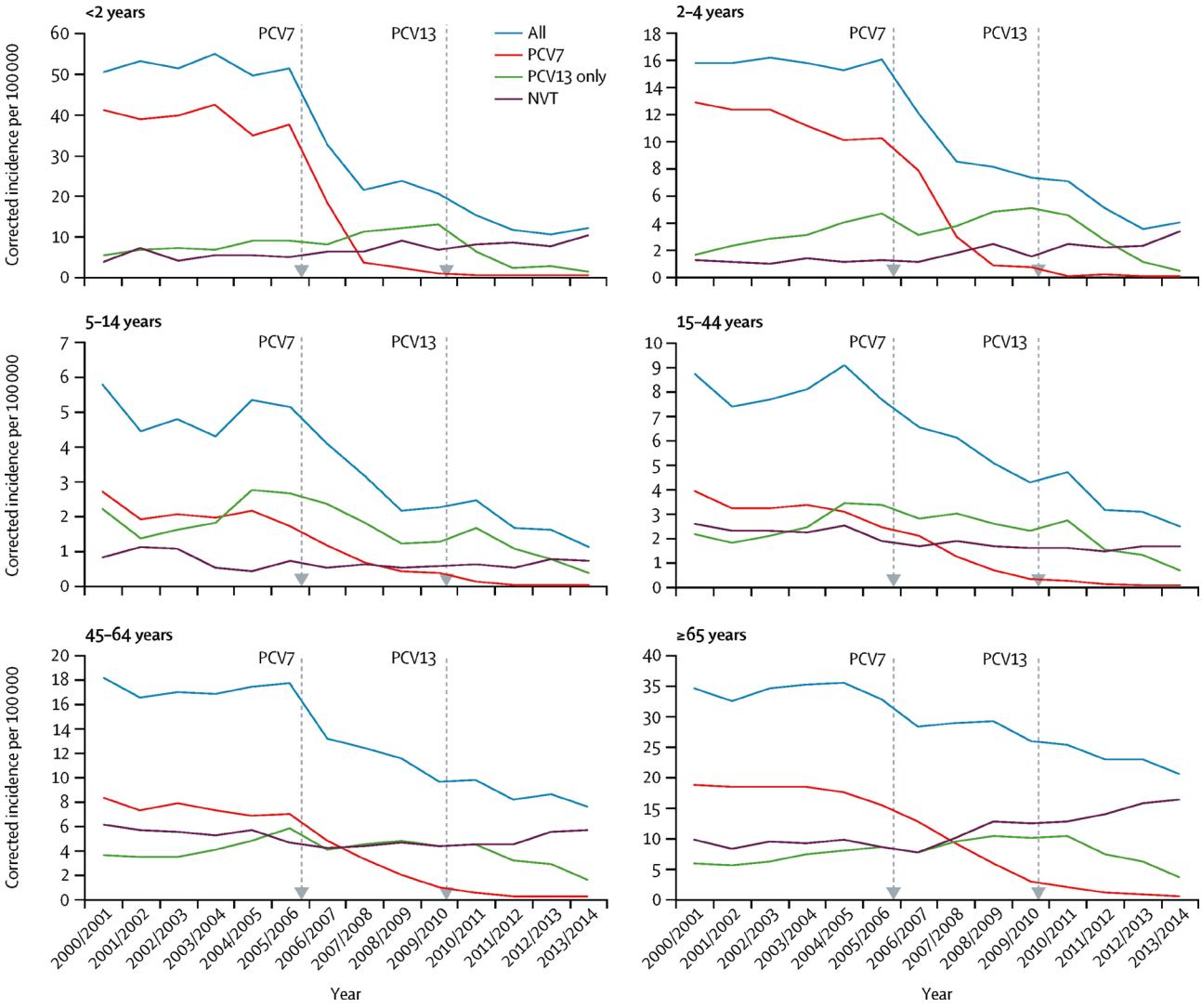
Around this time, a new hyperinvasive MenW strain, also associated with severe disease and a high case fatality ratio, emerged in several countries in south America and Europe, including the UK. Cases from the MenW strain increased from 19 (2% of all IMD) in 2008 to 2009 to 176 (24% of all IMD) in 2014 to 2015 in England (Figure 5). Prior experience with MenC in the 1990s, and the availability of licensed MenACWY conjugate vaccines, allowed for an emergency programme specifically targeted to teenagers aged 13 to 18 years. Young people in this age group have low disease incidence but high meningococcal carriage. Vaccinating this population directly protects those vaccinated and interrupts transmission across the wider population. A routine teenage programme continues, with MenACWY vaccine offered at 13 to 15 years.

UKHSA analysis showed high direct and indirect impact with overall MenACWY vaccine effectiveness of 94% (95% CI 80%–99%) against MenCWY disease combined.[13] The implementation of social distancing measures during the COVID-19 pandemic across the UK in 2020 and 2021 had a marked impact on reducing the incidence of IMD.[14] This further accelerated population control of MenC, MenW and MenY such that carriage prevalence is predicted to reduce to near elimination levels over time provided that teenage MenACWY uptake remains high.[15,16] This success has allowed for the removal of the last MenC vaccine dose

in the infant/toddler vaccination programme, spurred by a change in supply of the combined Hib-MenC vaccine (Menitorix) which has now ceased production. A fourth dose of the combined hexavalent (6-in-1) vaccine will now replace the Hib component of the previous Hib-MenC vaccine dose that was given at one year of age.

The first pneumococcal conjugate vaccine, targeting 7 serotypes of the infection, was introduced with a routine booster dose in the second year of life and a toddler catch-up campaign. The strategy of using conjugate vaccines to maximise indirect protection, by targeting carriage in toddlers, was used to inform the schedule. This allowed the UK to achieve and sustain good control in infancy with fewer doses, initially only 2 doses (at 8 and 16 weeks of age) compared to the approved schedule of 3 doses as used in other countries. The profound effect of reducing carriage rates in toddlers included a major decline in the incidence of vaccine serotypes in adults and contributed to control of infection in infants through herd immunity (Figure 7). This enabled the UK to then become the first country to reduce the schedule further in January 2020. UK infants are now offered only a single dose of pneumococcal conjugate vaccine (updated to protect against 13 strains – PCV13) in infancy, followed by the booster at one year of age.[17] Ensuring that strains from cases of invasive pneumococcal disease are accurately typed by the UKHSA national reference laboratory will allow for evaluation of the impact of this innovation in the longer term.

Figure 7: Invasive pneumococcal disease incidence from epidemiological year 2000/01 to 2013/14, by serotype grouping and age[18]



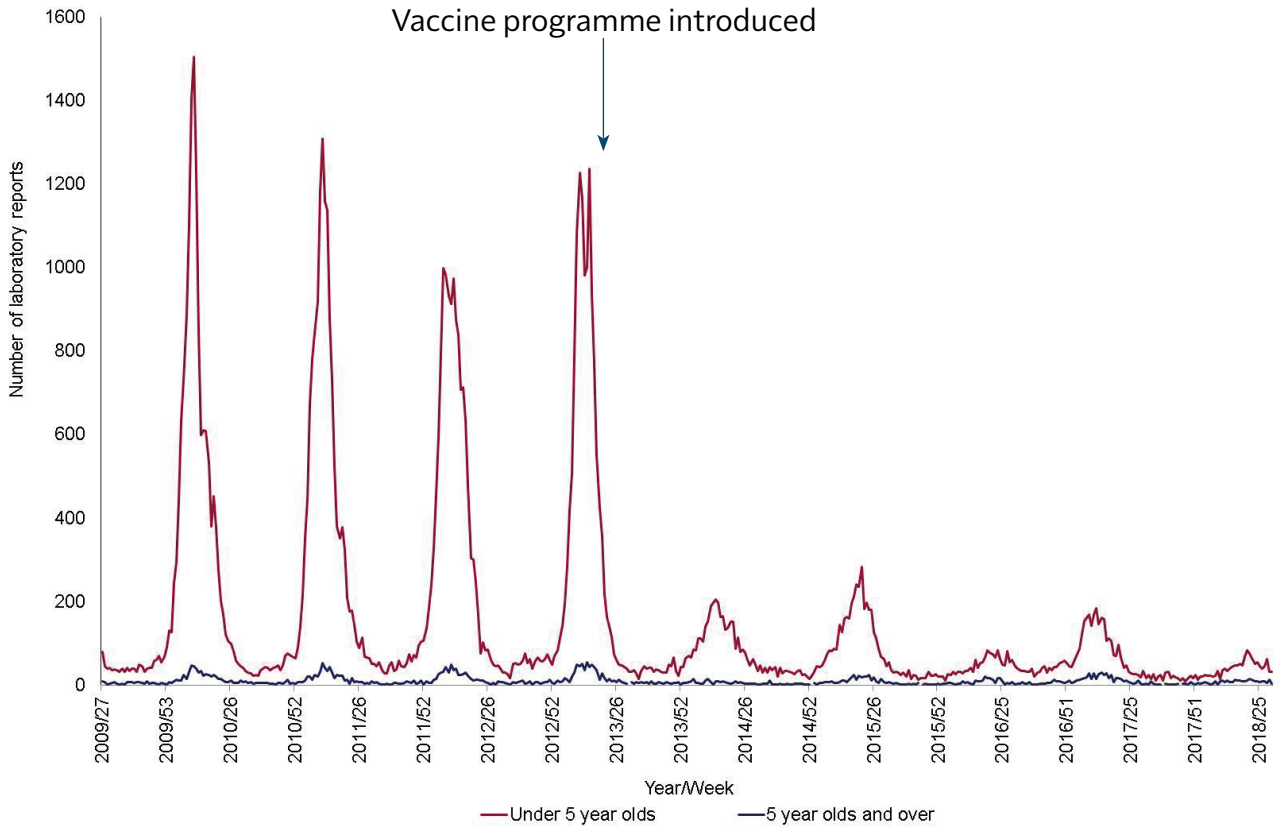
PCV7=seven-valent pneumococcal conjugate vaccine. PCV13=13-valent pneumococcal conjugate vaccine. NVT=non-vaccine type. Corrected for proportion of samples serotyped, missing age, and for the trend in total invasive pneumococcal disease up to 2009/10 (after which no trend correction was applied).

Source: Image by Waight, P. A. et al., Effect of the 13-valent pneumococcal conjugate vaccine on invasive pneumococcal disease in England and Wales 4 years after its introduction: an observational cohort study, 2015, is licensed under Creative Commons CC-BY.

The rotavirus vaccination programme

Rotavirus was the most common cause of diarrhoea in young infants prior to the introduction of vaccination in 2013, with tens of thousands of infections and several thousand hospital admissions each year. Hospitalised children could become severely dehydrated and some were admitted to intensive care. The rotavirus vaccination programme has successfully prevented tens of thousands of hospital admissions each year, including in age groups too old to be vaccinated, by reducing transmission in young children.[19] Rotavirus no longer presents a seasonal pressure in our hospitals.

Figure 8: Laboratory reports of rotavirus by week and age group, 2009 to 2018, England and Wales



Source: Image adapted from Gastrointestinal Infections Department, Centre for Infectious Disease Surveillance and Control, Public Health England, PHE National norovirus and rotavirus report, 2018.

Challenges and progress in the measles, mumps, rubella and varicella vaccination programme

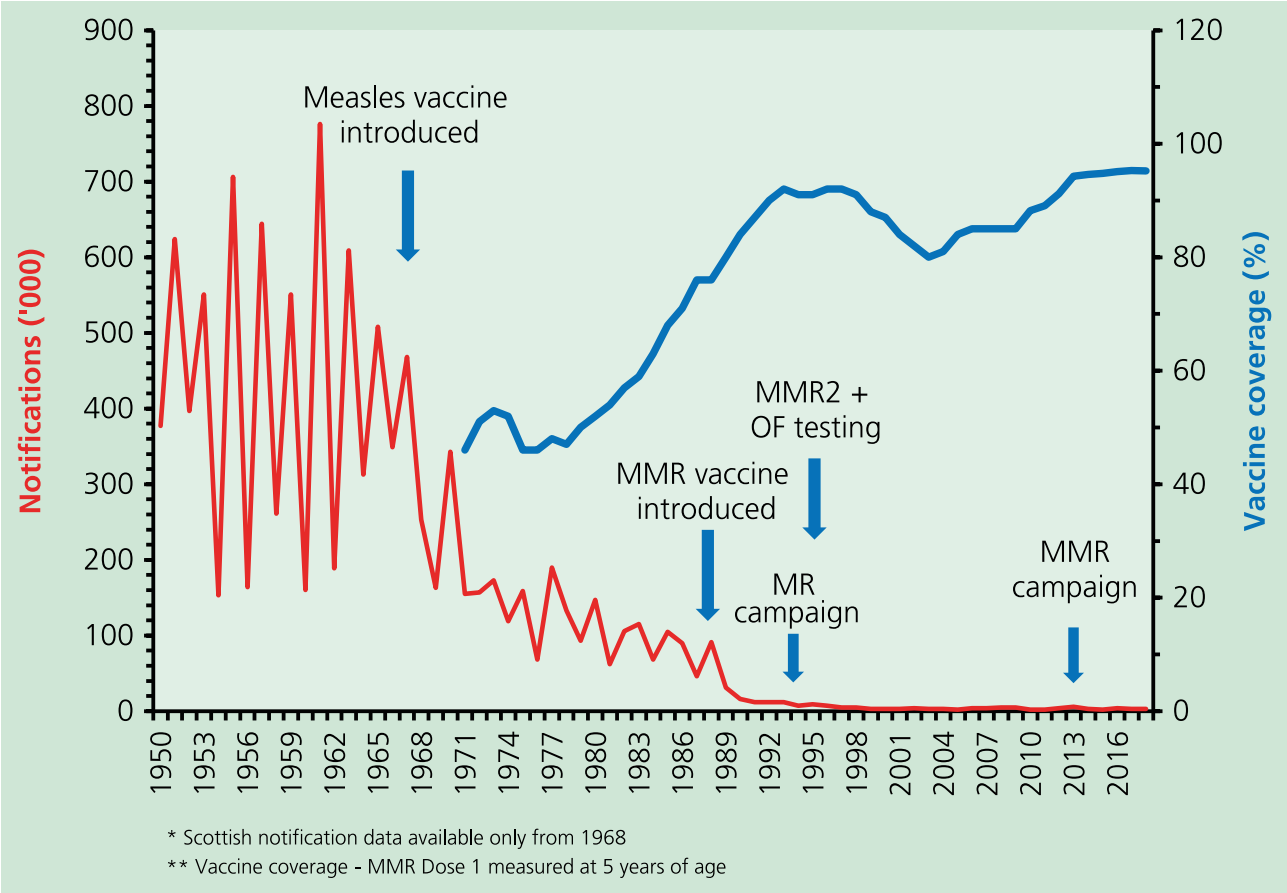
Measles, mumps and rubella are highly transmissible viral diseases which were almost always acquired in childhood prior to the introduction of vaccination. For example, before the introduction of the MMR vaccine when over 85% of adults had experienced mumps previously and it was the most common cause of viral meningitis in children.

Measles usually causes self-limiting rash and fever but can progress to pneumonia and encephalitis which may be fatal. Subacute sclerosing panencephalitis (SSPE), is a rare but fatal complication of measles that may occur many years after primary infection. Mumps causes painful swelling of the parotid glands with complications including meningitis, orchitis and pancreatitis. Rubella most often causes mild rash-illness but can be particularly serious in pregnancy when it can cause miscarriage or neonatal consequences such as sensory impairment.

The WHO European Region has declared both measles and rubella as targets for elimination. Although a single dose of measles vaccine is around 95% effective, 2 doses are required to achieve elimination.[20] The WHO has set a target to achieve 95% coverage of 2 doses of MMR vaccine.

The measles vaccine was first introduced in 1968, with the single rubella vaccine offered to teenage girls from 1970. Higher coverage was not achieved, however, until the programme was changed to use the combined MMR vaccine in October 1988. This consolidated the decline in cases of measles (Figure 9).

Figure 9: Coverage of measles vaccination and measles notifications, England and Wales, 1950 to 2018[21]



Source: Image from UKHSA, Measles: the green book, chapter 21, 2013 (updated 2019) is licensed under the Open Government Licence v3.0.

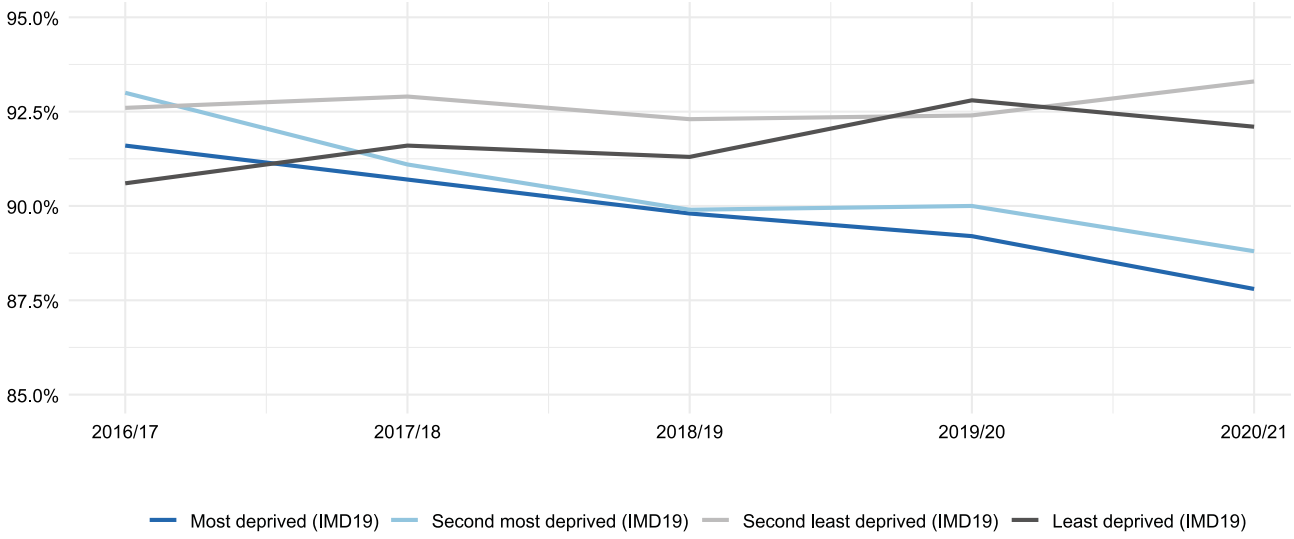
In the late 1990s and early 2000s, MMR vaccine coverage suffered after a single research group wrongly suggested a possible link between MMR vaccine and autism in 1998.[22] The impact of this misinformation was monitored by surveillance of vaccine coverage and regular surveys of parental knowledge and attitudes, in place since 1991.[23] The attitudinal tracking showed that, after the substantial drop between 1998 and 2005, confidence of parents had increased by 2010. By 2016 to 2017, MMR vaccine coverage had improved to the point that, for the first time, over 95% of English children had received their first dose of the MMR vaccine by the age of 5 years. The UK was declared to have eliminated measles in 2016 and 2017.[24]

This achievement was short lived, however, as coverage of MMR and other vaccines delivered to pre-school children has since declined consistently in recent years (Figure 2). Outbreaks of measles have recently been observed in London and the West Midlands (see chapter 5.2).

Inequalities in vaccine uptake by ethnicity mean some communities are at higher risk from measles than others. These inequalities have particularly affected some Black ethnicities, in whom the gap in coverage of 2 doses of MMR vaccine widened from 12% to 22% between 2012 and 2020, although coverage in Indian, Pakistani, Bangladeshi, Chinese, and other Asian groups had similar vaccination coverage to the White British group and was above 90% for most vaccines in most years.

There is also clear evidence that the decline in coverage has not occurred uniformly across communities by level of deprivation; the greatest falls in coverage have been seen in the most deprived areas, with higher levels of coverage maintained in the least deprived groups (Figure 10).

Figure 10: Trend in disparity in coverage of first dose MMR vaccine at age 2 years of age by unitary authority deprivation deciles, 2016/17 to 2023/24



Source: Data from Department of Health and Social Care, Public Health Outcomes Framework, Fingertips.

A decision to bring the second dose of MMR vaccine (MMR2) forward in 2025 was based on evidence from pilots conducted in some London boroughs during an outbreak of measles in 2012 to 2013. These pilots showed improved uptake, even for the first dose, likely because the second dose visit provided an earlier opportunity to catch up those that missed out at one year of age.[25] Recent modelling also demonstrated that delivering MMR2 earlier may also improve control of measles,[26] potentially adding to the benefit expected from improvement in coverage.

In addition, from January 2026 this new visit at 18 months will be used to provide vaccination against varicella. The varicella zoster virus which causes chickenpox can have serious complications, including life threatening pneumonia, tissue infections and brain inflammation, resulting in admission to hospital and can rarely be fatal. The combined measles-mumps-rubella-varicella (MMRV) vaccine, used in place of the MMR vaccine, will aim to directly protect children under the age of 5. If high coverage is achieved, the programme will also indirectly protect adults, who typically experience a more severe disease course, especially those on cancer treatment or in mid-pregnancy. As chickenpox is one of the most common vaccine

preventable diseases of childhood, the benefits for children, parents and the economy, for example, by reducing time off work and school, should be significant.

Factors associated with declines in childhood vaccine coverage

The Peckham Report,[27] conducted in 1989, classified factors associated with low vaccine uptake into socio-demographic, personal and service factors. Socio-demographic factors included inner city areas of deprivation, more mobile families, higher birth order and children with chronic illness. Associations with ethnicity were inconsistent at that time. Personal variables included parental and professional attitudes. Parental attitudes included both to the disease (perception of severity increases uptake) and to the vaccine (safety concerns reduce uptake; higher effectiveness increases uptake, although this is a weaker influencing factor than safety). In professionals, the same attitudes prevailed but misconceptions around indications and contraindications also tended to act as barriers to high uptake. Health service variables reducing uptake included poor co-ordination, unclear responsibility for provision, lack of access to guidelines, policies and training, and accuracy of information (numerator and denominator). Recent reviews have found similar influences.[28,29]

Many barriers are common across vaccines, but the extent to which they operate can vary for different vaccines, settings and groups. Declines in uptake are usually multifactorial and different elements will interact in different ways depending on the programme and the populations concerned.

Parental attitudes

The framework identified by Peckham was used to initiate regular surveys of parental attitudes in England which have been conducted since 1991. The decline in childhood vaccine coverage since 2013 has not been accompanied by a corresponding decline in confidence. For example, in 2019 95% of parents reported being confident in vaccines,[30] one of the highest values recorded in this regular long-term survey. Unlike the period affecting MMR vaccine uptake in the early 2000s, declining coverage over the last decade has been consistent across all vaccines and mainly affects those vaccines given at an older age. For example, coverage of the first dose of hexavalent vaccine at the age of 6 months improved to 96% in 2018 and early 2019. In contrast, coverage of Hib-MenC, which is given at the same age as first dose of MMR vaccine (12 months) shows similar levels and overall trend in uptake as MMR at 24 months of age. This pattern of decline suggests that factors around access to healthcare may be a more important factor than any specific parental concerns around vaccination.[31] Access barriers may include issues with booking, time, distance, personal circumstances or lack of appointment notification or reminder.

There is no doubt, however, that misinformation and disinformation, particularly in social media, have increased since the pandemic and affected public confidence in vaccines.[32] A nationally representative survey of individuals over 18 years old in the UK, run by the Vaccine Confidence Project, identified a drop in population-wide vaccine confidence from 90% in 2018

to 72% in 2023.[33] Vaccine hesitancy, by definition, is not vaccine refusal. It is a state of indecision about vaccination,[34] and needs positive support and understanding. This is particularly important for parents in a confusing information environment faced with a mix of information, misinformation and purposefully misleading disinformation. Although this presents a challenge, is it reassuring that the UK public has generally high trust in official sources.[35,36] Recent attitudinal tracking suggests that the majority of parents still trust information on immunisation from the NHS and their general practice (Case study 1). For those who are hesitant, it is important that healthcare professionals listen to concerns non-judgementally and provide support to parental decision-making. Issues related to vaccine confidence include perceiving the vaccine not to be effective, to cause side effects (short-term and longer-term), to be unsafe or having low trust in the authorities recommending vaccination.

Access to healthcare

Whilst the importance of each factor may differ by population and by programme, the interventions required to address them include having a trained, competent and knowledgeable workforce, adequate staffing capacity, robust information sources and guidance for the public and professionals, and IT infrastructure to support booking, call-recall and accurate recording and reporting of vaccination events.

NICE guidance makes 5 key recommendations:[37,38]

- when a child or young person does not attend appointments, send tailored reminders and recall invitations and follow them up by telephone or text message
- check the immunisation status of children and young people at every appropriate opportunity
- ensure all staff involved in immunisation services are appropriately trained. Training should be regularly updated. It should be tailored to individual needs to ensure staff have the necessary skills and knowledge, for example, communications skills and the ability to answer questions about different vaccinations
- health professionals should check the immunisation history of new migrants, including asylum seekers, when they arrive in the country. They should discuss outstanding vaccinations with them and, if appropriate, their parents, and offer the necessary vaccinations administered by trained staff.
- adopt a multifaceted, coordinated programme across different settings to increase timely immunisation among groups with low or partial uptake

Given the NHS and healthcare professionals are trusted sources of information on vaccines across the population, differences in vaccine coverage by deprivation, ethnicity and geography may be more strongly associated with access to healthcare.

Communities facing barriers to accessing conversations with healthcare professionals or information from the NHS may then be more susceptible to mis- and dis-information without the counter of official, evidence-based advice. On top of the general approaches, specific outreach may be required for populations who are underserved or less able to benefit from routine service.[39] An example of a local initiative following this approach to improve access and address vaccine hesitancy is described in Case study 2.

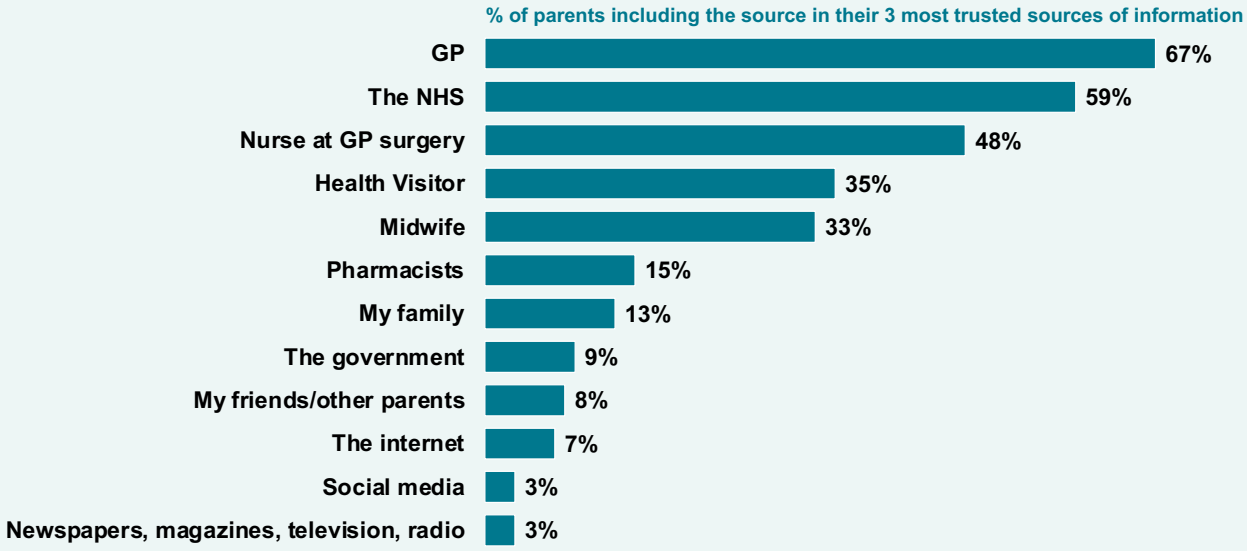
Case study 1: Childhood vaccines: parental attitudes survey 2025

UKHSA and Ipsos UK conducted an online survey of over 3,200 UK parents of children who were aged between 2 months to under 5 years of age between January and February 2025. The survey was representative of parents of under 5-year-olds in each UK nation by age and geography, with 19% of participating parents living in the most deprived areas and 22% from ethnic minority groups.

Although there was a drop in public confidence in vaccines during the pandemic,[40] findings from this survey showed that parental confidence in vaccines has recovered to high levels (87%). The NHS and/or health professionals were cited as a source of information for childhood vaccines by 77% of all parents surveyed.

Nearly all of the 1,730 parents with children too young to have been offered the pre-school booster vaccines (aged under 3 years and 4 months of age) recalled speaking to at least one health professional before their baby was vaccinated, most commonly their health visitor (53%) and/or midwife (39%). Three-quarters of parents surveyed said a health professional first talked to them about vaccines before their baby was born (27%) or before their baby was due to have their vaccines (48%).

Figure 11: Percentage of parents including the source in their 3 most trusted sources of information



The chart shows responses to the question: Here are some sources of information on vaccines. Please order these based on how much you trust them. Base: All respondents who ranked the sources of information (n=3,072).

Source: UKHSA/Ipsos, Childhood vaccines: parental attitudes survey 2025, July 2025, licensed under the Open Government Licence v3.0.

Whilst 79% said that they had decided to vaccinate their child before speaking to a health professional, 9% of parents were undecided about whether to vaccinate, 8% thought their child would have some but not all vaccines and only 2% had decided not to vaccinate. After discussion with a healthcare professional, 50% of parents felt more confident about their decision and, importantly, 15% changed their mind and decided to have their baby vaccinated. Parents from Black, Black British, Black African and Black Caribbean backgrounds, Muslim parents, those in younger age groups, fathers and those living in the 2 most deprived quintiles were more likely to say they changed their mind in favour of vaccination.

The NHS and healthcare professionals were the most trusted source of information on vaccines (Figure 11) with GPs and the NHS consistently top-ranked for trust across all social grades, index of multiple deprivation (IMD) quintiles and ethnic groups. Notably, social media (the primary source of information that made parents feel concerned or worried about their child/baby having a vaccine) was least trusted.

A vaccine conversation with a health professional before their baby is vaccinated helps give parents confidence in their decision to vaccinate and, through advice and sharing of appropriate information, supports parents who are unsure in their decision. Ensuring every parent can have a vaccine conversation with a health professional before their baby is offered their first vaccines, alongside effective training to support health professionals as positive, well-informed advocates for vaccination is key for maintaining and increasing parental confidence.

Case study 2: Addressing barriers to vaccine uptake in Hackney

Ratidzo Chinyuku – Senior Public Health Specialist, London Borough of Hackney

Samina Tarafder – Immunisations Engagement Lead, Springfield Park Primary Care Network, Hackney

Introduction

The decline in childhood immunisation coverage over the last decade has been steeper in London than elsewhere in England and even more pronounced in the London Borough of Hackney. The borough is home to one of the largest Charedi (strictly Orthodox) Jewish communities in Europe. The community is among several population groups in Hackney with persistently low immunisation coverage and has been disproportionately affected by outbreaks of vaccine-preventable diseases.

In response, Hackney has developed a culturally tailored and community-led approach, grounded in the '3C Model of Vaccine Hesitancy'.[41] This framework guides the development of public health messaging, engagement strategies and the design and delivery of local vaccination services.

Table 1: Using the 3C model to address barriers to vaccine uptake in Hackney's Charedi Jewish community

	Barriers	Local approach
Complacency	A low perceived risk of vaccine preventable diseases – particularly when no outbreaks are present – has contributed to vaccine complacency within the community. Although the community responds quickly during outbreaks, this reactive behaviour does not support consistent immunisation coverage. Mainstream digital communication and health promotion messages do not always reach or resonate with Charedi families, partly due to limited digital access.	We have adapted routine messaging and communication methods during outbreaks and in the lead up to religious holidays, to highlight the value of avoiding illness, particularly during times of celebration and religious observance. Integrating vaccines into wider health and wellbeing offers – such as the provision of oral health packs, bicycle 'health checks' and health visiting reviews – have proved effective at increasing engagement in vaccine conversations. GP practices also use proactive call/recall methods, including text messages to parents of children with missed doses, offering timely follow-up and tailored support.

	Barriers	Local approach
Confidence	Parental concerns around vaccine safety and misinformation on "overloading babies' and infants' immune systems" drive a preference for delayed immunisation; this concern is not unique to the Charedi Jewish community.	A dedicated immunisation engagement lead works closely with parents, rabbis, community groups and system partners to design and deliver culturally appropriate resources and campaigns. Public health messages are disseminated via trusted local channels, including co-produced adverts within the Jewish press.
Convenience	The Charedi community's large family sizes and structured religious observances require flexible and accessible service models around schooling and the Sabbath.	In 2022, Springfield Park Primary Care Network launched an Enhanced Access Immunisation Service to deliver Sunday clinics that respect Sabbath observance. These clinics operate across 2 GP practices and a local community children's centre. During the recent measles outbreak in Hackney, in May to July 2025, the service delivered 51 clinics, with over 1,500 children receiving over 2,500 childhood immunisations including 1,800 MMR jabs.

"Get Ahead of the Yomim Tovim" MMR vaccine campaign (2023)

Ahead of the Jewish High Holidays in 2023, the "Get Ahead of the Yomim Tovim" campaign focused on increasing MMR vaccine uptake. Over 200 children were vaccinated through the campaign, which integrated all elements of the 3C framework.

The campaign included:

- Adapted letters for independent Charedi schools
- Co-produced infographics on MMR vaccine
- A community-developed advert with Charedi mothers
- Targeted messaging via local Jewish media
- Vaccination outreach at community events

This approach successfully shifted engagement from reactive to preventative, enabling the increased uptake of vaccinations ahead of the religious holidays.

Conclusion

By addressing the barriers of confidence, complacency and convenience through culturally sensitive and community-driven strategies, we are working to improve childhood immunisation rates and reduce inequalities.

Source: Images by Samina Tarafder with permission.

Conclusion

The UK has a 30-year track record of designing a childhood immunisation schedule to optimise delivery and control vaccine preventable infectious disease. In comparison to other high-income countries, the UK programme provides comprehensive protection using relatively few injections and clinic visits.[42] This facilitates high coverage and timely protection. Risk from choosing an imperfect schedule is mitigated by high-quality surveillance based on accurate laboratory diagnosis and characterisation of the organism conducted in the national reference laboratories.

Recent declining trends in coverage require improvement in the delivery of, and access to, immunisation services. A key focus for the NHS must be to support providers in following best practice, for example, that outlined in guidance on vaccine uptake from the National Institute for Health and Care Excellence.[43] This includes a requirement to identify a named vaccination lead with responsibility for minimising service barriers and ensuring that data systems are available to identify those who are eligible (including those that facilitate opportunistic vaccination), to send invitations and reminders and to promote the accurate recording of vaccination status. Efforts to increase routine uptake are likely to contribute to reducing inequity, but additional adaptations to services, tailored to the needs of each local community, may also be helpful.

Although the majority of the UK public believe that immunisation is both effective and safe, vaccine confidence is fragile and can easily be lost when vaccine scares become mainstream. Recovery from these scares can take many years.[44] Communicating the evidence base for vaccination programmes, whilst being transparent about the degree of uncertainty, can help to prevent incorrect information taking hold.[45] In the main, primary care providers are well trusted by parents, and can call upon high quality information sources, in a range of different languages and formats, to support informed consent. Ensuring that our front-line staff have time to listen to parents' concerns and are trained to discuss the benefits and risks of vaccination is an important mechanism to sustain that trust.

These lessons may also inform ongoing development of adult vaccination programmes which may require different approaches to delivery in line with the needs of this population.

References

1 People's History of the NHS. Childhood Vaccination and the NHS. [Internet] [Accessed 15 October 2025] Available from: https://peopleshistorynhs.org/encyclopaedia/childhood-vaccination-and-the-nhs/

2 History of Vaccines. What do vaccines do? How Herd Immunity Works? [Internet] 2025. [Accessed 15 October 2025] Available from: https://historyofvaccines.org/vaccines-101/what-do-vaccines-do/how-herd-immunity-works

3 UK Health Security Agency. Historical vaccine development and introduction of routine vaccine programmes in the UK. [Internet] [Accessed 15 October 2025] Available from: https://assets.publishing.service.gov.uk/media/61fab1bae90e0768a4477f4f/UKHSA-vaccine-timeline.pdf

4 Nuffield Trust. Vaccination coverage for children and mothers. [Internet] 2025. [Accessed 15 October 2025] Available from: https://www.nuffieldtrust.org.uk/resource/vaccination-coverage-for-children-and-mothers-1

5 UK Health Security Agency. Vaccination coverage statistics for children aged up to 5 years, England (COVER programme) report: April 2024 to March 2025. [Internet] 2025. [Accessed 29 September 2025]. Available from: https://www.gov.uk/government/statistics/cover-of-vaccination-evaluated-rapidly-cover-programme-annual-reports

6 NHS Digital. Childhood Vaccination Coverage Statistics, England, 2023-24. [Internet] 2024. [Accessed 15 October 2025] Available from: https://digital.nhs.uk/data-and-information/publications/statistical/nhs-immunisation-statistics/england-2023-24

7 McDonald HI, Tessier E, White JM et al. Early impact of the coronavirus disease (COVID-19) pandemic and physical distancing measures on routine childhood vaccinations in England, January to April 2020. Euro Surveill. 2020;25(19):2000848. doi: 10.2807/1560-7917.ES.2020.25.19.2000848.

8 UK Health Security Agency. Evaluating the impact of national and regional measles catch-up activity on MMR vaccine coverage in England, 2023 to 2024. [Internet] 2024. [Accessed 15 October 2025] Available from: https://www.gov.uk/government/publications/evaluation-of-vaccine-uptake-during-the-2023-to-2024-mmr-catch-up-campaigns-in-england/evaluating-the-impact-of-national-and-regional-measles-catch-up-activity-on-mmr-vaccine-coverage-in-england-2023-to-2024#

9 Zhang CX, Bankhead C, Quigley MA, Kwok CH, Carson C. Ethnic inequities in routine childhood vaccinations in England 2006-2021: an observational cohort study using electronic health records. EClinicalMedicine. 2023;65:102281. doi: 10.1016/j.eclinm.2023.102281.

10 UK Health Security Agency. Vaccination coverage statistics for children aged up to 5 years, England (COVER programme) report: April 2024 to March 2025. [Internet] 2025. [Accessed 29 September 2025]. Available from: https://www.gov.uk/government/statistics/cover-of-vaccination-evaluated-rapidly-cover-programme-annual-reports

11 Christensen H, May M, Bowen L, Hickman M, Trotter CL. Meningococcal carriage by age: a systematic review and meta-analysis. Lancet Infect Dis. 2010;10(12):853-61. doi: 10.1016/S1473-3099(10)70251-6.

12 Public Health England. Haemophilus influenzae: epidemiological data. [Internet] 2015. [Accessed: 1 October 2025] Available from: https://www.gov.uk/government/publications/haemophilus-influenzae-epidemiological-data

13 Campbell H, Andrews N, Parikh SR et al. Impact of an adolescent meningococcal ACWY immunisation programme to control a national outbreak of group W meningococcal disease in England: a national surveillance and modelling study. Lancet Child Adolesc Health. 2021:S2352-4642(21)00335-7. doi: 10.1016/S2352-4642(21)00335-7.

14 Subbarao S, Ribeiro S, Campbell H, Okike I, Ramsay ME, Ladhani SN. Trends in laboratory-confirmed bacterial meningitis (2012-2019): national observational study, England. Lancet Reg Health Eur. 2023;32:100692. doi: 10.1016/j.lanepe.2023.100692.

15 Hadley L, Karachaliou Prasinou A, Christensen H, Ramsay M, Trotter C. Modelling the impact of COVID-19 and routine MenACWY vaccination on meningococcal carriage and disease in the UK. Epidemiol Infect. 2023;151:e98. doi: 10.1017/S0950268823000870

16 Adams L, Prasinou AK, Hadley L, Ramsay M, Campbell H, Trotter C. Estimating the potential number of cases prevented by infant/ toddler immunisation with a MenACWY vaccine. Vaccine. 2024;42(23):126240. doi: 10.1016/j.vaccine.2024

17 Ladhani SN, Andrews N, Ramsay ME. Summary of evidence to reduce the two-dose infant priming schedule to a single dose of the 13-valent pneumococcal conjugate vaccine in the national immunisation programme in the UK. Lancet Infect Dis. 2021;21(4):e93-e102. doi: 10.1016/S1473-3099(20)30492-8.

18 Waight PA, Andrews NJ, Ladhani SN, Sheppard CL, Slack MPE, Miller E. Effect of the 13-valent pneumococcal conjugate vaccine on invasive pneumococcal disease in England and Wales 4 years after its introduction: an observational cohort study. Lancet Infect Dis. 2015;15(5):535-43. doi: 10.1016/S1473-3099(15)70044-7.

19 Gower CM, Stowe J, Andrews NJ, Dunning J, Ramsay ME, Ladhani SN. Sustained Declines in Age Group-Specific Rotavirus Infection and Acute Gastroenteritis in Vaccinated and Unvaccinated Individuals During the 5 Years Since Rotavirus Vaccine Introduction in England. Clin Infect Dis. 2022;74(3):437-445. doi: 10.1093/cid/ciab460.

20 World Health Organization. Measles. [Internet] 2024. [Accessed 15 October 2025] Available from: https://www.who.int/news-room/fact-sheets/detail/measles

21 Public Health England. Measles: the green book, chapter 21. [Internet] 2019. [Accessed 15 October 2025] Available from: https://assets.publishing.service.gov.uk/media/5e021b9140f0b6665e80187b/Greenbook_chapter_21_Measles_December_2019.pdf

22 Godlee F. Wakefield's article linking MMR vaccine and autism was fraudulent. BMJ. 2011;342:c7452 doi: 10.1136/bmj.c7452.

23 Ramsay ME, Yarwood J, Lewis D, et al. Parental confidence in measles, mumps and rubella vaccine: evidence from vaccine coverage and attitudinal surveys. Br J Gen Pract. 2002;52:912-6.

24 UK Health Security Agency. UK measles and rubella elimination indicators and status. [Internet] 2025. [Accessed 15 October 2025] Available from: https://www.gov.uk/government/publications/measles-and-rubella-elimination-uk/uk-measles-and-rubella-elimination

25 Lacy J, Tessier E, Andrews N, White J, Ramsay M, Edelstein M. Impact of an accelerated measles-mumps-rubella (MMR) vaccine schedule on vaccine coverage: An ecological study among London children, 2012-2018. Vaccine. 2022;40(3):444-449. doi: 10.1016/j.vaccine.2021.12.011

26 Suffel AM, Warren-Gash C, McDonald HI, Kucharski A, Robert A. Impact of vaccination timing and coverage on measles near elimination dynamics: a mathematical modelling analysis. Nat Commun. 2025;16:8601. doi: 10.1038/s41467-025-63710-w.

27 Peckham C. The Peckham report. National Immunisation Study. Factors influencing immunisation uptake in childhood. Action Research for the Crippled Child, London (1989).

28 National Audit Office. Investigation into pre-school vaccinations. [Internet] 2019. [Accessed 15 October 2025] Available from : https://www.nao.org.uk/wp-content/uploads/2019/08/Investigation-into-pre-school-vaccinations.pdf

29 Royal College of Paediatrics and Child Health. Vaccination in the UK: Access, uptake and equity. [Internet] 2025. [Accessed 15 October 2025] Available from: https://www.rcpch.ac.uk/sites/default/files/2025-06/Vaccination-in-UK-access-uptake-equity_policy-report-2025.pdf

30 UK Health Security Agency. Childhood vaccines: parental attitudes survey 2019 findings. [Internet] 2022. [Accessed 15 October 2025] Available from: https://www.gov.uk/government/publications/childhood-vaccines-parental-attitudes-survey-2019/findings-from-the-2019-survey

31 Edelstein M, Müller M, Ladhani S, Yarwood J, Salathé M, Ramsay M. Keep calm and carry on vaccinating: Is anti-vaccination sentiment contributing to declining vaccine coverage in England? Vaccine. 2020;38(33):5297-5304. doi: 10.1016/j.vaccine.2020.05.082.

32 UNICEF. [Press Release] New Data indicates declining confidence in childhood vaccines of up to 44 percentage points in some countries during the COVID-19 pandemic. [Internet] 2023. [Accessed 15 October 2025] Available from: https://www.unicef.org/cuba/en/press-releases/state-of-the-world-children-vaccination-2023

33 Vaccine Confidence Project. UK. [Internet] [Accessed 15 October 2025] Available from: https://www.vaccineconfidence.org/vci/country/gb

34 Larson HJ. Defining and measuring vaccine hesitancy. Nat Hum Behav. 2022;6(12): 1609-1610. doi: 10.1038/s41562-022-01484-7.

35 Global Listening Project. Societal Preparedness Insights. [Internet] [Accessed 15 October 2025] Available from: https://global-listening.org/societal-preparedness-insights/

36 Campbell H, Paterson P, Letley L, Saliba V, Mounier-Jack S, Yarwood J. Vaccination, information and parental confidence in the digital age in England. Vaccine: X. 2023;14:100345. doi: 10.1016/j.jvacx.2023.100345.

37 National Institute for Health and Care Excellence. Vaccine uptake in under 19s. [Internet] 2022. [Accessed 15 October 2025] Available from: https://www.nice.org.uk/guidance/qs145

38 National Institute for Health and Care Excellence. Vaccine uptake in the general population. [Internet] 2022. [Accessed 15 October 2025] Available from: https://www.nice.org.uk/guidance/ng218

39 World Health Organization. TIP: tailoring immunization programmes. [Internet] 2019. [Accessed 15 October 2025] Available from: https://www.who.int/europe/publications/i/item/9789289054492

40 UK Covid-19 Inquiry. INQ000474705 – Expert Report from Professor Heidi Larson et al. titled 'Expert Report for the UK Covid-19 Public Inquiry, Module 4 – Vaccines and therapeutics. Vaccine hesitancy and confidence during the Covid-19 pandemic', dated 11/12/2924. [Internet] 2025. [Accessed 15 October 2025]. Available from: https://covid19.public-inquiry.uk/documents/inq000474705-expert-report-from-professor-heidi-larson-et-al-titled-expert-report-for-the-uk-covid-19-public-inquiry-module-4-vaccines-and-therapeutics-vaccine-hesitancy-and-confidence-during-t/

41 World Health Organization. Report of the SAGE working group on vaccine hesitancy. [Internet] 2014. [Accessed 1 February 2022] Available from: https://www.asset-scienceinsociety.eu/sites/default/files/sage_working_group_revised_report_vaccine_hesitancy.pdf

42 Bencina, G., Bento-Abreu, A., Sabale, Uet al. Estimating the lifetime cost of vaccination in 23 European Countries: a modeling study. Expert Rev Vaccines. 2023;22(1), 148–160. doi: 10.1080/14760584.2023.2157266.

43 National Institute for Health and Care Excellence. Vaccine uptake in the general population. [Internet] 2022. [Accessed 15 October 2025] Available from: https://www.nice.org.uk/guidance/ng218

44 Ramsay ME. Measles: the legacy of low vaccine coverage. Archives of Disease in Childhood 2013;98:752-754. doi: 10.1136/archdischild-2013-304292

45 Whitehead HS, French CE, Caldwell DM, Letley L, Mounier-Jack S. A systematic review of communication interventions for countering vaccine misinformation. Vaccine. 2023;41(5):1018-1034. doi: 10.1016/j.vaccine.2022.12.059.

3.6 Infections in young adults

Thomas Waite – Deputy Chief Medical Officer for England

Introduction

Young adulthood is a period in which people typically move to new environments away from their family home, often in shared and sometimes crowded accommodation, start sexual relationships and experiment with new foods and ways of living. Whilst a wide range of infections affect people most severely at the extremes of age, there are several which can cause significant ill health in young adults or are more common in this age group due to their route of transmission. Important infections in this age group include infections in pregnancy, which are covered elsewhere (see chapter 3.2), sexually transmitted infections (STIs) and certain respiratory diseases which can spread more easily in shared living arrangements. This chapter considers the key STIs (HIV, chlamydia and gonorrhoea) for young adults as well as examining the burden of meningococcal disease.

Meningococcal disease

Universities and higher education settings can be hot spots for a range of respiratory diseases among young adults including COVID-19, influenza, measles, mumps and meningococcal disease. These settings present the perfect opportunity for transmission of infection as people come together in confined environments and mix closely with a new social network.

Meningococcus (*Neisseria meningitidis*) is a rare but serious cause of infection which is spread via respiratory and throat secretions. Whilst carriage of meningococcus in the throat or nasopharynx is common, invasive infection can cause meningitis and bloodstream infections with significant mortality and long-term impacts for those who survive infection.[1] In England, there were 341 confirmed cases of invasive meningococcal disease (IMD) in the year July 2023 to June 2024.[2]

There are 6 meningococcal groups, distinguished by their polysaccharide capsule (A, B, C, W, X and Y) with differing epidemiology for the different serogroups.

Prevalence of throat carriage increases through childhood and peaks at 18 to 20 years before declining. Outbreaks are seen among young adults, often after moving to a new city or town for university. Following the easing of measures put in place to control the COVID-19 pandemic in 2020 to 2021, there was a notable increase in group B cases of invasive meningococcal disease from 61 cases in 2020 to 2021 to 256 cases in 2022 to 2023, with numbers in adolescents and young adults rising first and increasing in other age groups over the next 12 months. Invasive disease due to other groups has remained very low in all age groups.

A quadrivalent Men ACWY vaccine is offered to teenagers. A separate vaccine against group B is also included in the infant immunisation programme. See chapter 3.5 for a broader discussion of childhood vaccinations.

Over the last 2 decades, there has been a marked decline in confirmed meningococcal disease cases from a peak of 2,595 cases in England in 1999 to 2000. The initial decline was driven by the introduction of vaccination against group C disease in 1999, which reduced group C cases by approximately 96% (to around 30 to 40 cases each year).

In 2023 to 2024 group B accounted for 88% (301 of 341) of cases, followed by group W (5%, 17 cases), group Y (4.4%, 15 cases) and group C (0.9%, 3 cases). Disease covered by the MenACWY vaccine has markedly reduced since this vaccine was introduced for teenagers in August 2015.

Sexually transmitted infections

STIs are an important infectious public health issue in young adults. It is sometimes assumed that STIs have only trivial health impact, but many have serious systemic or local effects and even those with relatively low medical impacts can cause significant stress and social impacts. If untreated, many STIs can remain infectious for years or even for life. People are often unaware they are infected, as they can have minimal or no symptoms. A particularly important time of life for these infections is in those who are pregnant or wish to become pregnant, as several STIs can affect fertility in both women and men.

New STI diagnoses in England decreased slightly from 399,947 in 2023 to 364,750 in 2024, with diagnosis rates of STIs highest in young people aged 15 to 24 years, gay, bisexual and other men who have sex with men (GBMSM) and some minority ethnic groups.

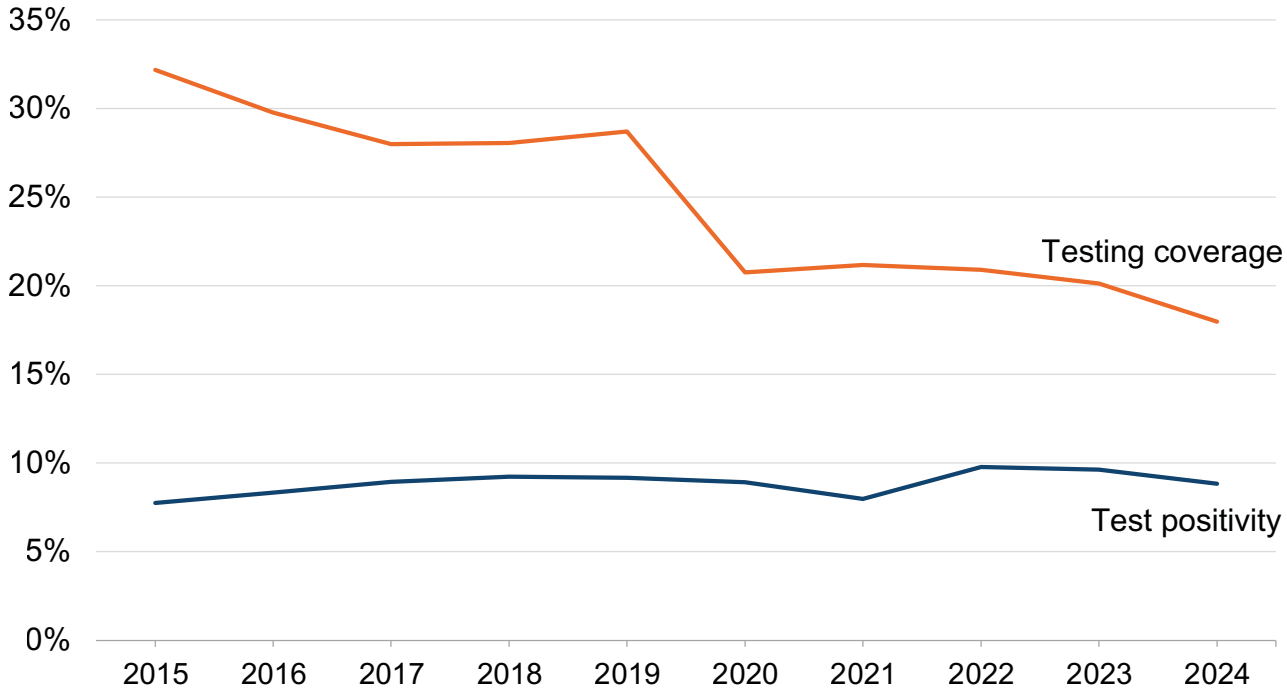
Young people, particularly those young adults aged 20 to 24 years, experience high diagnosis rates of the most common STIs, and this reflects the higher rates of partner change among this age group. Compared to 2023, the number of new STI diagnoses in 2024 among young people aged 15 to 24 years decreased by 18.5% (166,827 to 135,965). This is largely due to a 17.5% decrease in the number of chlamydia diagnoses (from 104,008 in 2023 to 85,757 in 2024) and a 36.3% decrease in the number of gonorrhoea diagnoses (from 30,045 in 2023 to 19,114 in 2024).[3]

Chlamydia

Genital chlamydia infection is caused by the *Chlamydia trachomatis* bacterium which is the most common bacterial STI in England. The prevalence of infection is highest in young sexually active adults (15 to 24 years olds). There were 168,889 diagnoses of chlamydia in England in 2024, a 13% drop on the previous year.

Chlamydia often has no symptoms but can lead to a wide range of complications, including pelvic inflammatory disease (PID), ectopic pregnancy and tubal factor infertility (TFI) in women, and represents a substantial public health problem. For this reason, there is a proactive, opportunistic National Chlamydia Screening Programme for young women aged 15 to 24 in England which aims to reduce the health harm caused by untreated infection. The aims of the programme were changed in 2021 with a subsequent reduction in testing coverage (Figure 1).

Figure 1: Chlamydia testing coverage and test positivity among young women aged 15 to 24 years, 2015 to 2024, England



Note: figures reported in 2020 and 2021 are notably lower than previous years due to the disruption to sexual health services during the national response to the COVID-19 pandemic.

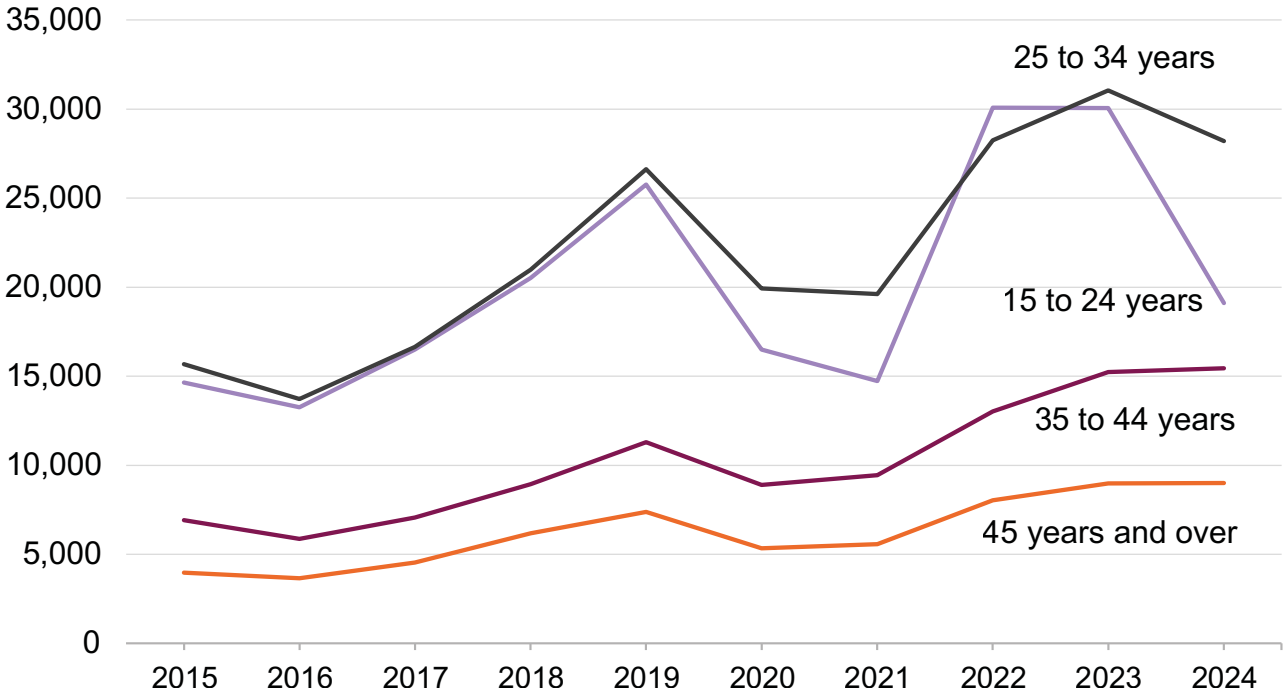
Source: Image from UKHSA, Sexually transmitted infections and screening for chlamydia in England: 2024 report, updated 10 June 2025, is licensed under the Open Government Licence v3.0.

Gonorrhoea

Gonorrhoea is caused by the bacterium *Neisseria gonorrhoeae*. It is the second most common bacterial STI in England. Diagnosed infections fell by 15.9% in 2024; of the 71,802 diagnoses, 39,046 were in GBMSM.

Gonorrhoea is transmitted through unprotected vaginal, oral or anal intercourse or genital contact with an infected partner. An infected person may have no symptoms but still transmit the infection. Occasionally, gonorrhoea can cause serious complications such as pelvic inflammatory disease, ectopic pregnancy and infertility. Gonorrhoea causes significant morbidity and remains a public health concern globally. Increased resistance to most antibiotics used to treat gonococcal infection has been reported worldwide, with extensively resistant strains exhibiting resistance to multiple antibiotic classes.

Figure 2: Number of gonorrhoea diagnoses by age group, 2015 to 2024



Note 1: figures reported in 2020 and 2021 are notably lower than previous years due to the disruption to sexual health services during the national response to the COVID-19 pandemic.

Source: Image from UKHSA, Sexually transmitted infections and screening for chlamydia in England: 2024 report, updated 10 June 2025, is licensed under the Open Government Licence v3.0.

Natural infection does not give protection against future infections. Given that *Neisseria meningitidis* and *Neisseria gonorrhoeae* are closely genetically related, in 2023 the Joint Committee for Vaccination and Immunisation (JCVI) recommended a targeted vaccination programme using the 4CMenB vaccine for the prevention of gonorrhoea in those who are at greatest risk of infection. The vaccination programme began in England in 2025 and is the first in the world. The impact on infection rates among high-risk groups will be seen in the coming years.

Whilst vaccination would be expected to reduce the chance of becoming infected with gonorrhoea, it would not completely eliminate the possibility. Vaccinated individuals could expect to have some reduction in their own risk of contracting gonorrhoea, however the main benefit of a vaccination programme is expected to be at a community level with a potential reduction in the number of cases overall.

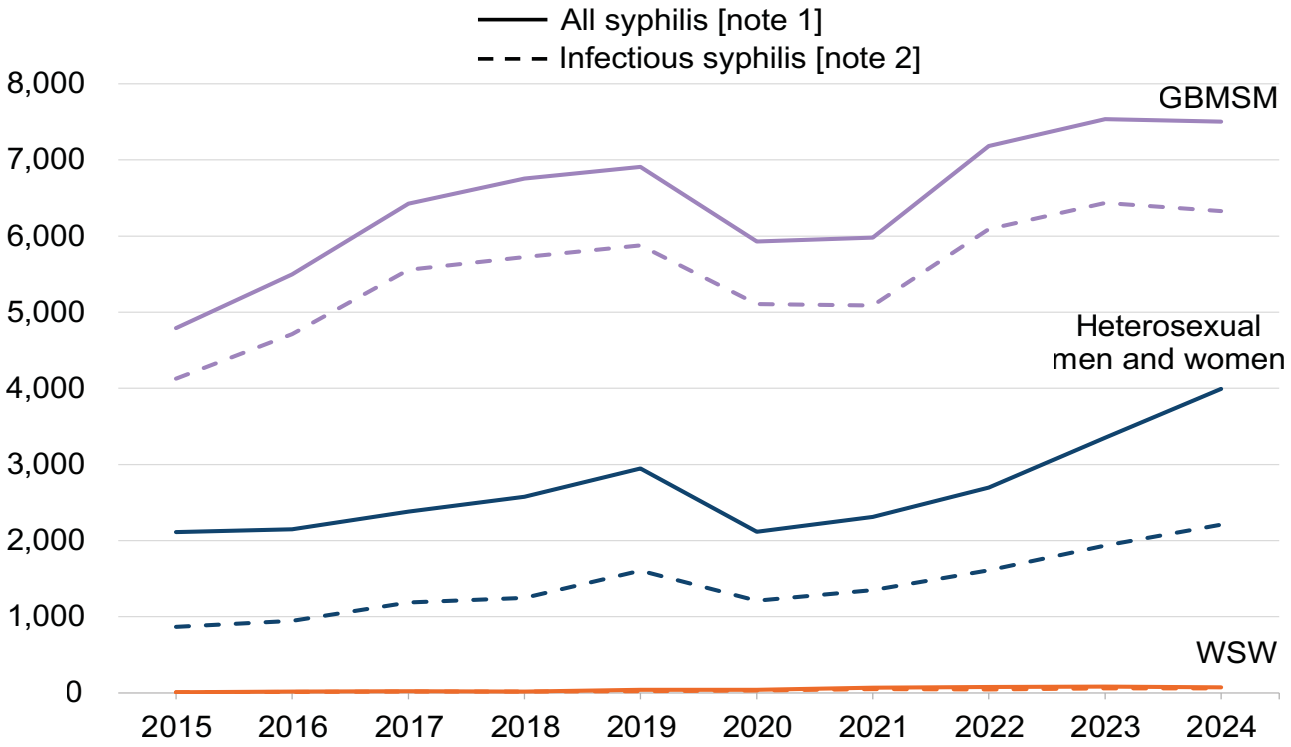
Syphilis

Cases of syphilis in England have increased considerably in recent years. Syphilis is a multisystem disease which can affect almost all parts of the body. Primary infection usually presents as a painless ulcer lasting a few weeks after acquiring infection. Once diagnosed, it is easy to treat with antibiotics. This is followed by secondary syphilis with a fever, generalised rash and further ulcers.

Untreated syphilis can go on to cause damage to the nervous system, musculoskeletal system and cardiovascular system and present as tertiary syphilis, sometimes many years after the initial infection.

In England, syphilis rates have continued to increase – diagnoses increased 1.7% from 9,375 in 2023 to 9,535 in 2024. This represents the largest number of reported infections since 1948. There was a particularly large increase (in relative terms) in infectious syphilis diagnoses among heterosexual men (23.8%, from 1,115 to 1,380), whilst numbers remained relatively constant for women who have sex with men (a 1.0% increase, from 822 to 830) and women who have sex with women (60 diagnoses in both 2023 and 2024). Among GBMSM, the number of syphilis diagnoses decreased slightly (1.6%, from 6,435 to 6,330).

Figure 3: Number of diagnoses of syphilis among England residents accessing sexual health services, 2015 to 2024



Note 1: includes infectious syphilis and late stage and complications of syphilis.

Note 2: includes diagnoses of primary, secondary and early latent syphilis.

Note 3: figures reported in 2020 and 2021 are notably lower than previous years due to the disruption to sexual health services during the national response to the COVID-19 pandemic.

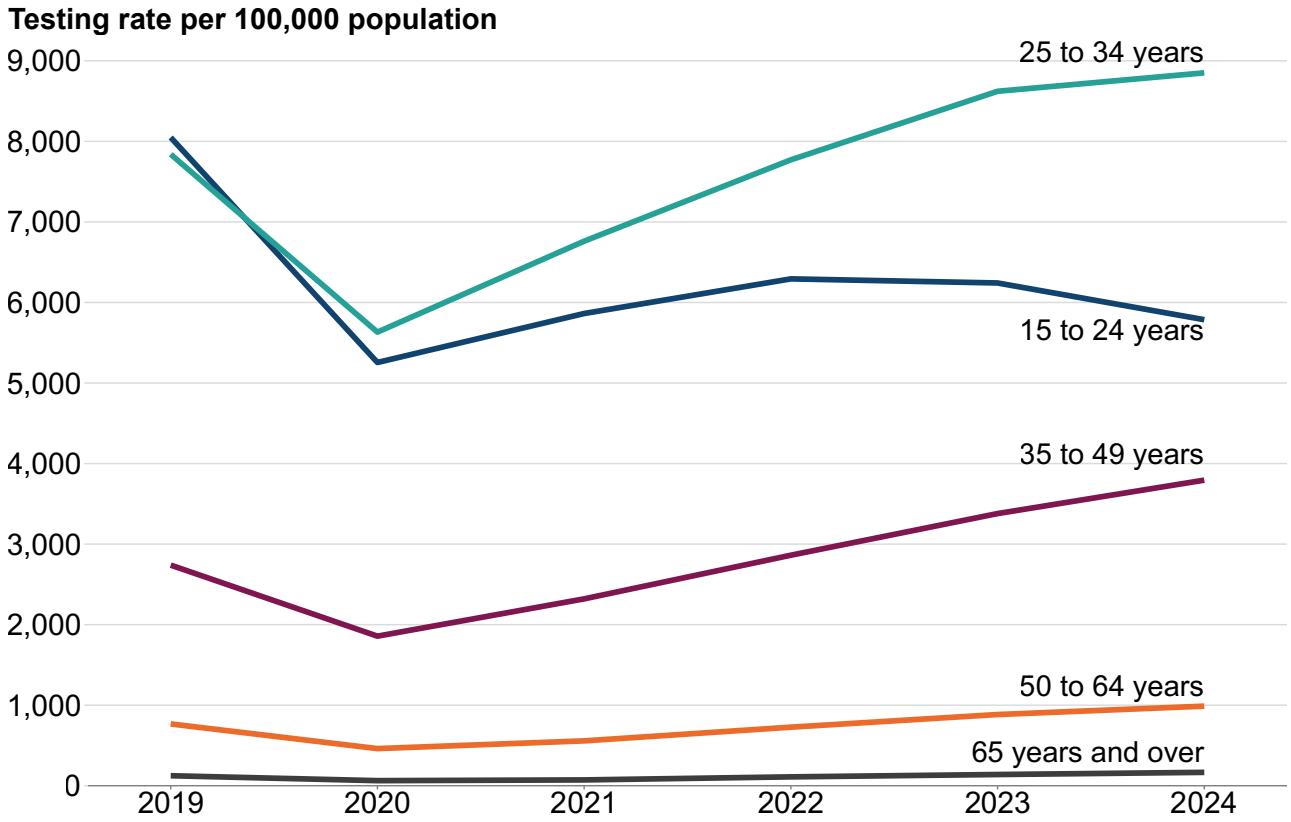
Source: Image from UKHSA, Sexually transmitted infections and screening for chlamydia in England: 2024 report, updated 10 June 2025, is licensed under the Open Government Licence v3.0.

Given the serious nature of syphilis infection, both treatment and prevention are important. In June 2025, the British Association for Sexual Health and HIV (BASHH) published the first UK national guideline for the use of the antibiotic doxycycline as post-exposure prophylaxis for the prevention of syphilis (DoxyPEP). This follows data from clinical trials as well as real world data from the USA which demonstrated meaningful reductions in new diagnoses of syphilis and chlamydia with the use of DoxyPEP. It is unlikely that any protective effect would be seen against gonorrhoea as there is already extensive tetracycline resistance in gonorrhoea.

HIV

The epidemiology of HIV has changed considerably in England over recent years. Differences in testing, infection rates and treatment coverage persist between young adults and older adults.

Figure 4: HIV testing rate at sexual health services by age group, England, 2020 to 2024



Source: Image from UKHSA, HIV testing, PrEP, new HIV diagnoses and care outcomes for people accessing HIV services: 2025 report, updated 7 October 2025, is licensed under the Open Government Licence v3.0.

In 2024, there were 2,773 new HIV diagnoses among people in England, a small drop from 2,838 in 2023. In addition, there were 2,525 diagnoses among people diagnosed with HIV overseas before continuing their care in England.

From 2023 to 2024, there was a decrease in the number of new diagnoses for all age groups under 65 years old among gay and bisexual men. The largest decrease was observed among men aged 15 to 24 years with an 11% decrease (from 123 to 110) and the 25 to 34 age group with a 10% decrease (from 363 to 328). However, between 2023 to 2024, there was a 7% decrease in the HIV testing rate in people aged 15 to 24 years (6,242 to 5,786 per 100,000 population). This compares with a continued increase in the HIV testing rate in all other ages.

Early treatment is essential to prevent the development of complications of HIV. Whilst overall treatment coverage in England is very high at approximately 99% of all known cases, in 2024 treatment coverage was lowest among people aged 15 to 24 years at 96% (1,538 of 1,604). Treatment also achieves viral suppression, with those living with HIV who have an undetectable viral load unable to pass the virus on to sexual partners even without condoms or PrEP. Only 91% (1,233 of 1,351) of people aged between 15 and 24 years were virally suppressed in 2024.

The proportion of those receiving treatment who are virally suppressed increases with age and is highest among people aged 65 years and over (99%, 9,894 of 10,001).

Conclusion

Infectious disease can pose significant risks even to young healthy adults when many aspects of life can increase the risk of transmission of infectious diseases including changes to living arrangements and sexual partners. Most of the infections laid out here can be prevented through a range of strategies for the use of medical countermeasures including vaccines, PrEP and antiretrovirals (for HIV). Better access to appropriate testing and ongoing health care can help ensure rapid detection of infectious diseases and more timely treatment to prevent the consequences of long term or uncontrolled infection. Whilst there have been recent innovations, such as the use of 4CMenB vaccination for gonorrhoea and DoxyPEP for syphilis and chlamydia, there remains no vaccine or cure for HIV. Future prevention and mitigation strategies for infections among young people will have to continue to adopt the latest technology. It is important not to forget the contribution of existing efforts such as current immunisation programmes preventing the most severe infections among young people and we must continue to promote these activities.

References

1 UK Health Security Agency. Guidance for public health management of meningococcal disease in the UK. [Internet] 2024. Available from: https://assets.publishing.service.gov.uk/media/673257250a2b4132b43d1448/UKHSA-meningo-disease-guidelines-november2024.pdf

2 UK Health Security Agency. Invasive meningococcal disease in England: annual laboratory confirmed reports for epidemiological year 2023 to 2024. [Internet] 2024.Available from: https://www.gov.uk/government/publications/meningococcal-disease-laboratory-confirmed-cases-in-england-2023-to-2024/invasive-meningococcal-disease-in-england-annual-laboratory-confirmed-reports-for-epidemiological-year-2023-to-2024#:~:text=In%20England%2C%20the%20national%20UK,pandemic%20restrictions%20(table%201).

3 UK Health Security Agency. Sexually transmitted infections and screening for chlamydia in England: 2024 report. [Internet] 2025. Available from: https://www.gov.uk/government/statistics/sexually-transmitted-infections-stis-annual-data-tables/sexually-transmitted-infections-and-screening-for-chlamydia-in-england-2024-report#main-points

4 Special topics in infection

4.1 Vaccines

Andrew Pollard – Ashall Professor of Infection and Immunity, University of Oxford and Chair of the Joint Committee on Vaccination and Immunisation 2013 to 2025

Melita Gordon – AXA Research Professor in Vaccinology and Global Health, University of Edinburgh

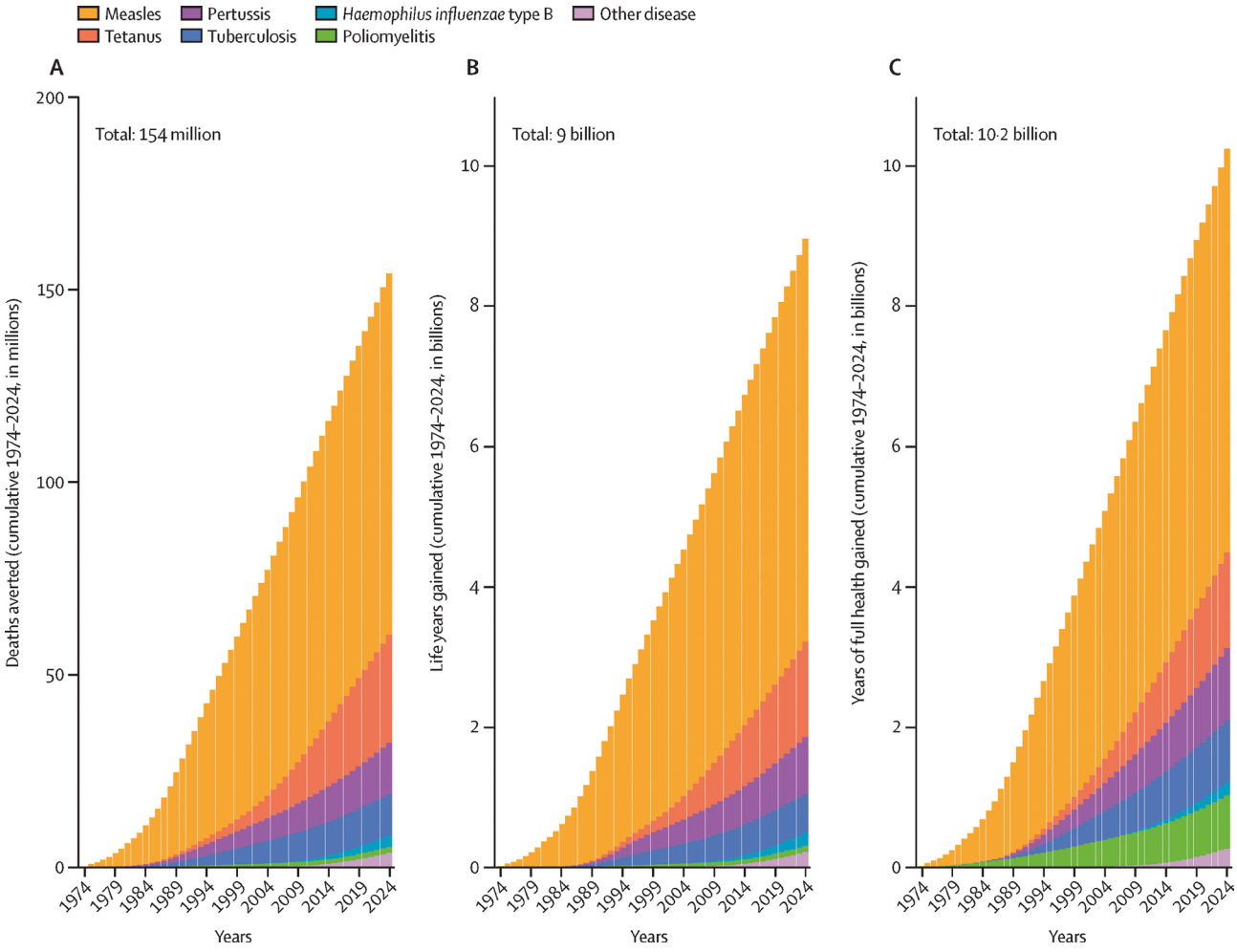
Contributors: Charlie Firth, Gayatri Amirthalingam, Nick Chapman

Introduction

In the UK, infectious diseases were the leading causes of death in childhood until the 1970s,[1] with the highest burden occurring in children under 5 years of age. While many factors contributed to improvements in the survival of children in the UK, the provision of clean water and vaccination to prevent life-threatening infections were the most effective.

On a global level, the UK was one of the countries that contributed to the Expanded Programme on Immunisation (EPI), led by the World Health Organization (WHO), which started in 1974 and is estimated to have saved 154 million lives globally over the past half century (Figure 1).[2] Over this period, an extraordinary 40% of the reduction in infant deaths globally can be ascribed to vaccination. This expectation of health is dependent on maintenance of high uptake, since vaccine-preventable pathogens remain at large and a risk to the unvaccinated.

Figure 1: Impact of the Expanded Programme on Immunisation (EPI), 1974 to 2024[3]



Source: Image by Shattock, A. J., Johnson, H. C., Sim, S. Y., et al., Contribution of vaccination to improved survival and health: modelling 50 years of the Expanded Programme on Immunization, The Lancet, 2024 is licensed under CC BY 3.0 IGO.

Remarkable advances in science over the past half century mean that, today, many of the life-threatening infections of childhood can be prevented by vaccination and a new era is being ushered in where vaccines can protect older adults and pregnant women and their babies from serious infections and even prevent some forms of cancer. Technological improvements are also enabling greater speed of vaccine discovery and development, and scalability of manufacture and distribution. The UK has played a leadership role in many of these advances in technological innovation and continues to support research and development at a global level to maximise the potential of vaccines in tackling infectious diseases that are emerging, neglected or have pandemic potential.

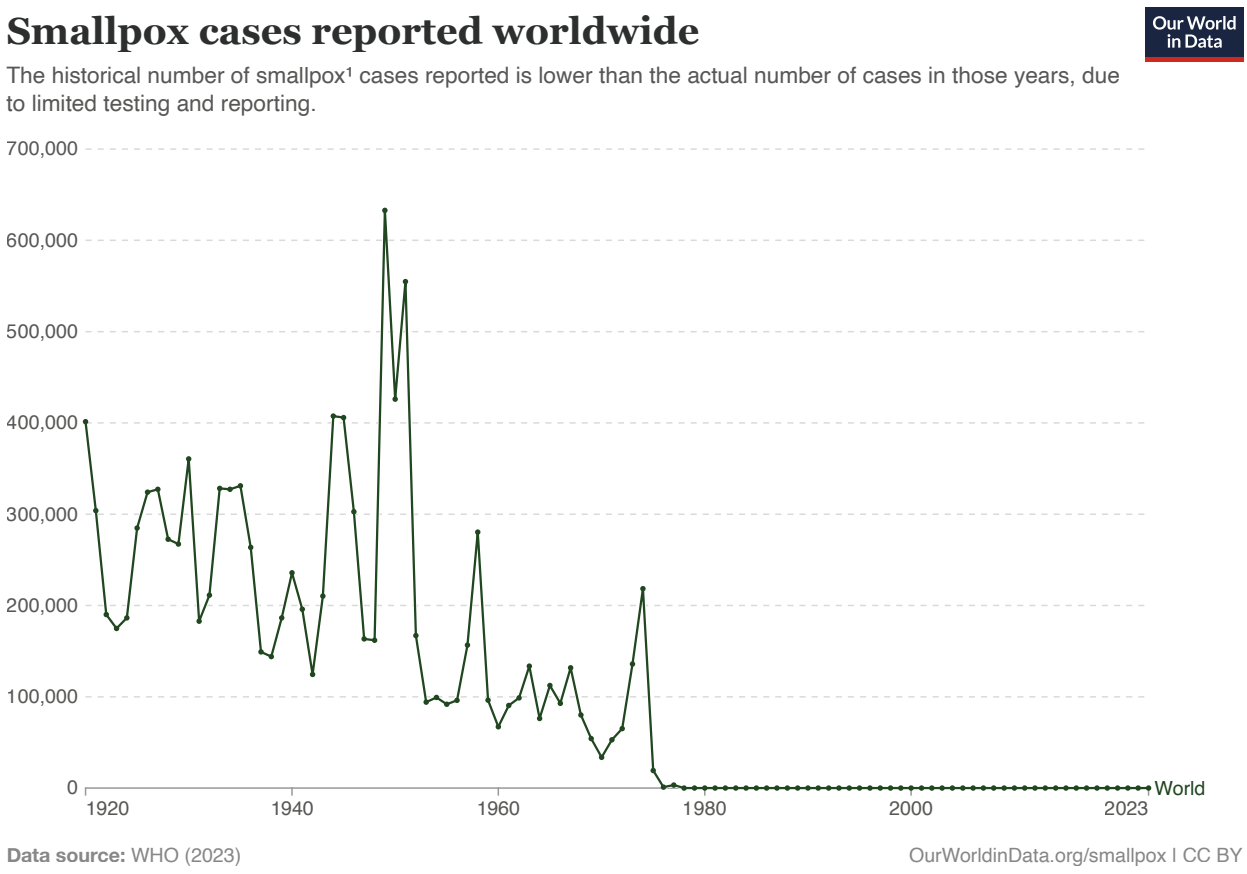
Impact of vaccination in the UK

The eradication of smallpox, elimination of polio and reduction in cases of diphtheria in the UK illustrate early examples of the effectiveness of vaccines when delivered at population scale. Vaccination has also been successful in suppressing measles in the UK, but recent outbreaks of measles as a result of a sustained decline in childhood vaccine coverage over the past decade serve as a reminder of the threats posed by vaccine-preventable infections.

Smallpox

The first true vaccine used in the UK was Edward Jenner's smallpox vaccine (described in 1796 and used in Britain from the early 1800s). Smallpox is a viral disease with a case fatality rate of up to 30%.[4] By 1825, about half of all children received the smallpox vaccine but there were still many cases of the disease among the unvaccinated. To try and combat the problem of low uptake, compulsory smallpox vaccination was introduced in 1853, improving coverage by the end of the century, but the policy was unpopular and opt-out provisions for the policy were introduced. Increasing vaccine coverage over time in the UK and around the world sustained a decrease in cases to the point of eradication in 1980 (Figure 2).

Figure 2: Global number of smallpox cases, 1920 to 2023[5]



1. Smallpox Smallpox was a severe and contagious disease caused by the variola virus.
Patients infected by the virus developed fever, body aches, and a distinctive rash that developed into fluid-filled blisters.
The disease was known for its high mortality rate and the permanent scarring it often left on survivors. Historically, it affected people across various continents. Through a global vaccination campaign, smallpox became the first disease to be eradicated by human effort.

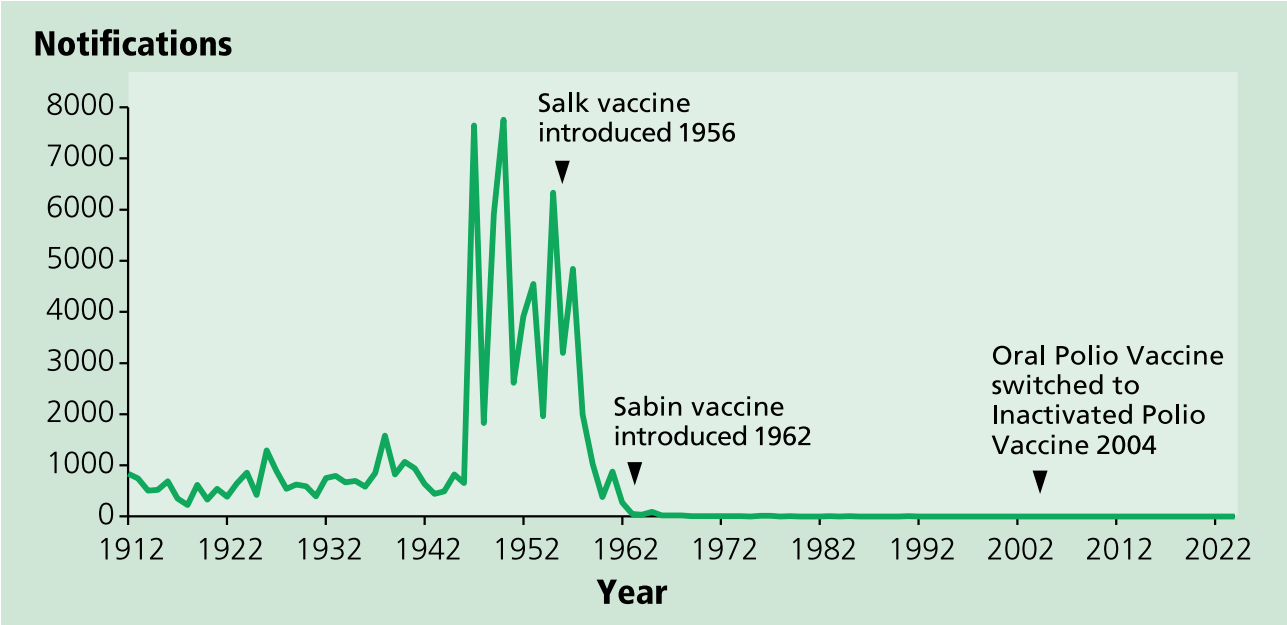
Source: WHO (2011) – processed by Our World in Data, Smallpox cases reported worldwide is licensed under CC-BY

Polio

Polio is a highly transmissible infection caused by 3 closely related polio viruses that primarily affect the nervous system. Severe cases of polio can result in permanent paralysis or even be fatal.[6] In 1955, a large epidemic of polio led to the widespread use of the 'iron lung' to support the breathing of affected individuals and the outbreak is still characterised in the public mind by images of children with paralysis.

The polio vaccination programme, which started the following year, was so successful that polio all but disappeared within a few years and was eventually eliminated, with the last case of wild polio infection in the UK in 1984 (Figure 3). Today, 2 of the 3 polio viruses have been eradicated through vaccination, with the remaining virus endemic in just 2 countries, Pakistan and Afghanistan.[7]

Figure 3: The impact of polio vaccination in the UK leading to elimination of polio[8]

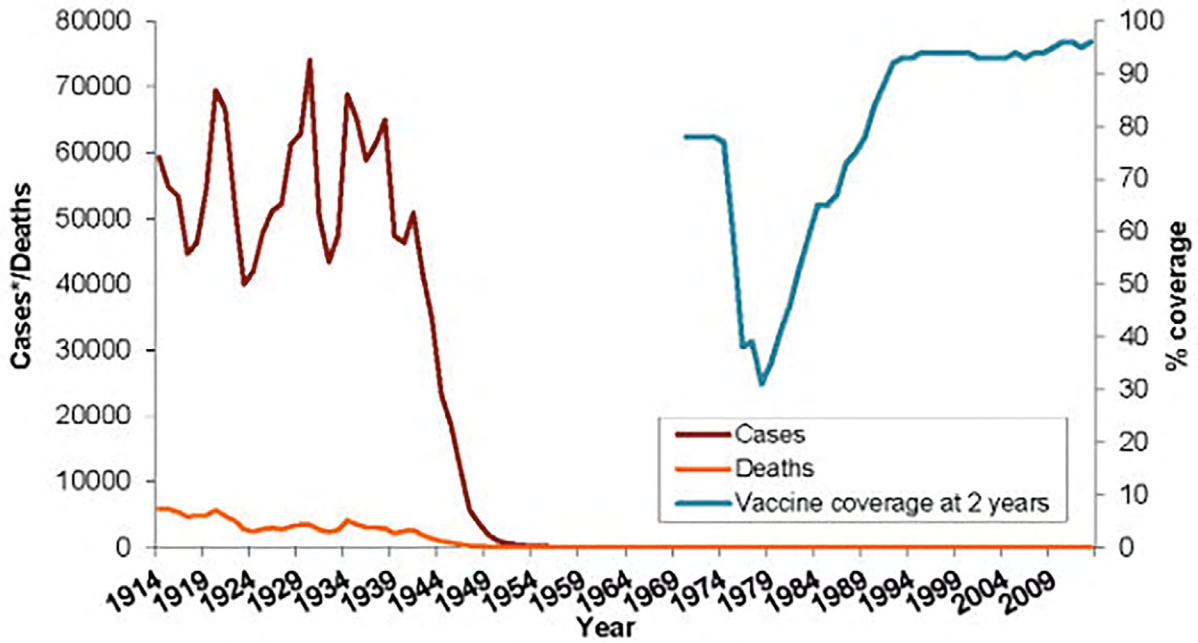


Source: Image by UK Health Security Agency, Polio: the green book, chapter 26, 2025, is licensed under the Open Government Licence v3.0

Diphtheria

Diphtheria is a bacterial infection that affects the upper respiratory tract and skin, sometimes causing ulcers and pus-filled blisters.[9] Outbreaks of diphtheria were widespread in the 1930s (Figure 4). A major diphtheria vaccine drive from 1940 led to its almost complete disappearance as coverage improved over the next decade (Figure 4). While diphtheria is now rare in the UK, the infection remains a global public health problem and outbreaks have continued to occur in countries with suboptimal vaccine coverage. In the 1990s, outbreaks occurred across the newly independent states of the former Soviet Union as a result of disruption of vaccination programmes, with tens of thousands of cases each year, showing how quickly this disease comes back when vaccination is disrupted.[10] Moreover, children who do not have access to vaccination services are at heightened risk of diphtheria. This was evident in the large outbreak which occurred in the Rohingya refugee camps in Bangladesh in 2017 to 2018.[11]

Figure 4: Diphtheria cases* and deaths, England and Wales, 1914 to 2013



*notifications up to 1985, laboratory confirmed cases 1986 to 2013

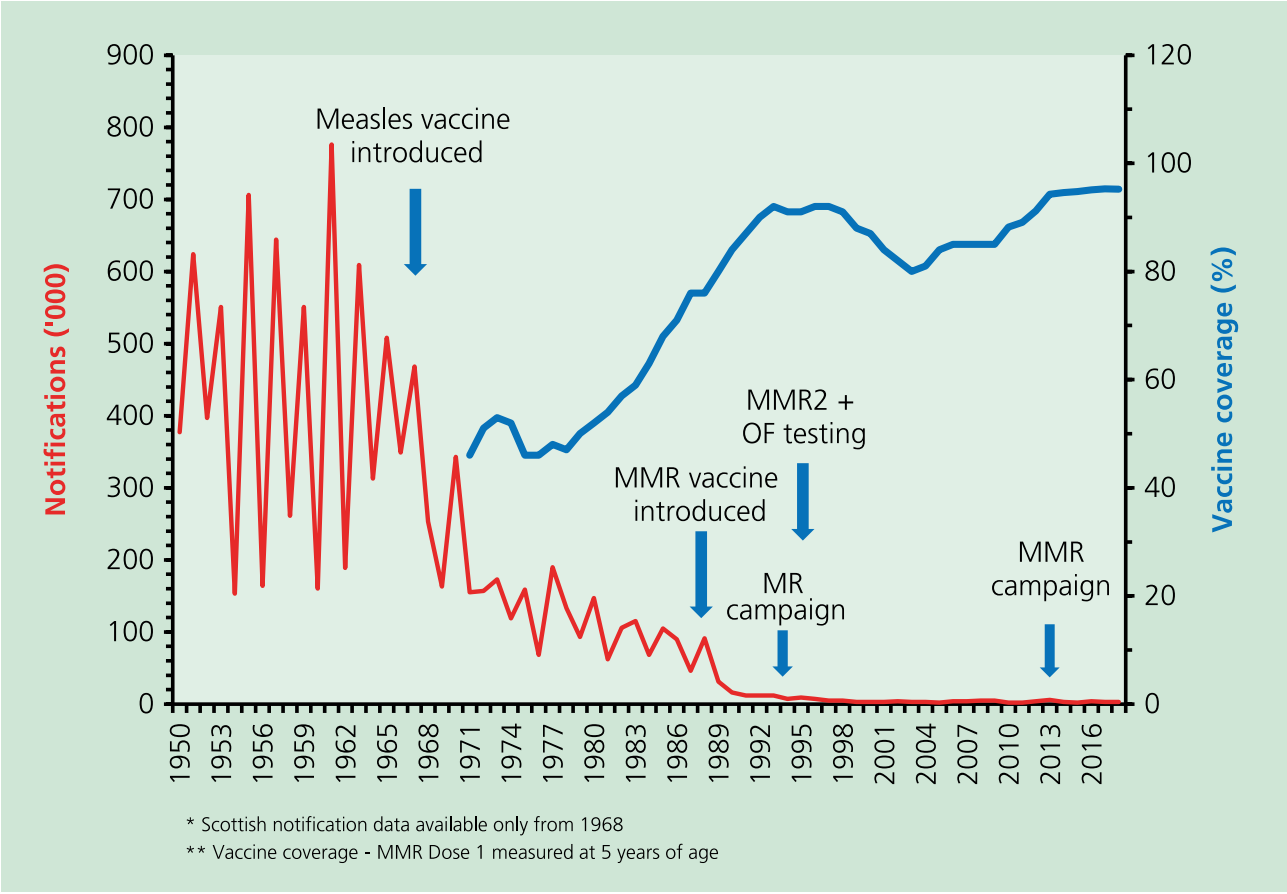
Source: Public Health England via The National Archives, Diphtheria cases* and deaths, England and Wales, 1914 – 2013 (2014).

Measles

The success and sustained impact of vaccination programmes relies on the adequacy of health infrastructure that makes vaccination accessible and convenient. This is even more important when a disease has become uncommon (through vaccination) because the perception of the importance of vaccination declines and coverage can fall. One of the first diseases to re-emerge in the UK following a decline in vaccine coverage has been measles.

Approximately 1 in 5,000 people die from measles in high income countries, rising to as many as 1 in 100 in low income settings.[12] Among survivors, serious complications such as severe pneumonia and encephalitis can occur. A rare, late complication of measles is a degenerative brain disease caused by persistent infection with the virus called SSPE (subacute sclerosing panencephalitis) with onset on average 7 years after the infection and which invariably ends in death. SSPE occurs more commonly when measles infection is acquired in infancy. In the UK, introduction of the highly effective measles vaccine significantly reduced transmission and disease severity as coverage increased, especially after the measles-mumps-rubella (MMR) vaccine was introduced (Figure 5).

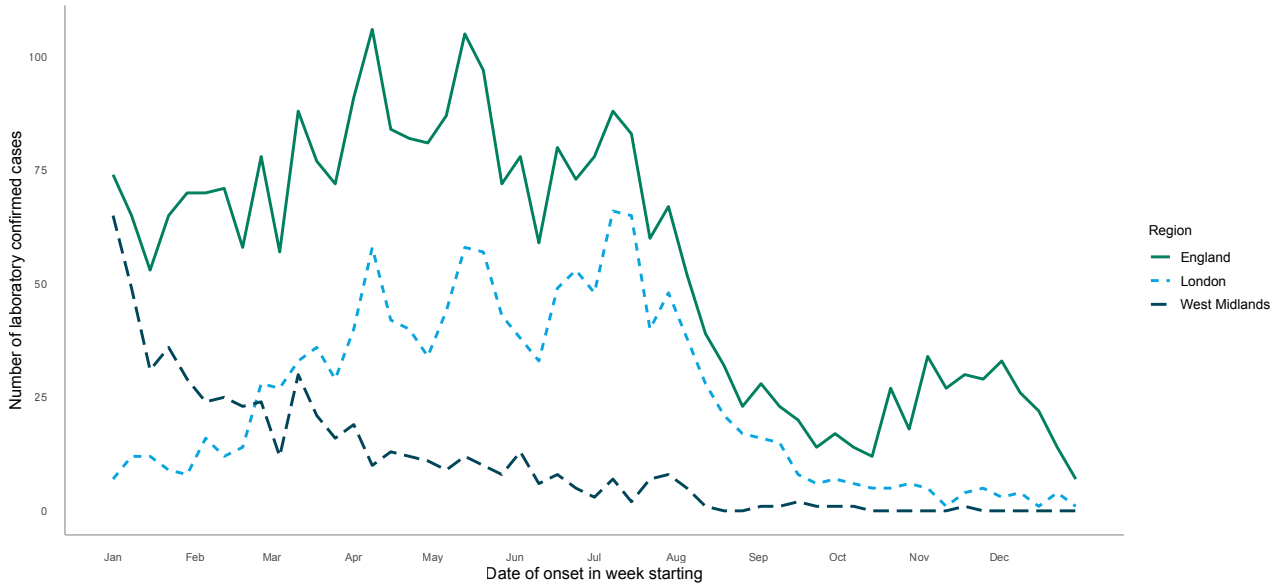
Figure 5: Coverage of measles vaccination and measles notifications from 1950 to 2018[13]



Source: Image by UK Health Security Agency, Measles: the green book, chapter 21, 2019, is licensed under the Open Government Licence v3.0

However, measles vaccine coverage in the UK has been declining over the last decade, with re-emerging disease causing a recent outbreak especially affecting people in London and the West Midlands (Figure 6; see also chapters 3.5 and 5.2).

Figure 6: Laboratory confirmed cases of measles by week of onset of rash or symptoms reported, London and England: 1 January 2024 to 31 December 2024[14]



Source: Image by UK Health Security Agency, Confirmed cases of measles in England by month, age, region and upper-tier local authority: 2024, 2019, is licensed under the Open Government Licence v3.0

Vaccine coverage is highly dependent on access to vaccination services and trusted health professionals to provide information and answer the questions of parents and patients. This is discussed further in chapter 3.5.

Future vaccine priorities for the UK and in global health

Availability and delivery of vaccines through the NHS immunisation schedule continues to be evaluated and optimised by the Joint Committee on Vaccination and Immunisation (JCVI). This includes appraisal of the number of and intervals between doses of current vaccines as well as the inclusion of new vaccines. For example, new vaccines that cover more strains of pneumococcal bacteria are currently under consideration. New vaccines on the horizon include those for:

- Group B Streptococcus (GBS), which causes 500 to 750 cases per year of meningitis, sepsis and pneumonia and largely affects neonates[15,16,17]
- human metapneumovirus (hMPV): while influenza, respiratory syncytial virus (RSV) and COVID-19 are the major respiratory viruses affecting the elderly, vaccines for viruses such as hMPV and parainfluenza could further reduce the burden of respiratory illness in this population; a phase one study of a combination RSV and hMPV vaccine was launched last year in the UK[18]
- gastrointestinal and healthcare acquired infections: researchers continue to work on vaccines to prevent norovirus[19] and other causes of diarrhoea and to prevent infections that are commonly acquired in hospitals

Vaccination across the life course is a major focus for vaccine developers as populations other than children also experience greater susceptibility to and severity of infectious disease, namely pregnant women, neonates and the elderly (see chapters 3.1 and 3.2). Researchers are especially considering how adult vaccination against infection could be deployed to support healthy ageing and reduce the risk of chronic diseases. Evidence suggests indirect improvements in health also result from vaccination against infection. For example, influenza vaccination is associated with improved cardiovascular outcomes[20] and early suggestions of a possible association between shingles vaccine and a reduction in dementia onset have been observed.[21] Another study proposed that the new RSV vaccine could also impact on dementia risk.[22] Recent evidence also suggests that glandular fever (infectious mononucleosis, caused by Epstein-Barr Virus – EBV) may be associated with the onset of multiple sclerosis decades later, raising the intriguing possibility of vaccination against EBV to treat or prevent multiple sclerosis in the future.[23]

Vaccination to prevent hepatitis-related liver cancer and against human papilloma virus (HPV), which causes cervical cancer, is discussed in chapter 4.3. Developments in the use of vaccines specifically targeting cancers are set to transform the approach to treatment of some cancers possibly as soon as in the next 5 years. Furthermore, some researchers are envisioning a future where cancer vaccines given to healthy people at high risk of certain cancers could prevent disease, building on knowledge and expertise already deployed to prevent infectious diseases before they occur.[24]

To prioritise international effort and investment on a global level, the WHO recently conducted a comprehensive and principled multi-criteria vaccine prioritisation decision analysis. This considered criteria including infections that already have a known high burden of human disease and death, those for which there are no current licensed vaccines, those with a high risk of antimicrobial resistance (AMR), a risk of disruption from outbreaks, and infections for which there is good technical feasibility for potential vaccine research and development approaches. This yielded 17 global priority pathogens, of which 9 are priorities in at least 5 of 6 regions of the globe including Europe and 10 are priorities in their own right for Europe itself (Figure 7). These priorities form the backbone of the WHO Immunisation Agenda 2030,[25] with recommended interventions including new research, investment in product development and preparation for implementation. This global prioritisation approach adds confidence to national decision making, affirms the priorities identified by UK health agencies and suggests areas for research and development opportunities at the interface between UK global health research and vaccine industrial partners.

Figure 7: WHO global priority pathogens[26]

Source: Image from Hasso Agopsowicz et al, Identifying WHO global priority endemic pathogens for vaccine research and development (R&D) using multi-criteria decision analysis (MCDA): an objective of the Immunization Agenda 2030, 2024, is licensed under CC BY.

Protecting populations from vaccine preventable diseases without increasing the number of injections and visits needed will be a challenging balance. In the past, this has been successfully achieved for some infant vaccines – for example, the 6-in-1 (hexavalent) combination vaccine for babies protects against 6 life threatening diseases all with one injection. Combination vaccines can also be used for different variants of the same virus or bacterium, such as some existing influenza vaccines.

However, developing combination vaccines can be technologically and epidemiologically challenging. Providing equal immunity against all the constituents can be difficult because of

an issue known as 'immunodominance'. Additionally, changes in circulating strains of a given pathogen may necessitate repeat vaccination (for example, annually for influenza). Furthermore, differences in the frequency of vaccination required between vaccines may limit the suitability of certain combinations. For example, the new RSV vaccine is not likely to require repeat vaccination for several years; combining this with the influenza vaccine, which requires annual vaccination, may therefore not be practical for these otherwise apparently similar diseases. These challenges offer opportunities for new innovations in vaccine development.

Advances in vaccine discovery and development

For most vaccines, years of research happen before human trials can begin. This was true of the vaccines used in the COVID-19 pandemic, where 20 years of research on vaccines for related coronaviruses had happened even before the COVID-19 virus emerged. In this 'preclinical' phase much of the work is in identifying which components of a bacterium or virus could be used to make a vaccine and to establish whether these components are likely to be recognised by the human immune system and, crucially, whether these immune responses confer protection. Advances in biology and artificial intelligence (AI) mean that understanding the 3-dimensional structure of bacterial and viral proteins is now possible and quicker. Deeper understanding of how the human system recognises these foreign microbial components is also rapidly advancing.

For now, confidence in prototype vaccines is often built by testing in animal models which has significant limitations. Animals, for example, do not have the same immune system as humans and we cannot yet accurately predict the human immune response before we start clinical trials. However, recent advances in immunology and AI may make this possible, substantially shortening the time from discovery to predictably successful human studies.

Currently, human trials go through a series of phases to test safety, assess different vaccine doses and schedules and build confidence that potentially protective immune responses are generated. This is prior to formal testing of efficacy, usually in very large clinical trials. Active work to identify correlates of protection (blood tests showing protective responses after vaccination) is being undertaken to reduce the need for large-scale efficacy trials. For example, the 2 recently licensed vaccines for chikungunya (a viral infection spread by mosquitoes that causes often severe and long-term joint pain)[27] were licensed on the basis of vaccine-induced antibodies that were able to neutralise the virus in the laboratory, which was known to be a protective immune response, avoiding the need for large trials prior to licensure in an outbreak. This is particularly helpful in the absence of an outbreak of a rare or emerging disease (which is unpredictable in location and time), when it is difficult to recruit a large enough sample population. In another approach, one of the Ebola vaccines (the Johnson and Johnson vaccine) was licensed on the basis that it protected animals from Ebola and the same immune protective responses could be induced in humans giving confidence that the vaccine would work to protect individuals in at-risk regions of Africa.

Adaptive clinical trials or combining phases of clinical trials can be more efficient ways of testing different vaccines, doses and schedules, to shorten the time needed to demonstrate

effectiveness without cutting any corners in testing safety. The use of human pathogen challenge studies (controlled human infection models, known as CHIM), in which healthy volunteers are deliberately (and safely) exposed to a virus or bacterium can be used to identify likely vaccine candidates, identify potential correlates of protection or even demonstrate the efficacy of new vaccines. The acceptance by regulators of these different approaches to vaccine testing has already accelerated vaccines and improved public health.

In a pandemic, such as that caused by SARS-CoV-2 in 2020, clinical trials are conducted to test efficacy in much the same way as in peacetime, with regulators requiring a high level of certainty about estimates of efficacy, which necessitates large trials. Pivotal studies for the viral vector and mRNA COVID-19 vaccines used in the UK involved 25,000 to 40,000 volunteers and more than 100 cases of COVID-19 among the trial participants to meet the licensing criteria. The NHS was a major contributor to the success of these studies, particularly with respect to participant recruitment.[28]

While it is appropriate that there is confidence in the efficacy of a vaccine that is used on such a large scale, guidelines are urgently needed for other potential scenarios. For example, there is currently no regulatory guidance about how to design trials for a rapidly spreading pandemic with high case fatality as, for example, seen during the Black Death of 1348 (caused by plague, *Yersinia pestis*, which killed 30% to 50% of the population). In such a situation, real-time clinical evaluation during a carefully monitored roll-out might be more appropriate than a traditional set of COVID-19-like trials. Giving half the trial participants a placebo in similar scenarios where mortality is lower (for example, <1% with COVID-19) may be more acceptable. Scenario planning in this way could inform regulatory guidance that gives greater clarity to developers than was available at the start of the COVID-19 pandemic and save lives sooner.

The balance point between benefit and harm of a given vaccine also remains a key consideration in emergency situations and needs to be proportionate to the severity of infectious disease. For example, outbreaks of infection with high mortality, such as Ebola, may allow for higher tolerance of side effects than those with low overall mortality, such as COVID-19.

New vaccine technologies

One of the most important innovations of the past decade has been the arrival of mRNA technology for vaccine production. The significance of this scientific advance was recognised with the 2023 Nobel prize in physiology or medicine going to Drew Weissman and Katalin Kariko for their work on this technology.

mRNA-based vaccines were used against SARS-CoV-2 during the COVID-19 pandemic on a massive scale and demonstrated high levels of protection and safety both in rigorous clinical trials and real world use. These vaccines use genetic material (mRNA) to instruct the body's own cells to produce the protein that generates an immune response instead of, for example, a live attenuated or inactive pathogen as in other more traditional vaccines.

Perhaps the most important practical aspect of this technology, as it exists today, is the speed with which mRNA vaccines can be manufactured. Highest on the Government risk register is a new influenza pandemic. It would take 5 to 6 months to start producing traditional egg-based pandemic influenza vaccines, which models predict is too long to make a major impact in a high mortality pandemic with rapid spread.[29] It would be possible to produce mRNA vaccine doses in the order of millions within about 6 weeks of identifying a suitable candidate, as mRNA vaccine manufacture is a rapid, mainly chemical process which is much more reliable and easier to control than the use of eggs. Some of the challenges of the first use of this technology at scale (such as the need to store at ultra-cold temperatures and the high cost of products) have been overcome. While a cold chain is still required, related challenges are more relevant to low- and middle-income settings than the UK where facilitative infrastructure is in place. For scientists, mRNA technology makes it possible to study many different iterations of a vaccine (different variants, combinations of components of the pathogen, addition of RNA sequences to strengthen immune responses) and find the optimal version to take forward into human studies. Broader potential applications for mRNA technology include treatment and prevention of cancer and as a biotherapeutic option for rare diseases.

Another technology, which has been available for about 40 years, is viral vector vaccines. The first licensed products with this technology to fight serious infectious diseases were developed in response to the Ebola outbreak in 2014 to 2015 in West Africa. These products are still being deployed today to respond to new outbreaks and protect healthcare workers in affected areas of Africa. Viral vector vaccines work in a similar way to mRNA vaccines except that they use a harmless virus to take genetic material into our cells. Viral vector vaccines were also used at scale and deployed in the COVID-19 pandemic, including the Oxford-AstraZeneca vaccine (based on a chimpanzee adenovirus and for which trials in the UK were funded by the National Institute for Health Research) and the Johnson and Johnson vaccine (using a human adenovirus). Manufacturing is more complex than with mRNA but still quicker than many older technologies and is also scalable. Concerns over very rare side effects (vaccine-induced immune thrombotic thrombocytopenia or thrombosis with thrombocytopenia syndrome) have limited the use of viral vector vaccines outside of a serious outbreak of an infection, but they are likely to be key to saving lives in the next pandemic or in localised outbreaks. Indeed, if there was a pandemic of a new virus today, we would likely need both viral vector and mRNA technologies to be able to respond rapidly.

There have also been innovations in route of vaccine administration such as the nasal spray influenza vaccine offered to children. This approach is advantageous as it is generally more acceptable and easier to administer, especially in this age group.[30] The vaccination programme against influenza for children not only provides them with direct protection but also contributes to reduced spread to others in their frequent contact such as parents and grandparents.

The role of vaccines in emergency preparedness

As suggested above, and demonstrated through the recent COVID-19 pandemic, infectious diseases with the potential for epidemic or pandemic spread require special consideration. Several known families of viruses, some zoonotic, are considered to be of particular importance

for their risk of epidemic or pandemic disease. A priority list for research on infectious diseases of epidemic potential for which no vaccine was available was developed by the UK Vaccine Network (UKVN) in 2016 and revised in 2022 (Table 1). The UKVN was set up in response to the West African Ebola outbreak.

All but one of the vaccine candidates in clinical trials targeting UKVN priority pathogens which were developed in the UK were supported by over £200 million of UK Aid funding through the UKVN between 2016 and 2022. Prior to 2016, none of the vaccine candidates in clinical development for these targets had been developed in the UK. WHO data shows that in the same period, the UKVN contributed 25% of vaccine candidates entering clinical development.[31]

Table 1: UK Vaccine Network priority pathogen list (viruses and bacteria)[32]

Priority families	Exemplar pathogen(s)
Arenaviridae	Lassa fever virus
Coronaviridae	Middle East respiratory syndrome (MERS)
Filoviridae	Marburg virus, Sudan ebolavirus
Flaviridae	Zika virus
Hantaviridae	Hantaan virus
Nairoviridae	Crimean Congo Hemorrhagic Fever (CCHF) virus
Paramyxoviridae	Nipah virus
Phenuiviridae	Rift Valley Fever (RVF) virus; Dabie bandavirus (formerly severe fever with thombocytopenia syndrome (SFTS) virus)
Picornaviridae	Enterovirus 68
Togaviridae	Chikungunya virus
Coxiellaceae	Q fever (*Coxiella burnetii*)
Yersiniaceae	Plague (*Yersinia pestis*)

Source: UK Vaccine Network – GOV.UK, 2025, licensed under the Open Government Licence v3.0

Research on these diseases is strategically focused in 4 main areas to address emerging threats, encourage scientific innovation and build emergency response capacity:

- developing vaccines that cause sporadic outbreaks of disease around the world today, for example, Nipah virus in South Asia, Rift Valley Fever (RVF) virus, Marburg, Ebola and Lassa

fever viruses in Africa and bacteria such as plague which still causes sporadic human cases on most continents and outbreaks in Africa

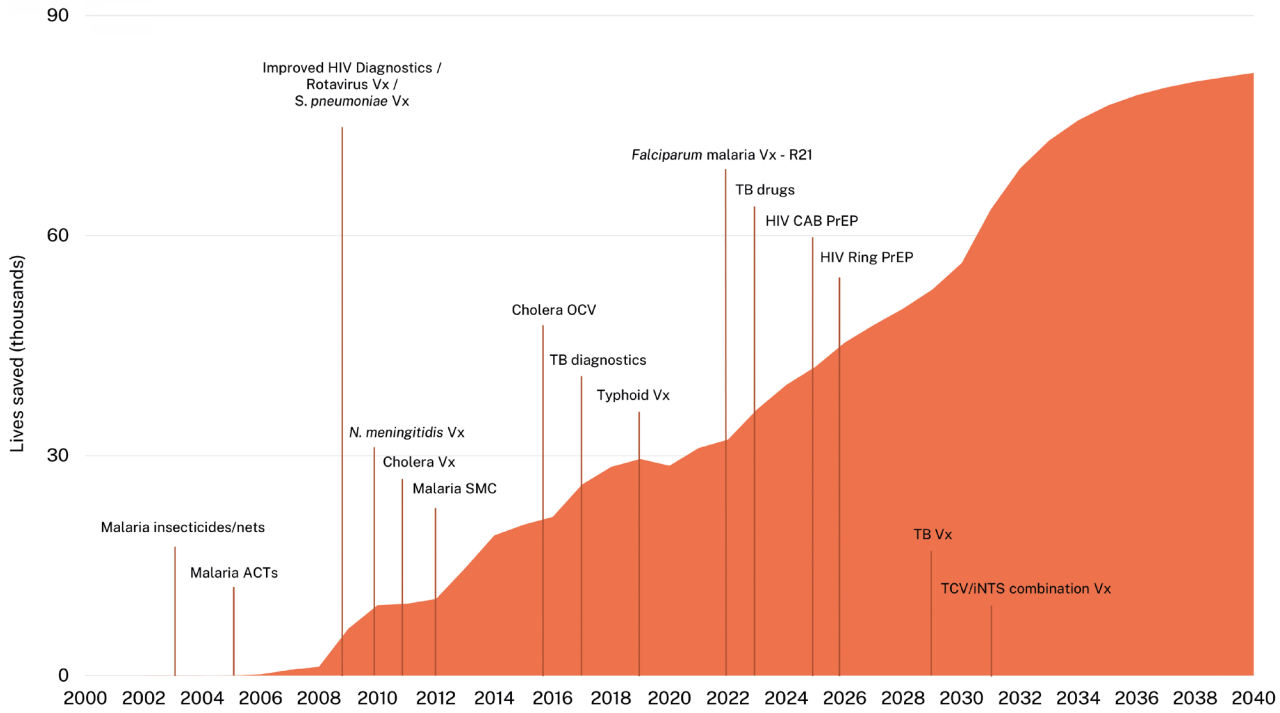
- understanding how vaccines can be developed against exemplar diseases from the many and various families of viruses. For example, can the same approach used for SARS-CoV-2 be used for all coronaviruses
- vaccine platforms that could be best used to fight outbreaks of a new, previously unknown infection – examples here are mRNA vaccines, viral vector vaccines, killed vaccines, protein vaccines and virus-like-particle vaccines
- faster manufacturing and scale up of vaccines through capacity and capability building in the UK life sciences sector

It is notable that these approaches to tackle the "known unknowns" of future epidemic or pandemic illnesses will build considerable capacity in technical investment and scientific innovation, with future applications that may extend beyond their original intended purpose.

UK impact on global vaccine development

It is estimated that, from 1994 to 2040, public sector funders from the UK will have invested £3.05 billion in global health research and development (R&D) focused on neglected diseases, led by investments from the Foreign, Commonwealth and Development Office (FCDO), Medical Research Council (MRC) and National Institute for Health and Care Research (NIHR) in addition to private industry investment. In the period from 2007 to 2023, during which product-specific figures are available, 14% of this funding was for vaccine development. In total, UK R&D investments in neglected diseases between 1994 and 2040 are estimated to save 1.43 million lives, prevent 183 million cases of disease and save 99 million disability-adjusted life years. Of these benefits, 40% are attributable to vaccines. The overall economic global societal return from UK neglected disease R&D in this period is estimated as £1.39 trillion, of which 45% (£6.25 billion) is directly attributable to vaccines. The estimated global return on UK R&D investment for vaccine products is over £400 for every £1 spent.[33]

Figure 8: Timeline for the launch of UK R&D products and lives that have been saved[34]



Estimated lives saved by individual interventions are indicated by the height of each line, and cumulative thousands of lives saved by UK R&D since 2000 are shown in orange. Vx = vaccine; ACTs = Artemisinin-based Combination Therapies; SMC = Malaria Seasonal Chemoprevention; OCV = Oral Cholera Vaccine; CAB PreP = cabotegravir pre-exposure prophylaxis; PrEP = pre-exposure prophylaxis; TCV/iNTS = typhoid conjugate vaccine/ invasive non-typhoid Salmonellae

Source: Image by Impact Global Health, A stronger and safer United Kingdom through global health R&D investment, 2025, used with permission.

Additionally, within UK borders, it is estimated that nearly £7.7 billion of additional economic activity will be catalysed from UK government investment in R&D for neglected diseases over the period 1994 to 2040, including £4.8 billion of long-term private sector investment, and 54 patents.[35] Vaccines account for a large proportion of these internal UK economic benefits.

The UK is a founding member of and leading contributor to the Vaccine Alliance, Gavi, donating US$8.4 billion to date. Gavi has vaccinated 1.1 billion children, saving 18.8 million lives and generating US$250 million of global economic benefit. Two billion doses of COVID-19 vaccine were disbursed to low- and middle-income countries through Gavi via the COVAX initiative, enabling global control and accelerating conclusion of the pandemic.

Gavi has also led numerous innovative investment and funding support mechanisms including Advance Market Commitments, the launch of Vaccine Bonds, private sector fund-matching and vaccine manufacturing accelerators.

Gavi estimates that for every US$1 spent on vaccination, there is an economic return of US$54 for recipient countries. Importantly, the economic benefits of vaccination have contributed to long-term economic sustainability for recipient countries – since 2000, 19 countries have graduated out of Gavi support to become fully self-funding, and since 2008 a total of US$1.7 billion has been contributed in vaccine co-financing from recipient countries. The Gavi vaccination programme has also resulted in significant UK returns with a projected £2 billion of activity for UK firms, £4 billion of private UK investment and 4,000 UK jobs created.

The UK is also a founding partner and major donor to the Coalition for Epidemic Preparedness Innovation (CEPI), a global partnership working to accelerate the development of vaccines and other biologic countermeasures against epidemic and pandemic threats. The UK has invested a total of £406 million in CEPI, including £228 million for COVID-19 vaccines. CEPI continues to lead the 100 Days Mission for rapid pandemic responses.

Separately, (as not included in analyses described above) the UK Astra Zeneca vaccine alone is estimated to have saved 6 million lives globally in the first year of the pandemic. For example, in a recent analysis the Oxford AstraZeneca COVID-19 vaccine is estimated to have saved £42 billion for the UK economy and £2 trillion globally in the first year of use.[36]

Conclusion

Vaccines have played a significant role in the prevention of infectious disease over history, within and outside the UK. Going forward, new technologies and adaptations to development hold promise for the discovery of effective vaccines against infections for which these do not currently exist and improvements in the speed and scale of implementation. Continued investments in vaccine R&D and deployment, focused within and beyond UK borders will ensure and sustain UK health security and preparedness, generate societal and economic returns globally and domestically, and enhance the UK's strong international leadership in technical and scientific innovation.

References

1 Patel, N., Vousden, N., Anderson, G., Griffiths, C., Masey, M., Fitzpatrick, J., Health trends and variation in England, 2025, A Chief Medical Officer report, 25 September 2025. [Internet] 2025. Available from: https://www.gov.uk/government/collections/chief-medical-officer-annual-reports

2 Shattock AJ, Johnson HC, Sim SY et al. Contribution of vaccination to improved survival and health: modelling 50 years of the Expanded Programme on Immunization. Lancet. 2024;403(10441):2307-16. doi: 10.1016/S0140-6736(24)00850-X

3 Shattock AJ, Johnson HC, Sim SY et al. Contribution of vaccination to improved survival and health: modelling 50 years of the Expanded Programme on Immunization. Lancet. 2024;403(10441):2307-16. doi: 10.1016/S0140-6736(24)00850-X

4 World Health Organization. Smallpox [Internet]. 2025. [Accessed 21 August 2025] Available from: https://www.who.int/teams/health-product-policy-and-standards/standards-and-specifications/norms-and-standards/vaccine-standardization/smallpox

5 World Health Organisation – processed by Our World in Data. "Reported Smallpox Cases (WHO, 2011)" [dataset]. WHO, "Reported Smallpox Cases (WHO, 2023)" [original data]. [Internet] 2023. [Accessed 17 July 2025] Available from: https://ourworldindata.org/grapher/global-smallpox-cases

6 NHS. Polio. [Internet] 2022. [Accessed 21 August 2025] Available from: https://www.nhs.uk/conditions/polio/

7 World Health Organisation. Poliomyelitis (polio) [Internet] 2025. [Accessed 25 September 2025] Available from: https://www.who.int/health-topics/poliomyelitis#tab=tab_1

8 UK Health Security Agency. Polio: the green book, chapter 26. [Internet] 2025. [Accessed 19 September 2025] Available from: https://www.gov.uk/government/publications/polio-the-green-book-chapter-26

9 NHS. Diphtheria. [Internet] 2025. [Accessed 21 August 2025] Available from: https://www.nhs.uk/conditions/diphtheria/

10 Fontanarosa PB. Diphtheria in Russia a Reminder of Risk. JAMA. 1995;273(16):1245-1245. doi: 10.1001/jama.1995.03520400015006

11 Polonsky JA, Ivey M, Mazhar MKA et al. Epidemiological, clinical, and public health response characteristics of a large outbreak of diphtheria among the Rohingya population in Cox's Bazar, Bangladesh, 2017 to 2019: A retrospective study. PLoS Med. 2021;18(4):e1003587. doi: 10.1371/journal.pmed.1003587.

12 Oxford Vaccine Group, University of Oxford. Measles [Internet] 2025. [Accessed 19 September 2025] Available from: https://vaccineknowledge.ox.ac.uk/measles#Key-disease-facts

13 UK Health Security Agency. Measles: the green book, chapter 21. [Internet] 2019. [Accessed 19 September 2025] Accessed: 2025 09 19. Available from: https://www.gov.uk/government/publications/measles-the-green-book-chapter-21

14 UK Health Security Agency. Confirmed cases of measles in England by month, age, region and upper-tier local authority: 2024. [Internet] 2025. [Accessed 19 September 2025] Available from: https://www.gov.uk/government/publications/measles-epidemiology-2023/confirmed-cases-of-measles-in-england-by-month-age-region-and-upper-tier-local-authority-2024

15 UK Health Security Agency. Laboratory surveillance of streptococcal bacteraemia in England: 2023 update. [Internet] 2024. Available from: https://assets.publishing.service.gov.uk/media/675983f3ad4694c785b0ed4a/hpr1124-annual-streptococcal-bacteraemia-2023.pdf

16 Group B Strep Support. UK Guidelines. [Internet] Available from: https://gbss.org.uk/professional-resources/key-points-for-health-professionals/

17 UK National Screening Committee. Group B streptococcus, Evidence summary Group B Streptococcus (2017) compressed, 2017. [Internet] Available from: https://view-health-screening-recommendations.service.gov.uk/group-b-streptococcus/

18 Department of Paediatrics, University of Oxford. New trial launches for two-in-one vaccine to prevent RSV and hMPV [Internet] 2024. [Accessed 21 August 2025] Available from: https://www.paediatrics.ox.ac.uk/news/new-trial-launches-for-two-in-one-vaccine-to-prevent-rsv-and-hmpv

19 Geddes, L., Vomit-proof: how close are we to a norovirus vaccine? [Internet] 2025. [Accessed 21 August 2025] Available from: https://www.gavi.org/vaccineswork/vomit-proof-how-close-are-we-norovirus-vaccine

20 Omidi F, Zangiabadian M, Shahidi Bonjar AH, Nasiri MJ, Sarmastzadeh T. Influenza vaccination and major cardiovascular risk: a systematic review and meta-analysis of clinical trials studies. Sci Rep. 2023;13(1):20235. doi: 10.1038/s41598-023-47690-9

21 Eyting M, Xie M, Michalik F, Heß S, Chung S, Geldsetzer P. A natural experiment on the effect of herpes zoster vaccination on dementia. Nature. 2025;641(8062):438-446. doi: 10.1038/s41586-025-08800-x.

22 Taquet M, Todd JA, Harrison PJ. Lower risk of dementia with AS01-adjuvanted vaccination against shingles and respiratory syncytial virus infections. NPJ Vaccines. 2025;10(1):130. doi: 10.1038/s41541-025-01172-3.

23 Bjornevik K, Cortese M, Healy BC et al. Longitudinal analysis reveals high prevalence of Epstein-Barr virus associated with multiple sclerosis. Science. 2022;375(6578):296-301. doi: 10.1126/science.abj8222.

24 Blagden SP, Dodd KW, Brown K, Szabo E. Precision Prevention Studies: A Targeted Approach to Cancer Prevention. Cancer Prev Res (Phila). 2025;18(9):499-507. doi: 10.1158/1940-6207.CAPR-25-0035.

25 Hasso-Agopsowicz M, Hwang A, Hollm-Delgado MG et al. Identifying WHO global priority endemic pathogens for vaccine research and development (R&D) using multi-criteria decision analysis (MCDA): an objective of the Immunization Agenda 2030. EBioMedicine 2024:110:105424. doi: 10.1016/j.ebiom.2024.105424

26 Hasso-Agopsowicz M, Hwang A, Hollm-Delgado MG et al. Identifying WHO global priority endemic pathogens for vaccine research and development (R&D) using multi-criteria decision analysis (MCDA): an objective of the Immunization Agenda 2030. EBioMedicine 2024:110:105424. doi: 10.1016/j.ebiom.2024.105424

27 World Health Organization. Chikungunya [Internet] 2025. [Accessed 21 August 2025] Available from: https://www.who.int/news-room/fact-sheets/detail/chikungunya

28 Darzi A, Goddard A, Henderson K et al. Increasing recruitment into covid-19 trials. BMJ. 2021;372:n235. doi: https://doi.org/10.1136/bmj.n235

29 Ferguson NM, Cummings DA, Fraser C, Cajka JC, Cooley PC, Burke DS. Strategies for mitigating an influenza pandemic. Nature. 2006;442(7101):448-52. doi: 10.1038/nature04795.

30 UK Health Security Agency. Influenza: the green book, chapter 19. [Internet] 2025. [Accessed 10 October 2025] Available from: https://www.gov.uk/government/publications/influenza-the-green-book-chapter-19

31 Raabe, B., Rentel, M., Babb, R., et al., Evaluation of the UK Vaccine Network Project 1.0 (NIHR207661). [Internet] 2025. [Accessed 7 October 2025] Available from: https://technopolis-group.com/report/evaluation-of-the-uk-vaccine-network-project-1-0/

32 GOV.UK. UK Vaccine Network. [Internet] [Accessed 28 August 2025] Available from: http://www.gov.uk/government/groups/uk-vaccines-network

33 Impact Global Health. A stronger and safer United Kingdom through global health R&D investment. [Internet] 2025. [Accessed 26 August 2025] Available from: https://www.impactglobalhealth.org/insights/report-library/a-stronger-and-safer-united-kingdom-through-global-health-rd-investment

34 Impact Global Health. A stronger and safer United Kingdom through global health R&D investment. [Internet] 2025. [Accessed 26 August 2025] Available from: https://www.impactglobalhealth.org/insights/report-library/a-stronger-and-safer-united-kingdom-through-global-health-rd-investment

35 Impact Global Health. A stronger and safer United Kingdom through global health R&D investment. [Internet] 2025. [Accessed 26 August 2025] Available from: https://www.impactglobalhealth.org/insights/report-library/a-stronger-and-safer-united-kingdom-through-global-health-rd-investment

36 Booth, J., Profanter, M., Kennedy, C., Symington, M., Conlon, G., Halterbeck M., The economic impact of the University of Oxford. [Internet] 2025. Available from: https://www.ox.ac.uk/sites/files/oxford/LE%20Economic%20Impact%20of%20the%20University%20of%20Oxford%202025.pdf

4.2 Fungal infections

Neil Stone – Consultant in Infectious Diseases and Microbiology, University College London Hospitals and Associate Professor, Division of Infection and Immunity, University College London

Andrew Borman – Acting Head and Consultant Clinical Mycologist, Mycology Reference Laboratory, Honorary Professor of Medical Mycology, University of Exeter, MRC Centre for Medical Mycology

Neil Gow – Professor of Microbiology, University of Exeter, MRC Centre for Medical Mycology

Tihana Bicanic – Professor in Infectious Diseases and Mycology, Institute of Infection and Immunity, St George's School of Health and Medical Sciences, City St George's University of London

Acknowledgements: Figures 4, 6-9 and 10 drawn by Phoebe Allebone-Salt

Introduction

Fungal infections are extremely common, with a recent report estimating 1 in 6 people suffer from a fungal infection at any one time globally. Whilst often causing skin and nail infections, or oral or vaginal thrush, fungal infections can also be life-threatening, particularly for people with suppressed immune systems due to underlying diseases or their treatments. Recent estimates suggest that, globally, 2.5 million deaths are directly attributable to fungal infections per annum.[1]

Transmission and types of fungal infections

Fungal infections are acquired either from exposure to environmental fungi, for example, *Aspergillus* and *Cryptococcus*, or infection by fungi that are commensal organisms in the gastrointestinal tract or on the skin, such as *Candida spp.* They are generally opportunistic infections, which means that people with functioning immune systems either harbour them without symptoms, or if newly exposed to them, will not develop symptoms. However, those with risk factors for fungal disease may go on to develop clinical disease. Exposure to fungi is usually environmental (via inhalation or traumatic inoculation); person-to-person transmission of fungal disease is rare. Exceptions to this include dermatophytes which are transmitted directly via shed skin flakes and the recently emerged drug-resistant yeast *Candidozyma auris* (formerly called *Candida auris*), which can be indirectly transmitted between colonised patients in hospital settings via contaminated equipment or healthcare workers' hands.

Fungal infections are generally categorised in 2 ways:

1) By clinical syndrome – skin/nail infection, mucosal infection (oral or vaginal thrush), chronic infection (for example, chronic pulmonary aspergillosis) and invasive infection (such as invasive aspergillosis, candidiasis, cryptococcal meningitis, pneumocystis pneumonia (PCP)). The latter are severe, life-threatening infections, most commonly affecting the lung, the bloodstream, or the brain.

2) According to the organism (or group of organisms) causing the disease, for example, yeast infections (including candidiasis or cryptococcosis) or mould infections (such as aspergillosis or mucormycosis). Fungi, particularly moulds, can also trigger allergic respiratory conditions, for example, Allergic Bronchopulmonary Aspergillosis (ABPA).

Trends in fungal infections

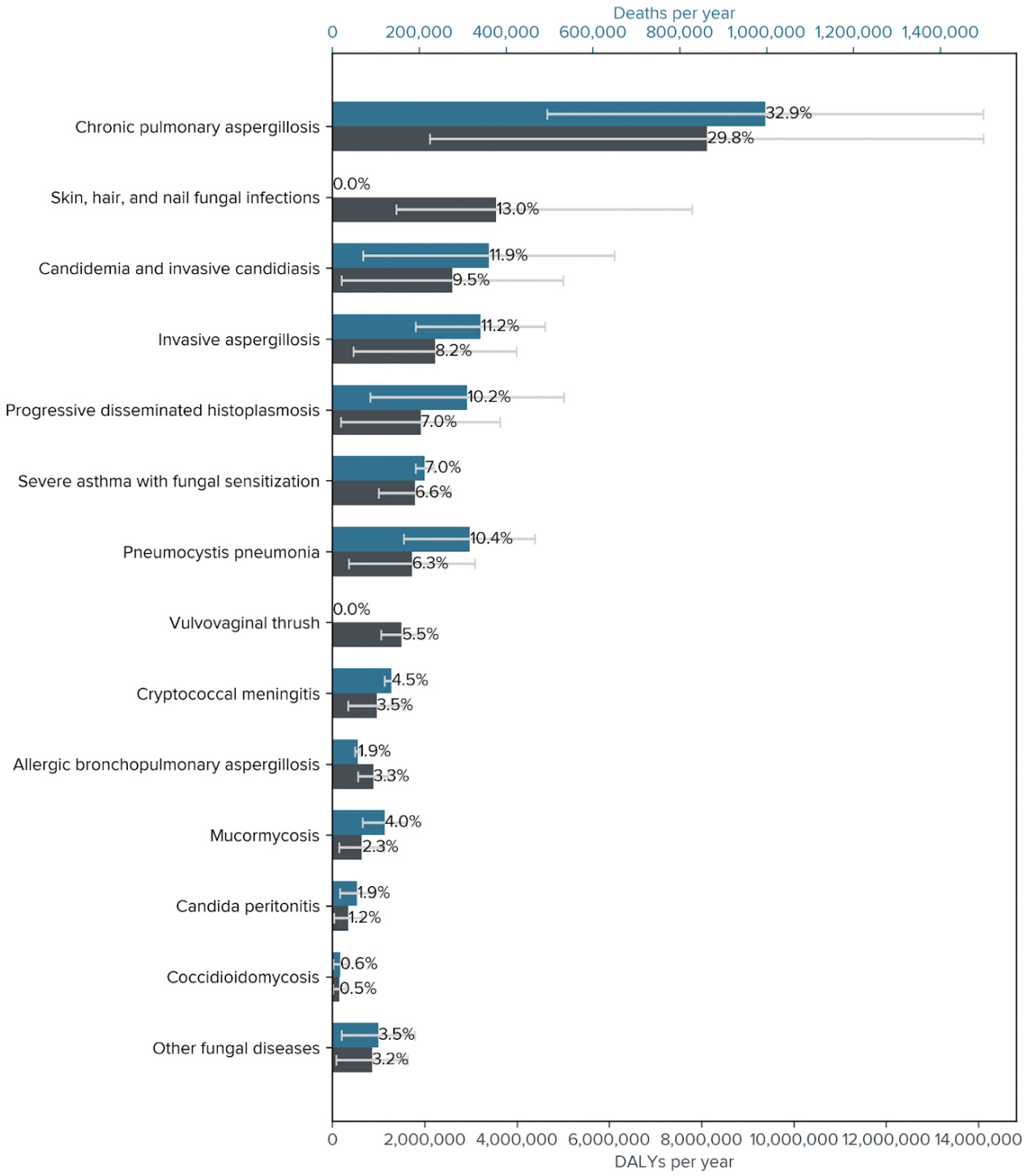
Global epidemiology

Accurate data on the incidence, prevalence, morbidity and mortality of severe fungal disease is limited due to a lack of robust surveillance programmes globally. However, recent estimates suggest approximately 2.5 million people per year worldwide die of invasive fungal infections, such as aspergillosis, candidiasis and cryptococcosis (Figure 1).[2] This collective burden is comparable to, or in some cases exceeds, globally important infections such as HIV, TB and malaria.

The incidence of fungal infections is rising globally, driven by newly emerging species, rising antifungal resistance and an increasing susceptible population. Climate change may also play a role. The gradual rise in average global temperatures is punctuated by sporadic extremes of high temperatures, droughts, storms, flooding and other adverse weather events. Most fungi do not grow well at body temperature, and it has been speculated that some environmentally restricted fungal species may adapt to periods of sustained or intermittent higher ambient temperatures, enabling them to overcome the natural infection barrier of normal human body temperature (37°C). This "host-jump" hypothesis has been validated by laboratory experimentation[3] but it is not yet clear whether this is occurring in the real world.[4] It is likely that extreme weather conditions and consequential natural disasters will increasingly impact fungal infections.[5] The very recent near simultaneous emergence of six distantly related classes of the previously unrecognised human fungal pathogen *C. auris* in different regions of the world has been hypothesised to be the first example of an emergent fungal species resulting from climate change,[6,7] although it is likely that other factors related to the drug-resistant phenotype of these strains are critical.

Figure 1: Global number of deaths (blue) and Disability Adjusted Life Years (DALYs) (grey) per year attributable to fungal diseases – based on data from 2010 to 2023[8]

Blue bars represent deaths and gray bars represent DALYs. Central estimates reported are midpoints of 80% confidence intervals, except for "skin, hair, and nail fungal infections," where the 2019 Global Burden of Disease estimate was used. Data labels (percentages) refer to proportion of total global fungal disease burden.

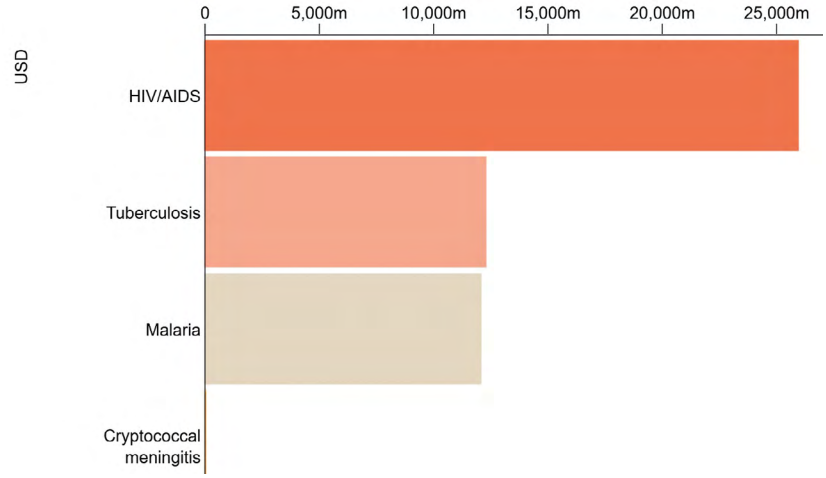


Source: Image by Kudymowa, J., Hu, J., & Hird, T. 2024. Fungal diseases: Health burden, neglectedness, and potential interventions. Rethink Priorities. With original data from Denning 2024.[9]

Additionally, more people than ever before are at risk of fungal disease because they are immune suppressed. Advancement in treatments for malignancies such as leukaemia and lymphoma, which often involve bone marrow or stem cell transplants, improves the chance of cure and survival from these conditions. However, it leaves patients vulnerable to opportunistic infections including those due to fungi.[10,11] Serious fungal disease usually affects individuals with predisposing risk factors such as neutropenia (a low white cell count) due to cancer chemotherapy, high dose steroid and other immunosuppressive treatment (for example, following organ transplantation), immunotherapy for autoimmune conditions, poorly controlled diabetes or advanced HIV infection. Patients in intensive care units (ICUs) with intravenous catheters, receiving broad spectrum antibacterials, following abdominal surgery or receiving intravenous nutrition are also at risk for serious fungal disease.[12]

Despite this high and rising burden of disease, fungal diseases have had limited resources allocated to their study by science research funders (Figure 2).[13] There has been a misconception that they are rare and benign when in fact neither is true. As a result, these infections can be very difficult to diagnose due to a lack of reliable and accurate diagnostic tests and treatment options are more limited than they are for bacterial or viral infections. To date, no vaccines are available for the prevention of fungal disease.

Figure 2: Global research funding (USD) for HIV, TB, malaria and fungal (cryptococcal) meningitis, 2007 to 2023[14]



Source: Impact Global Health, G-FINDER data portal and is open access.

The impact of the COVID-19 pandemic

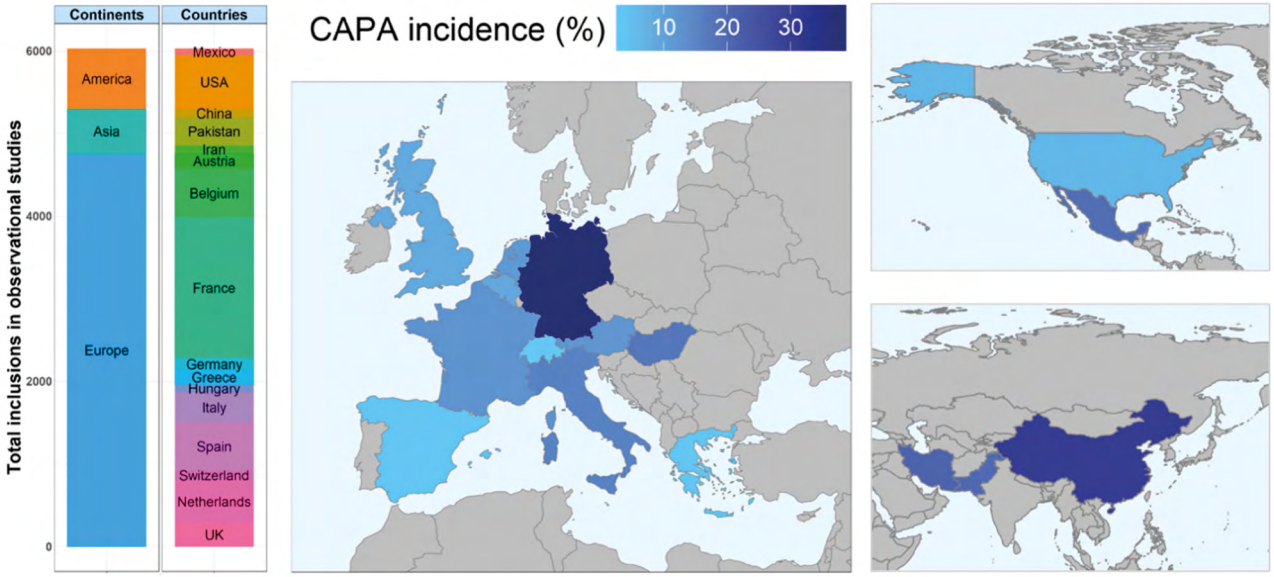
The COVID-19 pandemic impacted fungal disease epidemiology in three key ways:

1) Covid Associated Pulmonary Aspergillosis (CAPA) was a newly observed clinical entity with severe *Aspergillus* lung disease complicating COVID-19 pneumonitis, usually in ICU patients with life threatening COVID-19 infection. Globally, incidence varied widely, with a range of 0.7 – 7% of patients hospitalised with COVID-19 having their course complicated by CAPA (Figure 3).[15] UK centres reported an incidence of 3% to 14%,[16,17] including one prospective study which reported an incidence of 11%.[18] Mortality from CAPA is very high, with reports ranging from 52% – 71%.[19]

2) A significant global increase in cases of mucormycosis due to widespread and sometimes inappropriate use of steroids, particularly in patients with poorly controlled diabetes during the COVID 19 pandemic. This occurred most dramatically in India, which reported over 50,000 cases.[20] Mucormycosis is a life-threatening mould infection. Mortality due to these fungal infections is upwards of 40%.[21]

3) Incidence of *C. auris* increased significantly following the pandemic (after a temporary lull in cases, likely related to travel restrictions).

Figure 3: Global incidence (%) of Covid Associated Pulmonary Aspergillosis, 2020 to 2021[22]



Source: Image by Simon Feys, Maria Panagiota Almyroudi, Reinout Braspenning, Katrien Lagrou, Isabel Spriet, George Dimopoulos and Joost Wauters from A Visual and Comprehensive Review on COVID-19-Associated Pulmonary Aspergillosis (CAPA) and is licensed under CC BY 4.0.

Fungal disease in England

The absence of mandatory surveillance programmes for fungal infection in England make estimation of the burden of fungal disease difficult. Until recently, there have been no notifiable fungal diseases in England – notification of *C. auris* became mandatory in April 2025. The lack of centralised data necessitates reliance on a number of disparate and incomplete sources, such as isolates submitted to the national Mycology Reference Laboratory (MRL) in Bristol or incidence reports of specific fungal infections and/or single centre case series. The most recent estimate for the burden of fungal infection across the UK was in 2016 and estimated at a range of 241,500 to 663,000 cases per year (Table 1).[23] However, this is likely to be an underestimate of the rarer and systemic deep infections.[24] By comparison, in Wales, which is served by mycology testing through a single reference laboratory coupled with universal IT reporting systems, there is an annual incidence of up to 30 cases per 100,000 population for invasive fungal disease, which rises to 500 cases per 100,000 population when chronic, allergic fungal disease and fungal sensitisation are considered (unpublished data courtesy of Public Health Wales).

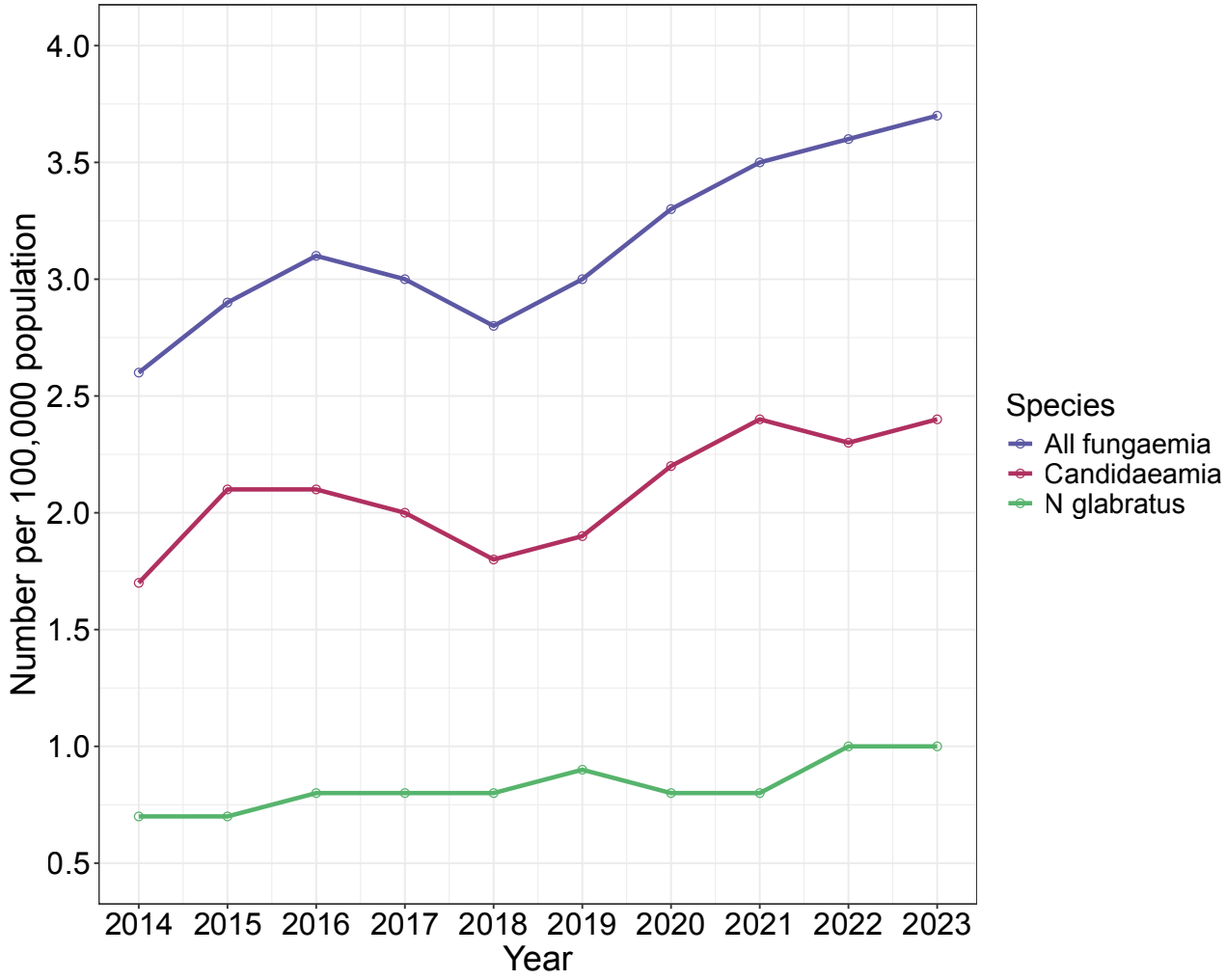
Table 1: Estimated annual burden of severe/invasive fungal disease in the UK

Infection	Estimated annual burden (cases)
Invasive candidiasis	5,142
Pneumocystis pneumonia	207–587
Invasive aspergillosis excluding critical care patients	2,901–2,912
Invasive aspergillosis in critical care patients	387–1,345
Cryptococcal meningitis	100
Allergic bronchopulmonary aspergillosis cases in people with asthma	178,000 (50,000–250,000)

Source data from Pegorie, N., Estimating the burden of invasive and serious fungal disease in the United Kingdom (2017).[25]

Mirroring global trends, serious or life-threatening fungal disease (also known as invasive fungal infection) are also on the rise in England and across the UK. The most common invasive fungal infection is candidaemia (blood stream infection with *Candida* species). Data based on laboratory surveillance analysed by UKHSA found that, between 2014 and 2023, there was a 42% increase in incidence to 3.7 per 100,000 population – the highest rate observed in the last ten years.[26] Between 2019 and 2023 (pre- and post-COVID-19 pandemic) there was a 23% increase in the number of laboratory reports of bloodstream infection due to yeasts (from 1,714 to 2,112 reports) in England, potentially due to the increased number of patients being admitted to ICUs. After *C. albicans* (42%), the second most common species isolated was *N. glabratus* (formerly named *C. glabrata*, 27%), the incidence of which has also increased (Figure 4). This is important as this species is more resistant to fluconazole, a commonly used antifungal drug therapy for yeast infections. Rates of bloodstream infection due to fungi were highest amongst people living in the most deprived areas (4.8 versus 3 per 100,000 in the 5th compared to the 1st Indices of Multiple Deprivation (IMD) quintiles in 2023).[27]

Figure 4: Rising incidence of fungaemia due to yeasts (purple), *Candida* spp. (red) and *Nakaseomyces glabratus*. (formerly *Candida glabrata*) (green) in England, 2014 to 2023



Source: Created using data from Health Protection Report Volume 18 Number 10: Laboratory surveillance of fungaemia due to yeasts in England: 2023[28]

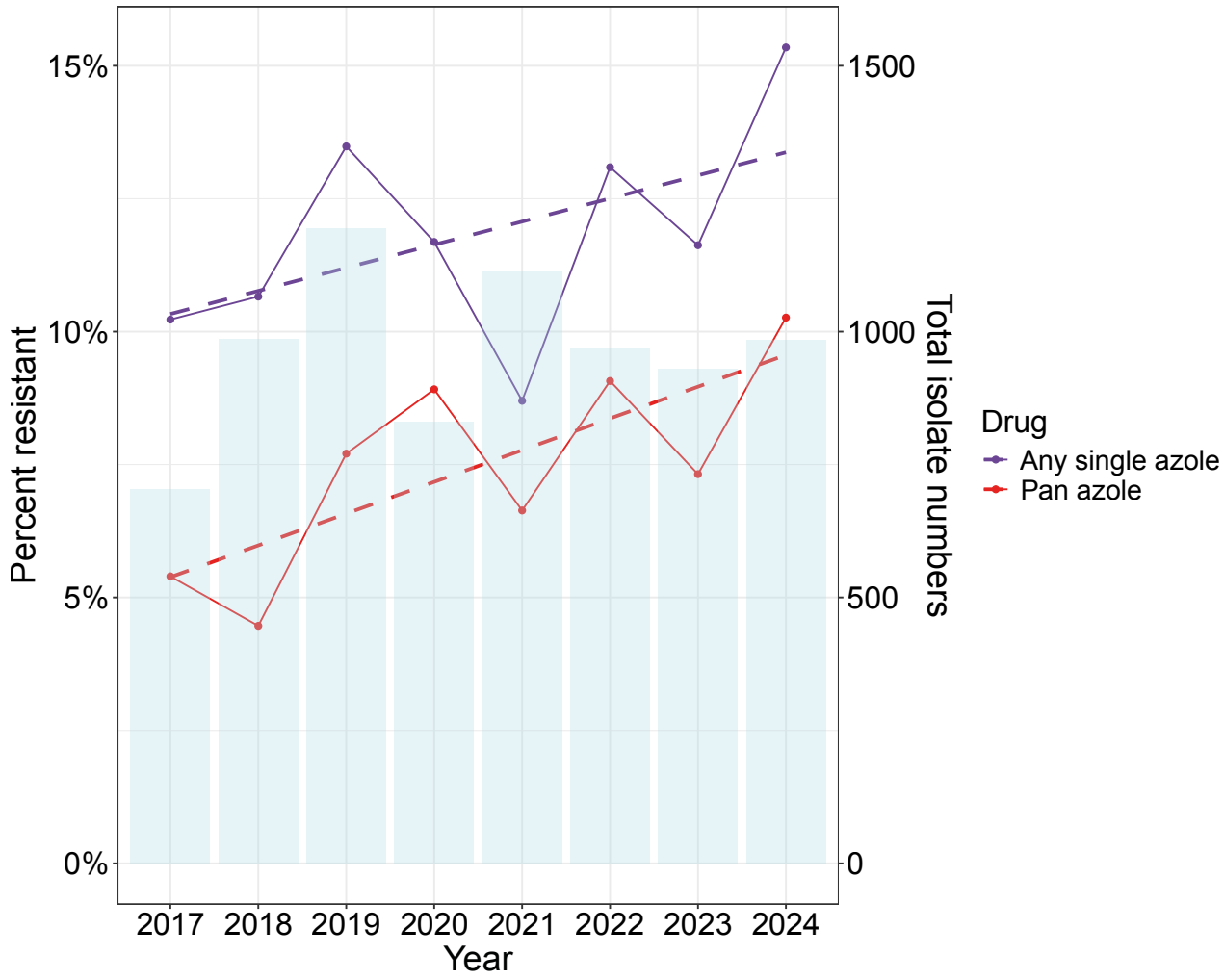
The rise of antifungal drug resistance

In contrast to antibiotics, antifungal treatment of systemic fungal infection relies heavily on just 3 major classes of drugs: azoles (for example, fluconazole, voriconazole, posaconazole), polyenes (for example, nystatin, amphotericin B) and echinocandins (for example, caspofungin, anidulafungin, micafungin, rezafungin), of which azoles are the only orally available class and the one at greatest risk of emerging antifungal resistance. To address the global threat to public health posed by fungal disease and the emergence of antifungal resistance the WHO published a fungal priority pathogens list in 2022, with *C. neoformans, C. auris, A. fumigatus* and *C. albicans* deemed critical or highest priority for policymaker action in terms of surveillance, support for research, development and innovation, and public health interventions.[29]

Resistance in aspergillosis

Dual use of azoles for crop spraying in agriculture and medical prophylaxis and treatment has led to the emergence of environmentally acquired azole-resistant pulmonary aspergillosis in patients with chronic respiratory disease.[30] Data from the national MRL indicate a rise in the proportion of strains of *A. fumigatus*, the most common cause of pulmonary aspergillosis, resistant to any azole (more than 15% in 2024) or across all azoles (more than 10%, Figure 5). This represents an increase compared to 2012 to 2016 (less than 10% for any single azole).[31] Currently, only intravenous drugs (amphotericin B or echinocandins) can be used to treat azole resistant aspergillosis, precluding outpatient treatment for this patient group which includes those with underlying chronic obstructive pulmonary disease and cystic fibrosis.[32]

Figure 5: Change in proportion of azole-resistant *A. fumigatus* isolates tested at the UKHSA mycology reference laboratory in England, 2017 to 2024



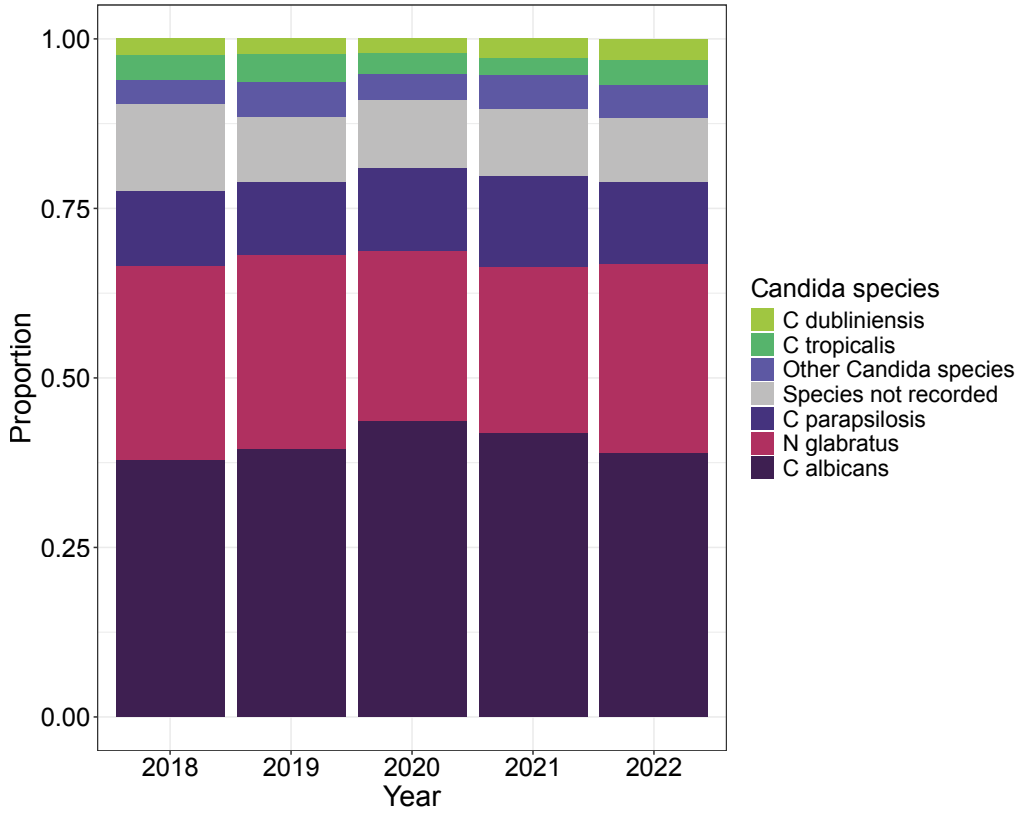
Purple line indicates resistance to any of itraconazole, voriconazole, posaconazole or isavuconazole, red line indicate resistance to all 4 drugs, dashed line represents the linear regression line.

Source: Unpublished data from the UKHSA Mycology Reference Laboratory (MRL), with permission.

Resistance in candidiasis

Invasive candidiasis (invasive infection caused by *Candida* species and related genera, as opposed to cutaneous or mucosal infection) is the most common invasive fungal disease in the UK. Whilst *Candida albicans* has historically been the most common causative species, there has been a rise in infection by *N. glabratus* and fluconazole resistance in this species (Figures 6 and 7). At the same time, the almost universally fluconazole-resistant *C. auris* has emerged, with both species having a propensity to develop multi-drug resistance (echinocandins, and in the case of *C. auris* also to amphotericin B).[33,34] Resistance to echinocandins, the first line treatment for yeast bloodstream infections including *N. glabratus* and *C. auris*, is currently low in England at less than 5%. The third most common cause of candidiasis in the England – *Candida parapsilosis* – has evolved a fluconazole-resistant strain that now predominates in South Africa, the Middle East and southern Europe causing ICU and hospital outbreaks akin to *C. auris.* Whilst rare in the UK at present, future introduction of these *C. parapsilosis* azole resistant strains into England are likely.[35]

Figure 6: Fungaemia due to yeasts in England, 2018 to 2022



Source: Created using data from Voluntary laboratory reporting through the English Second Generation Surveillance System (SGSS); UKHSA, Laboratory surveillance of fungaemia due to yeasts in England: 2023, HPR 18(10).

Figure 7: Trends in *N. glabratus* susceptibility in England, 2018 to 2022

Source: Created using data from UKHSA, Bloodstream infection due to Candida etc (England, 2022): data tables.

Currently, the most significant antifungal resistance threat in England is the newly emerged yeast *C. auris*. Discovered as recently as 2009, it was first reported in the UK in 2013.[36] Cases have been reported globally – in India and South Africa, *C auris* is now amongst the top causes of candidemia,[37] although candidemia due to this species remains very low in the UK. In the US, where *C. auris* has been notifiable since 2018, rapid spread across states has been reported, with reports of 3- or even 4-class (pan-) antifungal resistance emerging on therapy.[38]

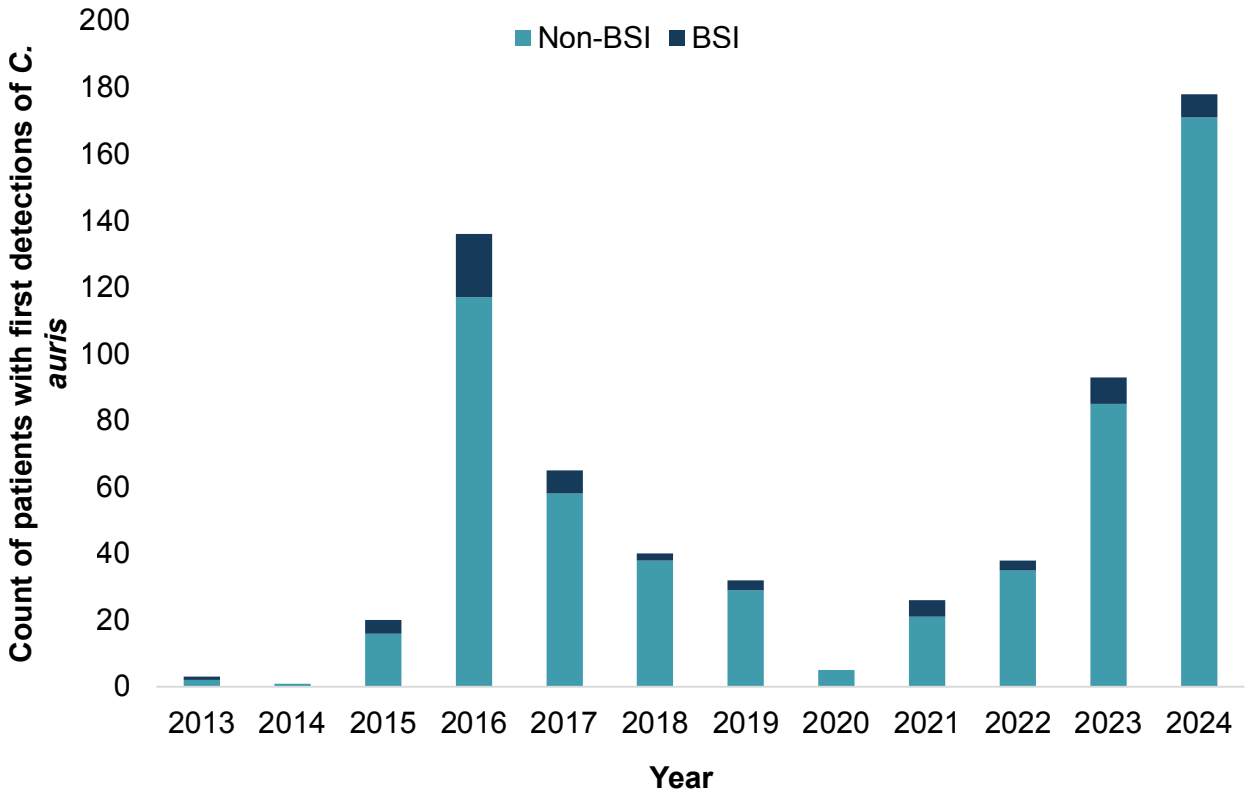
Following a 2015 to 2016 spike in numbers largely related to three outbreaks at the Royal Brompton, Oxford University and Kings College hospitals,[39,40] *C. auris* has resurged in England following the COVID-19 pandemic (Figure 8). Protracted outbreaks at two large English teaching hospitals in London and the Southeast (as well as cases in London private hospitals with high proportions of expatriate patients) led to spillovers to surrounding hospitals, prompting UKHSA to declare a national incident in December 2024 and make *C. auris* a notifiable organism from April 2025. This is the first notifiable fungal infection in UK history.

Akin to methicillin resistant staphylococcus aureus (MRSA), *C. auris* is an often highly drug-resistant organism that is also a persistent coloniser of patient skin and environmental surfaces and is readily transmissible from person to person.[41] It is, however, very difficult to eradicate from the hospital environment, and high-risk patients are not routinely screened for the organism in most centres in the UK.[42,43,44] Efforts to control *C. auris* will require expansion of surveillance to all high-risk patients (rather than just inter-hospital transfers and those coming from hospitals abroad).

Whilst the majority of detected *C. auris* reflects colonisation rather than infection, the organism can cause bloodstream infections in 5 to 10% of patients and up to 25% of patients on the ICU. In the recent surge in UK cases, 14% of reported isolates have been associated with invasive disease.[45] Given that *C. auris* is almost always resistant to fluconazole (the only oral option), this means more patients requiring intravenous therapy with echinocandins or amphotericin B which impacts on length of inpatient stay. Reported mortality rates for *C. auris* infection range from 29 to 62%, with longer length of stay in hospitals compared to candidaemia caused by other *Candida* spp.[46]

Outbreaks are occurring in the context of an ageing NHS hospital estate and wards with outdated equipment that is challenging to clean. These have necessitated ward and ICU closures (at Royal Brompton, Guy's and St Thomas', Southampton) and complete refurbishments. At one hospital in North London, a small outbreak (2 babies) in the neonatal unit has cost approximately £100,000 to date, most of which has been for ongoing surveillance. The King's College Hospital outbreak was estimated to cost £1 million,[47] a large part of which was for surveillance and decontamination. Current guidance recommends isolating or cohorting positive cases for any hospital admission or readmission, posing challenges to patient flow, availability of side rooms and patient safety (access to nursing, observation and procedures).

Figure 8: Number of patients with first detections of *C. auris* in England, January 2013 to December 2024 by isolate site: bloodstream infections (BSI) and non-BSI[48]



Source: Image by UKHSA, Candidozyma auris (formerly Candida auris): guidance for acute healthcare settings is licensed under Open Government Licence v3.0.

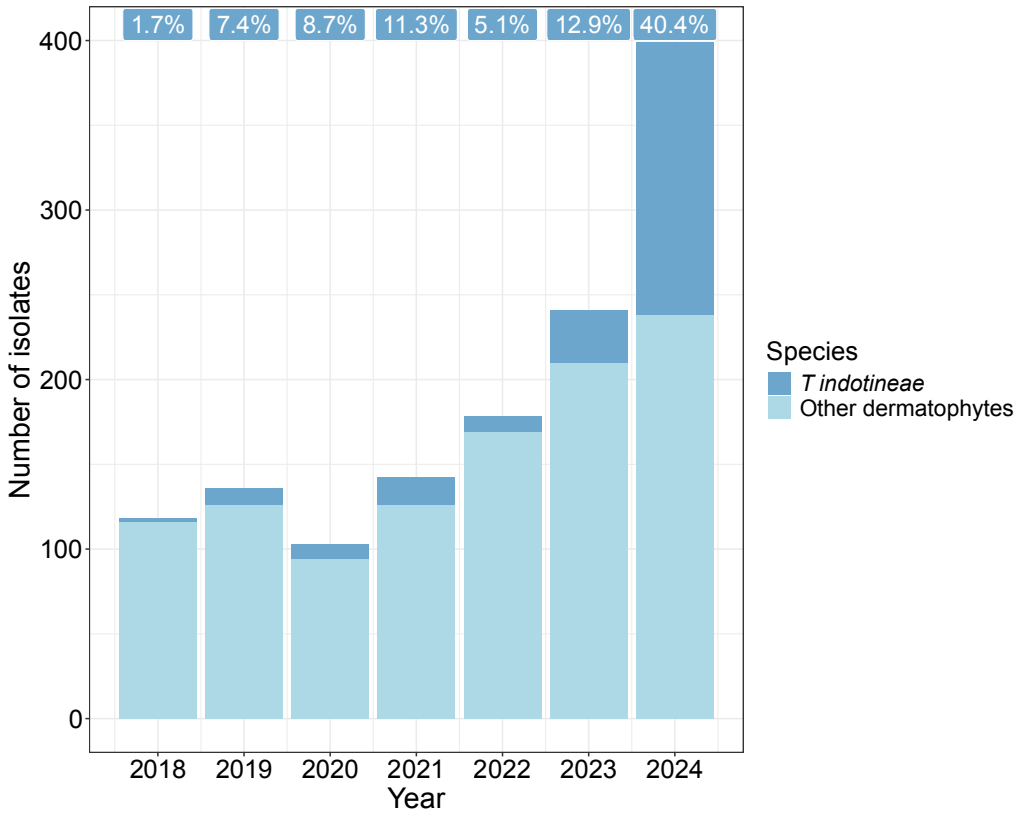
Resistance in dermatophytes

Outside of hospitals, dermatophytosis (also known as "ringworm") is the most common superficial fungal infection globally. Until recently, most cases of dermatophyte infection were spread by the shedding of skin squames and hairs by infected humans or animals and acquisition from the environment. Athletes foot, often acquired from sharing changing facilities with infected persons, is the most widespread. However, direct person-to-person, or animal-to-person, transmission also occurs and recently there has been a marked increase in the spread of two novel human pathogens previously most often associated with rodents, via close skin (including sexual) contact. Importantly, these species are often resistant to terbinafine, which is the first-line treatment for most dermatophyte infections of skin and nails in the UK. Itraconazole is the second-line option which requires significant monitoring.[49]

Known as *Trichophyton indotineae* (formerly *Trichophyton mentagrophytes* genotype VIII, first described causing human epidemics in India), UK incidence has gone from zero cases in 2017 to nearly 40% of dermatophyte samples characterised by the MRL (Figure 9).[50] To date, the majority of UK cases are in patients with family links or recent travel to South Asia. In the UK, the first report of a second and related skin infecting fungus (*T. mentagrophytes* genotype VII) was recorded in 2025. Although the origin of this second dermatophyte currently appears mainly in men-who-have-sex-with-men (MSM), little is known about the transmissibility and infectivity of these novel epidemic fungi, and it is likely that their transmission will increasingly

involve wider patient groups. These 2 species cause widespread and rapidly progressive erythematous lesions spreading from the groin over large areas of the body. It is likely that the selective pressure imposed by unrestricted access to over-the-counter use of terbinafine in India and other countries has led to the emergence of resistance, with implications for the management of these infections in the UK, including advice given to patients, their families and settings such as hospitality, hotels and sports facilities.

Figure 9: Trends in the number of dermatophyte isolates sent to MRL in 2018 to 2024



Source: Updated and redrawn from Abdolraouli, Barton and Borman (2025).[51]

Drivers of antifungal resistance

There is no consensus yet on the drivers of emerging drug-resistant fungal strains, but it is almost certain that widespread agricultural use of azole fungicides in crop protection is partly attributable.[52] Antibiofouling agents, wood preservatives, paints, veterinary use of antifungals and indiscriminate use of antifungals clinically and in other industries are also drivers of resistance.[53,54] A current example of concern is the simultaneous introduction of 2 new classes of antifungal compounds being trialled concurrently in both medical and agricultural settings.[55] Olorofim and ipflufenoquin are both orotomides which target fungal mitochondria. Olorofim is now recruiting for phase 3 clinical trials as a new generation oral antifungal and ipflufenoquin is being used as a new agricultural fungicide. Cross resistance to these related compounds has already been demonstrated experimentally.[56] A second class of inhibitor are the cell wall acting Gwt1 inhibitors, of which fosmanogepix is a broad-spectrum antifungal in phase 2 clinical trials, and a similar compound aminopyrifen is being used as a new fungicide against various plant pathogens.[57]

Transmission networks for the spread of drug-resistant strains are also diverse and include bioaerosols, natural fresh and sea waters, wastewaters, and animal, birds and other vectors. Thus, fungal antimicrobial resistance (AMR) may have multiple origins that relate to the activities of a range of commercial sectors concerned with crop security, and other critical global businesses and socio-economic drivers outside of the health care setting.

The rising tide of antifungal resistance is the most pressing threat in fungal infection as typified by the emergence of *C. auris*. Strategies to prevent, diagnose and treat fungal infections, including those caused by highly drug-resistant species, as well as stewardship of existing and novel antifungals, are essential.

The future of diagnostics and treatments for fungal infection

Novel diagnostics for fungal infections

Fungal infections can be difficult to diagnose. Many of the currently available tests are either slow or insensitive (or both). This results in significant use of empirical therapy (treating a patient with an antifungal when fungal infection is suspected rather than proven). This leads to overuse of antifungals, which has implications for cost, toxicity to the patient and driving antifungal resistance.[58] To address this, antifungal stewardship programmes were introduced at some centres; in particular, London hospitals with high numbers of at-risk patients and appropriate physician and pharmacist expertise, with significant cost-savings demonstrated without compromising patient outcomes.[59] A survey in 2017 reported that just 5 out of 46 (11%) trusts had a dedicated antifungal stewardship programme,[60] with lack of staff resources and access to timely diagnostics cited as the main barriers.[61] In 2019, NHS trusts were financially incentivised to implement antifungal stewardship via the NHS England Commissioning for Quality and Innovation (CQUIN) scheme which aimed to standardise the use of antifungals, perform a diagnostic gap analysis and optimise use of cheaper generic products wherever clinically appropriate.[62] This was disrupted by, and has not been renewed since, the pandemic.

Improving diagnostics is key to more accurate and timely diagnosis of fungal disease. Fungal antigens in blood, respiratory samples or other bodily fluids can be markers for infection. Commonly used biomarkers include the ß-D-glucan test and galactomannan antigen test; however, these suffer from poor diagnostic accuracy, leading to frequent false positive and false negative results.[63] Moreover, many laboratories in England do not have on-site access to these tests.[64]

Currently available diagnostics for fungal infection

Rapid antigen tests

Point-of-care (POC) tests have the advantage of providing rapid results as well as being performed at or near the bedside with minimal laboratory infrastructure and operator expertise required. The cryptococcal antigen lateral flow assay (LFA) has proved highly successful at

diagnosing cryptococcosis and now several other rapid antigen tests are becoming available to diagnose fungal infection. These include an LFA for aspergillosis,[65] histoplasmosis[66] and coccidioidomycosis (Valley Fever).[67] A *Mucorales* antigen test is in pre-clinical development.[68]

Nucleic acid diagnostics

Molecular tests rely on detection of fungal DNA in samples, rather than culture. This can detect smaller amounts of fungi in a clinical sample and make diagnosis faster.

Polymerase chain reaction (PCR) based testing is now commonplace in infection diagnostics and the repertoire of fungal specific PCRs is increasing. These include *Aspergillus*, *Pneumocystis*, *Candida* and *Mucorales* PCR, as well as PCR tests designed to pick up any fungus in a specimen.[69]

Metagenomics

This is a highly sensitive technique whereby all genetic material in a sample is sequenced, including human DNA. A bioinformatic pipeline is then used to detect any microbial DNA, including that of fungi. Early use of this technique has shown promise in diagnosing fungal infection where conventional diagnostics have failed.[70]

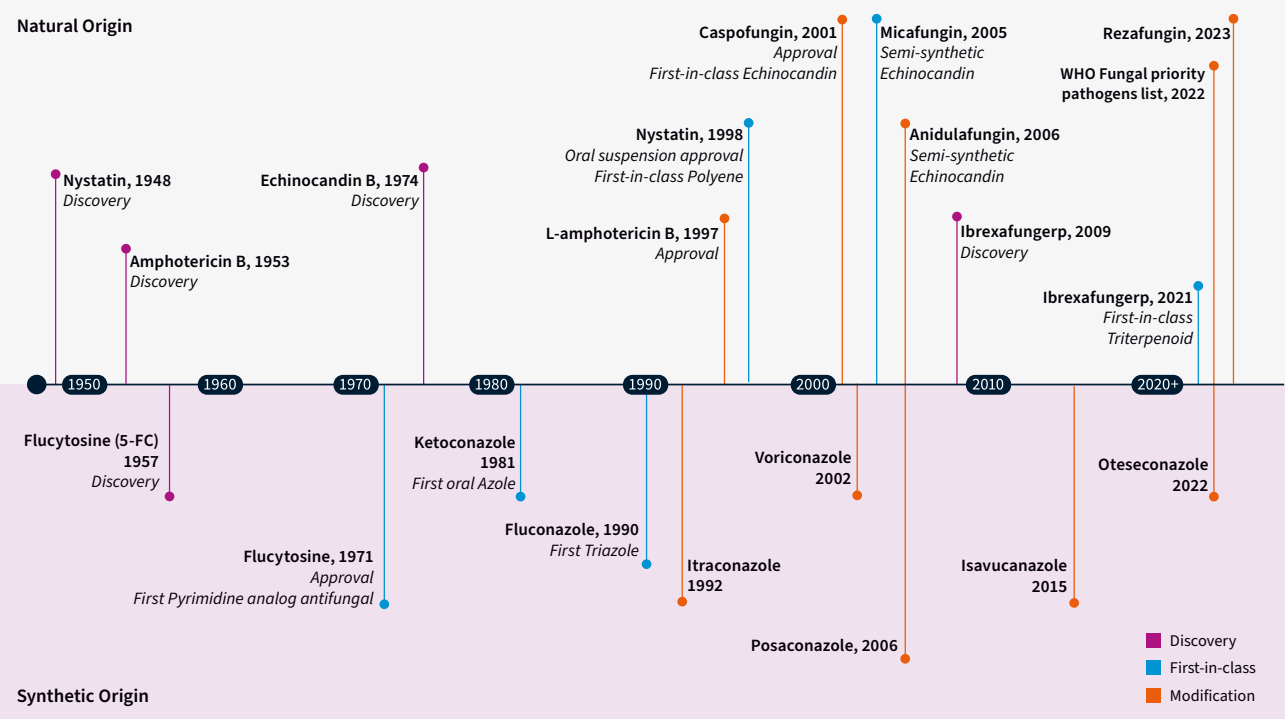
Artificial Intelligence (AI)

Although the use of AI is in its infancy in fungal diagnostics, exploratory studies have assessed its use in interpreting CT scans of patients with possible fungal infection[71] as well as identifying fungi in histopathological specimens.[72]

New treatments for fungal infection

Treatment options for invasive fungal disease are limited, with three classes of antifungal drug predominantly used (amphotericin B, echinocandins and azoles). The antifungal pipeline has been historically slow, with few new antifungals becoming available for clinical use over several decades.[73] Significant toxicities and rising antifungal resistance make the development of novel antifungal drugs an urgent priority. Fortunately, several novel antifungal drugs are now in late-stage clinical trials and show promise (Figure 10). These are summarised in Table 2. The once-weekly dosed echinocandin rezafungin, licensed in the UK since January 2024, has facilitated outpatient therapy of candidiasis.[74]

Figure 10: Timeline of antifungal drug development

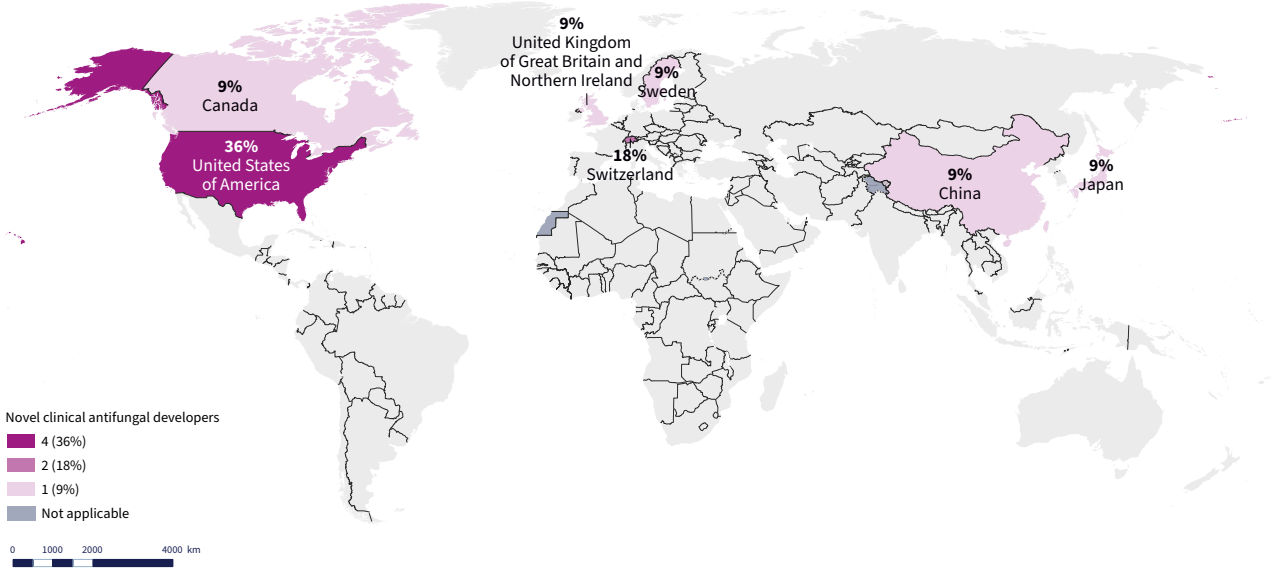


Note: The above timeline does not include antifungal agents approved for topical use, or any agent found on a discontinued drug product list.

Source: Image by World Health Organisation, Antifungal agents in clinical and preclinical development: overview and analysis and is licensed under CC BY 4.0.

Most clinical trials for novel antifungals take place in the United States. UK participation is currently relatively low, although several mycology centres have the capacity and patient cohorts to recruit patients (Figure 11).

Figure 11: Geographical distribution of the developers involved in clinical trials for antifungal agents against WHO fungal priority pathogens



Source: Image from World Health Organisation, Antifungal agents in clinical and preclinical development: overview and analysis and is licensed under CC BY 4.0.

Table 2: Novel antifungal drugs in late-stage clinical trials

Novel Antifungal	Rezafungin	Ibrexafungerp	Olorofim	Opelconazole	Fosmanogepix
Target in fungal cell / mechanism	Cell wall	Cell wall	Dihydroorotate	Cell membrane	GWT1 protein inhibitor
Novel mechanism of activity	No	No	Yes	No	Yes
New mode of delivery	Once weekly	Oral	Oral and IV	Inhaled	Oral and IV
Potential uses	Candidiasis	Candidiasis	Aspergillosis, Rarer moulds	Aspergillosis	Candidiasis, Cryptococcus, aspergillosis, mucormycosis
Clinical Trial Phase	III	III	III	III	III
Licensed in UK at time of writing	Yes	No	No	No	No

Source: Data from World Health Organisation, Antifungal agents in clinical and preclinical development: overview and analysis and is licensed under CC BY 4.0.

Capacity in medical mycology, education, training and research

The lack of capacity to manage fungal infections in the healthcare and research community can be explained by the steep rise in the incidence of fungal infections over the last 40 years and a lag in training an adequate number of clinical and applied and basic medical mycology research specialists to address current demands. The numbers of microbiologists being trained in virology, bacteriology and parasitology remains much higher than those undertaking research and clinical mycology training. In the UK, the Medical Research Council (MRC), National Institute for Health and Care Research (NIHR), Wellcome Trust and other UK Research and Innovation (UKRI) councils now recognise the importance of medical mycology and encourage submissions via generic and sometimes targeted funding calls. Nevertheless, it will be some time before the needs for bespoke expertise in medical mycology are matched by adequate capacity in the sector.

Within the NHS, there is a single national reference laboratory in Bristol for advanced diagnostics and clinical advice, as well as regional centres of excellence such as the National Aspergillosis Centre in Manchester. The UK Clinical Mycology Network (UKCMN) is a network of diagnostic labs which promotes excellence in fungal diagnostics and quality control support. However, mycology is not a recognised medical subspeciality in the UK and there are few dedicated clinical mycologists, of which most are in London and the Southwest. Most clinical microbiology laboratories in the UK are unable to perform fungal susceptibility testing or antigen testing "in house", requiring transport of samples to the reference laboratory.[75]

Conclusion

The field of medical mycology has been neglected for many years by funding bodies, despite evidence of increasing national and worldwide prevalence of a range of both superficial and deep, invasive fungal infections. The last decade has seen the rapid, worldwide emergence of a number of completely novel fungal pathogens that are both highly transmissible and treatment resistant. Antifungal resistance in a number of established pathogenic fungi is clearly increasing, likely driven by numerous factors including climate change and agricultural use of fungicides for crop protection. Urgent support is required to develop novel fungal diagnostics, support the antifungal pipeline and help train the next generation of medical mycologists.

References

1 Denning DW. Global incidence and mortality of severe fungal disease. The Lancet Infectious diseases. 2024;24(7). doi: 10.1016/S1473-3099(23)00692-8

2 Denning DW. Global incidence and mortality of severe fungal disease. The Lancet Infectious diseases. 2024;24(7). doi: 10.1016/S1473-3099(23)00692-8

3 Huang J, Hu P, Ye L et al. Pan-drug resistance and hypervirulence in a human fungal pathogen are enabled by mutagenesis induced by mammalian body temperature. Nat Microbiol. 2024;9(7):1686-99. doi: 10.1038/s41564-024-01720-y.

4 Sedik S, Egger M, Hoenigl M. Climate Change and Medical Mycology. Infect Dis Clin North Am. 2025;39(1):1-22. doi: 10.1016/j.idc.2024.11.002.

5 Seidel D, Wurster S, Jenks JD et al. Impact of climate change and natural disasters on fungal infections. Lancet Microbe. 2024;5(6):e594-e605. doi: 10.1016/S2666-5247(24)00039-9.

6 Casadevall A, Kontoyiannis DP, Robert V. On the Emergence of Candida auris: Climate Change, Azoles, Swamps, and Birds. mBio. 2019;10(4). doi: 10.1128/mBio.01397-19.

7 Suphavilai C, Ko KKK, Lim KM et al. Detection and characterisation of a sixth Candida auris clade in Singapore: a genomic and phenotypic study. Lancet Microbe. 2024;5(9):100878. doi: 10.1016/S2666-5247(24)00101-0.

8 Rethink Priorities. Fungal diseases: Health burden, neglectedness, and potential interventions. [Internet] 2024. Available from: https://rethinkpriorities.org/research-area/fungal-diseases/

9 Denning DW. Global incidence and mortality of severe fungal disease. The Lancet Infectious diseases. 2024;24(7). doi: 10.1016/S1473-3099(23)00692-8

10 Elhaj Mahmoud D, Hérivaux A, Morio F et al. The epidemiology of invasive fungal infections in transplant recipients. Biomed J.2024;47(3):100719. doi: 10.1016/j.bj.2024.100719

11 Passweg JR, Baldomero H, Atlija M et al. The 2023 EBMT report on hematopoietic cell transplantation and cellular therapies. Increased use of allogeneic HCT for myeloid malignancies and of CAR-T at the expense of autologous HCT. Bone Marrow Transplant. 2025;60(4):519-528. doi: 10.1038/s41409-025-02524-2.

12 Keighley Cea. Risk factors for candidaemia: A prospective multi-centre case-control study. Mycoses. 2021;64(3). doi: 10.1111/myc.13211.

13 Head M. The allocation of US $105 billion in global funding from G20 countries for infectious disease research between 2000 and 2017: a content analysis of investments. The Lancet Global Health. 2020;8(10). doi: 10.1016/S2214-109X(20)30357-0.

14 Impact Global Health. G-FINDER data portal: tracking funding for global health R&D [Internet]. Available from: https://gfinderdata.impactglobalhealth.org/

15 Egger M, Bussini L, Hoenigl M and Bartoletti M. Prevalence of COVID-19-Associated Pulmonary Aspergillosis: Critical Review and Conclusions. Journal of Fungi. 2025;8(4):390. doi: 10.3390/jof8040390

16 Brown L-AK, Ellis J, Gorton R, De S, Stone N. Surveillance for COVID-19-associated pulmonary aspergillosis. The Lancet Microbe. 2020;1(4):e152. doi: 10.1016/S2666-5247(20)30091-4

17 P Lewis W, Dhillon R, Cordey A et al. A national strategy to diagnose COVID-19 associated invasive fungal disease in the ICU. Clin Infect Dis. 2020;ciaa1298. doi: 10.1093/cid/ciaa1298

18 Hurt W, Youngs J, Ball J et al. COVID-19-associated pulmonary aspergillosis in mechanically ventilated patients: a prospective, multicentre UK study. Thorax. 2023;79(1):75-82. doi: 10.1136/thorax-2023-220002.

19 Egger M, Bussini L, Hoenigl M and Bartoletti M. Prevalence of COVID-19-Associated Pulmonary Aspergillosis: Critical Review and Conclusions. Journal of Fungi. 2025;8(4):390. doi: 10.3390/jof8040390

20 Sen M, Honavar S, Bansal R et al. Epidemiology, clinical profile, management, and outcome of COVID-19-associated rhino-orbital-cerebral mucormycosis in 2826 patients in India – Collaborative OPAI-IJO Study on Mucormycosis in COVID-19 (COSMIC), Report 1. Indian J Ophthalmol. 2021;69(7). doi: 10.4103/ijo.IJO_1565_21.

21 Lea O, Topcu U, Manay M et al. COVID-19–associated mucormycosis: a systematic review and meta-analysis of 958 cases. Clin Microbiol Infect. 2023;29(6):722 doi: 10.1016/j.cmi.2023.03.008.

22 Feys, S., Almyroudi, M. P., Braspenning, R et al. A Visual and Comprehensive Review on COVID-19-Associated Pulmonary Aspergillosis (CAPA). J Fungi (Basel). 2021;7(12):1067 doi: 10.3390/jof7121067.

23 Pegorie M, Denning D, Welfare W. Estimating the burden of invasive and serious fungal disease in the United Kingdom. J Infect. 2017;74(1):60-71. doi: 10.1016/j.jinf.2016.10.005

24 Borman A, Szekely A, Palmer M et al. The burden of serious fungal disease in the UK – infections with "rare" organisms. J Infect. 2018;77(6):561-71. doi: 10.1016/j.jinf.2018.10.010.

25 Pegorie M, Denning D, Welfare W. Estimating the burden of invasive and serious fungal disease in the United Kingdom. J Infect. 2017;74(1):60-71. doi: 10.1016/j.jinf.2016.10.005

26 UK Health Security Agency. Laboratory surveillance of fungaemia due to yeasts in England: 2023. [Internet]. 2023. [Accessed 14 August 2025]. Available from: https://assets.publishing.service.gov.uk/media/6735aa6b2469c5b71dbc7ac9/hpr1024-fungaemia-2023.pdf

27 UK Health Security Agency. Laboratory surveillance of fungaemia due to yeasts in England: 2023. [Internet]. 2023. [Accessed 14 August 2025]. Available from: https://assets.publishing.service.gov.uk/media/6735aa6b2469c5b71dbc7ac9/hpr1024-fungaemia-2023.pdf

28 UK Health Security Agency. Laboratory surveillance of fungaemia due to yeasts in England: 2023. [Internet]. 2023. [Accessed 14 August 2025]. Available from: https://assets.publishing.service.gov.uk/media/6735aa6b2469c5b71dbc7ac9/hpr1024-fungaemia-2023.pdf

29 World Health Organisation. WHO fungal priority pathogens list to guide research, development and public health action. [Internet] 2022. Available from: https://www.who.int/publications/i/item/9789240060241

30 Verweij PE, Lucas JA, Arendrup MC et al. The one health problem of azole resistance in Aspergillus fumigatus: current insights and future research agenda. Fungal Biology Reviews. 2020;34(4):202-14. doi: 10.1016/j.fbr.2020.10.003

31 Public Health England. English Surveillance Programme for Antimicrobial Utilisation and Resistance (ESPAUR). [Internet]. 2018. [Accessed 14 August 2025]. Available from: https://webarchive.nationalarchives.gov.uk/ukgwa/20181130125613/https:/www.gov.uk/government/publications/english-surveillance-programme-antimicrobial-utilisation-and-resistance-espaur-report

32 Abdolrasouli A, Petrou MA, Park H et al. Surveillance for Azole-Resistant Aspergillus fumigatus in a Centralized Diagnostic Mycology Service, London, United Kingdom, 1998–2017. Front Microbiol. 2018;9:2234 doi: 10.3389/fmicb.2018.02234

33 Lockhart SR, Etienne KA, Vallabhaneni S et al. Simultaneous Emergence of Multidrug-Resistant Candida auris on 3 Continents Confirmed by Whole-Genome Sequencing and Epidemiological Analyses. Clin Infect Dis. 2017;64(2):134-40. doi: 10.1093/cid/ciw691.

34 Kim HY, Nguyen TA, Kidd S et al. Candida auris-a systematic review to inform the world health organization fungal priority pathogens list. Med Mycol. 2024;62(6). doi: 10.1093/mmy/myae042.

35 Daneshnia F, de Almeida Júnior JN, Ilkit M et al. Worldwide emergence of fluconazole-resistant Candida parapsilosis: current framework and future research roadmap. Lancet Microbe. 2023;4(6):e470-e80. doi: 10.1016/S2666-5247(23)00067-8.

36 UK Health Security Agency. Candidozyma auris: guidance for acute healthcare settings. [Internet]. 2016. [Accessed 14 August 2025]. Available from: https://www.gov.uk/government/publications/candida-auris-laboratory-investigation-management-and-infection-prevention-and-control

37 van Schalkwyk E, Mpembe RS, Thomas J et al. Epidemiologic Shift in Candidemia Driven by Candida auris, South Africa, 2016-2017. Emerg Infect Dis. 2019;25(9):1698-707. doi: 10.3201/eid2509.190040.

38 Jacobs SE, Jacobs JL, Dennis EK et al. Candida auris Pan-Drug-Resistant to Four Classes of Antifungal Agents. Antimicrob Agents Chemother. 2022;66(7):e0005322. doi: 10.1128/aac.00053-22

39 Eyre DW, Sheppard AE, Madder H et al. A Candida auris Outbreak and Its Control in an Intensive Care Setting. N Engl J Med. 2018;379(14):1322-31. doi: 10.1056/NEJMoa1714373.

40 Taori SK, Khonyongwa K, Hayden I et al. Candida auris outbreak: Mortality, interventions and cost of sustaining control. J Infect. 2019;79(6):601-11. doi: 10.1016/j.jinf.2019.09.007

41 Proctor DM, Dangana T, Sexton DJ et al. Integrated genomic, epidemiologic investigation of Candida auris skin colonization in a skilled nursing facility. Nat Med. 2021;27(8):1401-9. doi: 10.1038/s41591-021-01383-w.

42 UK Health Security Agency. Laboratory surveillance of fungaemia due to yeasts in England: 2023. [Internet]. 2023. [Accessed 14 August 2025]. Available from: https://assets.publishing.service.gov.uk/media/6735aa6b2469c5b71dbc7ac9/hpr1024-fungaemia-2023.pdf

43 Sansom SE, Gussin GM, Schoeny M et al. Rapid Environmental Contamination With Candida auris and Multidrug-Resistant Bacterial Pathogens Near Colonized Patients. Clin Infect Dis. 2024;78(5):1276-84. doi: 10.1093/cid/ciad752.

44 Jones CR, Neill C, Borman AM et al. The laboratory investigation, management, and infection prevention and control of Candida auris: a narrative review to inform the 2024 national guidance update in England. J Med Microbiol. 2024;73(5). doi: 10.1099/jmm.0.001820

45 UK Health Security Agency. Candidozyma auris: guidance for acute healthcare settings. [Internet]. 2016. [Accessed 14 August 2025]. Available from: https://www.gov.uk/government/publications/candida-auris-laboratory-investigation-management-and-infection-prevention-and-control

46 Cortegiani A, Misseri G, Fasciana T, Giammanco A, Giarratano A, Chowdhary A. Epidemiology, clinical characteristics, resistance, and treatment of infections by Candida auris. J Intensive Care. 2018;6:1-13. doi: 10.1186/s40560-018-0342-4

47 Taori SK, Khonyongwa K, Hayden I et al. Candida auris outbreak: Mortality, interventions and cost of sustaining control. J Infect. 2019;79(6):601-11. doi: 10.1016/j.jinf.2019.09.007

48 UK Health Security Agency. Candidozyma auris: guidance for acute healthcare settings. [Internet]. 2016. [Accessed 14 August 2025]. Available from: https://www.gov.uk/government/publications/candida-auris-laboratory-investigation-management-and-infection-prevention-and-control

49 Abdolrasouli A, Barton RC, Borman AM. Spread of Antifungal-Resistant Trichophyton indotineae, United Kingdom, 2017-2024. Emerg Infect Dis. 2025;31(1):192-4. doi: 10.3201/eid3101.240923.

50 Abdolrasouli A, Barton RC, Borman AM. Spread of Antifungal-Resistant Trichophyton indotineae, United Kingdom, 2017-2024. Emerg Infect Dis. 2025;31(1):192-4. doi: 10.3201/eid3101.240923.

51 Abdolrasouli A, Barton RC, Borman AM. Spread of Antifungal-Resistant Trichophyton indotineae, United Kingdom, 2017-2024. Emerg Infect Dis. 2025;31(1):192-4. doi: 10.3201/eid3101.240923.

52 Verweij PE, Arendrup MC, Alastruey-Izquierdo A et al. Dual use of antifungals in medicine and agriculture: How do we help prevent resistance developing in human pathogens? Drug Resist Updat. 2022;65:100885. doi: 10.1016/j.drup.2022.100885

53 Fisher MC, Burnett F, Chandler C et al. A one health roadmap towards understanding and mitigating emerging Fungal Antimicrobial Resistance: fAMR. NPJ Antimicrob Resist. 2024;2(1):36. doi: 10.1038/s44259-024-00055-2.

54 Jørgensen LN, Heick TM. Azole Use in Agriculture, Horticulture, and Wood Preservation – Is It Indispensable? Front Cell Infect Microbiol. 2021;11:730297. doi: 10.3389/fcimb.2021.730297.

55 Fisher MC, Burnett F, Chandler C et al. A one health roadmap towards understanding and mitigating emerging Fungal Antimicrobial Resistance: fAMR. NPJ Antimicrob Resist. 2024;2(1):36. doi: 10.1038/s44259-024-00055-2

56 van Rhijn N, Storer ISR, Birch M, Oliver JD, Bottery MJ, Bromley MJ. Aspergillus fumigatus strains that evolve resistance to the agrochemical fungicide ipflufenoquin in vitro are also resistant to olorofim. Nat Microbiol. 2024;9(1):29-34. doi: 10.1038/s41564-023-01542-4.

57 Hatamoto M, Aizawa R, Koda K, Fukuchi T. Aminopyrifen, a novel 2-aminonicotinate fungicide with a unique effect and broad-spectrum activity against plant pathogenic fungi. J Pestic Sci. 2021;46(2):198-205. doi: 10.1584/jpestics.D20-094.

58 Houston H, Dutey-Magni P, Steel M et al. Patterns and drivers of antifungal prescribing in acute leukaemia: a retrospective cohort study. Open Forum Infect Dis. 2024;11(6):ofae094 doi: 10.1093/ofid/ofae094

59 Whitney L, Al-Ghusein H, Glass S et al. Effectiveness of an antifungal stewardship programme at a London teaching hospital 2010-16. J Antimicrob Chemother. 2019;74(1):234-41. doi: 10.1093/jac/dky389.

60 Micallef C, Ashiru-Oredope D, Hansraj S et al. An investigation of antifungal stewardship programmes in England. J Med Microbiol. 2017;66(11):1581-9. doi: 10.1099/jmm.0.000612

61 Schelenz S, Agrawal S, Brady A et al. Antifungal stewardship in the UK: where are we now? JAC Antimicrob Resist. 2025;7(1):dlae209. doi: 10.1093/jacamr/dlae209.

62 NHS England. Antifungal Stewardship Implementation Pack. [Internet]. 2019. [Accessed 14 August 2025]. Available from: https://www.england.nhs.uk/wp-content/uploads/2019/03/PSS1-meds-optimisation-trigger-5-antifungal-stewardship-implementation-pack-v7.pdf

63 Karageorgopoulos DE, Vouloumanou EK, Ntziora F et al. ß-D-Glucan Assay for the Diagnosis of Invasive Fungal Infections: A Meta-analysis. Clin Infect Dis. 2025;52(6):750-70. doi: 10.1093/cid/ciq206.

64 Schelenz S, Owens K, Guy R et al. National mycology laboratory diagnostic capacity for invasive fungal diseases in 2017: Evidence of sub-optimal practice. J Infect. 2019;79(2):167-73. doi: 10.1016/j.jinf.2019.06.009.

65 Kwizera R, Bongomin F, Olum R et al. Evaluation of an Aspergillus IgG/IgM lateral flow assay for serodiagnosis of fungal asthma in Uganda. PLoS One. 2021;16(5):e0252553. doi: 10.1371/journal.pone.0252553

66 Cáceres DH, Gómez BL, Tobón AM, Chiller TM, Lindsley MD. Evaluation of a Histoplasma antigen lateral flow assay for the rapid diagnosis of progressive disseminated histoplasmosis in Colombian patients with AIDS. Mycoses. 2020;63(2):139-44. doi: 10.1111/myc.13023

67 Donovan FM, Ramadan FA, Khan SA et al. Comparison of a Novel Rapid Lateral Flow Assay to Enzyme Immunoassay Results for Early Diagnosis of Coccidioidomycosis. Clin Infect Dis. 2021;73(9):e2746-e53. doi: 10.1093/cid/ciaa1205.

68 Davies GE, Thornton CR. Development of a Monoclonal Antibody and a Serodiagnostic Lateral-Flow Device Specific to. J Fungi (Basel). 2022;8(7). doi: 10.3390/jof8070756.

69 Jenks JD, White PL, Kidd SE et al. An update on current and novel molecular diagnostics for the diagnosis of invasive fungal infections. Expert Rev Mol Diagn. 2023;23(12):1135-52. doi: 10.1080/14737159.2023.2267977

70 Babady NE, Chiu CY, Craney A et al. Diagnosis and management of invasive fungal diseases by next-generation sequencing: are we there yet? Expert Rev Mol Diagn. 2024:1-14. doi: 10.1080/14737159.2024.2436396.

71 Angelini E, Shah A. Using Artificial Intelligence in Fungal Lung Disease: CPA CT Imaging as an Example. Mycopathologia. 2021;186(5):733-7. doi: 10.1007/s11046-021-00546-0.

72 Rahman MA, Clinch M, Reynolds J et al. Classification of fungal genera from microscopic images using artificial intelligence. J Pathol Inform. 2023;14:100314. doi: 10.1016/j.jpi.2023.100314

73 Ostrosky-Zeichner L, Casadevall A, Galgiani JN, Odds FC, Rex JH. An insight into the antifungal pipeline: selected new molecules and beyond. Nat Rev Drug Discov. 2010;9(9):719-27. doi: 10.1038/nrd3074. Epub 2010 Aug 20

74 Davidson HC, Yau T, Dunstan I, Houston A, Basarab M, Bicanic T. Early use of the novel antifungal rezafungin: a case series and literature review. J Antimicrob Chemother. 2025;80(7):1885-1892. doi: 10.1093/jac/dkaf143.

75 Schelenz S, Owens K, Guy R et al. National mycology laboratory diagnostic capacity for invasive fungal diseases in 2017: Evidence of sub-optimal practice. J Infect. 2019;79(2):167-73. doi: 10.1016/j.jinf.2019.06.009

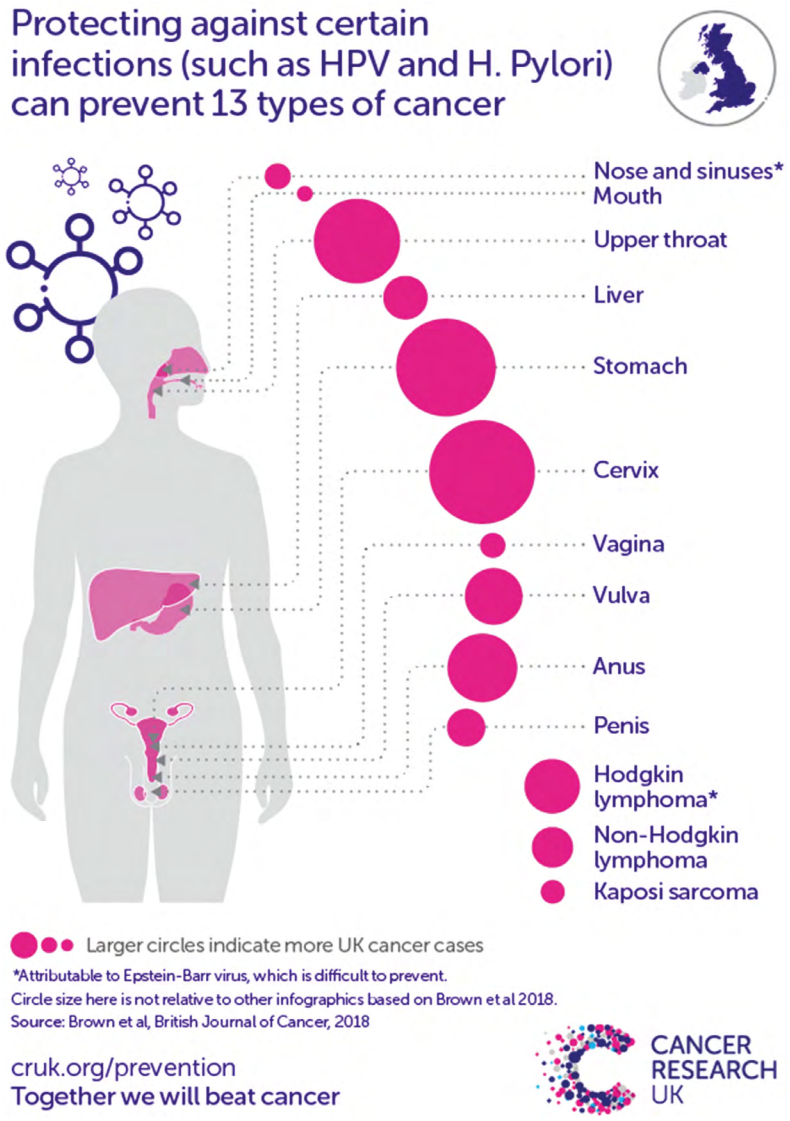
4.3 Cancer and infections

Emily Whamond – Head of Chief Medical Officer Office

Introduction

Certain cancers have well-established links to infections, including cervical (human papillomavirus – HPV), liver (Hepatitis B and C), stomach (*Helicobacter pylori*) and some lymphomas (Epstein-Barr virus – EBV; human immunodeficiency virus – HIV). Vaccination and early treatment of these infections can prevent development of related cancers — for instance, HPV and Hepatitis B vaccination programmes have led to dramatic reductions in cervical and liver cancer incidence. Figure 1 shows some of the important cancers caused by infections in the UK.

Figure 1: Cancers associated with infection[1]



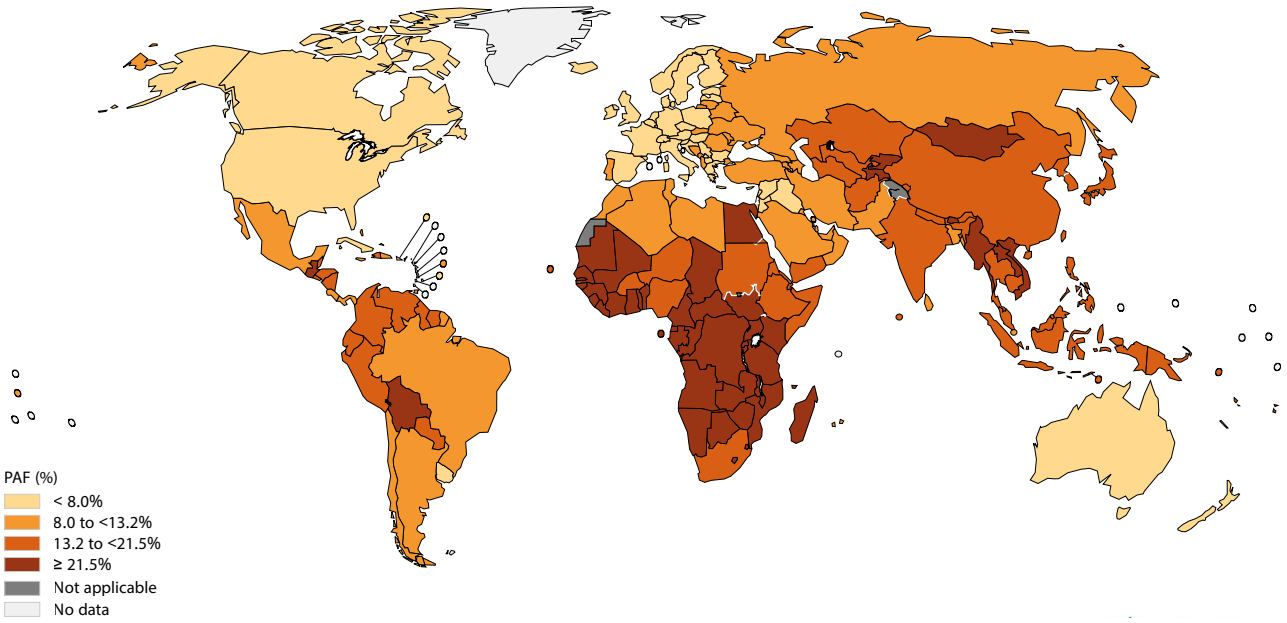
Source: Image by Cancer Research UK with original data from Brown et al. 2018.[2]

Whilst this chapter focuses on infection-associated cancers only, it is worth noting that cancer treatment is increasingly being transformed via immunotherapy. Therapies such as checkpoint inhibitors, antibody-based treatments and CAR-T cell therapy are offering new hope, particularly in previously untreatable cancers like advanced melanoma. Although challenges remain, especially in managing side effects, combining infection prevention and early treatment together with immune-based therapies will substantially improve cancer-related outcomes over coming years.

Burden of disease

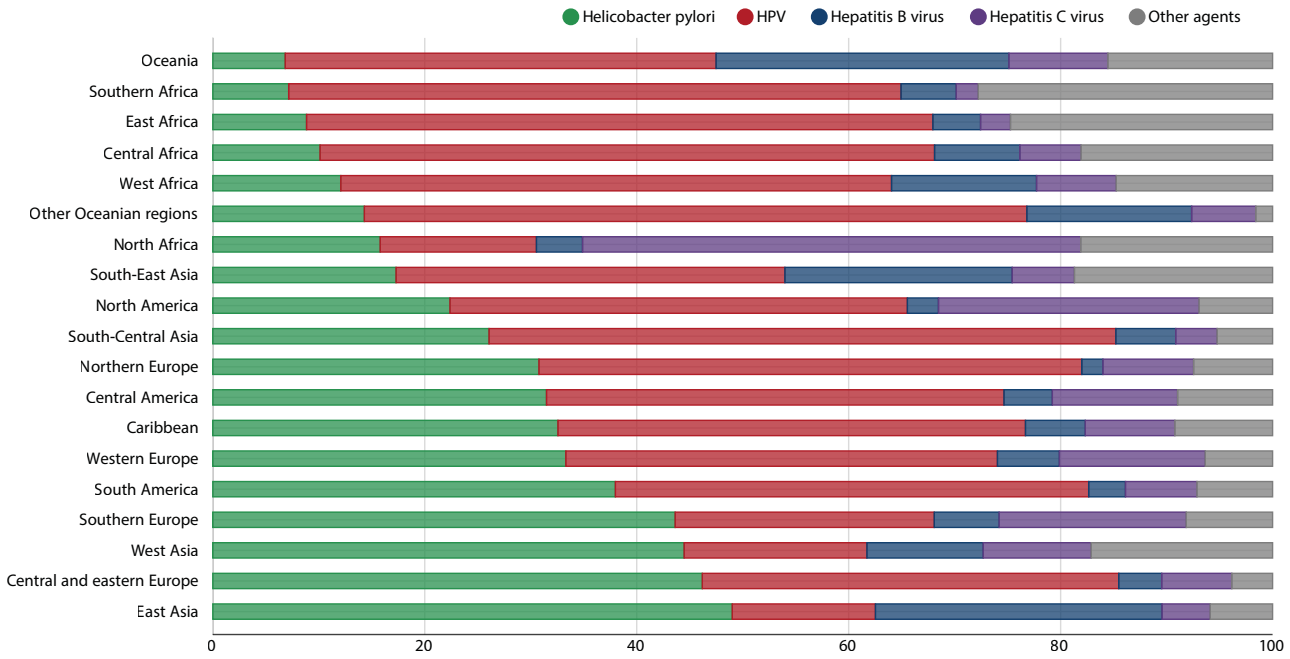
In the UK, approximately 4% of cancers are infection-related, compared with up to 30% in parts of Africa.[3] The proportion of cancers attributable to different infectious agents varies significantly between regions, with HPV and *H. pylori* accounting for the majority of infection-associated cancers around the world (Figure 2; Figure 3). In Western Europe, around 41% of infection-related cancers are due to HPV infection, 33% due to *H. pylori*, 14% to Hepatitis C, 6% to Hepatitis B and 6% to other agents such as HIV.[4] Notably, around 47% of infection-related cancers in North Africa are caused by Hepatitis C infection, which accounts for considerably lower proportions of cancer in all other regions (for example, 14% in Western Europe).[5]

Figure 2: Proportion (%) (worldwide) of all cancer cases among both sexes in 2020 attributable to infections (all infectious agents), by country[6]



Source: World Health Organisation, International Agency for Research on Cancer. Reproduced with permission from the World Health Organisation and International Agency for Research on Cancer.

Figure 3: Proportion of cancer cases among both sexes attributable to infections in 2020 (by region)[7]



Source: World Health Organisation, International Agency for Research on Cancer. Reproduced with permission from the World Health Organisation and International Agency for Research on Cancer.

Human papillomavirus (HPV)

HPV is passed through close skin-to-skin and mucous membrane contact, primarily during sexual activity. Whilst the majority of HPV infections will clear naturally within a few years, persistent infection is the most important causal factor for cervical cancer. HPV currently causes more than 99% of cervical cancer as well as a significant proportion of anal, vaginal, vulval, penile and some types of mouth and throat cancers.[8] The majority of HPV-associated cancers are linked to HPV types 16 and 18, which currently cause around 70% of all cervical cancer cases, although this will change with increased vaccination.[9]

Cervical cancer is the fourth most common cancer in women globally, with around 660,000 new cases and 350,000 deaths annually.[10] In the UK, there are around 3,300 new cases per year and, whilst survival has improved by over 70% since the 1970s, between 2021 to 2023 there were around 885 deaths annually on average, often at a young age.[11,12] Cervical cancer incidence is significantly higher in many low- and middle-income countries, reflecting the success of vaccination and screening programmes in high-income countries such as the UK.

In March 2025, NHS England published a plan to reduce cervical cancer incidence rate to below 4 per 100,000 women from the current incidence rate of 9 per 100,000, in line with the 2018 WHO global initiative.[13,14]

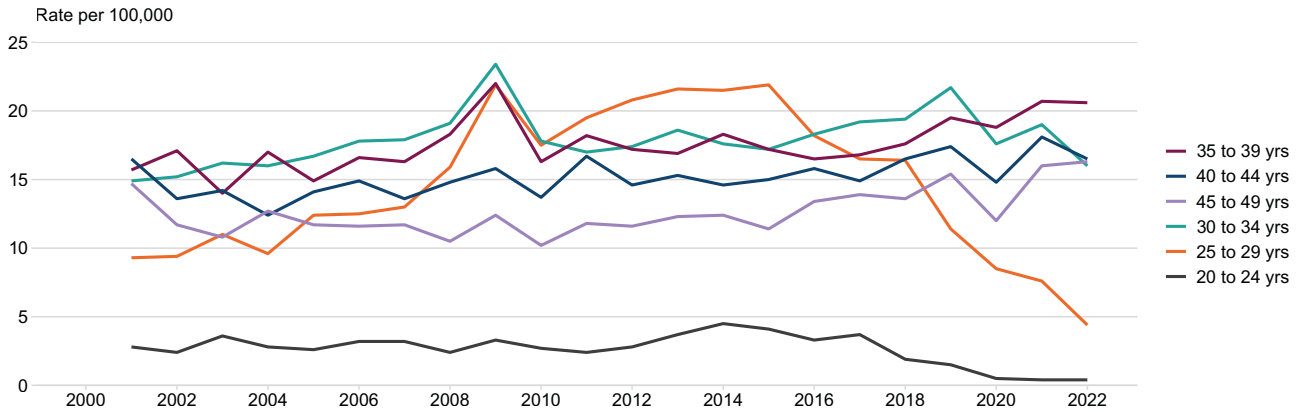
HPV vaccination programme

HPV vaccine effectiveness for preventing cervical cancer is very high, and highest when vaccination is administered before sexual debut. Data from England show that cervical cancer rates among those vaccinated at age 12 to 13 years are around 90% lower than for those unvaccinated.[15]

The HPV national vaccination programme in England was introduced in September 2008 for secondary school Year 8 girls (aged 12 to 13 years) and, in September 2019, the programme was extended to Year 8 boys. In July 2022, the vaccine type was changed to protect against 9 HPV types and, from September 2023, the programme was changed to a one dose only schedule for those eligible under the adolescent programme.[16]

The NHS HPV vaccination programme in England has significantly lowered HPV infections and rates of cervical cancer in vaccine-eligible young women (Figure 4), with the strongest effects seen in those vaccinated at younger ages. The programme is also reducing differences in incidence across socioeconomic groups.[17] HPV vaccination protects men and women against genital warts and other cancers of the genital areas and anus, as well as some mouth and throat (head and neck) cancers.

Figure 4: Trend in cervical cancer incidence by age group



Source: Chief Medical Officer report on Health trends and Variation 2025[18]

However, vaccine coverage for female students has declined from the high levels seen prior to the COVID-19 pandemic (Figure 5). This pattern is also seen in male students although the 2019 to 2020 academic year was the first year male students were eligible (Figure 6).

Figure 5: HPV vaccine coverage for female students by cohort and school year of vaccination between the 2014 to 2015 and the 2023 to 2024 academic years

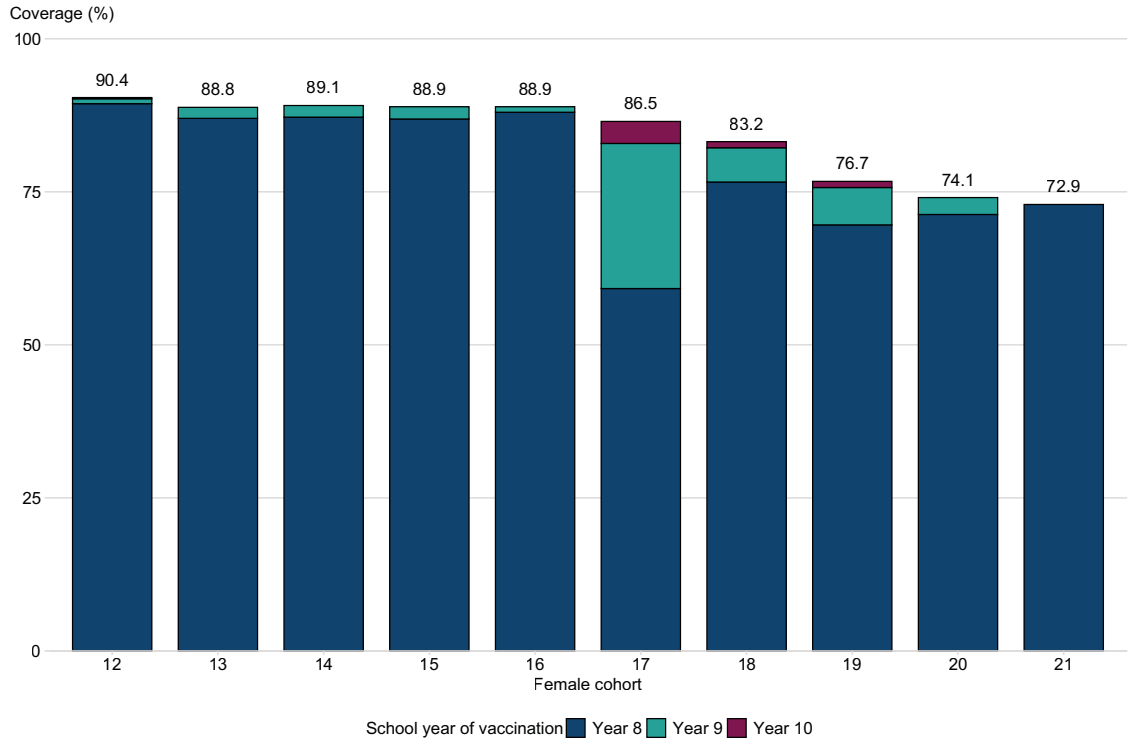
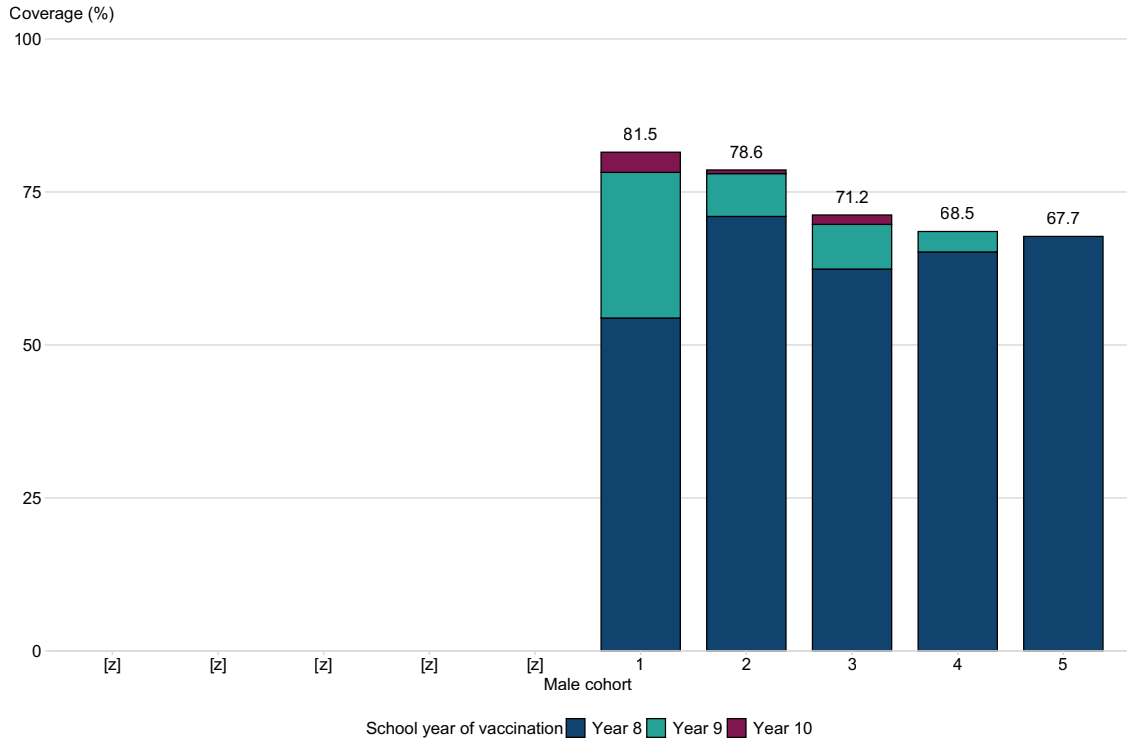


Figure 6: HPV vaccine coverage for male students by cohort and school year of vaccination between the 2014 to 2015 and the 2023 to 2024 academic years



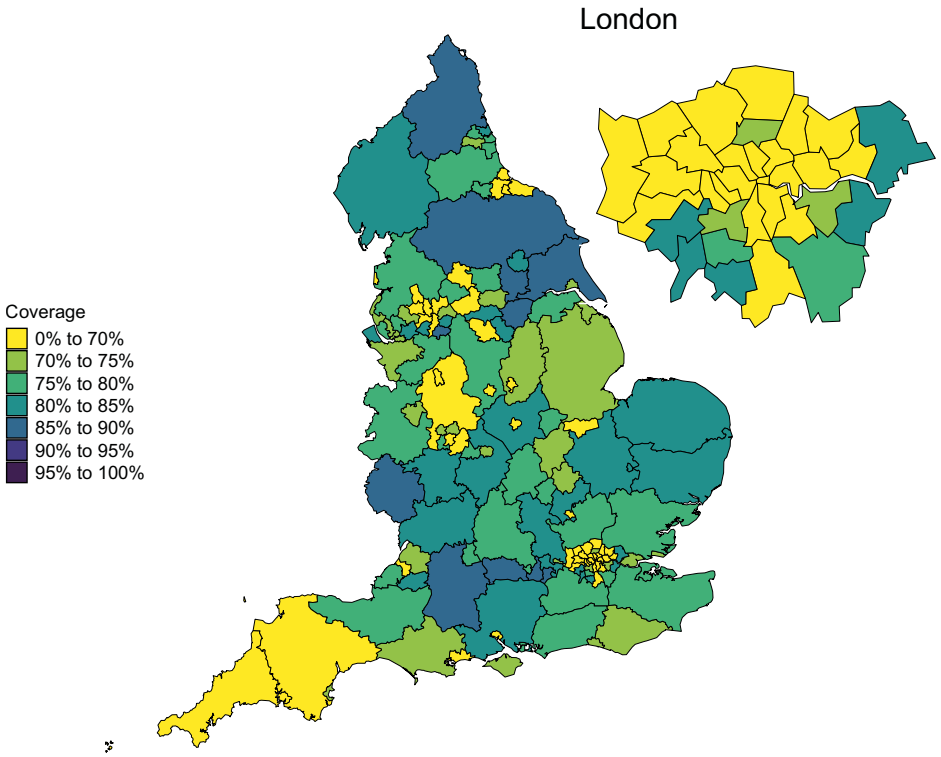
Note 1: the shorthand '[z]' is used to mark cohorts that were not eligible in the given academic year so do not have a coverage estimate.

Source: UK Health Security Agency, available under the Open Government License v 3.0.[19]

It is important to restore uptake of the HPV vaccination programme to pre-2020 levels through reinforcement of the core school-based offer and strengthened catch-up offers for those eligible for adolescent vaccination who missed out in school Year 8.

There is also significant variation across the country, both between and within regions. In 2023 to 2024 , HPV vaccine coverage for female Year 8 students was lowest in London (61.6%) and highest in the South East (78.6%). Within London, coverage ranged from 32.9% to 84.3% in females.[20] Higher and more equitable coverage of HPV vaccine would further reduce cervical cancer incidence over the next few decades. In addition, there will be a degree of 'herd immunity' whereby cervical cancer incidence will continue to decrease in unvaccinated populations as the majority of sexual partners will be vaccinated.

Figure 7: HPV vaccine coverage by local authority for Year 8 female students in the 2023 to 2024 academic year



Source: UK Health Security Agency, available under the Open Government License v 3.0.[21]

Cervical cancer screening programme

With the introduction of the HPV vaccination programme, and associated falls in vaccine-type HPV infection, cervical cancer incidence will now be predominantly observed in people born before 1991. Screening to enable early diagnosis and treatment prevents associated morbidity and mortality. For example, cervical cancer screening has led to around a 40% reduction in cervical cancer incidence and has been estimated to save over 4,500 lives in the UK each year.[22] In England, the NHS Cervical Screening Programme offers screening for HPV to women aged between 25 to 64 years every 5 years. If HPV is found, a cytology test is used to detect cervical intraepithelial neoplasia (CIN), a precursor to cervical cancer which can be treated. However, cervical screening coverage has declined over recent years and varies significantly across the

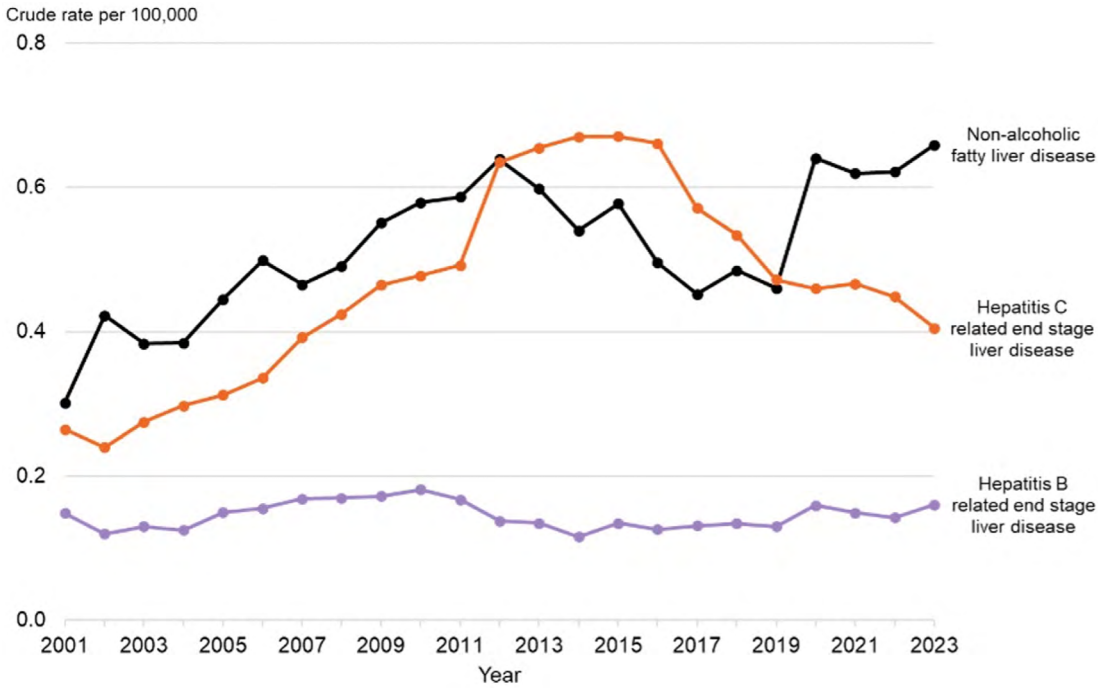
country, with people from some ethnic minority groups less likely to take up screening.[23,24] In addition, women in the most deprived groups are less likely to attend screening but are at increased risk of being diagnosed or dying from cervical cancer.[25] Initiatives, including self-sampling, tailored to the needs of under-served groups will help to address this.[26]

Hepatitis

Chronic infection with Hepatitis B or Hepatitis C virus is the globally leading cause of hepatocellular carcinoma (HCC), the most common type of primary liver cancer (around 85% of all primary liver cancers). Chronic viral Hepatitis causes about 80% of all HCC globally but in the UK only around 10% of HCC is viral related, with alcohol, smoking and obesity being the major drivers. The UK has committed to targets set out in the WHO Global Health Sector Strategy (GHSS) on viral Hepatitis 2022 to 2030.[27]

In England, premature mortality rates from Hepatitis B-related HCC and end-stage liver disease (ESLD) have remained low and not significantly varied over the last few decades. For Hepatitis C-related HCC and ESLD, premature mortality rates peaked in 2015 and have been steadily decreasing since (Figure 8). Vaccination for Hepatitis B and timely antiviral therapies for Hepatitis B and C can prevent disease or slow disease progression, significantly decreasing the risk of liver damage and HCC. However, population groups affected are typically transient and underserved, requiring tailored community-based approaches. Furthermore, a stigma unfortunately remains around hepatitis which can prevent people from seeking timely treatment.

Figure 8: Crude rates of death from Hepatitis B and Hepatitis C related end stage liver disease or hepatocellular carcinoma, and non-alcoholic fatty liver disease, in persons aged under 75 years, England, 2001 to 2023



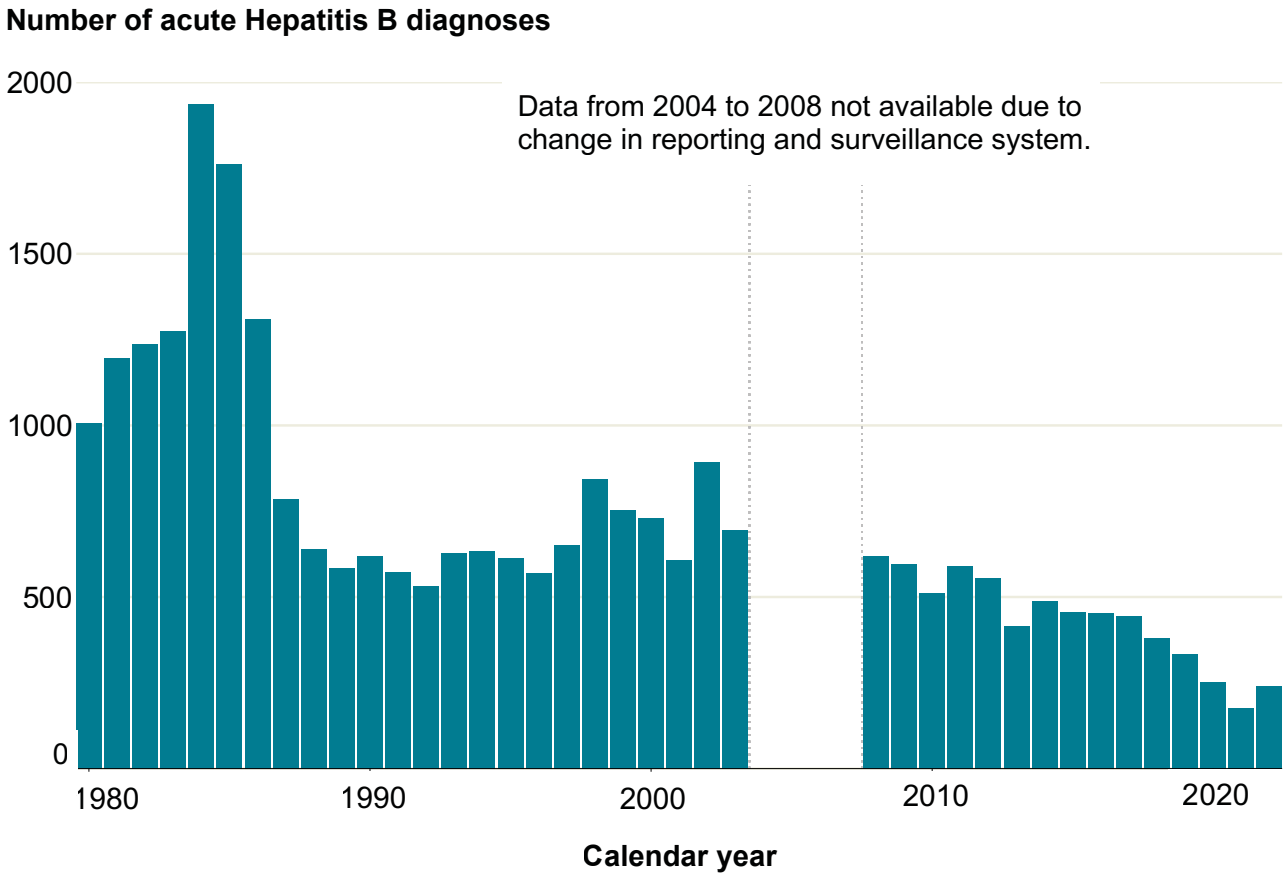
Source: UK Health Security Agency, available under the Open Government License v 3.0.[28]

Hepatitis B

Hepatitis B is common and can be transmitted vertically from mother to child as well as horizontally by sexual or blood-to-blood (for example, needle sharing) contact. Whilst only around 10% of adults infected with Hepatitis B will go on to develop chronic disease, children and infants under 5 years have a higher risk and 90% of children infected perinatally go on to have chronic infection.[29] There is a highly effective vaccine for Hepatitis B. There are also antiviral treatments which can prevent or significantly slow disease progression. However, the most effective prevention of Hepatitis B infection and related cancer remains vaccination.

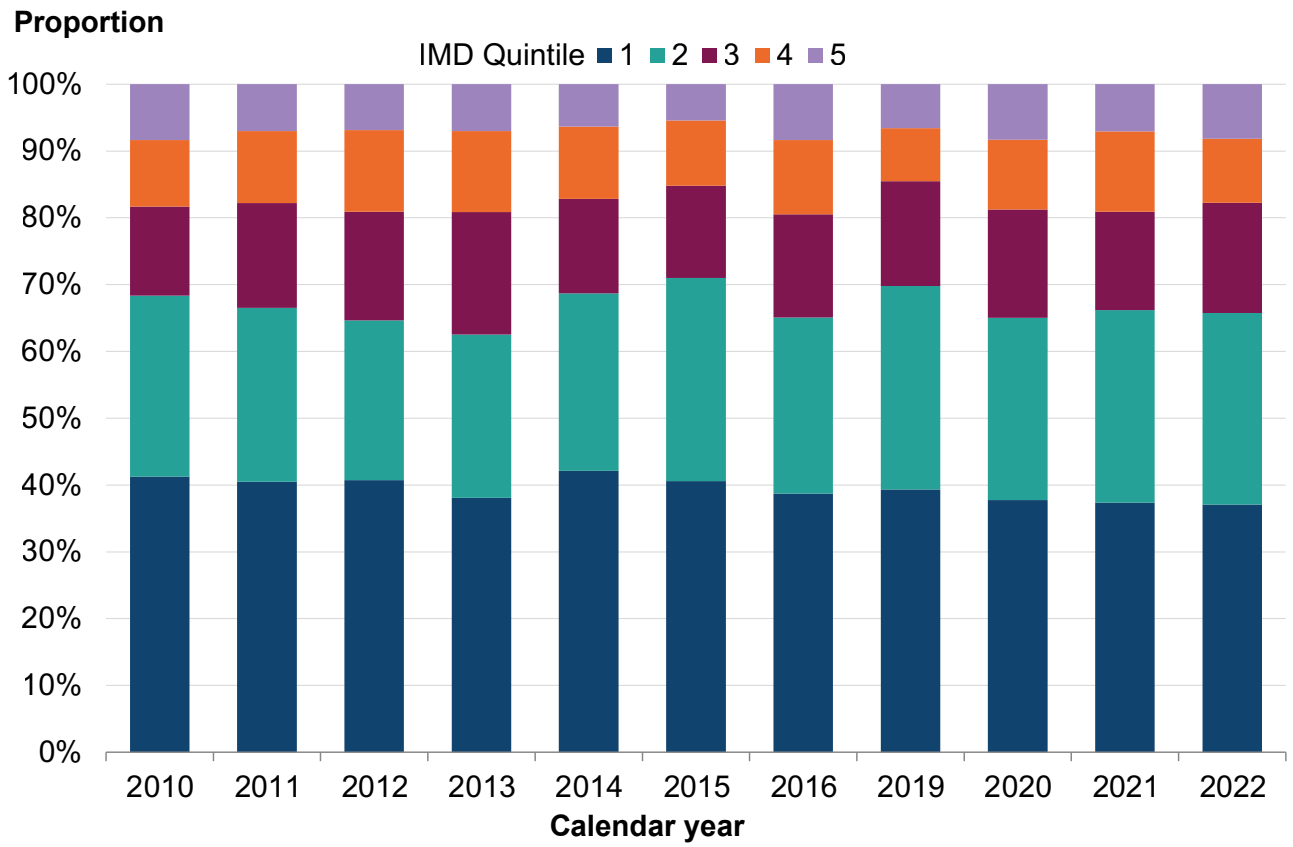
There are around 270,000 people living with chronic Hepatitis B in England – about 0.6% of the population. The number of people diagnosed with acute Hepatitis B in England has decreased over recent decades (Figure 9). The proportion of deaths and diagnoses is higher in people living in the most deprived areas, with the majority occurring in those living in the 2 most deprived quintiles (Figure 10).

Figure 9: Number of people diagnosed with acute Hepatitis B, England, 1980 to 2022 calendar year



Source: UK Health Security Agency, available under the Open Government License v 3.0.[30]

Figure 10: IMD breakdown of people newly diagnosed with Hepatitis B-related ESLD and/or HCC in England by calendar year, 2010 to 2022



Source: UK Health Security Agency, available under the Open Government License v 3.0.[31]

However, there remains significant levels of undetected infection. Bloodborne virus opt out testing in select emergency departments, implemented in April 2022, identified 646 new Hepatitis B diagnoses in its first year, highlighting a possible role for expanded access to testing.[32] In the UK, around 95% of new chronic Hepatitis B diagnoses in England are in migrants, most often acquired perinatally or during childhood in endemic countries. In the UK, the death rate from Hepatitis B-related ESLD and/or HCC has remained low but steady over the last few decades, below (0.2 per 100,000 population) (Figure 8).

Prevention

Deaths caused by Hepatitis B-related HCC and ESLD are largely preventable. Hepatitis B vaccines are highly effective in preventing infection in infants born to women living with Hepatitis B and most adults. Implementation of a national newborn Hepatitis B immunisation programme in Taiwan, for example, reduced HCC incidence by more than 80% and mortality by more than 90%.[33]

In England, the Hepatitis B vaccine has been offered to all babies since 2017 as part of the hexavalent vaccine. Coverage is high (91.8% for 3 doses). Targeted neonatal vaccination and Hepatitis B immunoglobulin (HBIG) for babies at high risk also have high coverage (98.8%). Universal antenatal screening for Hepatitis B, HIV and syphilis, is also available for pregnant

women living with these conditions to prevent vertical transmission (99.8% coverage).[34] This is discussed further in chapter 3.2.

Targeted vaccination for those with an increased risk of acquiring Hepatitis B or its complications, such as people who inject drugs, gay, bisexual and other men who have sex with men (GBMSM), close household (usually family) contacts of people living with Hepatitis B, and people with chronic kidney disease, can also prevent population transmission. Vaccine coverage among these groups varies but is generally below target thresholds, for example, self-reported uptake of at least one dose of Hepatitis B vaccine has decreased from 74.6% in 2015 to 60.7% in 2022 among people who inject drugs.[35] Hepatitis B vaccination is also effective as post-exposure prophylaxis up to a week post-exposure.[36]

Early diagnosis and treatment

Whilst there is currently no cure for chronic Hepatitis B, antiviral therapies can be effective to prevent liver damage progression. The most used treatment is a nucleoside or nucleotide analogue taken daily and usually lifelong. In addition, NICE guidelines recommend that people at high risk of HCC, including those with Hepatitis B, receive 6-monthly liver surveillance which increases the chance of early detection and improved outcomes.[37]

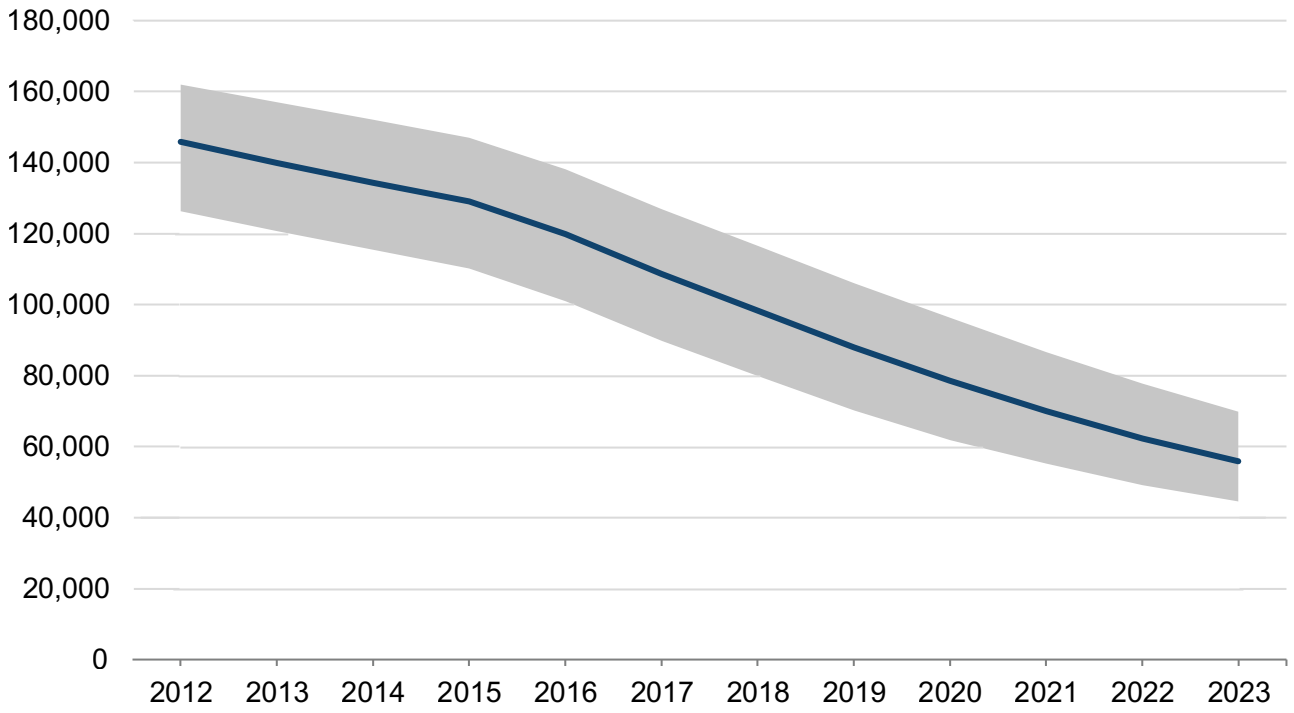
It is important to improve and sustain Hepatitis B vaccination uptake in the highest risk and often underserved populations, and strengthen surveillance, testing and treatment services to support diagnosis and effective treatment for those living with Hepatitis B.

Hepatitis C

Hepatitis C is a blood-borne virus that is predominantly acquired in adults through unsafe medical practice and injecting drug use. There are 6 main strains of the virus and it is possible to be infected with multiple strains. Different strains require different treatment. The most common strains in the UK are genotype 1 and genotype 3. Acute infection is usually asymptomatic and cleared spontaneously by around 20% of people infected, with 80% progressing to chronic infection. Between 10% to 15% will develop cirrhosis over a 20-year period and of those around 2% will develop HCC each year. Progression of disease is faster when there are co-factors for liver damage such as excess alcohol consumption and co-infection with HIV or Hepatitis B.

In England, around 55,900 adults were estimated to be living with chronic Hepatitis C in 2023, a decline of around 56% from 2015 (Figure 11). The prevalence of chronic Hepatitis C in people who inject drugs has decreased over recent years, with around 7% estimated to be living with chronic Hepatitis C in 2023, compared to around 26% in 2017.[38] The proportion of those who cleared the virus increased, from 23% in 2015 to over 45% in 2023. This improvement is largely attributable to increased access to treatment over the last decade. However, awareness of infection, particularly among those who report injecting drugs, is low and has decreased over recent years suggesting that more work is needed to ensure prompt diagnosis and treatment.[39]

Figure 11: Estimated number of people living with chronic Hepatitis C in the general adult population in England, 2012 to 2023



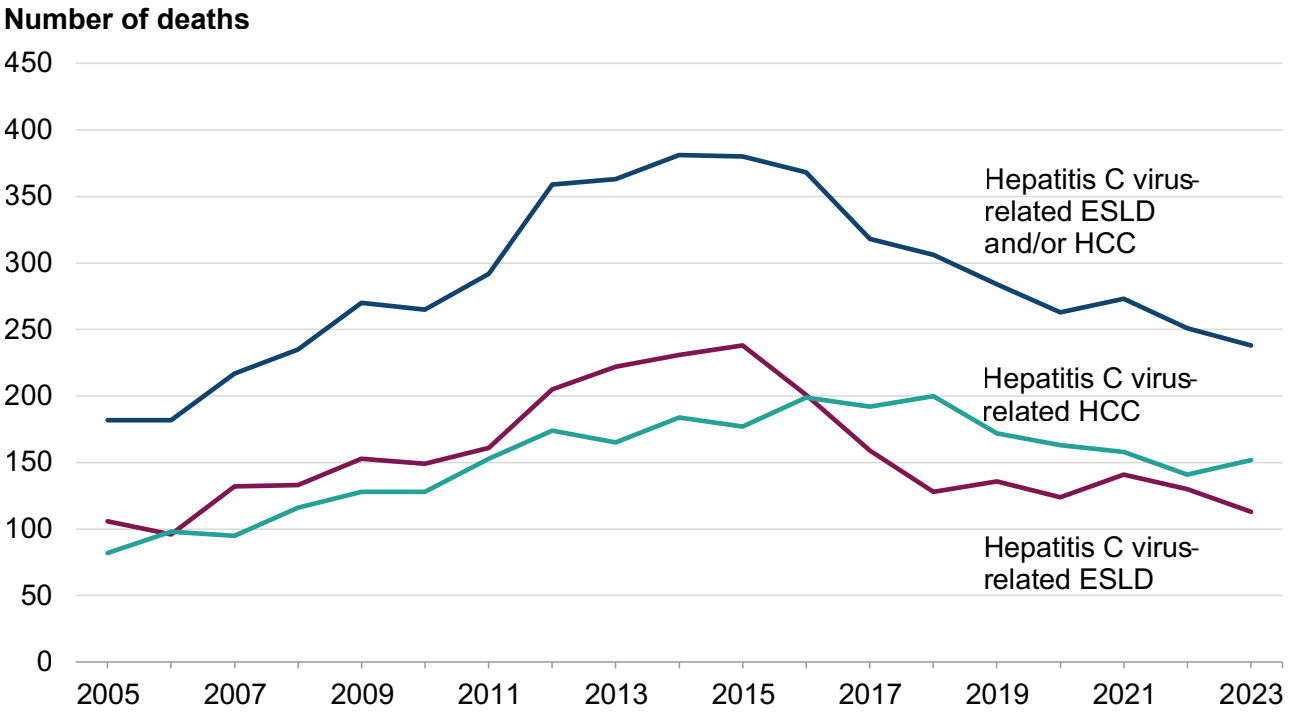
(Shaded line shows 95% credible Interval)

Source: UK Health Security Agency, available under the Open Government License v 3.0.[40]

There is no vaccine for Hepatitis C currently but in the last 10 years several highly effective and well tolerated oral drugs have been developed with up to a 90% cure rate. Early treatment can prevent Hepatitis C virus related HCC mortality by ensuring early clearance of the virus before it can cause liver damage.

In 2023, the rate of Hepatitis C-related ESLD or HCC mortality was 0.41 per 100,000 population in England.[41] The number of death registrations for Hepatitis C-related HCC peaked in 2018 at 200, and steadily decreased until 2022. There was a 7.8% increase in deaths between 2022 and 2023 (141 and 152 deaths respectively), although this increase is below levels in previous years.[42] The general decline in mortality from Hepatitis C-related ESLD and HCC is likely to be the result of increased access to testing and treatment by antiviral drugs introduced in 2015, particularly for those with advanced disease.

Figure 12: Number of death registrations for Hepatitis C virus-related ESLD and HCC in England, 2005 to 2023



Source: UK Health Security Agency, available under the Open Government License v 3.0.[43]

Treatment

The development of safe, tolerable and highly effective direct acting antivirals (DAAs) in 2011 was a turning point for Hepatitis C treatment and prevention of ESLD and HCC. Treatment regimen is typically one oral tablet daily for 8 or 12 weeks and is over 90% effective at clearing infection. It is most effective when given before the onset of cirrhosis. However, successful treatment does not provide protection against reinfection and reinfection can occur with continued injecting drug use. One key public health measure is therefore clean needle and syringe provision alongside opiate agonist therapy. A focus on equitable and easy access to testing and treatment is also important to address more complex needs in this population group.

HIV

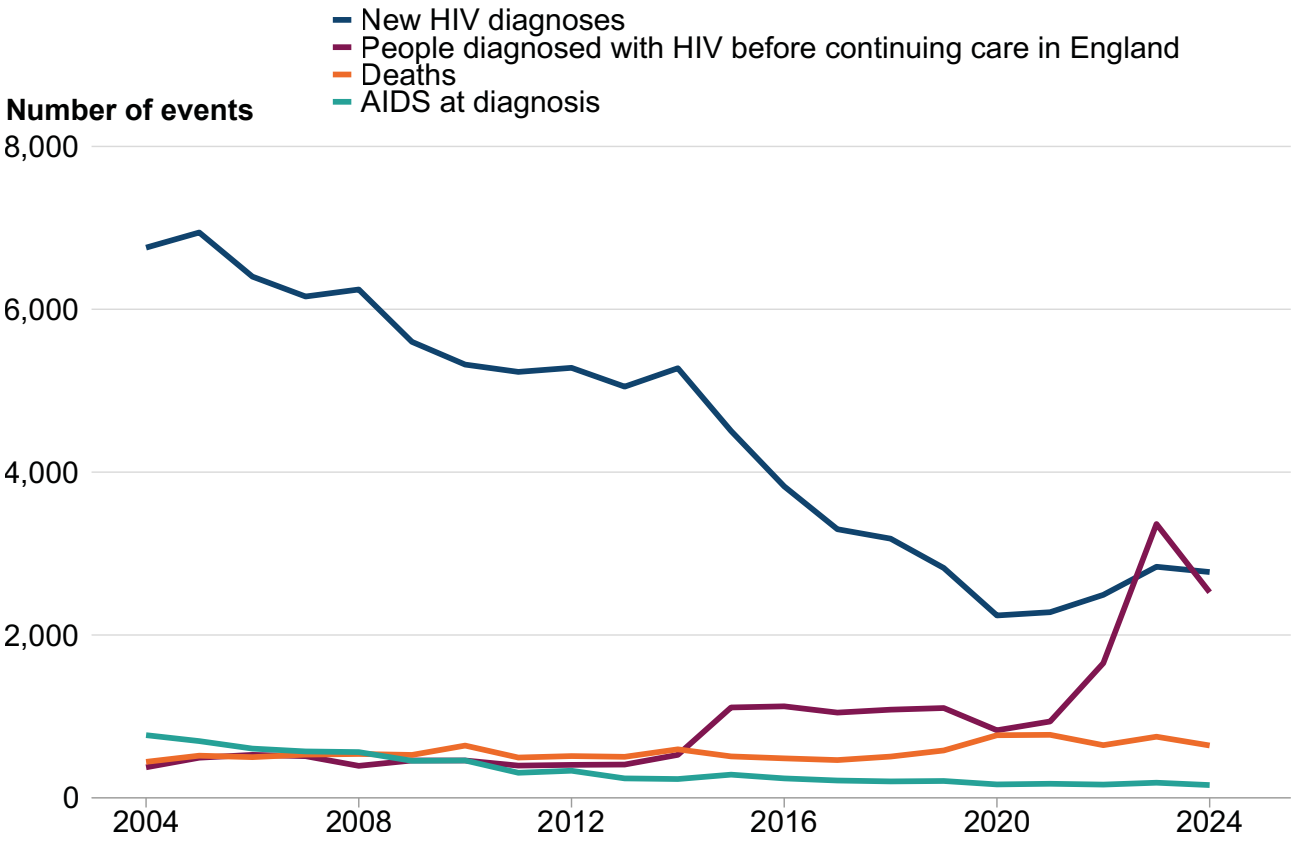
HIV remains a major global public health issue, with an estimated 40.8 million people living with the virus in 2024, 65% of whom are in the WHO African region. Around 630,000 people were estimated to have died from HIV related causes in 2024.[44] Its principal effect on cancer is to reduce substantially the effectiveness of the immune system in people who progress to AIDS, worsening susceptibility to and severity of other viral infections like Hepatitis B and C. This increases the risk of several of the infection-associated cancers outlined in this chapter including cervical and liver cancer. Recent global estimates put women living with HIV at a 6-fold increased risk of cervical cancer, for example.[45] Kaposi's sarcoma (KS), a cancer caused by

the HHV-8 virus, which is extremely rare in people who do not have HIV, is common in those with AIDS, as is non-Hodgkin's lymphoma.

Over recent years, the HIV epidemic in England has changed. There has been an increase in total diagnoses and changing demographics of new cases, a rise in cases in heterosexual people and increases in cases outside London and major conurbations. In 2024, around 103,700 adults were estimated to be living with HIV in England, with over half aged 50 years and older, compared to 26% in 2015, reflecting the ageing population living with HIV.[46] Most importantly, over 98% of people living with diagnosed HIV in the UK had an undetectable viral load and were unable to pass the virus to a sexual partner, highlighting the major success in HIV treatment over recent decades.

In 2024, there were 2,773 new HIV cases diagnosed in England. Additionally, there were 2,525 people diagnosed with HIV before continuing care in England. Of those, over 70% were virally supressed within a month of their diagnosis in England and therefore unlikely to contribute to HIV transmission. It is key that people arriving in England are quickly linked to treatment services. Notably, between 2023 and 2024 the number of heterosexual people of Black African ethnicity tested increased by around 19% with a relatively stable trend in positivity rate since 2019, which may suggest ongoing transmission in this group.[47]

Figure 13: New HIV diagnoses, people diagnosed with HIV before continuing care in England, AIDS at diagnosis, and all-cause deaths in people with HIV, England, 2004 to 2024



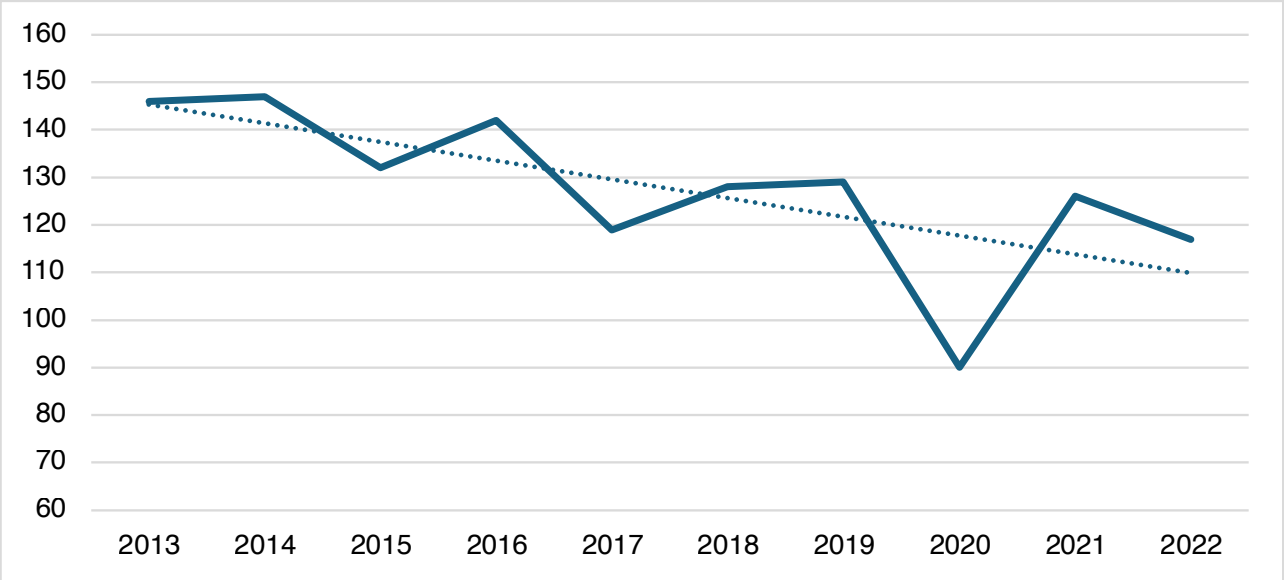
Source: UK Health Security Agency, available under the Open Government License v 3.0.[48]

Over recent decades, significant improvements in prevention strategies, testing, pre- and post-exposure prophylaxis and treatment have seen a significant reduction in HIV infection and associated disease. Whilst there is no cure for HIV, antiretroviral therapy now lowers the amount of detectable virus in the body to such a degree that transmission does not occur. These therapies have saved millions of lives worldwide and have led to a reduction in HIV related cancers.

Kaposi's sarcoma (KS)

KS is a rare soft tissue sarcoma caused by the HHV-8 virus, a mostly sexually transmitted virus and common infection which is typically controlled by a healthy immune system. However, people living with AIDS are more likely to develop this otherwise rare cancer due to the extent of immune system compromise. The first symptoms are usually skin lesions although other areas such as lungs, liver, stomach and bowel can be affected.

Figure 14: Number of registered new diagnoses of Kaposi Sarcoma, England, 2013 to 2022

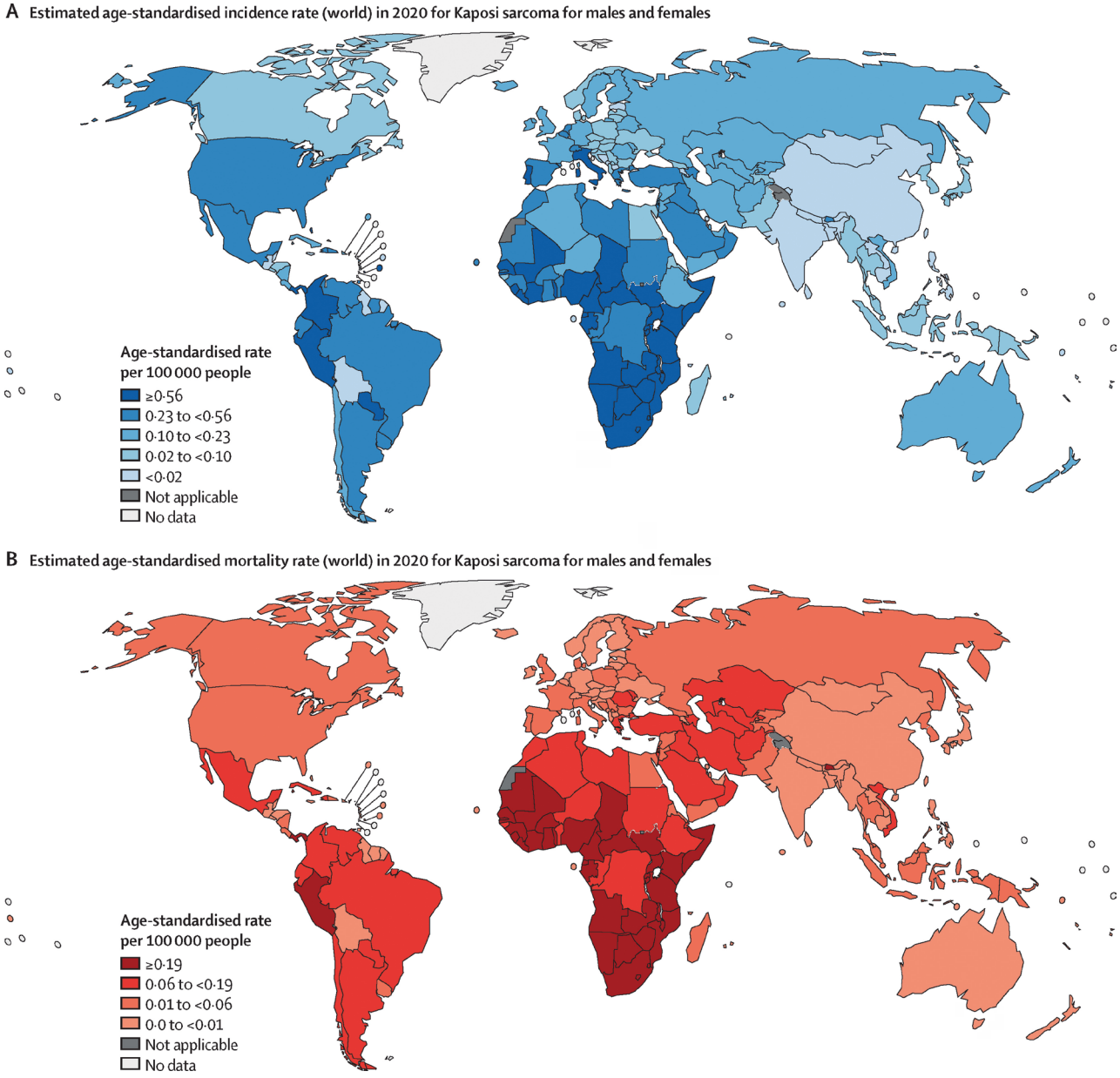


Dotted line is a line of best fit.

Source: Data taken from NHS Digital.[49]

Almost all KS cases in the UK are AIDS-related (Figure 14). Mortality and incidence is much higher in Africa and Latin America (Figure 15), although it is much less common than it was 20 years ago in most countries. If antiretroviral treatment is started early in HIV infection, KS can be prevented.

Figure 15: Global map of Kaposi Sarcoma incidence and deaths



Source: Fu et al. 2023 under Creative Commons license.[50]

Non-Hodgkin lymphoma (NHL)

Together with KS, NHL is one of the most common cancers in people living with HIV in the UK. NHL is a cancer of the white blood cells, specifically lymphocytes. The most common types of NHL in people with HIV are generally more aggressive and fast growing – diffuse large B-cell lymphoma and Burkitt lymphoma. NHL is still significantly more likely to occur in those with HIV even if their HIV is well controlled, although poorly controlled disease increases this risk further. Globally, around 7% of new NHL cases were attributable to HIV infection in 2019, with the highest proportion (44%) in UNAIDS region of Eastern and Southern Africa.[51] However, cure rates for HIV-positive people who take chemotherapy and HIV treatment are similar to those in the general population.

Epstein-Barr Virus (EBV)

EBV is an extremely common human herpesvirus spread through saliva, infecting over 90% of the global population. Whilst most people are infected in childhood and have no symptoms, infection during adolescence or adulthood can cause infectious mononucleosis (glandular fever), which typically resolves over a few weeks.

However, EBV infection can significantly increase the risk of a number of cancers in some people and was the first human oncogenic virus to be discovered in 1964. EBV is estimated to cause around 200,000 cases of cancer globally. Cancers most strongly associated with EBV include Hodgkin lymphoma, Burkitt lymphoma and nasopharyngeal carcinoma. There is also a suspected association with Multiple Sclerosis and other cancers including gastric cancer.

- **Hodgkin's lymphoma** is a relatively rare blood cancer, with around 1,800 cases each year in England. It can develop at any age, but most people are diagnosed between 15 to 34 years with around 20% diagnosed over 60 years. Around 40% of cases are estimated to be associated with EBV infection. Hodgkin's lymphoma generally responds well to chemotherapy treatment.
- **Burkitt's lymphoma** is a rare and aggressive type of B-cell non-Hodgkin lymphoma. Risk factors include EBV infection and immunodeficiency (as seen in HIV, for example), as well as infection with malaria. Whilst Burkitt lymphoma is very rare in the UK, with only a few hundred cases per year, it is more common in areas with high levels of EBV and malaria. Burkitt's lymphoma advances rapidly; early detection and treatment with chemotherapy can improve outcomes.
- **Nasopharyngeal cancer** is a rare cancer with around 200 cases every year diagnosed in England, although it is more prevalent in east and southeast Asia. EBV is thought to cause the majority of cases, with smoking another significant risk factor.

There is currently no approved vaccine against EBV, although there are several vaccines in clinical trials for treatment of EBV-associated malignancies, particularly nasopharyngeal carcinoma. Given the extremely high prevalence of EBV infection, a question remains around which age point an EBV vaccine may best be deployed.

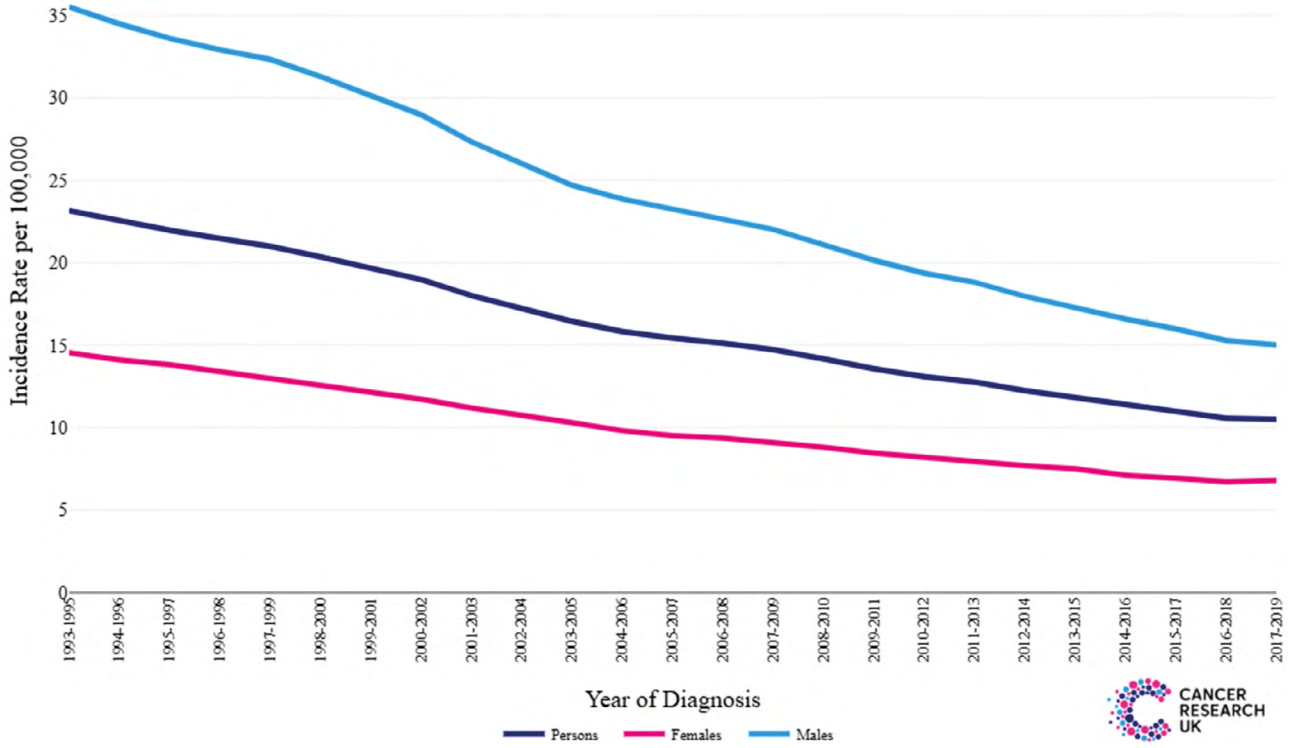
Helicobacter pylori (*H. pylori*)

H. pylori is a gram-negative bacterium that can chronically infect gastric mucosa (stomach lining) and is likely primarily transmitted through close touch and contaminated food and water. Whist *H. pylori* infection does not cause any significant issues for most people, it can cause gastritis and is a major cause of peptic ulcer disease and also significantly increases the risk of non-cardia gastric adenocarcinoma (stomach cancer) by 6 to 8 times. It is also a major risk for a rare gut lymphoma – mucosa-associated lymphoid tissue (MALT) lymphoma.

Treatment

Around 40% of people in the UK are estimated to be infected with *H. pylori* although very few will go on to have cancer. *H. pylori* is treated with a course of 2 antibiotics and a protein pump inhibitor co-administered for around 7 days. Treatment is around 90% effective with good adherence. A century ago, stomach cancer was a leading cause of cancer death, but rates have significantly declined. Incidence has reduced by around 55% over the last 2 decades and is expected to continue falling.[52] The combination of early treatment of *H. pylori* and reductions in smoking, and possibly some changes in diet are likely to be major drivers of this improvement.

Figure 16: Stomach cancer (ICD-10 C16), European age-standardised incidence rates, per 100,000 persons, UK, 1993 to 2019



Source: Cancer Research UK, Cancer Statistics Data Hub[53]

References

1 Cancer Research UK. Cervical cancer risk. Human papillomavirus (HPV). [Internet] 2019. [Accessed 22 October 2025] Available from: https://www.cancerresearchuk.org/health-professional/cancer-statistics/statistics-by-cancer-type/cervical-cancer/risk-factors#heading-Two

2 Brown K, Rumgay H, Dunlop C. The fraction of cancer attributable to modifiable risk factors in England, Wales, Scotland, Northern Ireland, and the United Kingdom in 2015. Br J Cancer. 2018;118,1130-1141 doi: 10.1038/s41416-018-0029-6

3 World Health Organization. International Agency for Research on Cancer. Cancers Attributable to Infections. [Internet] [Accessed 22 October 2025]. Available from: https://gco.iarc.fr/causes/infections/tools-map?mode=3&sex=0&continent=0&agent=0&cancer=0&key=asr&scale=quantile

4 World Health Organization. International Agency for Research on Cancer. Cancers Attributable to Infections. [Internet] 2025. [Accessed 22 October 2025]. Available from: https://gco.iarc.fr/causes/infections/tools-bars?mode=2&sex=0&population=who&country=4&continent=0&agent=0&cancer=0&key=attr_cases&lock_scale=0&nb_results=10

5 World Health Organization. International Agency for Research on Cancer. Cancers Attributable to Infections. [Internet] 2025. [Accessed 22 October 2025]. Available from: https://gco.iarc.fr/causes/infections/tools-multi-bars?mode=1&sex=0&population=regions&country=4&continent=0&agent=0&cancer=0&key=attr_cases&lock_scale=0&nb_results=10

6 World Health Organization. International Agency for Research on Cancer. Cancers Attributable to Infections. [Internet] [Accessed 22 October 2025]. Available from: https://gco.iarc.fr/causes/infections/tools-map?mode=3&sex=0&continent=0&agent=0&cancer=0&key=asr&scale=quantile

7 World Health Organization. International Agency for Research on Cancer. Cancers Attributable to Infections. [Internet] 2025. [Accessed 22 October 2025]. Available from: https://gco.iarc.fr/causes/infections/tools-multi-bars?mode=1&sex=0&population=regions&country=4&continent=0&agent=0&cancer=0&key=attr_cases&lock_scale=0&nb_results=10

8 World Health Organization. Health Topics. Cervical cancer. [Internet] [Accessed 22 October 2025] Available from: https://www.who.int/health-topics/cervical-cancer#tab=tab_1

9 Cancer Research UK. Risks and causes of cervical cancer. [Internet] 2023. [Accessed 22 October 2025] Available from: https://www.cancerresearchuk.org/about-cancer/cervical-cancer/risks-causes

10 World Health Organization. Fact sheets. Cervical cancer. [Internet] 2024. [Accessed 22 October 2025] Available from: https://www.who.int/news-room/fact-sheets/detail/cervical-cancer

11 Cancer Research UK. Cervical cancer incidence statistics. [Internet] [Accessed 22 October 2025] Available from: https://www.cancerresearchuk.org/health-professional/cancer-statistics/statistics-by-cancer-type/cervical-cancer/incidence

12 Cancer Research UK. Cervical cancer statistics. Cervical cancer mortality. [Internet] [Accessed 22 October 2025] Available from: https://www.cancerresearchuk.org/health-professional/cancer-statistics/statistics-by-cancer-type/cervical-cancer#Cervicalcs2

13 NHS England. Cervical cancer elimination by 2040 – plan for England. [Internet] 2025. [Accessed 22 October 2025] Available from: https://www.england.nhs.uk/long-read/cervical-cancer-elimination-by-2040-plan-for-england/

14 World Health Organization. Cervical Cancer Elimination Initiative. [Internet] [Accessed 22 October 2025] Available from: https://www.who.int/initiatives/cervical-cancer-elimination-initiative

15 Falcaro M, Castanon A, Ndlela B, et al. The effects of the national HPV vaccination programme in England, UK, on cervical cancer and grade 3 cervical intraepithelial neoplasia incidence: a register-based observational study. Lancet. 2021;398,10316. doi: 10.1016/S0140-6736(21)02178-4.

16 UK Health Security Agency. Human papillomavirus (HPV) vaccination coverage in adolescents in England: 2023 to 2024. [Internet] 2025. [Accessed 22 October 2025] Available from: https://www.gov.uk/government/statistics/human-papillomavirus-hpv-vaccine-coverage-estimates-in-england-2023-to-2024/

17 Falcaro M, Soldan K, Ndlela B, Sasieni P. Effect of the HPV vaccination programme on incidence of cervical cancer and grade 3 cervical intraepithelial neoplasia by socioeconomic deprivation in England: population based observational study. BMJ. 2024;385,e077341 doi: 10.1136/bmj-2023-077341

18 Health trends and variation in England 2025: a Chief Medical Officer report. [Internet]. [Accessed October 2025]. Available from: https://www.gov.uk/government/publications/health-trends-and-variation-in-england-2025-a-chief-medical-officer-report

19 UK Health Security Agency. Human papillomavirus (HPV) vaccination coverage in adolescents in England: 2023 to 2024. [Internet] 2025. [Accessed 22 October 2025] Available from: https://www.gov.uk/government/statistics/human-papillomavirus-hpv-vaccine-coverage-estimates-in-england-2023-to-2024/

20 UK Health Security Agency. Human papillomavirus (HPV) vaccination coverage in adolescents in England: 2023 to 2024. [Internet] 2025. [Accessed 22 October 2025] Available from: https://www.gov.uk/government/statistics/human-papillomavirus-hpv-vaccine-coverage-estimates-in-england-2023-to-2024/

21 UK Health Security Agency. Human papillomavirus (HPV) vaccination coverage in adolescents in England: 2023 to 2024. [Internet] 2025. [Accessed 22 October 2025] Available from: https://www.gov.uk/government/statistics/human-papillomavirus-hpv-vaccine-coverage-estimates-in-england-2023-to-2024/

22 UK National Screening Committee. Adult screening programme. Cervical cancer. [Internet] 2025. [Accessed 22 October 2025] Available from: https://view-health-screening-recommendations.service.gov.uk/cervical-cancer/

23 NHS Digital. Cervical Screening Programme, England – 2023-2024. [Internet] 2024. [Accessed 22 October 2025] Available from: https://digital.nhs.uk/data-and-information/publications/statistical/cervical-screening-annual/england-2023-24

24 Lim A, Deats K, Gambell J, et al. Opportunistic offering of self-sampling to non-attenders within the English cervical screening programme: a pragmatic, multicentre, implementation feasibility trial with randomly allocated cluster intervention start dates (YouScreen). eClinicalMedicine. 2024;73,102672 doi: 10.1016/j.eclinm.2024.102672

25 UK Health Security Agency. The Green Book. Chapter 18a: Human papillomavirus (HPV). [Internet] 2023. [Accessed 22 October 2025] Available from: https://assets.publishing.service.gov.uk/media/649032b6b32b9e000ca969a7/HPV-green-book-chapter-18a-June-2023.pdf

26 Department of Health and Social Care. Impact Assessment. Cervical screening HPV self-sampling: impact assessments. [Internet] 2025. [Accessed 22 October 2025] Available from: https://www.gov.uk/government/publications/cervical-screening-hpv-self-sampling-impact-assessments

27 World Health Organization. Global health sector strategies on, respectively, HIV, viral hepatitis and sexually transmitted infections for the period 2022-2030. [Internet] 2022. [Accessed 22 October 2025] Available from: https://www.who.int/publications/i/item/9789240053779

28 UK Health Security Agency. Liver disease profile, December 2024 update. [Internet] 2024. [Accessed 22 October 2025] Available from: https://www.gov.uk/government/statistics/liver-disease-profile-december-2024-update/liver-disease-profile-december-2024-update

29 UK Health Security Agency. Hepatitis B in England 2024. [Internet] 2025. [Accessed 22 October 2025] Available from: https://www.gov.uk/government/publications/hepatitis-b-in-england/hepatitis-b-in-england-2024#foreword

30 UK Health Security Agency. Hepatitis B in England 2024. [Internet] 2025. [Accessed 22 October 2025] Available from: https://www.gov.uk/government/publications/hepatitis-b-in-england/hepatitis-b-in-england-2024#foreword

31 UK Health Security Agency. Hepatitis B in England 2024. [Internet] 2025. [Accessed 22 October 2025] Available from: https://www.gov.uk/government/publications/hepatitis-b-in-england/hepatitis-b-in-england-2024#reducing-incidence-and-prevalence-of-hepatitis-b

32 UK Health Security Agency. Emergency department bloodborne virus opt-out testing: 12-month interim report 2023. [Internet] 2024. [Accessed 22 October 2025] Available from: https://www.gov.uk/government/publications/bloodborne-viruses-opt-out-testing-in-emergency-departments/emergency-department-bloodborne-virus-opt-out-testing-12-month-interim-report-2023

33 Chiang C, Yang Y, You S, et al. Thirty-Year Outcomes of the National Hepatitis B Immunization Program in Taiwan. JAMA. 2013;310,9 doi: 10.1001/jama.2013.276701.

34 UK Health Security Agency. Hepatitis B in England 2024. [Internet] 2025. [Accessed 22 October 2025] Available from: https://www.gov.uk/government/publications/hepatitis-b-in-england/hepatitis-b-in-england-2024#reducing-hepatitis-b-related-mortality-by-increasing-diagnosis-and-treatment

35 UK Health Security Agency. Hepatitis B in England 2024. [Internet] 2025. [Accessed 22 October 2025] Available from: https://www.gov.uk/government/publications/hepatitis-b-in-england/hepatitis-b-in-england-2024#reducing-incidence-and-prevalence-of-hepatitis-b

36 UK Health Security Agency. The Green Book. Chapter 18: Hepatitis B. [Internet] 2025. [Accessed 22 October 2025] Available from: https://assets.publishing.service.gov.uk/media/68385046e0f10eed80aafad9/Hepatitis-B-green_book-chapter-18-06-03-2025.pdf

37 NHS England. Hepatocellular carcinoma surveillance: minimum standards. [Internet] 2024. [Accessed 22 October 2025] Available from: https://www.england.nhs.uk/long-read/hepatocellular-carcinoma-surveillance-minimum-standards/

38 UK Health Security Agency. Hepatitis C in England 2024. [Internet] 2025. [Accessed 22 October 2025] Available from: https://www.gov.uk/government/publications/hepatitis-c-in-the-uk/hepatitis-c-in-england-2024#figure_2

39 UK Health Security Agency. Hepatitis C in England 2024. [Internet] 2025. [Accessed 22 October 2025] Available from: https://www.gov.uk/government/publications/hepatitis-c-in-the-uk/hepatitis-c-in-england-2024#reducing-prevalence-and-incidence-of-hepatitis-c-virus-infection

40 UK Health Security Agency. Hepatitis C in England 2024. [Internet] 2025. [Accessed 22 October 2025] Available from: https://www.gov.uk/government/publications/hepatitis-c-in-the-uk/hepatitis-c-in-england-2024#reducing-prevalence-and-incidence-of-hepatitis-c-virus-infection

41 UK Health Security Agency. Hepatitis C in England 2024. [Internet] 2025. [Accessed 22 October 2025] Available from: https://www.gov.uk/government/publications/hepatitis-c-in-the-uk/hepatitis-c-in-england-2024#reducing-hepatitis-c-virus-related-mortality

42 UK Health Security Agency. Hepatitis_C_in_England_2024_data_tables. [Internet] 2025. [Accessed 22 October 2025] Available from: https://view.officeapps.live.com/op/view.aspx?src=https%3A%2F%2Fassets.publishing.service.gov.uk%2Fmedia%2F67c87d17ae2aa47d2f5ae335%2FHepatits_C_in_England_2024_data_tables.ods&wdOrigin=BROWSELINK

43 UK Health Security Agency. Hepatitis C in England 2024. [Internet] 2025. [Accessed 22 October 2025] Available from: https://www.gov.uk/government/publications/hepatitis-c-in-the-uk/hepatitis-c-in-england-2024#reducing-hepatitis-c-virus-related-mortality

44 World Health Organization. Fact sheets. HIV and AIDS. [Internet] 2025. [Accessed 22 October 2025] Available from: https://www.who.int/news-room/fact-sheets/detail/hiv-aids

45 World Health Organization. WHO releases new estimates of the global burden of cervical cancer associated with HIV. [Internet] 2020. [Accessed 22 October 2025] Available from: https://www.who.int/news/item/16-11-2020-who-releases-new-estimates-of-the-global-burden-of-cervical-cancer-associated-with-hiv

46 UK Health Security Agency. HIV testing, PrEP, new HIV diagnoses and care outcomes for people accessing HIV services: 2025 report. [Internet] 2025. Available from: https://www.gov.uk/government/statistics/hiv-annual-data-tables/hiv-testing-prep-new-hiv-diagnoses-and-care-outcomes-for-people-accessing-hiv-services-2025-report

47 UK Health Security Agency. HIV testing, PrEP, new HIV diagnoses and care outcomes for people accessing HIV services: 2025 report. [Internet] 2025. Available from: https://www.gov.uk/government/statistics/hiv-annual-data-tables/hiv-testing-prep-new-hiv-diagnoses-and-care-outcomes-for-people-accessing-hiv-services-2025-report#new-hiv-diagnoses

48 UK Health Security Agency. HIV: annual data. [Internet] 2025. [Accessed 22 October 2025] Available from: https://www.gov.uk/government/statistics/hiv-annual-data-tables#summary-of-main-messages

49 NHS Digital. Cancer Registration Statistics, England, 2022. [Internet] 2024. [Accessed 22 October 2025] Available from: https://digital.nhs.uk/data-and-information/publications/statistical/cancer-registration-statistics/england-2022

50 Fu L, Tian T, Wang B, et al. Global patterns and trends in Kaposi sarcoma incidence: a population-based study. Lancet Glob Health. 2023;11,10. doi: 10.1016/S2214-109X(23)00349-2.

51 Chen Y, Zhao J, Sun P, et al. Estimates of the global burden of non-Hodgkin lymphoma attributable to HIV: a population attributable modeling study. EClinicalMedicine. 2023;16:67:102370 doi: 10.1016/j.eclinm.2023.102370.

52 Cancer Research UK. Stomach cancer statistics. [Internet] [Accessed 22 October 2025]. Available from: https://www.cancerresearchuk.org/health-professional/cancer-statistics/statistics-by-cancer-type/stomach-cancer#stomach_stats0

53 Cancer Research UK. Stomach cancer incidence statistics. [Internet] [Accessed 22 October 2025]. Available from: https://www.cancerresearchuk.org/health-professional/cancer-statistics/statistics-by-cancer-type/stomach-cancer/incidence

4.4 Antimicrobial resistance (AMR)

Jonathan Sandoe – Associate Clinical Professor of Medical Microbiology, University of Leeds and Honorary Consultant Microbiologist, Leeds Teaching Hospital

Colin Brown – Deputy Director of Epidemic & Emerging Infections and Co-Director of WHO Collaborating Centre for Reference & Research on AMR & HCAI, UKHSA and UKHSA Lead for the NIHR Health Protection Research Unit on AMR & HCAI, University of Oxford

Contributors: Grace Eldridge, Viviana Finistrella, Jordan Charlesworth, Faiza Ambreen, Rohini Manuel, Emma Budd, Andy Borman, Julie Robotham, Diane Ashiru-Oredope, Katherine Henderson, Russell Hope, Sarah Gerver, Alicia Demirjian

Introduction

Antimicrobial resistance (AMR) describes the natural evolution of micro-organisms including bacteria, viruses, protozoa and fungi to survive the effects of antimicrobial treatments. We rely on antimicrobial agents ("antimicrobials") to treat and prevent infections in humans and animals. Antimicrobials are used to prevent infection following operations (such as hip replacements, Caesarian sections, mechanical heart valve insertion or bowel removal) and in immunocompromised people (for example, people with cancer). Because of the reliance of modern technology on antimicrobials, AMR threatens our ability to treat infection and carry out procedures or treatments for non-infective conditions, undermining the great progress in medicine that has been achieved so far.

Bacterial AMR

The English surveillance programme for antimicrobial utilisation and resistance (ESPAUR) report produced by the UK Health Security Agency (UKHSA) provides a yearly overview of the current state of antimicrobial usage (AMU) and AMR in England.[1] The burden of AMR in bacteria is estimated using resistance data for a small number of bacterial species that either commonly cause serious infection and/or have a major impact on public health (Table 1). Diagnostic microbiology laboratories test bacteria cultured from patient samples against a range of antibiotics and report the results of susceptibility testing of the bacteria using European (EUCAST) standards.[2] By necessity, this approach results in data on just a small proportion of infections. UKHSA data collection is aligned with key priority pathogens developed by the World Health Organisation (WHO) to guide research, development and strategies for public health action to prevent and control AMR.[3]

In 2023, the total burden of AMR bacteraemia (reports of blood cultures yielding bacteria likely to cause clinically relevant infections) in England was estimated to be 18,723 resistant infections, up by 3.5% since 2019 (18,082).[4] Counts of resistance in the 'ESKAPE' bacteria (Table 1) were similar to those seen before the COVID-19 pandemic in 2019 (Figure 1).[5] However, COVID-19 had a profound impact on healthcare and the effects of the disruption to services

may yet affect resistance rates, for example, through increased antimicrobial prescriptions with remote or altered services.

Table 1: Bacteria of public health importance due to association with antibiotic resistance and selected resistance profiles used to estimate AMR burden[6]

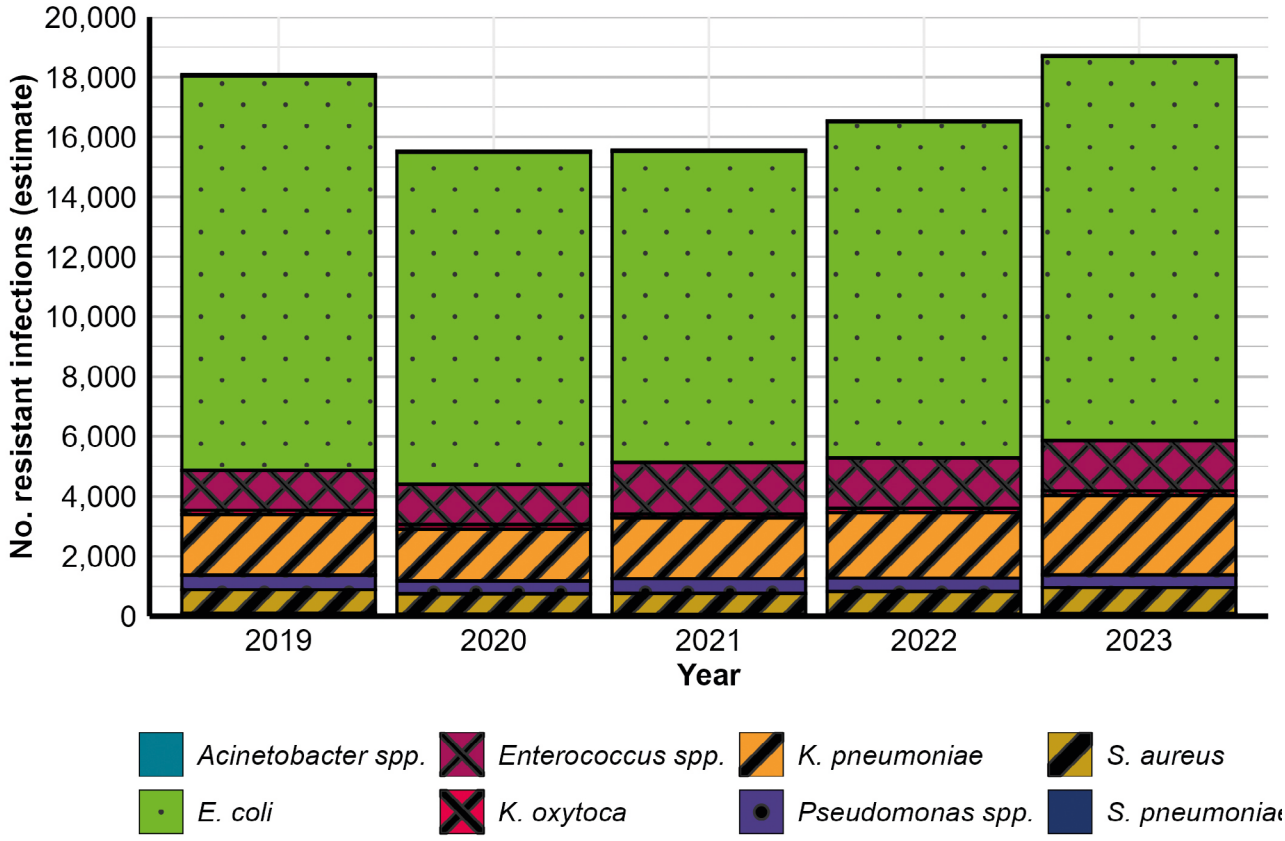
Common Bacterial Pathogens	Antibiotic Types for which Resistance Information is Collected	Clinical Syndromes
Gram-negative bacteria		
Escherichia coli	carbapenems, third-generation cephalosporins, aminoglycoside or fluoroquinolones	intestinal illnesses, urinary tract infections (UTIs), neonatal meningitis, bloodstream infections
Klebsiella spp.	carbapenems, third-generation cephalosporins, aminoglycoside or fluoroquinolones	pneumonia, bloodstream infections, UTIs, wound or surgical site infections, and meningitis
Pseudomonas aeruginosa	carbapenems, aminoglycoside or resistance to 3 groups (excluding carbapenems)	opportunistic pathogen* causing pneumonia, bloodstream infections, UTIs, skin and soft tissue infections
Acinetobacter spp.	carbapenems, aminoglycoside or fluoroquinolones	opportunistic pathogen* causing pneumonia, bloodstream infections, UTIs, skin and soft tissue infections
Gram-positive bacteria		
Enterococcus spp.	glycopeptides	UTIs, bloodstream infections, infective endocarditis (infective endocarditis (IE), heart valve infection), intra-abdominal infections
Staphylococcus aureus	methicillin	skin and soft tissue infections, bloodstream infections, pneumonia, IE, and osteomyelitis (bone infection)

Common Bacterial Pathogens	Antibiotic Types for which Resistance Information is Collected	Clinical Syndromes
Streptococcus pneumoniae	penicillin and macrolides, or penicillin alone	pneumonia, meningitis, bloodstream infections

*Opportunistic pathogens usually cause infections in people with compromised immunity.

Source: Image adapted from UK Health Security Agency, English Surveillance Programme for Antimicrobial Utilisation and Resistance (ESPAUR) Report 2023-2024 is licensed under the Open Government Licence v3.0.

Figure 1: Annual estimated total burden of antibiotic-resistant bacteraemia episodes of selected pathogens of public health importance, England 2019 to 2023[7]



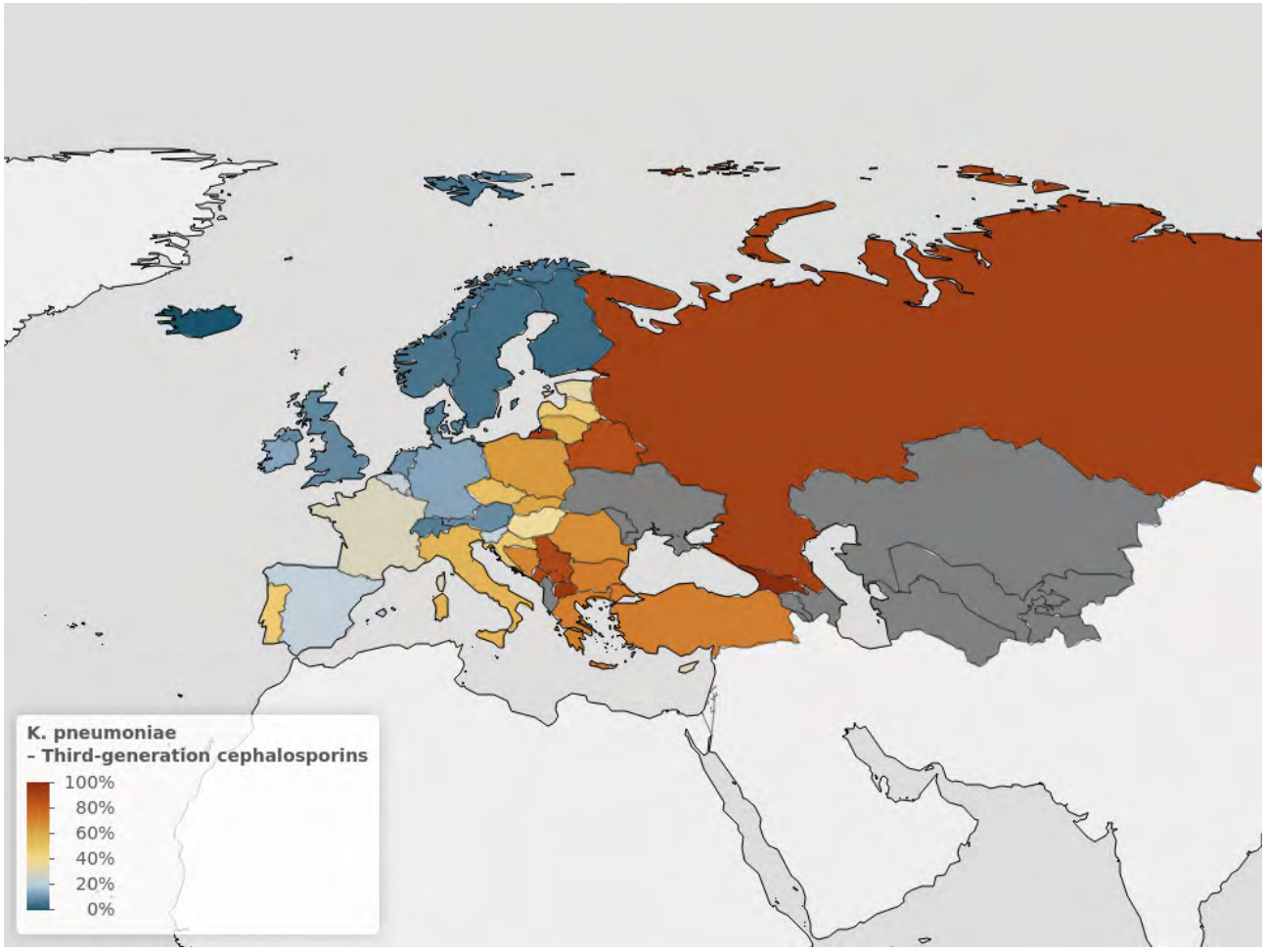
Source: Image by UK Health Security Agency, English Surveillance Programme for Antimicrobial Utilisation and Resistance (ESPAUR) Report 2023-2024 is licensed under the Open Government Licence v3.0.

Gram-negative bacteria dominated the burden of antibiotic-resistant bacteraemia, comprising 83.4% in 2023. *E. coli* is one of the most common bacteria to cause serious infection in England (Figure 1) and caused about 74 cases of bacteraemia per 100,000 population in 2023/24, an increase from 60 cases per 100,000 in 2012/13.[8] *Klebsiella* spp., although less common, have also progressively increased as a cause of bacteraemia from 17.6 cases per 100,000 population in 2017/18 to 22.9 per 100,000 population in 2023/24.[9] Between 2019 and 2023, *E. coli* and *K. pneumoniae* resistance to multiple antibiotics increased, with substantive rises reported for both organisms to the classes of antibiotics of most clinical importance regarding routine therapeutic practice.[10]

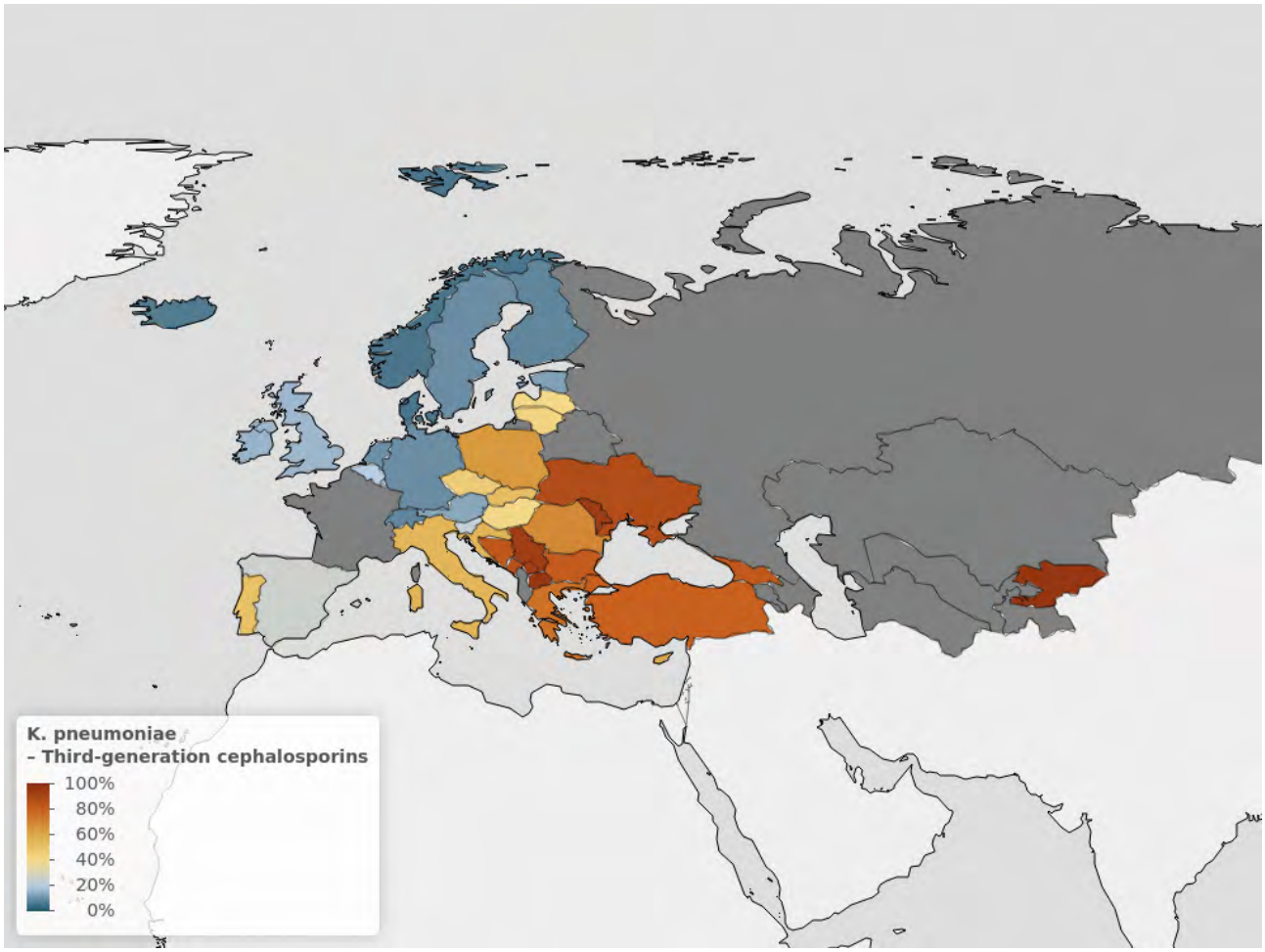
Although data reporting is still variable, resistance of *K. pneumoniae* to reported antibiotics has increased across several countries over time (Figure 2(a) and (b) for resistance to third-generation cephalosporins in Europe from 2016 to 2023), with resistance in the UK rising from 8.9% to 16.5% over this 7-year period.

Figure 2: *Klebsiella pneumoniae* percentage of invasive isolates resistant to third-generation cephalosporins (cefotaxime/ceftriaxone/ceftazidime), by country, WHO European Region, in (a) 2016 and (b) 2023[11]

(a)



(b)



Source: Maps from the World Health Organization AMR Dashboard.

There had been some examples of improvement in AMR, including a sustained decline in methicillin-resistant *Staphylococcus aureus* (MRSA) bloodstream infections in England, until upswings since the COVID-19 pandemic.[12] Globally, the proportion of *S. aureus* isolates that are methicillin-resistant has fallen since the early 21st century,[13] and the estimated incidence of MRSA bloodstream infections in Europe was 4.6 per 100,000 population in 2023, significantly lower (by 17.9%) than rates in 2019.[14] This European rate remains considerably higher than the rate of 1.6 bloodstream infections per 100,000 population in England for financial year (FY) 2023 to 2024.[15]

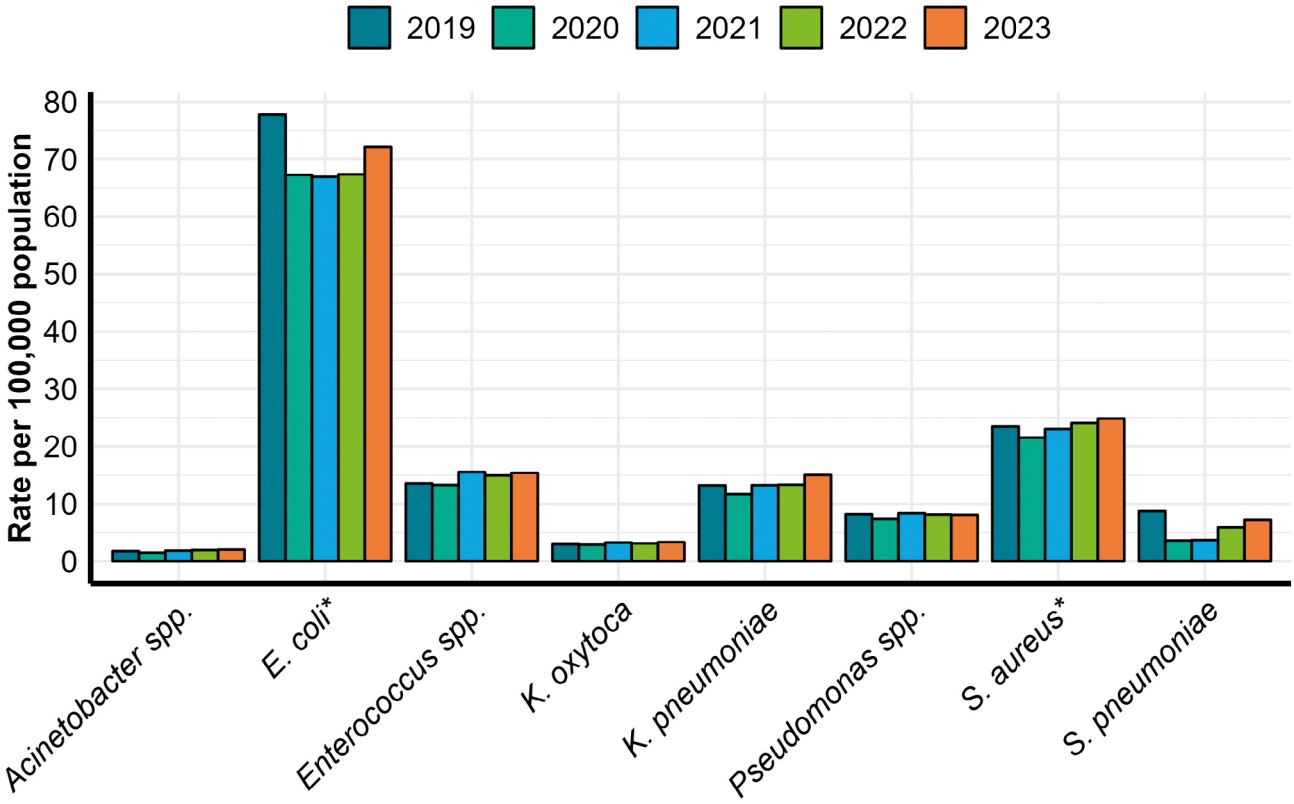
Reported rates of invasive infections (growth from cultures of samples from normally sterile sites) caused by acquired carbapenemase-producing Gram-negative organisms (CPOs) have doubled since mandatory reporting began in 2020.[16] CPOs are bacteria that have acquired resistance to carbapenem antibiotics, which are typically last-line antibiotics reserved to treat serious, life-threatening infections. Though rates of CPOs from all types of samples per 100,000 population doubled between 2021 (4.7 per 100,000) and 2023 (10.1 per 100,000), the absolute numbers remain low at a population level in England.[17]

Globally, the rate of *Klebsiella* spp. or *E. coli* that are resistant to carbapenems is 30% or more in countries across several continents – although bias in selection of bacteria for testing may

unintentionally overestimate these figures.[18] The European Centre for Disease Prevention and Control (ECDC) reports higher rates of carbapenem resistance in 2021 in the southern and eastern parts of the European Region than in the northern and western parts.[19] A geographical gradient is evident for carbapenem resistance in *Acinetobacter* spp., where UK prevalence was 2.1%, compared to 0.7% in Sweden and 86.9% in Italy.

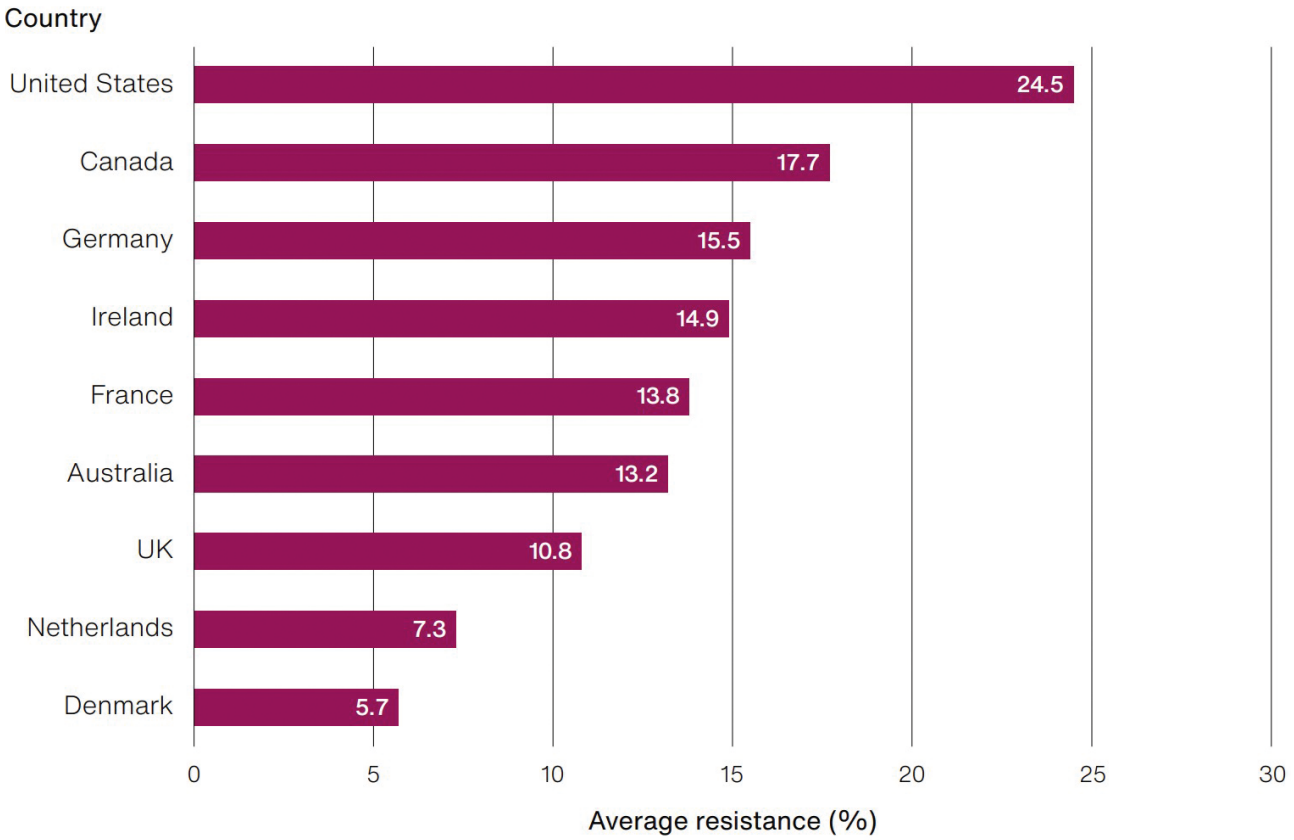
The overall burden of AMR in other types of bacteria that commonly cause bacteraemia (Table 1) such as *Enterococcus* spp. (9.0%), *S. aureus* (4.7%), and *S. pneumoniae* (0.4%) remained relatively unchanged at 14.1% in 2023 compared to 14.3% in 2019 (Figure 3). Average resistance to antibiotics in the UK is lower than in many comparable countries, though some European countries have lower levels (Figure 4).

Figure 3: Annual incidence rate of selected bacteria of public health importance causing bacteraemia, per 100,000 population, England, 2019 to 2023[20]



Source: Image by UK Health Security Agency, English Surveillance Programme for Antimicrobial Utilisation and Resistance (ESPAUR) Report 2023-2024 is licensed under the Open Government Licence v3.0.

Figure 4: Prevalence of high-risk antibiotic resistance, 2019[21]



Source: Image by National Audit Office, Investigation into how government is addressing antimicrobial resistance, 2025.

1. Average resistance was calculated across 12 antibiotic-bacteria combinations that present the highest risks to human health. The 12 priority antibiotic-bacteria combinations included in the analysis were vancomycin-resistant *Enterococcus faecalis*, vancomycin-resistant *Enterococcus faecium*, third-generation cephalosporin-resistant *Escherichia coli* (*E. coli)*, carbapenem-resistant *Klebsiella pneumoniae* (*K. pneumoniae*), third-generation cephalosporin-resistant *K. pneumoniae*, carbapenem-resistant *Pseudomonas aeruginosa*, methicillin-resistant *Staphylococcus aureus*, penicillin-resistant *Streptococcus pneumoniae*, fluoroquinolone-resistant *Acinetobacter baumannii* (*A. baumannii*), carbapenem-resistant *A. baumannii*, fluoroquinolone-resistant *E. coli* and carbapenem-resistant *E. coli*.
2. NAO have compared the UK with a selected group of countries with a similar economic and cultural profile to the UK.

Inequalities in bacterial AMR

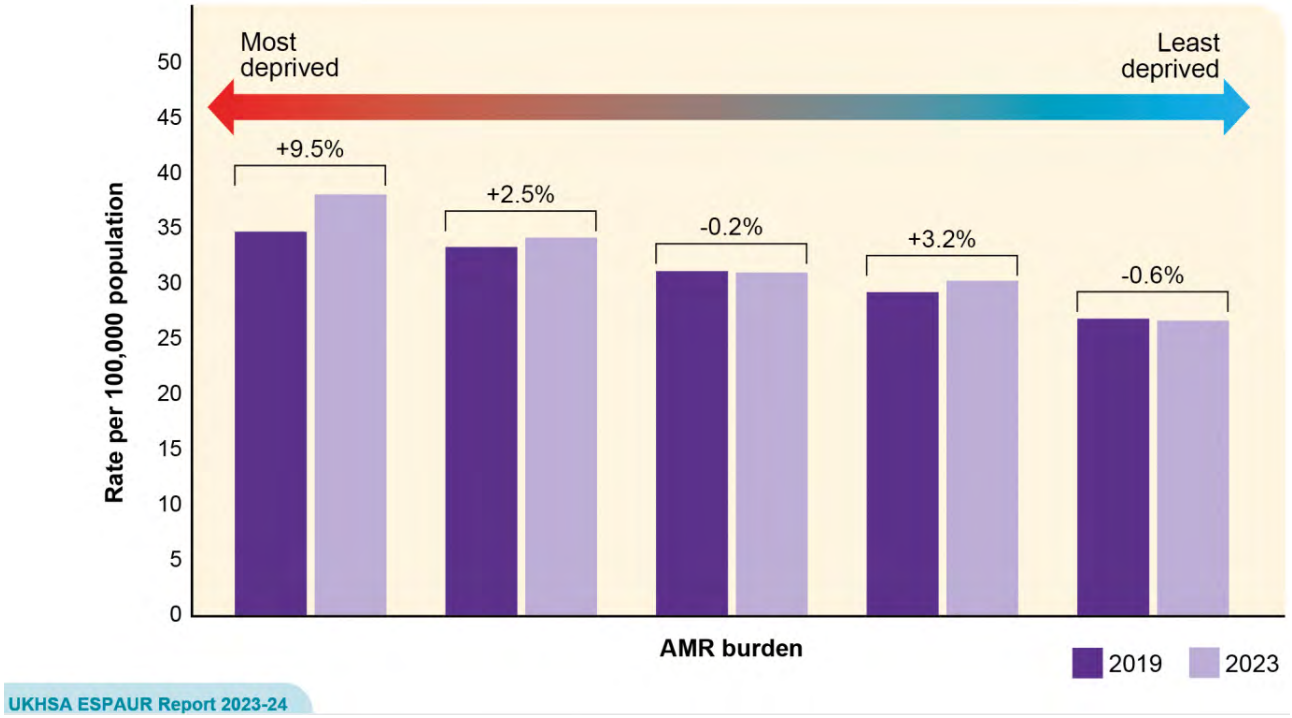
Age: Between 2019 and 2023, there was a 25% increase in rates of bacteraemia in children aged 0 to 17 years (118.5 to 148.6 per 100,000 population), albeit two-thirds of this rise may be due to a higher rate of blood culture contamination with skin commensals rather than a true increase in bloodstream infections.[22] Children experience relatively higher rates of MRSA (8.9% in 2023 for 0 to 17 year olds) compared to the general population (6.7%), with the highest rates in children aged 4 days to <1 year (11.2% in 2023), and increasing rates of resistance in *E. coli* and *K. pneumoniae*.[23,24] In addition, the number and rates of both bacteraemia and resistant bacteraemia were highest in people aged over 65 and then the youngest age groups.[25]

Ethnicity: Since 2021, the ESPAUR report has included variation in the burden of AMR bacteraemia by ethnic group.[26] The highest rate of bacteraemia episodes was recorded in the White ethnic group (146.7 per 100,000 population; n=71,457) in 2023. However, the highest percentage of resistance was reported in the Asian or Asian British ethnic group (39.4%;

n=1,835), followed by the Black, African, Caribbean or Black British ethnic group (26.5%; n=663).[27] Possible explanations for this include travel to or receiving care in hospitals in countries with higher prevalence of AMR bacteria.[28,29] People coming from and living within diaspora communities, where there are multigenerational households and family members returning from or seeking care overseas, may be at increased risk of AMR because of transmission between people in households.[30]

Deprivation: The difference in resistant bacteraemia rates between the most and least deprived areas in England increased from 34% in 2019 to 42.6% in 2023 (Figure 5).[31]

Figure 5: Rate of AMR burden per 100,00 population by Index of Multiple Deprivation in 2019 and 2023



Source: Image by UK Health Security Agency, English Surveillance Programme for Antimicrobial Utilisation and Resistance (ESPAUR) Report 2023-2024 is licensed under the Open Government Licence v3.0.

Fungal, viral and parasitic AMR

Resistant fungal infections pose a growing public health concern as demonstrated by the WHO fungal priority pathogens list.[32] In England, there have been increasing reports of antifungal resistant *Candidozyma auris* in hospitals[33] and *Trichophyton indotineae* in the community.[34] *Candidozyma auris* can cause serious infections particularly in critically ill patients, while *Trichophyton indotineae* causes skin infections. Azole-resistant isolates of *Aspergillus fumigatus*, a WHO critical pathogen, have also been increasingly detected in England. Antifungal resistance is discussed further in chapter 4.2.

Antiviral resistance affects people on treatment for viral diseases such as HIV, Hepatitis C and influenza. HIV requires lifelong medication. Between 2015 to 2019, the prevalence of overall HIV drug resistance in people on treatment in the UK was between 27% and 29%.[35] Treating

resistant infection often requires a larger number of medications or pill burden, often with greater side effects. For Hepatitis C, from 2019 to 2023, resistance to direct acting antiviral agents was low (under 20%) in treatment naïve individuals (those not previously treated for Hepatitis C). However, resistance was high for those who had received treatment, remaining at over 50% since 2020. For influenza, very low numbers of resistance to the mainstay of treatment, oseltamivir is reported (under 1%)[36] – resistant viruses emerge in immunocompromised individuals during treatment, highlighting the need for surveillance within vulnerable populations (as had previously been seen with the development of COVID-19 resistance).[37]

Parasites developing resistance to antiparasitic agents are of importance within England for imported infections in returning travellers. In the UK, resistance to key antimalarial drugs – particularly oral artemisinin-based combination therapies common in south-east Asia – remains rare. However, nearly 9 out of 10 returning travellers to the UK who contracted malaria overseas have taken no chemoprophylaxis, meaning they were at risk of contracting the infection.[38]

Tackling AMR

Prevention

Controlling the spread of infection is inextricably linked to efforts to prevent AMR. Ensuring sustained, equitable immunisation rates across England and working with international partners to improve coverage worldwide, are also fundamental. Vaccines play a key role in preventing infections and, therefore, the need for antimicrobials, preserving use for where they are most needed. For example, it is anticipated that roll-out of the new respiratory syncytial virus (RSV) vaccine will lead to a significant reduction in community antibiotic use. RSV is a virus that will not respond to antibiotic therapy, however RSV infections may be confused with bacterial infections, resulting in inappropriate antibiotic use. Preventing RSV infection will also reduce the risk of secondary bacterial infections which can occur with viral infections and thus reduce appropriate antibiotic use too. Prescriptions associated with this infection are thought to account for 2.1% of all antibiotics prescribed in England – an average of 640,000 prescriptions annually.[39]

A maternal Group B Streptococcus vaccine is under development, which if approved will protect infants from serious infections, reducing both infant mortality and antibiotic use in neonatal units worldwide.[40] Vaccines are under development for the prevention of several other bacterial infections, including Group A Streptococcus (GAS) and a maternal vaccine for *K. pneumoniae.* A recent WHO report highlighted that vaccines in late stages of clinical development could avert up to 135,000 AMR-associated deaths and reduce antimicrobial use by 1.9 billion defined daily doses annually across the world.[41] However, vaccine development can be challenging, as demonstrated by the discontinuation of a recent late-stage trial for a new *E. coli* vaccine due to insufficient evidence of its efficacy.[42]

The spread of AMR microorganisms is a major concern, particularly in healthcare settings. By reducing spread between patients, the risk of infection can be reduced and the need for

antibiotics avoided (see "Antimicrobial Stewardship" section, later). In fragile, stressed healthcare systems, including those still recovering from the after-effects of COVID-19, lapses in basic infection control practices (for example, hand washing) can occur. The rate of bloodstream infections nearly doubled in critical care units during the early stages of the COVID-19 pandemic and 30-day associated mortality increased from 25.6% at the start of surveillance to 33.3% during this time. It is possible that breakdowns in infection control practices contributed to this increase.[43]

The most recent English national point prevalence report on healthcare associated infection (HCAI), antimicrobial use and antimicrobial stewardship found a total HCAI prevalence of 8.0% in acute NHS trusts in 2023 – up from 6.6% in 2016.[44] This is likely multifactorial but an increase in infection control challenges is concerning. There was a resulting increase in antimicrobial prescribing; on average 37.3% of all patients in acute hospitals were on antibiotics at the time of the survey.[45] Developing the infection prevention and control evidence base and support for implementation of the most effective ways to reduce the spread of AMR within healthcare settings is a critical area for prevention of HCAI. These infections are discussed in more detail in chapter 4.5.

Better diagnostic tests

It is often difficult to determine if symptoms are a result of infection, and even if so, the microbial cause. This diagnostic uncertainty is a major driver of unnecessary antibiotic use, as healthcare professionals often prescribe antibiotics 'just in case' an infection is present and whether or not it is bacterial. Development and use of accurate point-of-care-tests which reduce diagnostic uncertainty will support more appropriate use of antimicrobials. There is a need for greater evidence to best position these tests within the NHS – both in the community (where they need to be cheap and determine whether an antimicrobial is needed or not) and in hospital (where they can be more expensive but need to deliver reliable results to aid selection of the best antimicrobial).[46]

Antimicrobial stewardship

Improving the use of antibiotics

Another way to prevent the emergence and spread of AMR is by reducing the unnecessary use of antimicrobials.

NHS England designs and administers improvement and assurance schemes related to antibiotic prescribing. The percentage of Integrated Care Boards (ICBs) meeting the national target for total primary care prescribing of antibiotics was low at 24%, while the percentage of ICBs meeting the national target for reducing "broad-spectrum" antibiotics in primary care was excellent at 95%. Further work is therefore needed to reduce overall antibiotic prescribing.

One way to reduce antibiotic consumption is to reduce standard course lengths, as many patients will get better with shorter courses of antibiotics. There is evidence of progress here, as

the proportion of 5-day prescriptions for amoxicillin has increased by a third, with 57% of all amoxicillin prescribed as a 5-day course by March 2024.[47]

The WHO has allocated all antibiotics into 3 AWaRe groups ("**A**ccess", "**Wa**tch", and "**Re**serve") in order to encourage use of antibiotics that are considered to be less likely to select for resistance ("Access") and to discourage use where resistance would have greater clinical implications ("Watch" and "Reserve").[48] In English hospitals, just 20% of NHS trusts achieved the NHS Standard Contract target to reduce "Watch" and "Reserve" antimicrobial prescribing.[49] A current target in the UK National Action Plan on AMR (see below) is for 70% of antibiotics used to come from the "Access" category. Ambitiously, the UK has adopted a more stringent AWaRe categorisation than the WHO, with a key antibiotic used in the community – amoxicillin with clavulanic acid – being a "Watch" rather than "Access" antibiotic.[50]

When using the WHO 2023 classification for international comparison, the proportional use of "Access" category antibiotics in the UK increased between 2019 and 2022.[51] In 2019, 68.03% of antibiotic use in the UK (including data from England and Scotland only) was from the "Access" category, above the WHO target of 60% and European target of at least 65%.[52,53] In 2022, performance against the global and European targets improved further to 71% of total antibiotic use from the "Access" category.

Meeting antibiotic prescribing targets is hampered by unpredictable changes in the incidence of infections. In winter 2022, there was an unprecedented increase in GAS, the bacteria that causes 'Strep throat' and scarlet fever, across the UK. English healthcare staff reported more scarlet fever cases than had been recorded since the 1950s, and there was a large rise in serious GAS infection, including fatal cases.[54] This wave of GAS infections led to a significant country-wide increase in antibiotic prescribing, leading to shortages of penicillins.[55] Similar increases in GAS infection were seen across the globe, likely related to decreased immunity to GAS from social distancing measures introduced to control the spread of COVID-19. In 2024, rates of scarlet fever had returned to usual levels, but an increase was seen in infections caused by *Mycoplasma pneumoniae.*[56]

The role of 'penicillin allergy' labels

New data from 2024 indicate that 8% of people registered with a general practice in England have a penicillin allergy label, slightly higher than previous estimates of 6%.[57,58] Penicillin allergy labels are associated with worse patient health outcomes (through increased mortality, hospital admission, intensive care unit admission) and prescribing of second/third line antibiotic treatments, more antibiotic use overall and less desirable antibiotic agents.[59] In addition, a recent rapid review has summarised current evidence that penicillin allergy labels are also associated with increased risk of infection or colonisation with resistant bacteria.[60]

More than 90% of patients labelled with a penicillin allergy do not have a true penicillin allergy. Unfortunately, there are insufficient consultant immunologists in the NHS, who have traditionally carried out penicillin allergy assessments, to undertake an evaluation of the estimated 3 to 4 million people with an incorrect penicillin allergy record. The current AMR National Action Plan considers that penicillin allergy assessment is vital to ensure patients are

not unnecessarily denied access to penicillins.[61] The British Society for Allergy and Clinical Immunology has published guidelines for non-specialist delivery of penicillin allergy assessment services.[62] New research carried out in NHS hospitals in Oxford, Leeds and Birmingham indicates that penicillin allergy assessment can be carried out in hospitals by non-allergy specialists and,[63] for the first time, a randomised clinical trial has confirmed that penicillin allergy assessment carried out in primary care patients increases penicillin prescribing, reduces total antibiotic use and is cost-effective.[64] We need to determine which patients are the most appropriate to be assessed by this route and where in the NHS is the best place to carry out the assessment. Greater patient harm is being caused by incorrect penicillin allergy labels and penicillin avoidance than is caused by true allergic reactions to penicillin.

Public and professional understanding of AMR and changing behaviours

Initiatives such as 'Treat Antibiotics Responsibly, Guidance, Education and Tools' (TARGET) help primary care professionals to improve antibiotic prescribing.[65] While many clinicians are aware of AMR, this does not necessarily translate into prescribing behaviour change, which continues to be excessive in some settings. Knowledge alone does not change behaviours and evidence-based interventions are needed to change prescribing behaviour. Moreover, we must address the structural problems that prevent clinicians from implementing antimicrobial stewardship such as short GP appointment times and access to point of care testing.[66]

Public understanding of AMR can support clinicians to change prescribing behaviours. Depictions of AMR in the media have generally focused on the threat posed by bacteria that are untreatable because of resistance to all available antibiotics (sometimes called pan-resistance). While these pan-resistant bacteria have profound implications for the patients affected, they are rare and do not represent the main burden of AMR. Initiatives such as the Antibiotic Guardian campaign and eBug support the public, including children and young people, to better understand infections, antibiotics and AMR.

New antimicrobials, treatments and technologies

The antimicrobial products subscription model was formally launched during 2024 to incentivise pharmaceutical companies to develop new antibiotics by delinking use of an antibiotic with reimbursement.[67] This means that companies producing suitable antimicrobials can be guaranteed a return on their product investment – regardless of how little those antibiotics are used – to safeguard newer antibiotics for when they are most needed. After a successful pilot, the scheme is now open to pharmaceutical companies who have developed new antibiotics and will guarantee a fixed annual fee based on their value to the NHS.[68]

Changing resistance patterns in bacteria are affecting recommended dosing regimens. Studies of the sickest patients indicate great variability in blood levels of antibiotics, with both personalised dosing and increased use of digital technologies offering potential improvements to antimicrobial prescribing. The best use of these promising areas remains an ongoing research area.[69,70]

In 2024, UKHSA developed a laboratory service to provide data on antimicrobial activity that can be used by pharmaceutical companies as evidence for their activity across highly resistant bacteria.[71] UKHSA also evaluates antibiotics in late clinical development, laboratory diagnostics, antibiotic combinations, vaccines and non-traditional therapies (notably phage and polyclonal antibody therapies), working with industry partnerships.[72] A subscription model adopted at a global level would also help to solve inequitable access to newer antibiotics for patients who cannot afford them, a particular issue in low and middle income countries.[73]

Within England, UKHSA and many academic centres are increasingly using whole genome sequencing to address the spread and treatment of AMR micro-organisms. Whole genome sequencing allows for more accurate identification and effective control of outbreaks preventing opportunities for AMR to emerge and spread. In UKHSA, AMR gene detection using whole genome sequencing services are in development for *Clostridioides difficile*, Group A Streptococcus, Group B Streptococcus and other bacteria. Recent genomic analysis has provided additional evidence of transfer of AMR genes between different bacteria.[74]

Data integration

Improved data sharing across the patient life course – including all healthcare utilisation, antimicrobial prescriptions and potential AMR exposures – can help to find areas for intervention. Cloud-based solutions have enabled greater scalability but advancing data availability and analysis across the whole healthcare system is needed. The Unified Infection Dataset, a software application which allows the standardised and automated linkage of data, was developed and launched during the COVID-19 pandemic to link hospital admission data, laboratory information about bacteria, primary care prescribing data and mortality.[75] As more information becomes available in an updated data platform – in particular, hospital prescribing and GP visits data – our ability to understand how resistant infections emerge will improve helping inform effective prevention strategies.[76]

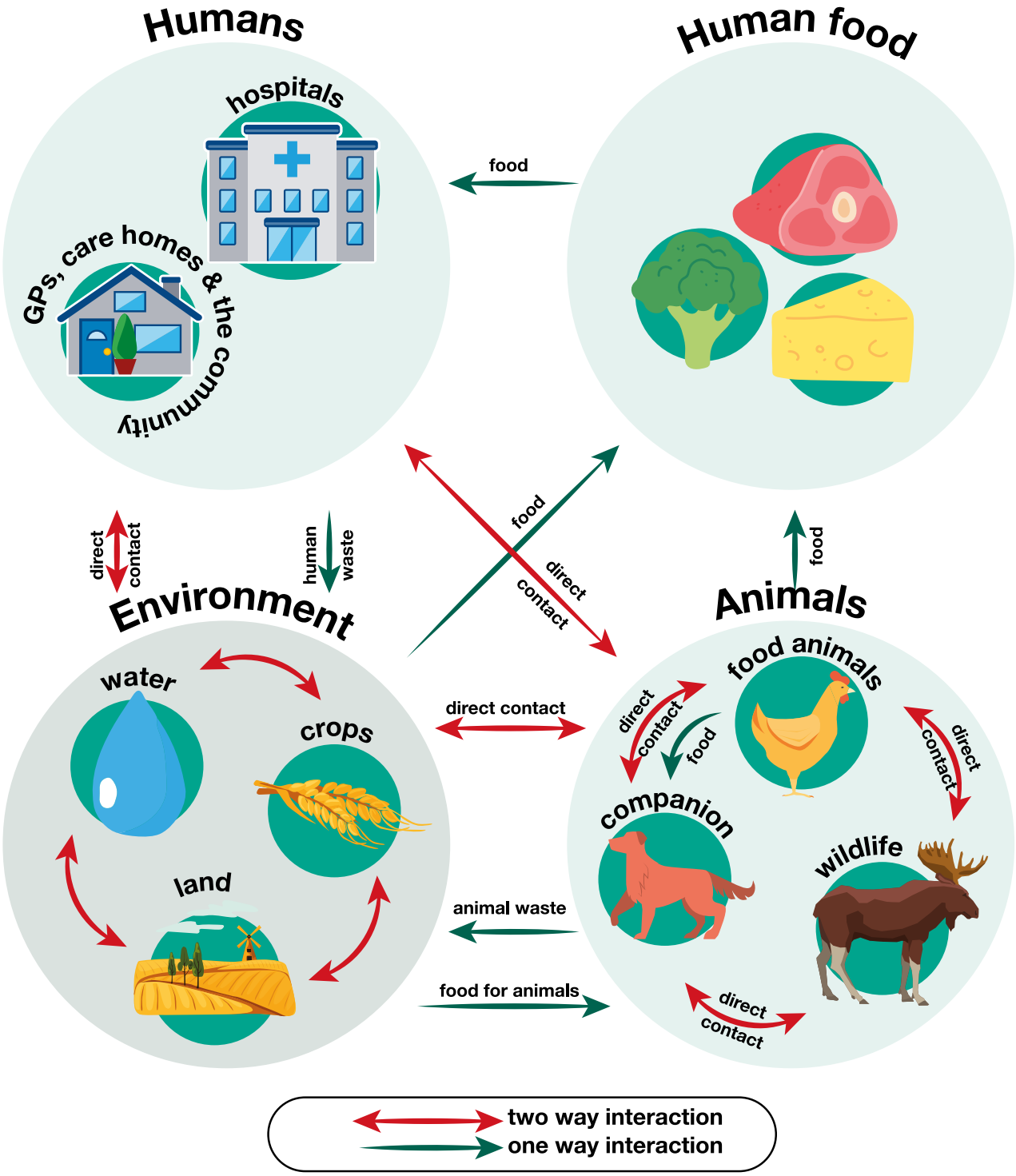
UK National Action Plan on AMR

The UK has developed a 20-year vision to contain, control and mitigate AMR by 2040.[77] This requires coordinated national and international action across multiple stakeholders, including governments, international organisations, private businesses, investors, civil society, academia and philanthropy. To deliver on this vision, the government committed to producing a series of 5-year national action plans to coordinate activity to mitigate the spread of AMR, the first of which ranked in the top 3 most developed country plans, with strengths in policy design, implementation, monitoring and evaluation.[78,79]

The different approaches aimed at containing, controlling and mitigating AMR take a "One health" perspective that recognises the fact that we (humans) do not exist in isolation but that micro-organisms move between people, animals, agriculture and the environment and likewise antimicrobials used in people and animals can also end up in the environment. To avoid unnecessary exposure to antimicrobials we need to act within and across all these sectors (Figure 6). For example, increasing global temperatures are driving changes in population

migration and the spread of pathogens; increasing levels of contact with animal reservoirs through agricultural practices and changing use of environments, facilitating AMR spread.[80]

Figure 6: One Health interactions for AMR[81]



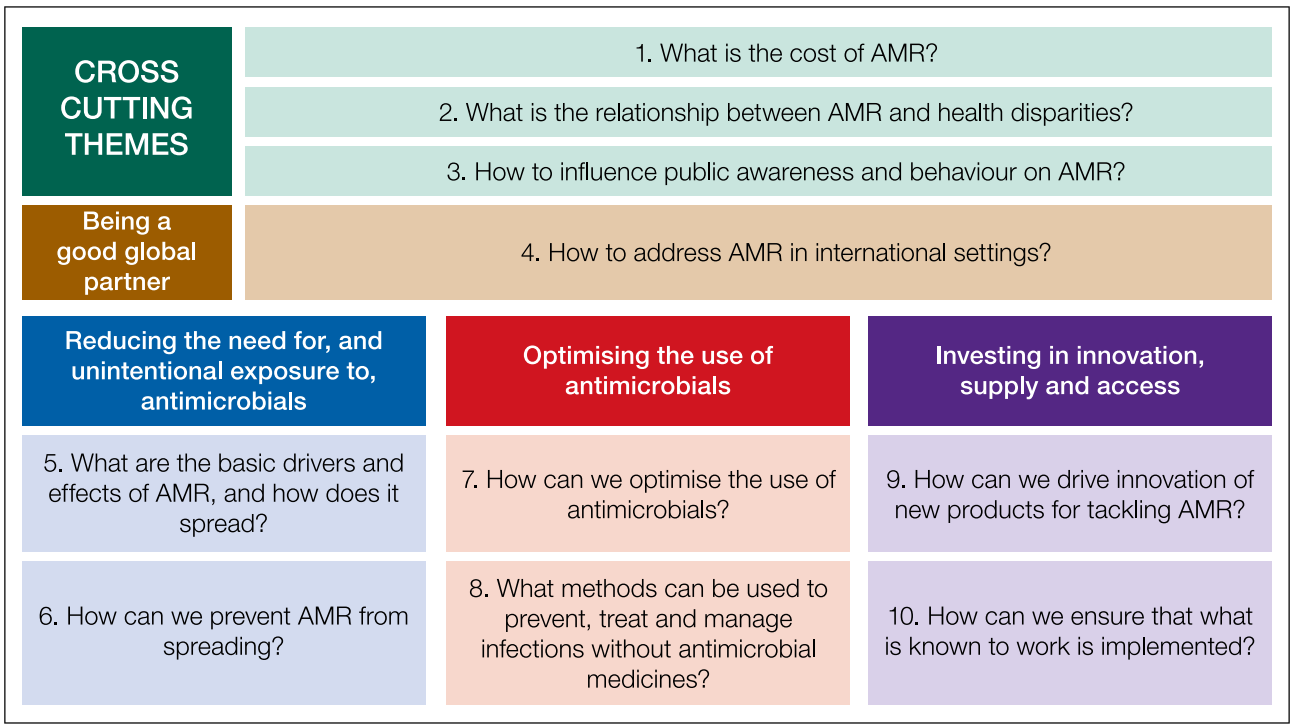
Source: Image by Department of Health & Social Care, Department for Environment, Food & Rural Affairs, Department of Health (Northern Ireland), Department of Agriculture, Environment and Rural Affairs (Northern Ireland), Scottish Government, Welsh Government, Confronting antimicrobial resistance 2024 to 2029 is licensed under the Open Government Licence v3.0.

The UK also plays an important role in tackling AMR globally, including through surveillance and reference microbiology, for example via the Fleming Fund, the NHS England subscription model, the Global AMR Innovation Fund and advancing stewardship of antibiotic use in animal health.

Research priorities for AMR

There is currently a lack of high-quality evidence to support planned actions aimed at reducing AMR. The latest national action plan has identified 10 key research areas to close the evidence gap (Figure 7).[82] AMR outcomes are not usually included in trials due to size and cost, however, large clinical trials or suitable alternatives are needed to support these research goals. In one example, the 'Improving Primary Care Antibiotic Prescribing (IPAP) – urinary tract infection (UTI) study' funded by the National Institute for Health and Care Research, is conducting 3 randomised controlled trials to understand how changing prescribing alters AMR to antibiotics prescribed for UTIs in primary care.[83]

Figure 7: Top 10 research priorities for the UK AMR National Action Plan 2024 to 2029[84]



Source: Image by UK Government, Confronting antimicrobial resistance 2024 to 2029 is licensed under the Open Government Licence v3.0.

Conclusion

Managing the risks of AMR includes adapting our strategies to better diagnose and manage infections to limit the development of resistance by reducing unnecessary use of antimicrobials, while producing new (and protecting older) treatments. There are considerable challenges ahead, with rising numbers of infections (and resistance), widening gaps in inequalities and impacts on vulnerable groups. The continued impact of the COVID-19 pandemic is likely to be profound, with a return to regular global travel coinciding with residual effects of altered

healthcare and changes in community vulnerability to seasonal pathogens. Preventing infection through vaccination and good infection, prevention and control practice are also key to tacking AMR. Reducing levels of infection would lower antimicrobial use and, by extension, the opportunity for AMR to develop. Improved diagnostic capability would reduce clinical uncertainty and enable healthcare professionals to more accurately and reliably prescribe antimicrobials as an adjunct to antimicrobial stewardship. New antimicrobials, treatments and technologies and improvements in data sharing and research will further progress action against AMR.

References

1 UK Health Security Agency. English Surveillance Programme for Antimicrobial Utilisation and Resistance (ESPAUR) Report 2023-2024. [Internet] 2024. [Accessed 25 August 2025] Available from: assets.publishing.service.gov.uk/media/6734e208b613efc3f1823095/ESPAUR-report-2023-2024.pdf

2 European Committee on Antimicrobial Susceptibility Testing. Clinical breakpoints – breakpoints and guidance. [Internet] 2025. [Accessed 25 August 2025] Available from: https://www.eucast.org/clinical_breakpoints

3 World Health Organization. Bacterial priority pathogens list, 2024: bacterial pathogens of public health importance to guide research, development and strategies to prevent and control antimicrobial resistance. [Internet] 2024. [Accessed 25 August 2025] Available from: https://www.who.int/publications/i/item/9789240093461

4 UK Health Security Agency. English Surveillance Programme for Antimicrobial Utilisation and Resistance (ESPAUR) Report 2023-2024. [Internet] 2024. [Accessed 25 August 2025] Available from: assets.publishing.service.gov.uk/media/6734e208b613efc3f1823095/ESPAUR-report-2023-2024.pdf

5 UK Health Security Agency. English Surveillance Programme for Antimicrobial Utilisation and Resistance (ESPAUR) Report 2023-2024. [Internet] 2024. [Accessed 25 August 2025] Available from: assets.publishing.service.gov.uk/media/6734e208b613efc3f1823095/ESPAUR-report-2023-2024.pdf

6 UK Health Security Agency. English Surveillance Programme for Antimicrobial Utilisation and Resistance (ESPAUR) Report 2023-2024. [Internet] 2024. [Accessed 25 August 2025] Available from: assets.publishing.service.gov.uk/media/6734e208b613efc3f1823095/ESPAUR-report-2023-2024.pdf

7 UK Health Security Agency. English Surveillance Programme for Antimicrobial Utilisation and Resistance (ESPAUR) Report 2023-2024. [Internet] 2024. [Accessed 25 August 2025] Available from: assets.publishing.service.gov.uk/media/6734e208b613efc3f1823095/ESPAUR-report-2023-2024.pdf

8 UK Health Security Agency. Annual epidemiological commentary: Gram-negative, MRSA, MSSA bacteraemia and C. difficile infections, up to and including financial year 2023 to 2024. [Internet] 2024. [Accessed 25 August 2025] Available from: https://www.gov.uk/government/statistics/mrsa-mssa-and-e-coli-bacteraemia-and-c-difficile-infection-annual-epidemiological-commentary/annual-epidemiological-commentary-gram-negative-mrsa-mssa-bacteraemia-and-c-difficile-infections-up-to-and-including-financial-year-2023-to-2024#meticillin-resistant-staphylococcus-aureus-bacteraemia-mrsa

9 UK Health Security Agency. Annual epidemiological commentary: Gram-negative, MRSA, MSSA bacteraemia and C. difficile infections, up to and including financial year 2023 to 2024. [Internet] 2024. [Accessed 25 August 2025] Available from: https://www.gov.uk/government/statistics/mrsa-mssa-and-e-coli-bacteraemia-and-c-difficile-infection-annual-epidemiological-commentary/annual-epidemiological-commentary-gram-negative-mrsa-mssa-bacteraemia-and-c-difficile-infections-up-to-and-including-financial-year-2023-to-2024#meticillin-resistant-staphylococcus-aureus-bacteraemia-mrsa

10 UK Health Security Agency. English Surveillance Programme for Antimicrobial Utilisation and Resistance (ESPAUR) Report 2023-2024. [Internet] 2024. [Accessed 25 August 2025] Available from: assets.publishing.service.gov.uk/media/6734e208b613efc3f1823095/ESPAUR-report-2023-2024.pdf

11 World Health Organization. AMR Dashboard, Antimicrobial Resistance Map. [Internet] Available from: https://worldhealthorg.shinyapps.io/WHO-AMR-Dashboard/

12 UK Health Security Agency. Annual epidemiological commentary: Gram-negative, MRSA, MSSA bacteraemia and C. difficile infections, up to and including financial year 2023 to 2024. [Internet] 2024. [Accessed 25 August 2025] Available from: https://www.gov.uk/government/statistics/mrsa-mssa-and-e-coli-bacteraemia-and-c-difficile-infection-annual-epidemiological-commentary/annual-epidemiological-commentary-gram-negative-mrsa-mssa-bacteraemia-and-c-difficile-infections-up-to-and-including-financial-year-2023-to-2024#meticillin-resistant-staphylococcus-aureus-bacteraemia-mrsa

13 Miller WR, Arias CA. ESKAPE pathogens: antimicrobial resistance, epidemiology, clinical impact and therapeutics. Nature Rev Microbiol 2024;22(10):598-616. doi: 10.1038/s41579-024-01054-w.

14 European Centre for Disease Prevention and Control. Antimicrobial resistance in the EU/EEA (EARS-NET) Annual epidemiological report for 2023. [Internet] 2024. [Accessed 25 August 2025]. Available from: https://www.ecdc.europa.eu/en/publications-data/antimicrobial-resistance-eueea-ears-net-annual-epidemiological-report-2023

15 UK Health Security Agency. Annual epidemiological commentary: Gram-negative, MRSA, MSSA bacteraemia and C. difficile infections, up to and including financial year 2023 to 2024. [Internet] 2024. [Accessed 25 August 2025]. Available from: https://www.gov.uk/government/statistics/mrsa-mssa-and-e-coli-bacteraemia-and-c-difficile-infection-annual-epidemiological-commentary/annual-epidemiological-commentary-gram-negative-mrsa-mssa-bacteraemia-and-c-difficile-infections-up-to-and-including-financial-year-2023-to-2024#meticillin-resistant-staphylococcus-aureus-bacteraemia-mrsa

16 UK Health Security Agency. Carbapenemase-producing Gram-negative organisms in England since October 2020: quarterly update, Q1 2025 [Internet] 2025. [Accessed 25 August 2025]. Available from: https://www.gov.uk/government/publications/carbapenemase-producing-gram-negative-bacteria-laboratory-surveillance/carbapenemase-producing-gram-negative-organisms-in-england-since-october-2020-quarterly-update-q1-2025

17 UK Health Security Agency. Carbapenemase-producing Gram-negative organisms in England since October 2020: quarterly update, Q1 2025. [Internet] 2025. [Accessed 25 August 2025] Available from: https://www.gov.uk/government/publications/carbapenemase-producing-gram-negative-bacteria-laboratory-surveillance/carbapenemase-producing-gram-negative-organisms-in-england-since-october-2020-quarterly-update-q1-2025

18 Ma J, Song X, Li, M, et al. Global spread of carbapenem-resistant Enterobacteriaceae: Epidemiological features, resistance mechanisms, detection and therapy. Microbiol Res 2023;266:127249. doi: 10.1016/j.micres.2022.127249.

19 European Centre for Disease Prevention and Control and World Health Organization. Antimicrobial resistance surveillance in Europe 2023 – 2021 data. [Internet] 2023. [Accessed 25 August 2025] Available from: https://www.ecdc.europa.eu/en/publications-data/antimicrobial-resistance-surveillance-europe-2023-2021-data

20 UK Health Security Agency. English Surveillance Programme for Antimicrobial Utilisation and Resistance (ESPAUR) Report 2023-2024. [Internet] 2024. [Accessed 25 August 2025] Available from: assets.publishing.service.gov.uk/media/6734e208b613efc3f1823095/ESPAUR-report-2023-2024.pdf

21 National Audit Office. Investigation into how government is addressing antimicrobial resistance. [Internet] 2025. [Accessed 25 August 2025] Available from: https://www.nao.org.uk/reports/investigation-into-how-government-is-addressing-antimicrobial-resistance/, p.17

22 UK Health Security Agency. Laboratory surveillance of paediatric bacterial bacteraemia and antimicrobial resistance in England: 2019 to 2023. [Internet] 2025. [Accessed 25 August 2025] Available from: https://assets.publishing.service.gov.uk/media/6842f691e5a089417c8060e7/hpr0225-paediatric-bacteraemia1.1.pdf

23 UK Health Security Agency. Laboratory surveillance of paediatric bacteraemia in England: 2019 to 2023. [Internet] 2025. [Accessed 25 August 2025] Available from: https://www.gov.uk/government/publications/laboratory-surveillance-of-paediatric-bloodstream-infections-in-england

24 Falola A, Squire H, Bou-Antoun S, Løchen A, Brown CS, Demirjian A. COVID-19 Therapeutics Use by Social Deprivation Index in England, July 2020–April 2023. COVID 2024;4(5):645-651. doi: 10.3390/covid4050043

25 UK Health Security Agency. English Surveillance Programme for Antimicrobial Utilisation and Resistance (ESPAUR) Report 2023-2024. [Internet] 2024. [Accessed 25 August 2025] Available from: assets.publishing.service.gov.uk/media/6734e208b613efc3f1823095/ESPAUR-report-2023-2024.pdf

26 UK Health Security Agency. English Surveillance Programme for Antimicrobial Utilisation and Resistance (ESPAUR) Report 2023-2024. [Internet] 2024. [Accessed 25 August 2025] Available from: assets.publishing.service.gov.uk/media/6734e208b613efc3f1823095/ESPAUR-report-2023-2024.pdf

27 UK Health Security Agency. English Surveillance Programme for Antimicrobial Utilisation and Resistance (ESPAUR) Report 2023-2024. [Internet] 2024. [Accessed 25 August 2025] Available from: assets.publishing.service.gov.uk/media/6734e208b613efc3f1823095/ESPAUR-report-2023-2024.pdf

28 Otter JA, Dyakova E, Bisnauthsing K, et al. Universal hospital admission screening for carbapenemase-producing organisms in a low-prevalence setting. J Antimicrob Chemother 2016;71(12):3556-3561. doi: 10.1093/jac/dkw309.

29 Henderson J, Cieseilczuk H, Nelson SM, Wilks N. Community prevalence of carbapenemase-producing organisms in East London. J Hosp Infect 2019;103(2):142-146. doi: 10.1016/j.jhin.2019.04.014

30 UK Health Security Agency. Carbapenemase-producing Gram-negative organisms in England since October 2020: quarterly update, Q4 2024. [Internet] 2025. [Accessed 25 August 2025] Available from: https://www.gov.uk/government/publications/carbapenemase-producing-gram-negative-bacteria-laboratory-surveillance/carbapenemase-producing-gram-negative-organisms-in-england-since-october-2020-quarterly-update-q4-2024

31 UK Health Security Agency. English Surveillance Programme for Antimicrobial Utilisation and Resistance (ESPAUR) Report 2023-2024. [Internet] 2024. [Accessed 25 August 2025] Available from: assets.publishing.service.gov.uk/media/6734e208b613efc3f1823095/ESPAUR-report-2023-2024.pdf

32 World Health Organization. WHO fungal priority pathogens list to guide research, development and public health action. [Internet] 2022. [Accessed 25 August 2025] Available from: https://www.who.int/publications/i/item/9789240060241

33 UK Health Security Agency. Increase in Candidozyma (Candida) auris reports in England, linked to hospital outbreaks. [Internet] 2025. [Accessed 25 August 2025] Available from: https://www.gov.uk/government/publications/health-protection-report-volume-19-2025/hpr-volume-19-issue-3-news-27-march-2025

34 Abdolrasouli A, Barton RC, Borman AM. Spread of Antifungal-Resistant Trichophyton indotineae, United Kingdom, 2017–2024. Emerg Infect Dis 2025;31(1):192–194. doi: 10.3201/eid3101.240923.

35 UK Health Security Agency. English Surveillance Programme for Antimicrobial Utilisation and Resistance (ESPAUR) Report 2023-2024. [Internet] 2024. [Accessed 1 August 2025] Available from: assets.publishing.service.gov.uk/media/6734e208b613efc3f1823095/ESPAUR-report-2023-2024.pdf

36 UK Health Security Agency. English Surveillance Programme for Antimicrobial Utilisation and Resistance (ESPAUR) Report 2023-2024. [Internet] 2024. [Accessed 1 August 2025] Available from: assets.publishing.service.gov.uk/media/6734e208b613efc3f1823095/ESPAUR-report-2023-2024.pdf

37 Ragonnet-Cronin M, Nutalai R, Huo J, et al. Generation of SARS-CoV-2 escape mutations by monoclonal antibody therapy. Nat Commun 2023;14(1):3334. doi: 10.1038/s41467-023-37826-w.

38 UK Health Security Agency. English Surveillance Programme for Antimicrobial Utilisation and Resistance (ESPAUR) Report 2023-2024. [Internet] 2024. [Accessed 25 August 2025] Available from: assets.publishing.service.gov.uk/media/6734e208b613efc3f1823095/ESPAUR-report-2023-2024.pdf

39 Miller L, Beaney T, Hope R, Costelloe CE. General practice antibiotic prescriptions attributable to respiratory syncytial virus by age and antibiotic class: an ecological analysis of the English population. J Antimicrob Chemother 2025;80(4):1116-1 doi: 10.1093/jac/dkaf043.

40 UK Health Security Agency. VDEC is supporting a GBS vaccine to prevent newborn deaths. [Internet] 2024. [Accessed 25 August 2025] Available from: https://www.gov.uk/government/case-studies/vdec-is-supporting-a-gbs-vaccine-to-prevent-newborn-deaths

41 World Health Organization. Estimating the impact of vaccines in reducing antimicrobial resistance and antibiotic use: technical report. [Internet] 2024. [Accessed 25 August 2025] Available from: https://www.who.int/publications/i/item/9789240098787

42 Sanofi. Press Release: Update on extraintestinal pathogenic E. coli vaccine phase 3 clinical study. [Internet] 2025. [Accessed 25 August 2025] Available from: https://www.sanofi.com/en/media-room/press-releases/2025/2025-02-13-06-00-00-3025576

43 UK Health Security Agency. Surveillance of bloodstream infections in critical care units, England: May 2016 to March 2024 report. [Internet] 2025. [Accessed 25 August 2025] Available from: https://www.gov.uk/government/statistics/surveillance-of-bloodstream-infections-in-critical-care-england/surveillance-of-bloodstream-infections-in-critical-care-units-england-may-2016-to-march-2024-report

44 UK Health Security Agency. Point prevalence survey on HCAI, AMU and AMS in England 2023: report. [Internet] 2025. [Accessed 25 August 2025]. Available from: https://www.gov.uk/government/news/ukhsa-publishes-latest-survey-on-healthcare-associated-infections

45 UK Health Security Agency. Point prevalence survey on HCAI, AMU and AMS in England 2023: report. [Internet] 2025. [Accessed 25 August 2025]. Available from: https://www.gov.uk/government/news/ukhsa-publishes-latest-survey-on-healthcare-associated-infections

46 Tomlinson E, Ward M, Cooper C, et al. Point-of-care tests for urinary tract infections to reduce antimicrobial resistance: a systematic review and conceptual economic model. Health Technol Assess 2024;28(77):1-109. doi: 10.3310/PTMV8524.

47 UK Health Security Agency. English Surveillance Programme for Antimicrobial Utilisation and Resistance (ESPAUR) Report 2023-2024. [Internet] 2024. [Accessed 25 August 2025] Available from: assets.publishing.service.gov.uk/media/6734e208b613efc3f1823095/ESPAUR-report-2023-2024.pdf

48 World Health Organization. WHO AWaRe (access, watch, reserve) classification of antibiotics for evaluation and monitoring of use, 2023. [Internet] 2023. [Accessed 25 August 2025] Available from: https://www.who.int/publications/i/item/WHO-MHP-HPS-EML-2023.04

49 UK Health Security Agency. English Surveillance Programme for Antimicrobial Utilisation and Resistance (ESPAUR) Report 2023-2024. [Internet] 2024. [Accessed 30 May 2025] Available from: assets.publishing.service.gov.uk/media/6734e208b613efc3f1823095/ESPAUR-report-2023-2024.pdf

50 UK Health Security Agency. UK Access, Watch, Reserve, and Other classification for antibiotics (UK-AWaRe antibiotic classification). [Internet] 2025. [Accessed 25 August 2025] Available from: https://www.gov.uk/government/publications/uk-aware-antibiotic-classification/uk-access-watch-reserve-and-other-classification-for-antibiotics-uk-aware-antibiotic-classification

51 World Health Organization. Global AMU data. [Internet] 2025. [Accessed 25 August 2025] Available from: https://worldhealthorg.shinyapps.io/glass-dashboard/_w_6d34622c43054c62a26950a82630a1a9/#!/amu

52 Public Health England. ESPAUR Report 2020: English Surveillance Programme for Antimicrobial Utilisation and Resistance. [Internet] 2020. [Accessed 25 August 2025].

53 Bou-Antoun S, Oettle R, Leaonard A, et al. Adaptation of the WHO AWaRe (Access, Watch, Reserve) antibiotic classification to support national antimicrobial stewardship priorities in the UK: findings from a modified Delphi approach to achieve expert consensus. JAC Antimicrob Resist 2025;7(1):dlae218. doi: 10.1093/jacamr/dlae218.

54 Guy R, Henderson KL, Coelho J et al. Increase in invasive group A streptococcal infection notifications, England, 2022. Euro Surveill 2023;28(1):2200942. doi: 10.2807/1560-7917.ES.2023.28.1.2200942.

55 Department of Health & Social Care. Pharmacists able to supply alternative penicillin to treat strep A. [Internet] 2022. [Accessed 25 August 2025]. Available from: https://www.gov.uk/government/news/pharmacists-able-to-supply-alternative-penicillin-to-treat-strep-a

56 Todkill D, Lamagni T, Pebody R, et al. Persistent elevation in incidence of pneumonia in children in England, 2023/24. Euro Surveill 2024;29(32):2400485. doi: 10.2807/1560-7917.ES.2024.29.32.2400485.

57 West RM, Smith CJ, Pavitt SH, et al. 'Warning: allergic to penicillin': association between penicillin allergy status in 2.3 million NHS general practice electronic health records, antibiotic prescribing and health outcomes. J Antimicrob Chemother 2019;74(7):2075-82. doi: 10.1093/jac/dkz127.

58 Jani Y, Chen B, Powell N, et al. Characteristics, risk factors and clinical impact of penicillin and other antibiotic allergies in adults in the UK General Practice: a population-based cohort study. J Infect 2025;90(2):106367. doi: 10.1016/j.jinf.2024.106367

59 Blumenthal KG, Peter JG, Trubiano JA, Phillips EJ. Antibiotic allergy. Lancet 2019;393(10167):183-98.

60 Ahmed S, Sandoe JAT. A rapid literature review of the impact of penicillin allergy on antibiotic resistance. JAC Antimicrob Resist 2025;7(1):dlaf002. doi: 10.1093/jacamr/dlaf002.

61 UK Government. Confronting antimicrobial resistance 2024 to 2029. [Internet] 2024. [Accessed 25 August 2025] Available from: https://www.gov.uk/government/publications/uk-5-year-action-plan-for-antimicrobial-resistance-2024-to-2029/confronting-antimicrobial-resistance-2024-to-2029

62 Savic L, Ardern-Jones M, Avery A, et al. BSACI guideline for the set-up of penicillin allergy de-labelling services by non-allergists working in a hospital setting. Clin Exp Allergy 2022;52(10):1135-41. doi: 10.1111/cea.14217

63 Krishna MT, Bhogal R, Ng BY, et al. A Multicentre Observational Study to Investigate Feasibility of a Direct Oral Penicillin Challenge in De-labelling 'Low Risk' Patients with Penicillin Allergy by Non-Allergy Healthcare Professionals (SPACE study) – implications for healthcare systems. J infect 2024;88(3):106116. doi: 10.1016/j.jinf.2024.01.015.

64 Sandoe JT, Ahmed S, Armitage K, et al. Penicillin allergy assessment pathway versus usual clinical care for primary care patients with a penicillin allergy record in the UK (ALABAMA): an open-label, multicentre, randomised controlled trial. *Lancet Prim Care* 2025;1(1):100006

65 UK Health Security Agency. Raising awareness about AMR: toolkits for healthcare professionals. [Internet] 2022. [Accessed 25 August 2025] Available from: https://ukhsa.blog.gov.uk/2022/11/17/raising-awareness-about-amr-toolkits-for-healthcare-professionals

66 Li X, Qiu S, Liu C, et al. Point-of-care testing reduces antibiotic prescribing in acute exacerbations of chronic obstructive pulmonary disease: A systematic review and meta-analysis. Int J Infect Dis 2025:155:107889. doi: 10.1016/j.ijid.2025.107889.

67 NHS England. Antimicrobial Products Subscription Model: guidance on commercial arrangements. [Internet] 2024. [Accessed 25 August 2025]. Available from: https://www.england.nhs.uk/publication/antimicrobial-products-subscription-model-guidance-on-commercial-arrangements/

68 National Institute for Health and Care Excellence. A new model for evaluating and purchasing antimicrobials in the UK. [Internet] 2024. [Accessed 25 August 2025] Available from: https://www.nice.org.uk/about/what-we-do/life-sciences/nice-advice-service/models-for-the-evaluation-and-purchase-of-antimicrobials

69 Rawson T, Zhu N, Galiwango R, et al. Using digital health technologies to optimise antimicrobial use globally. Lancet Digit Health 2024;6(12):e914-e925. doi: 10.1016/S2589-7500(24)00198-5.

70 Yalcin N, Dirik Y, Bayraktar I, et al. Optimizing Individualized Antimicrobial Dosing in Pediatric Patients: A Systematic Review and Meta-Analysis of Randomized Controlled Trials. Clin Drug Investig 2025;45(1):1-16. doi: 10.1007/s40261-024-01415-6.

71 National Institute for Health and Care Excellence. A new model for evaluating and purchasing antimicrobials in the UK. [Internet] 2024. [Accessed 25 August 2025] Available from: https://www.nice.org.uk/about/what-we-do/life-sciences/nice-advice-service/models-for-the-evaluation-and-purchase-of-antimicrobials

72 UK Health Security Agency. UKHSA Advisory Board: Antimicrobial resistance. [Internet] 2024. [Accessed 25 August 2025]. Available from: https://www.gov.uk/government/publications/ukhsa-advisory-board-meeting-papers-for-september-2024/ukhsa-advisory-board-antimicrobial-resistance

73 Laxminarayan R, Impalli I, Rangarajan R, et al. Expanding antibiotic, vaccine, and diagnostics development and access to tackle antimicrobial resistance. Lancet 2024;403(10443):2534-50. doi: 10.1016/S0140-6736(24)00878-X.

74 Lipworth S, Matlock W, Shaw L, et al. The plasmidome associated with Gram-negative bloodstream infections: A large-scale observational study using complete plasmid assemblies. Nature Comms 2024;15:1612. doi: 10.1038/s41467-024-45761-7.

75 UK Health Security Agency. Antimicrobial Resistance: Open-innovation in early stage antimicrobial discovery and evaluation. [Internet] 2021. [Accessed 25 August 2025]. Available from: https://research.ukhsa.gov.uk/documents/UKHSA-AMR-Open-Innovation-Factsheets-Oct-2021.pdf

76 UK Health Security Agency. UKHSA data strategy. [Internet] 2023. [Accessed 25 August 2025]. Available from: https://www.gov.uk/government/publications/ukhsa-data-strategy/ukhsa-data-strategy

77 Department of Health and Social Care. UK 20-year vision for antimicrobial resistance. [Internet] 2025. [Accessed 25 August 2025]. Available from: https://www.gov.uk/government/publications/uk-20-year-vision-for-antimicrobial-resistance

78 Patel J, Harant A, Fernandes G et al. Measuring the global response to antimicrobial resistance, 2020–21: a systematic governance analysis of 114 countries. Lancet Infect Dis 2023;23(6):706-718 doi: 10.1016/S1473-3099(22)00796-4

79 Rudnick W, Mukhi SN, Reid-Smith RJ, et al. Overview of Canada's Antimicrobial Resistance Network (AMRNet): A data-driven One Health approach to antimicrobial resistance surveillance. Can Commun Dis Rep 2022;48(11-12):522-528. doi: 10.14745/ccdr.v48i1112a05.

80 UK Health Security Agency. UKHSA Advisory Board: Antimicrobial resistance. [Internet] 2024. [Accessed 25 August 2025]. Available from: https://www.gov.uk/government/publications/ukhsa-advisory-board-meeting-papers-for-september-2024/ukhsa-advisory-board-antimicrobial-resistance

81 Department of Health & Social Care, Department for Environment, Food & Rural Affairs, Department of Health (Northern Ireland), Department of Agriculture, Environment and Rural Affairs (Northern Ireland), Scottish Government, Welsh Government. Confronting antimicrobial resistance 2024 to 2029. [Internet] 2024. [Accessed 1 October 2025] Available from: https://www.gov.uk/government/publications/uk-5-year-action-plan-for-antimicrobial-resistance-2024-to-2029/confronting-antimicrobial-resistance-2024-to-2029

82 UK Government. Confronting antimicrobial resistance 2024 to 2029. [Internet] 2024. [Accessed 25 August 2025] Available from: https://www.gov.uk/government/publications/uk-5-year-action-plan-for-antimicrobial-resistance-2024-to-2029/confronting-antimicrobial-resistance-2024-to-2029

83 University of Bristol. Improving primary care antibiotic prescribing to reduce antibiotic resistant urine infections. [Internet] 2025. [Accessed 25 August 2025] Available from: https://ipaputi.blogs.bristol.ac.uk/

84 UK Government. Confronting antimicrobial resistance 2024 to 2029. [Internet] 2024. [Accessed 25 August 2025] Available from: https://www.gov.uk/government/publications/uk-5-year-action-plan-for-antimicrobial-resistance-2024-to-2029/confronting-antimicrobial-resistance-2024-to-2029

4.5 Healthcare-associated infections

Russell Hope – Lead Scientist, AMR & HCAI Division, UK Health Security Agency

Mark Wilcox – Professor of Medical Microbiology, University of Leeds, Leeds Teaching Hospitals; National Clinical Director for Infection Prevention and Control, NHS England

Contributors: Dimple Chudasama, Zahin Amin-Chowdhury, Andrea Mazzella, Matt Wilson, Tim Pollington, Lucy Findlater, Miroslava Mihalkova, Berit Muller-Pebody, Emma Budd, Lucy Miller, Kate Hayes, Leila Uwais, Emily Agnew, James Stimson, Stephanie Evans, Edwin VanLeeuwen, Nichola Naylor, Julie Robotham, Megan Rome, Conall Watson, David Eyre

Overview of healthcare-associated infection prevalence

Healthcare-associated infections (HCAIs) can develop either as a direct result of healthcare interventions, such as medical or surgical treatment, or from being exposed to a healthcare setting. People in hospital are at greater risk of acquiring infection because they are more likely to be near others who may have infection and in contact with multiple people (for example, healthcare professionals, catering staff, chaplaincy services) who move frequently between patients, increasing the risk of transmission. They are also more likely to be exposed to invasive methods of treatment such as indwelling intravenous lines and urinary catheters. People in hospital are more likely to be clinically vulnerable to infection from co-morbidity and deconditioning. HCAIs can be associated with poor patient outcomes such as longer hospital stays or, in the most serious cases, death. Good infection prevention and control (IPC) can mitigate the risk of HCAI but, even with the best of care, some infections will be hard to prevent.

The latest point prevalence survey (PPS) on HCAIs, antimicrobial use and antimicrobial stewardship was conducted in England in 2023 to produce a snapshot of HCAI prevalence in hospitals (Figure 1). The overall prevalence of patients with at least one HCAI was 7.6% (3,359 patients), an increase compared to 2016 when the prevalence was 6.6%. COVID-19 was the sole HCAI for 321 patients. When COVID-19 was removed from the data, the national prevalence of HCAI in the 2023 PPS was 7.0%. The increase in HCAI prevalence could be associated with increased pressure on the healthcare system following the COVID-19 pandemic and more severely unwell patients due to changes in access to healthcare, for example, longer waiting times for GP appointments and elective procedures.

HCAI prevalence was higher in acute NHS trusts (8%, up from 6.6% in 2016), compared with other settings. Amongst these, acute specialist NHS trusts had the highest prevalence (16.6%, up from 10.2% in 2016). Lower HCAI prevalence rates were observed in mental health and community trusts compared to acute care NHS trusts. However, the high prevalence of urinary tract infections (UTIs) and skin and soft tissue infections in these settings raises the importance

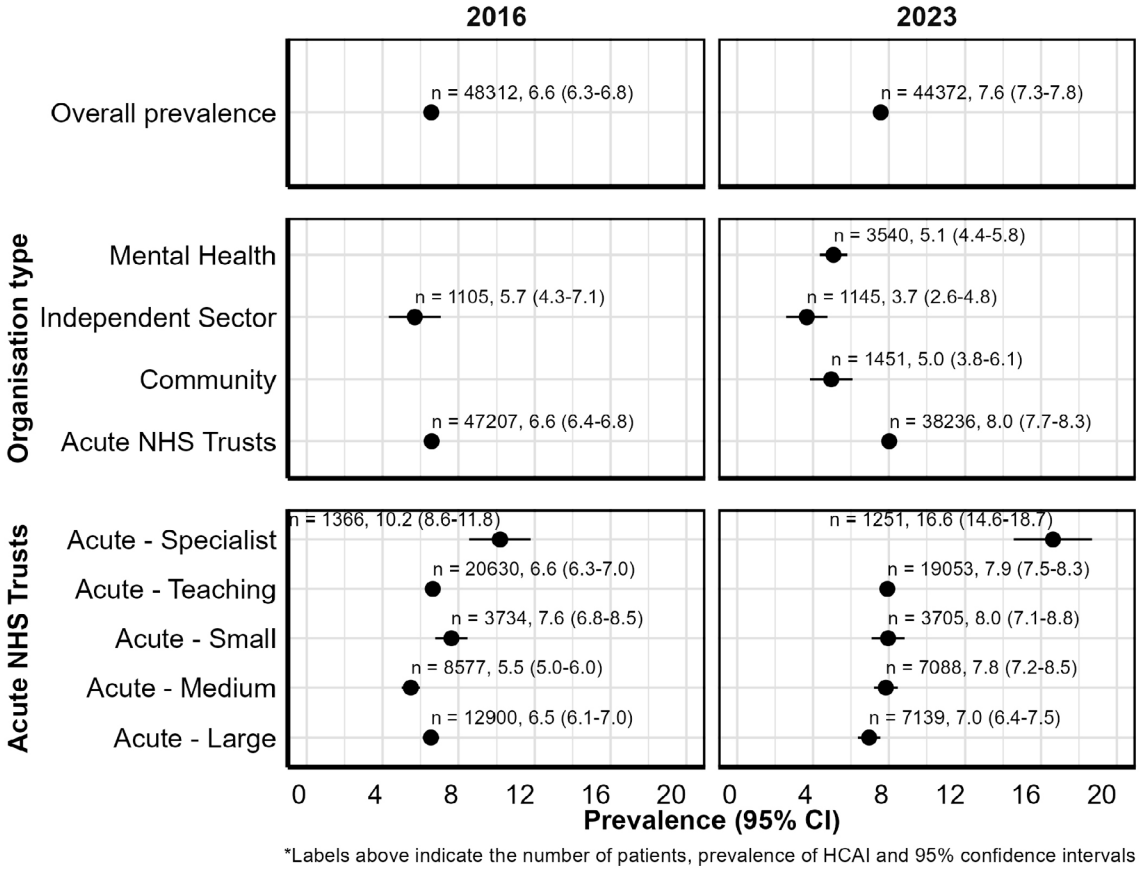
of basic nursing care, targeted IPC, and tackling contributing risk factors such as reduced mobility, device use, dehydration and incontinence.[1]

To account for the fact that each participating organisation dealt with patients of differing complexity, further analyses, including case-mix adjustment, will be conducted to allow for a meaningful comparison between organisations and over time. This more complex analysis is underway and UKHSA will publish findings at a later date.

At the specialty level, HCAI prevalence was highest in intensive care units (ICUs), including neonatal and paediatric ICUs, at 15.9%.

Of the total number of 3,493 HCAIs reported, pneumonia or lower respiratory tract infections (PNLRI) were the most common sites of infection (29.6%), followed by urinary tract infections (UTIs) (17.5%), and sepsis or disseminated infections (10.6%). The ranking of the top 3 most common infection sites for HCAIs did not differ by case-level assigned indices of multiple deprivation (IMD). For 37.5% of HCAIs, information for at least one confirmed microorganism was available on the day of the PPS. The most commonly isolated organisms were *Escherichia coli* (16.5%), SARS-CoV-2 (10.7%), *Staphylococcus aureus* (10.6%), *Clostridioides difficile* (7.4%) and *Pseudomonas aeruginosa* (7.2%).

Figure 1: Prevalence (%) of healthcare-associated infections by organisation type, England, 2016 and 2023[2]



*Labels above indicate the number of patients, prevalence of HCAI and 95% confidence intervals

Source: Image by UK Health Security Agency, Point prevalence survey on healthcare-associated infections, antimicrobial use and antimicrobial stewardship in England, 2023 is licensed under Open Government Licence v3.0.

Global comparison

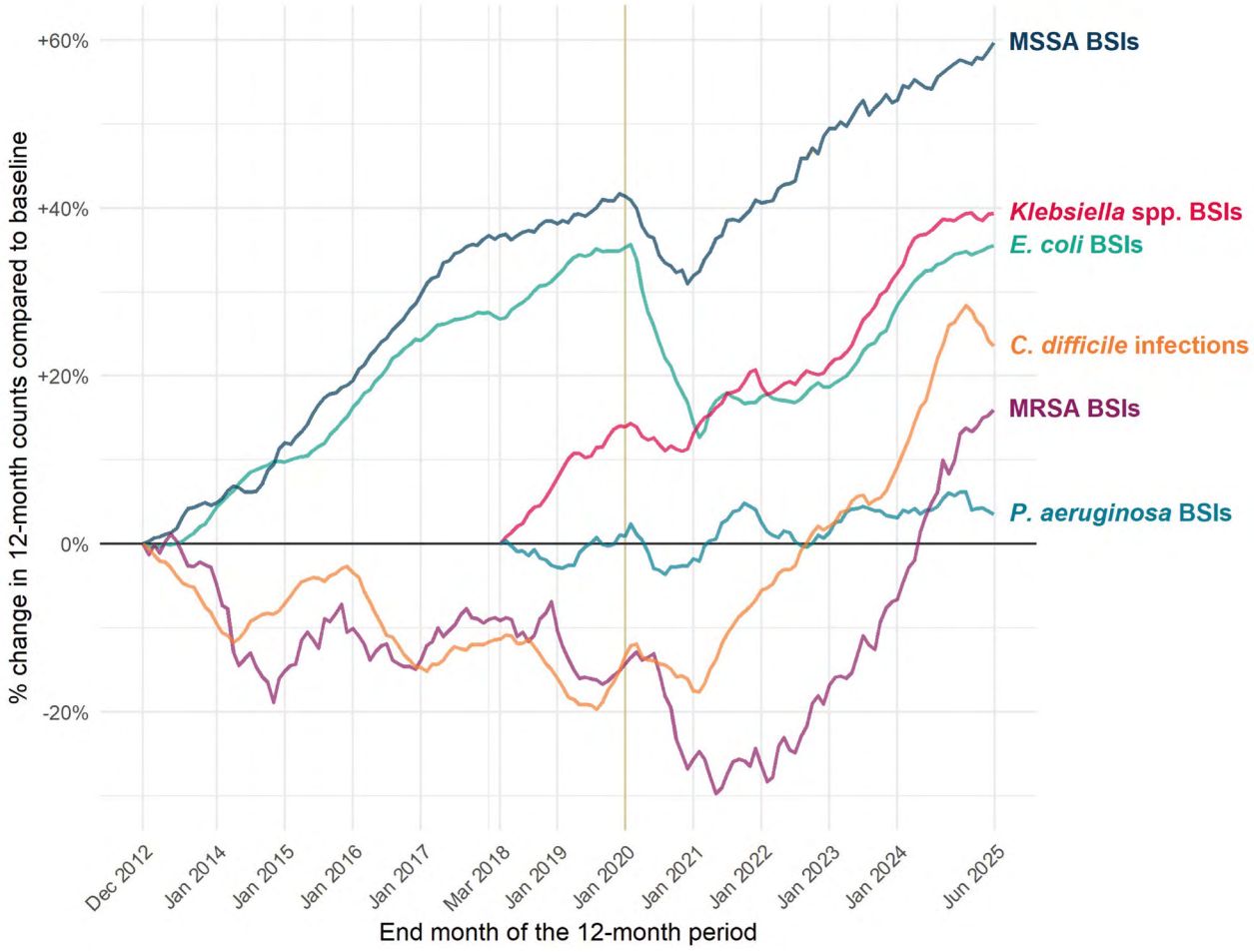
The Point Prevalence Survey of HCAI and antimicrobial use in European acute care hospitals 2022 to 2023[3] was published in May 2024. The overall HCAI prevalence of 8% in NHS acute trusts in 2023 would place England in the highest third of European countries which took part in the European surveillance programme. Case-mix adjusted prevalence needs to be determined for a more accurate assessment, although this is unlikely to change the rankings dramatically. Spain had a similar HCAI prevalence to England with 8.2%, France and Germany were lower with 6.4% and 4.2% respectively and Italy was higher at 9.8%. Low- and middle-income countries have seen significantly higher prevalence (10% to 16%), although there is significant variation in the methods used.[4]

Bloodstream and *C. difficile* infections

In England, mandatory surveillance is conducted for 6 HCAIs: bloodstream infections (BSI) caused by *Escherichia coli* (*E. coli*), *Klebsiella species* (spp.), *Pseudomonas aeruginosa* (*P. aeruginosa*), meticillin-resistant *Staphylococcus aureus* (MRSA) and meticillin-sensitive *Staphylococcus aureus* (MSSA), and *Clostridioides difficile* infection (CDI).[5]

Prior to the COVID-19 pandemic, MSSA, *Klebsiella* spp. and *E. coli* BSI case counts were increasing while MRSA BSI and CDI counts fluctuated but remained at relatively low levels and below 2012 levels. Case numbers for all mandatory surveyed infections declined to varying degrees in 2020, coinciding with the beginning of the COVID-19 pandemic. Following the pandemic, all infections under mandatory reporting have resumed or moved to an upward trajectory, with the exception of *P. aeruginosa* which remains broadly stable, with slight upward increase from 2022 (Figure 2). In financial year (FY) 2024 to 2025, there were 43,639 *E. coli*, 13,438 *Klebsiella* spp., 1,064 MRSA, 13,799 MSSA, 4,474 *P. aeruginosa* and 18,970 CDI cases.

Figure 2: *Clostridioides difficile* and bloodstream infections, 12-month rolling percent change since calendar year 2012*[6]

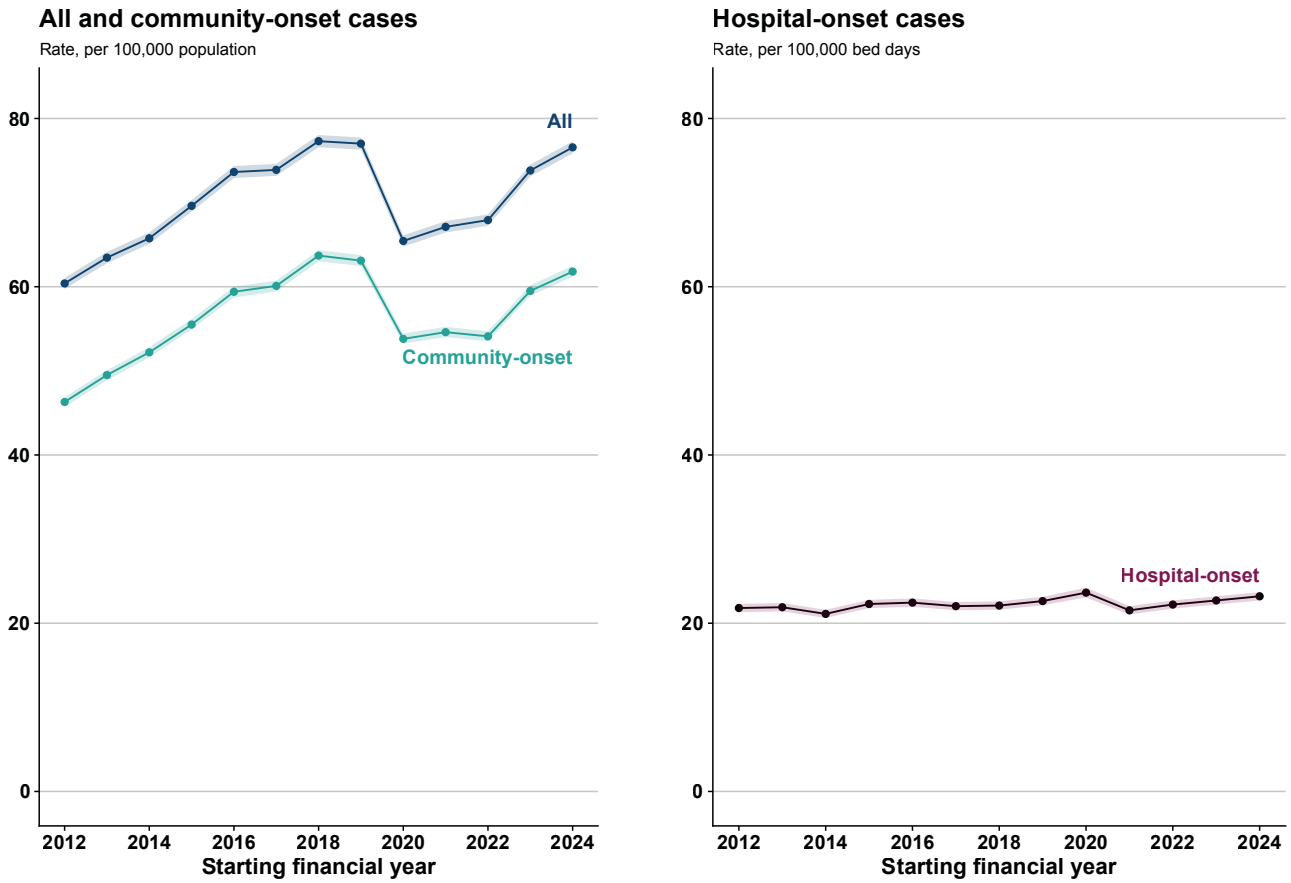


Source: Image by UK Health Security Agency, Quarterly epidemiological commentary: mandatory Gram-negative bacteraemia, MRSA, MSSA and *C. difficile* infections (data up to April to June 2025) is licensed under Open Government Licence v3.0.

The overall incidence rate of *E. coli* BSI has been increasing annually (Figure 3) from the inception of *E. coli* surveillance (with the exception of 2020 to mid-2022, coinciding with the COVID-19 pandemic years).[7] FY 2022 to 2023 to FY 2023 to 2024 saw the largest annual increase in *E. coli* BSI since the beginning of surveillance, with the increasing trend continuing in FY 2024 to 2025. Incidence has been driven primarily by community-onset cases, which represented 80.8% of cases in FY 2024 to 2025.[8]

* Since financial year 2018 to 2019 for *Klebsiella spp*. and *P. aeruginosa* bacteraemia

Figure 3: All reported hospital-onset and community-onset *E. coli* BSI incidence rates by financial year, 2012 to 2013 to 2024 to 2025[9]



Source: Image by UK Health Security Agency, Annual epidemiological commentary: Gram-negative, MRSA, MSSA bacteraemia and C. difficile infections, up to and including financial year 2024 to 2025 is licensed under Open Government Licence v3.0.

Klebsiella spp. BSI rates have been increasing year-on-year since the beginning of surveillance. FY 2024 to 2025 saw an increase of 2.5% from FY 2023 to 2024, marking a steady annual increase in cases since the greatest single year rise of 10.5% between FY 2022 to 2023 and FY 2023 to 2024, driven predominantly by community-onset cases.[10]

P. aeruginosa BSI rates remained stable with an overall rate of 7.8 per 100,000 population and a hospital-onset rate of 4.8 per 100,000 bed-days in FY 2024 to 2025.

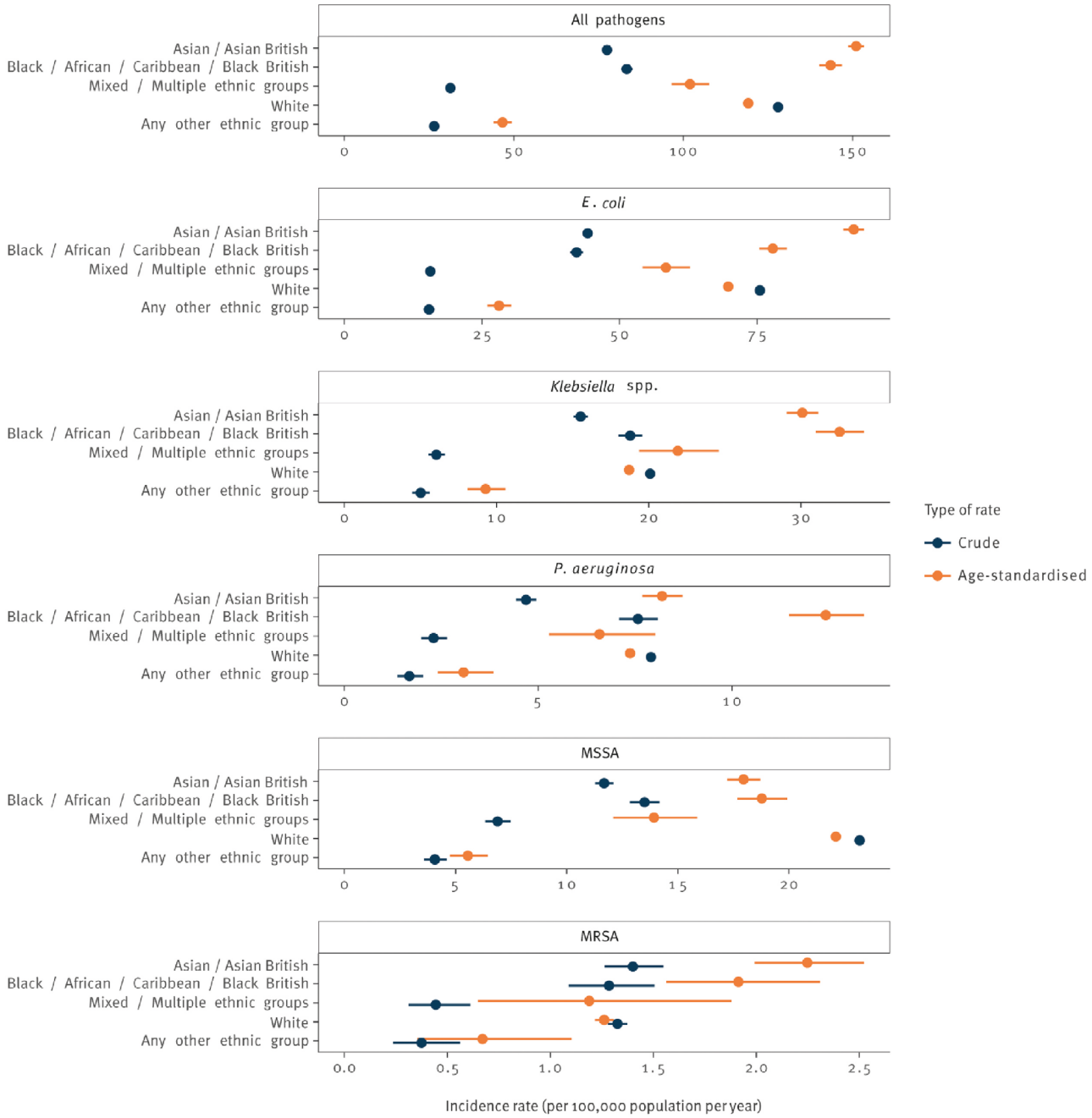
MRSA BSI rates in FY 2024 to 2025 have increased incrementally by 35.7% (since FY 2019 to 2020) after a sustained period of stability, with the highest rate seen since FY 2011 to 2012.[11]

The overall MSSA BSI rate exceeded pre-COVID-19-pandemic levels, reaching 24.2 cases per 100,000 population in FY 2024 to 2025, a 12.0% increase since FY 2018 to 2019. Recent increases have been driven by an increase in the rate of community-onset cases.[12]

CDI cases have shifted to an upward trajectory since FY 2020 to 2021, contrasting patterns seen in early years of surveillance as case rates increased by 50.0% between FY 2020 to 2021 and FY 2024 to 2025; this marks the highest overall case rate since FY 2011 to 2012, driven by recent increases in both hospital-onset and community-onset CDI cases.[13]

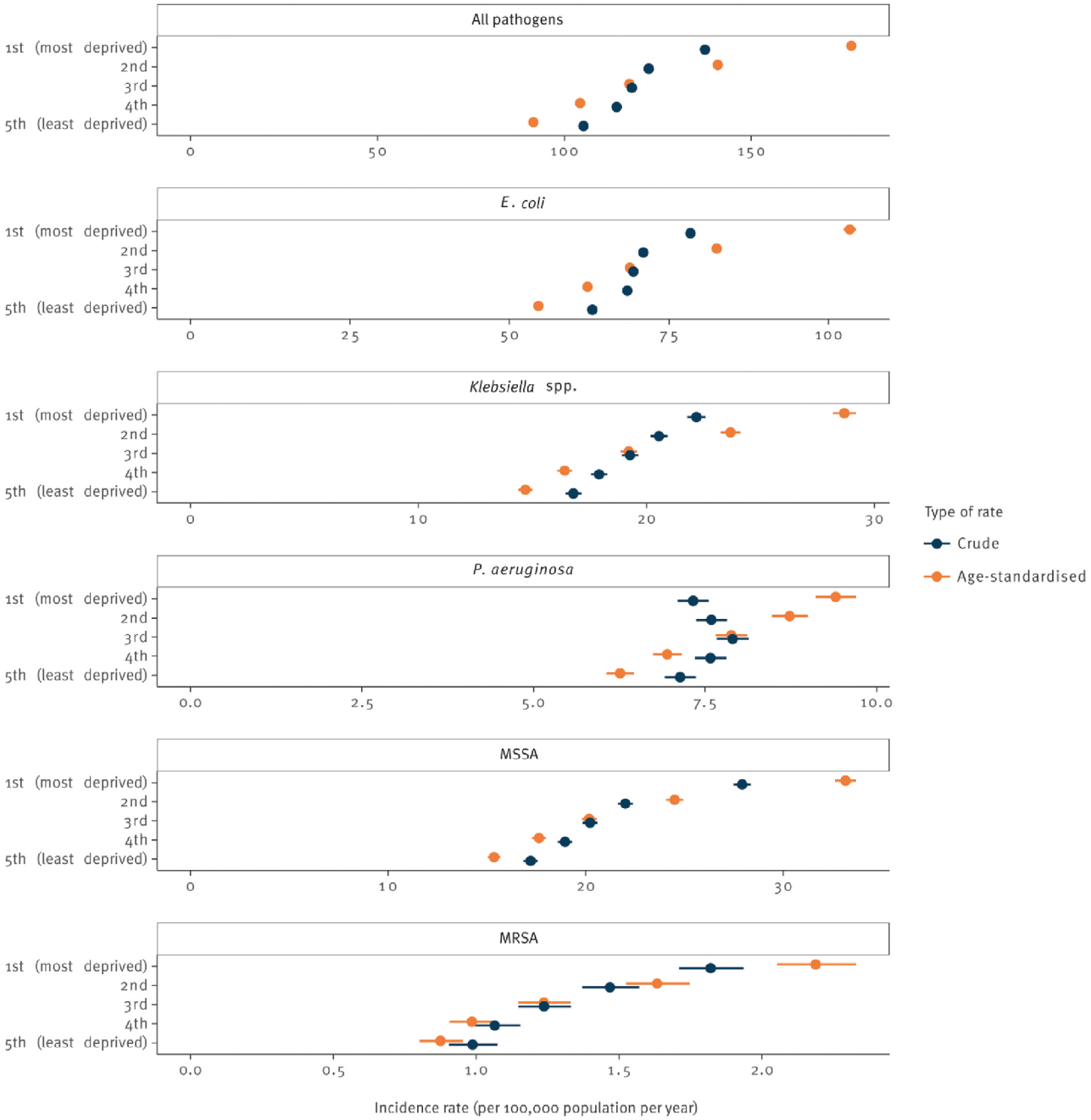
Minority ethnic groups, namely Black and Asian ethnic groups, had the highest age-standardised incidence of 3 Gram-negative bloodstream infections (GNBSIs – *E. coli*, *Klebsiella* spp. and *P. aeruginosa*) as well as MRSA. There was limited evidence of differences in the incidence of MSSA between these ethnic groups, while the White ethnic group had the highest age-standardised incidence. Age-standardised incidence rates varied significantly, with some ethnic groups experiencing rates 2.6 to 4.1 times higher than others (Figure 4).[14,15] Also, the higher the deprivation of an area, the higher the age-sex-standardised incidence of these infections (Figure 5).[16]

Figure 4: Crude and age-standardised incidence rate of BSI by ethnic group, England, January 2018 to December 2022[17]



Source: Image by Mazzella et al., Health inequalities in incidence of bacteraemias: a national surveillance and data linkage study, England, 2018 to 2022. Eurosurveillance. 2025;30(9) is licensed under Creative Commons Attribution 4.0 International License.

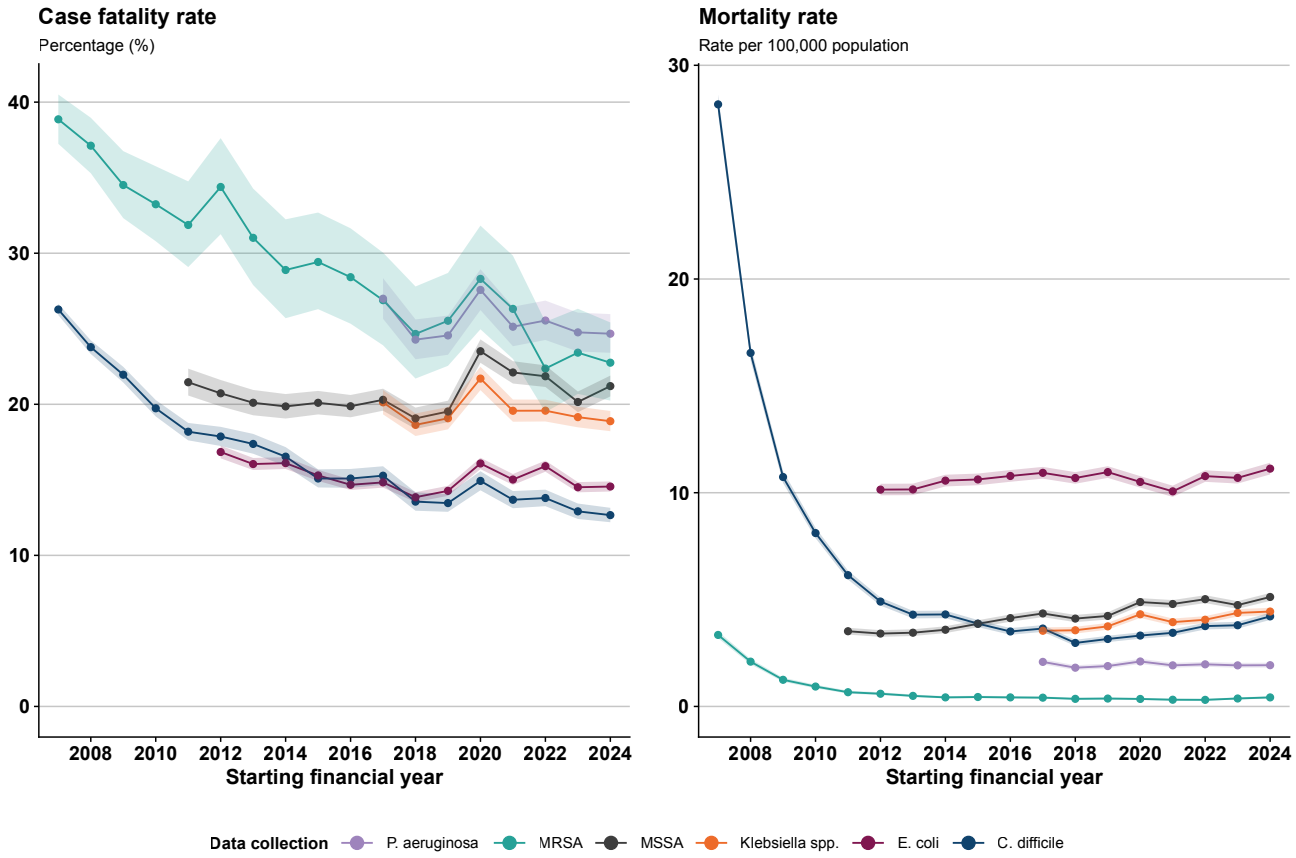
Figure 5: Crude and age-standardised incidence rate of BSI by Index of Multiple Deprivation quintile, England, January 2018 to December 2022 [18]



Source: Image by Mazzella et al., Health inequalities in incidence of bacteraemias: a national surveillance and data linkage study, England, 2018 to 2022. Eurosurveillance. 2025;30(9) is licensed under Creative Commons Attribution 4.0 International License.

Case-fatality rate decreased across all pathogens subject to mandatory surveillance except *E. coli* and MSSA where there were small increases between FY 2023 to 2024 and FY 2024 to 2025. The mortality rate remained stable for *Klebsiella*, *Pseudomonas* and MRSA, and slightly increased for CDI, *E. coli* and MSSA, since FY 2023 to 2024 (Figure 6).[19]

Figure 6: Case-fatality rate (CFR, %) and mortality rate (per 100,000 population) of BSI and CDI, England, April 2007 to March 2025[20]



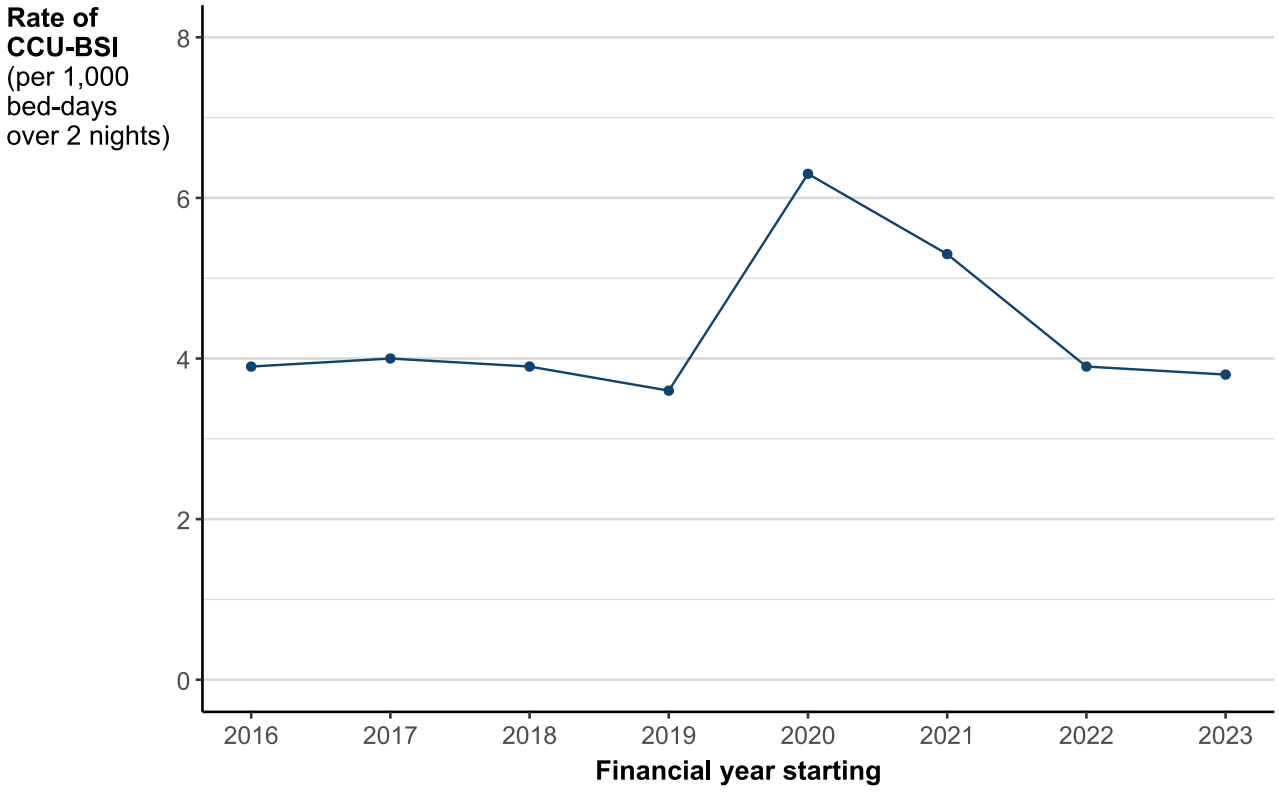
Source: Image by UK Health Security Agency. Data from Annual epidemiological commentary: Gram-negative, MRSA, MSSA bacteraemia and C. difficile infections, up to and including FY 2024 to 2025.

Bloodstream infections in intensive care units

The following surveillance results come from the Infection in Critical Care Quality Improvement Programme (ICCQIP). The programme is led by a collaboration of professional and audit organisations representing intensive care and infection, UKHSA, DHSC and NHS England.[21]

In participating adult units, the incidence of bloodstream infections associated with critical care units (CCU-BSI) ranged from 3.6 to 4 per 1,000 CCU-days between 2016 to 2017 and 2023 to 2024, except for a peak at 6.3 in 2020 to 2021 (Figure 7).[22] The surge in critical care occupancy rates and changes to IPC procedures, patient characteristics, patient care and reporting practices during COVID-19 are possibly associated with this peak. In these units, the use of central vascular catheters, a known risk factor for bloodstream infection, also peaked during 2020 to 2021.[23]

Figure 7: Incidence of bloodstream infections associated to critical care, adult units, England[24]



Source: Image by UK Health Security Agency, Surveillance of bloodstream infections in critical care units, England: May 2016 to March 2024 report is licensed under Open Government Licence v3.0.

Antimicrobial resistance in bloodstream infections

In 2019, the Government launched the UK antimicrobial resistance (AMR) 20-year vision and committed to developing a series of 5-year National Action Plans (NAP) taking a 'One Health Approach'. Each NAP will prioritise actions and direct resources based on the latest information regarding the biggest risks and what interventions are needed to tackle them. One area of focus is surveillance targets, specifically reducing the incidence of infection in humans.

In May 2024, 2 human health targets with a direct focus on infection rates were launched as part of the 2024 to 2029 AMR NAP:

- Target 1a: by 2029, we aim to prevent any increase in a specified set of drug-resistant infections in humans from the 2019 to 2020 FY baseline
- Target 1b: by 2029, we aim to prevent any increase in gram-negative bloodstream infections (GNBSIs*) in humans from the 2019 to 2020 FY baseline

Antimicrobial resistance in BSIs caused by *Escherichia coli*, *Pseudomonas aeruginosa* or *Klebsiella* spp. has been investigated by linking data from the UKHSA mandatory BSI surveillance system with AMR data from the Second-Generation Surveillance System.[25]

* Includes *Escherichia coli, Klebsiella* species, *Pseudomonas aeruginosa.*

This data has been further linked to the critical care subset of Hospital Episode Statistics Admitted Patient Care records to compare AMR in ICU-associated BSIs (ICU-BSIs) against other hospital-onset infections and community-onset infections.

Resistance percentage is higher in ICU-BSIs and other hospital-onset BSIs (oHO-BSIs) than community-onset BSIs for all studied antibiotics and pathogens (Figure 8).[26] In *P. aeruginosa* cases, resistance is higher in ICU-BSIs than oHO-BSIs for all studied antibiotics.[27] This finding is not seen for *E. coli* cases, except in the case of piperacillin/tazobactam resistance. *Klebsiella* spp. shows lower resistance in ICU-BSIs than oHO-BSIs across several studied antibiotics.[28] Counts of carbapenem resistance were too small in *E. coli* and *Klebsiella* spp. cases to make any firm conclusions.

Figure 8: Percentage of Gram-negative BSIs resistant to antibiotics by onset, for each of *E. coli*, *Klebsiella* spp., and *P. aeruginosa*[29]

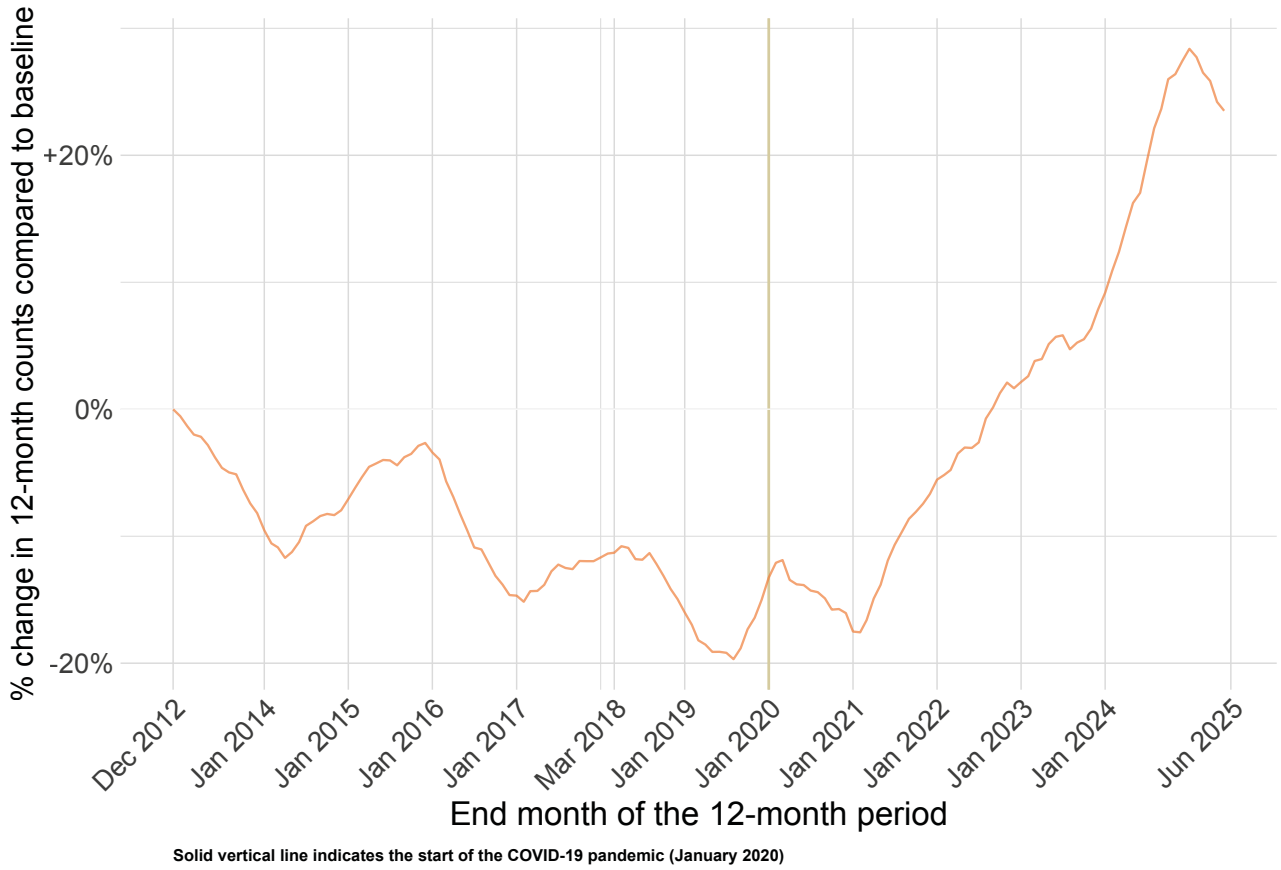
Source: Image by Wilson et al., Trends in critical care unit associated Gram-negative bloodstream infections and associated antibiotic resistance in England between 2017 and 2023: a data linkage study (poster), European Scientific Conference on Applied Infectious Disease Epidemiology, 2024, is reproduced here with permission from authors.

Examples of HCAI incidents

Rise in CDI infections post-pandemic

Prior to the COVID-19 pandemic, CDI followed a general decline from the beginning of surveillance, but from February 2021, CDI cases saw a consistent upward trajectory, surpassing the levels seen in 2012. CDI cases increased by 33% (Figure 9) between FY 2020 to 2021 and FY 2023 to 2024.[30] In November 2024, a national CDI incident was declared to determine the reason for the increase in CDIs. A published CDI technical report outlined key findings from investigations.[31] Increases in CDI incidence were observed in both hospital and community cases, and across all age and sex groups.

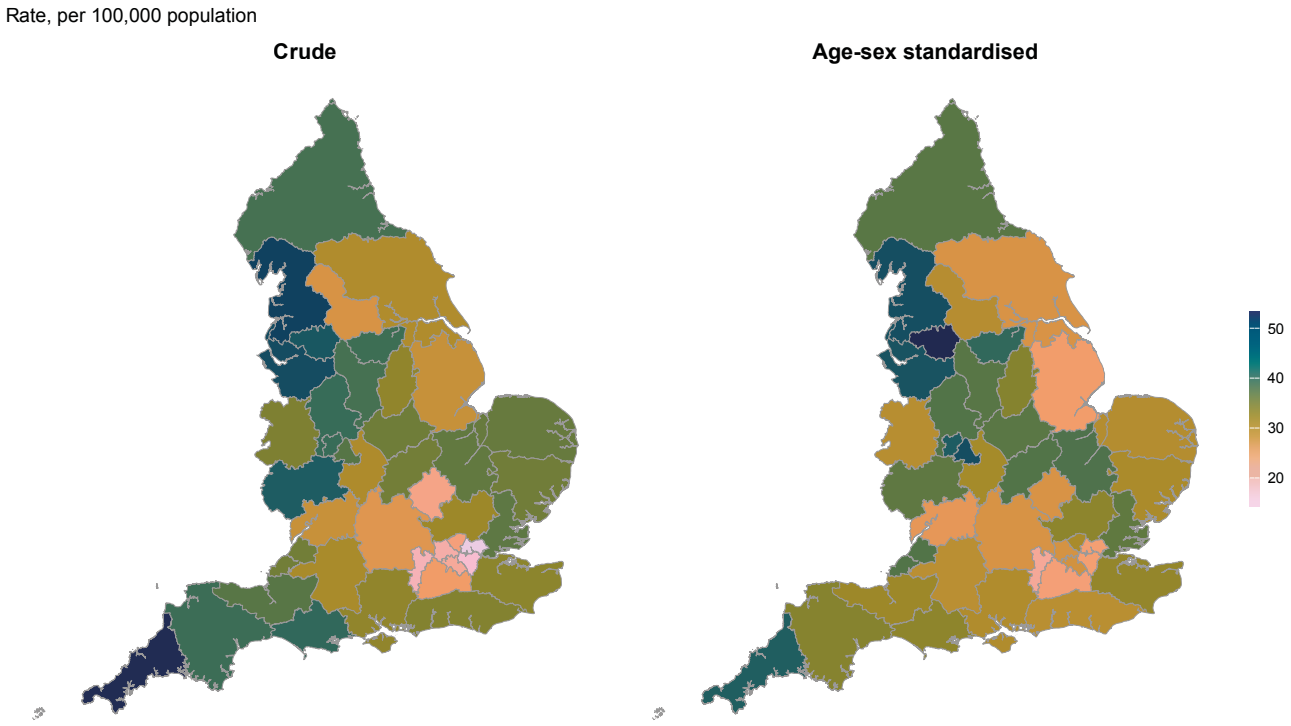
Figure 9: 12-month rolling percentage change since calendar year 2012 for CDI, until June 2025[32]



Source: Image by UK Health Security Agency. Data from Quarterly epidemiological commentary: mandatory Gram-negative bacteraemia, MRSA, MSSA and *C. difficile* infections (data up to April to June 2025) is licensed under Open Government Licence v3.0.

Cases also increased nationally across all 7 NHS regions in England, but we note regional variations, particularly at Integrated Care Board (ICB) and sub-ICB (sICB) levels (Figure 10). Data reported since February 2025 indicates the start of a downward trend (Figure 9).

Figure 10: Geographical distribution of crude and age-sex standardised CDI rate by integrated care board (ICB), FY 2024 to 2025[33]



Source: Image by UK Health Security Agency, Annual epidemiological commentary: Gram-negative, MRSA, MSSA bacteraemia and C. difficile infections, up to and including financial year 2024 to 2025 is licensed under Open Government Licence v3.0.

CDI immunoassay testing has increased since January 2018, however, positivity rates are relatively unchanged since FY 2012 to 2013 (when rates were first stable) and are insufficient to solely explain the large rise in CDI incidence.

Analysis of ribotyping data from the *Clostridioides difficile* Ribotyping Network (CDRN), linked to mandatory reported CDI cases by year does not indicate a particular clonal expansion driving the CDI increases we observe. It should be noted, there is substantial variation in isolate submission to the CDRN service by acute NHS trusts, including variation in those Trusts identified as seeing greater increases, leaving gaps in this data. More details on the CDRN service and submission of isolates, including criteria for submission, can be found in the CDRN report.[34]

Available data from the English Surveillance Programme for Antibiotic Prescribing, Usage and Resistance (ESPAUR)[35] demonstrates an increase in overall antibiotic consumption in England in 2023 (compared to 2022). However, levels remain below pre-pandemic levels, and significantly below the peak in consumption seen in 2014.

A logistic regression model was used to explore the factors that affect the likelihood of an individual developing a CDI infection between 2019 to 2020 and 2023 to 2024. Findings from the modelling analyses are in line with the known epidemiology of CDI in England and do not indicate a risk factor causing this increase.

Several data gaps have been identified for further investigation, including use of corridor care (care in unconventional places), IPC resource and staffing, cleaning procedures within the hospital, sampling and testing practices. Work is ongoing to gather this data and better understand the drivers of this recent increase in incidence.

C. auris HCAI outbreak

Candidozyma auris (formerly *Candida auris*) is an emerging multi-drug resistant (MDR) fungal pathogen notable for its resilience in clinical environments and limited treatment options.[36] It is rapidly emerging globally and has been highlighted by the World Health Organisation (WHO) as a critical priority for research and public health action.[37]

C. auris rarely causes disease in healthy individuals but can cause serious infections in the immunocompromised and invasive infection has been associated with significant mortality in non-UK settings.[38] It is a cause of outbreaks within healthcare settings which can be protracted and costly, highlighting the importance of prompt, effective and sustained IPC practices.

UKHSA has noted increasing detections of *C. auris* in the UK.[39] Most detections of *C. auris* represent colonisation rather than infection (though colonisations can increase the risk of subsequent infections). Peaks in incidence have largely been attributed to hospital outbreaks.

Seven hospital outbreaks of *C. auris* have been reported formally to UKHSA since 2016, all within London and the South-East of England. In 5 of these, 50 patients have been affected and have taken a minimum of 12 months to resolve. These protracted outbreaks have mainly occurred in adult surgical critical care and surgical ward settings, including neurosurgical, cardiothoracic and vascular units. They have led to closures of clinical areas and substantial disruption to healthcare provision.[40] The cost of a *C. auris* outbreak at one trust in 2016 to 2017 was estimated to exceed £1 million.[41]

In response to increasing case detections and outbreaks, particularly following the lifting of travel restrictions imposed during the COVID-19 pandemic period, *C. auris* was declared a national standard incident by UKHSA. This includes a multi-stakeholder incident management team overseeing the situation and working with the NHS and partners to implement interventions to reduce risks to patients and control transmission. Guidance for the laboratory investigation, management and IPC of *C. auris* in acute and community healthcare settings was updated and published by UKHSA in 2025.[42] Also, since April 2025, *C. auris* is considered a notifiable organism (causative agent) under Schedule 2 of the Health Protection (Notification) Regulations 2010.[43] This means that laboratories that test human samples in England are required to report *C. auris* cases to UKHSA. This change aims to strengthen surveillance and inform public health response to this organism. Reporting prior to this was on a voluntary basis. For further information on the epidemiology of *C. auris* in the UK please see the fungal infections chapter of this report (Chapter 4.2).

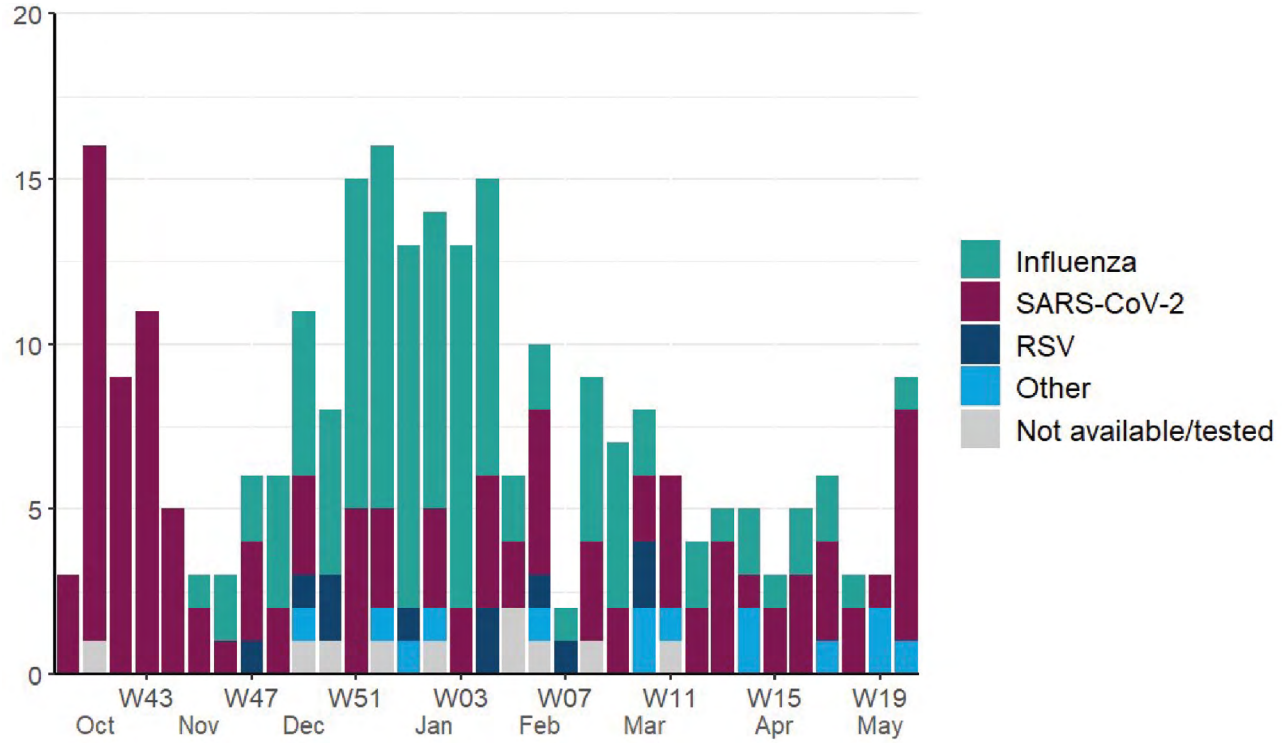
Acute respiratory infection incidents in hospitals

Information on institutional acute respiratory infection (ARI) incidents is based on situations reported to UKHSA health protection teams (HPTs) by hospital IPC teams. These include

confirmed outbreaks (2 or more laboratory-confirmed cases of the same pathogen) linked to a particular setting, and suspected outbreaks. Suspected outbreaks are typically investigated by hospital IPC teams, supported by the HPT and local partners. Respiratory sampling is encouraged. Incident reports are manually reviewed during the data cleaning process and assigned to a specific pathogen only if confirmation of a positive virological test can be identified. In summer 2024, UKHSA transitioned to a new data recording software platform which may introduce uncertainty in long-term comparisons due to potential changes in incident recording. Additionally, testing approaches will be based on local hospital practices.

In England, 3,627 ARI incidents were reported across all settings between week 40 (week commencing 30 September) 2024 and week 20 (week commencing 12 May) 2025. Of these, 258 (7.1%) incidents were reported from hospital settings. Virological testing information was available for 248 (96.1%) of these incidents, of which 109 (44.0%) were due to influenza, 114 (46.0%) were due to SARS-CoV-2, 11 (4.4%) were due to RSV, 2 (0.8%) were due to parainfluenza, 4 (1.6%) were due to other pathogens and 8 (3.2%) were due to multiple pathogens. In 10 (3.9%) incidents, virological testing results were not available (Figure 11).

Figure 11: Number of incidents in hospital settings by week and pathogen, England, week 40 2024 to week 20 2025[44]



Source: Image by UK Health Security Agency. Sub analysis of data in National flu and COVID-19 surveillance reports: 2024 to 2025 season.

Acute respiratory virus nosocomial infection

Respiratory virus outbreaks and other nosocomial transmission can be an important contributor to morbidity and mortality in already frail patients, from paediatric cardiology units, to care of the elderly wards and oncology services. Recent genetic-epidemiological analysis of seasonal

influenza in a large English teaching hospital group suggests that hospital-acquired cases may be an important source of transmission to other patients, indicating the utility of prompt identification and infection control interventions.[45]

A similar scenario was observed in the COVID-19 pandemic. Shedding from nosocomial SARS-CoV-2 case-patients was identified as a key source of infection for other patients.[46,47] Increased transmission was associated with having fewer side rooms and lower heated building volume per bed (as a proxy for spacing or ventilation).[48] The same analysis found that, during a pandemic, hospital transmission can reach a scale that makes hospital infection control an important counterpart to community public health and social measures in controlling overall epidemic dynamics.[49]

Surgical site infection

The Surgical Site Infection Surveillance Service (SSISS) is one of the most longstanding and comprehensive services of its kind globally, having supported over 400 NHS and independent sector hospitals to safeguard patient care for over 25 years, monitoring over 3 million surgical patients. The surveillance service provides hospitals with infrastructure, benchmarking and expert advice to support monitoring of infection risks across 17 different categories of major surgery and evaluating and improving practice. The SSISS team offer hospitals further help when needed, such as hospital visits, bespoke analyses and facilitating contact with exemplar hospitals. Multiple studies have demonstrated the effectiveness of surveillance in reducing the risk of SSI.[50,51]

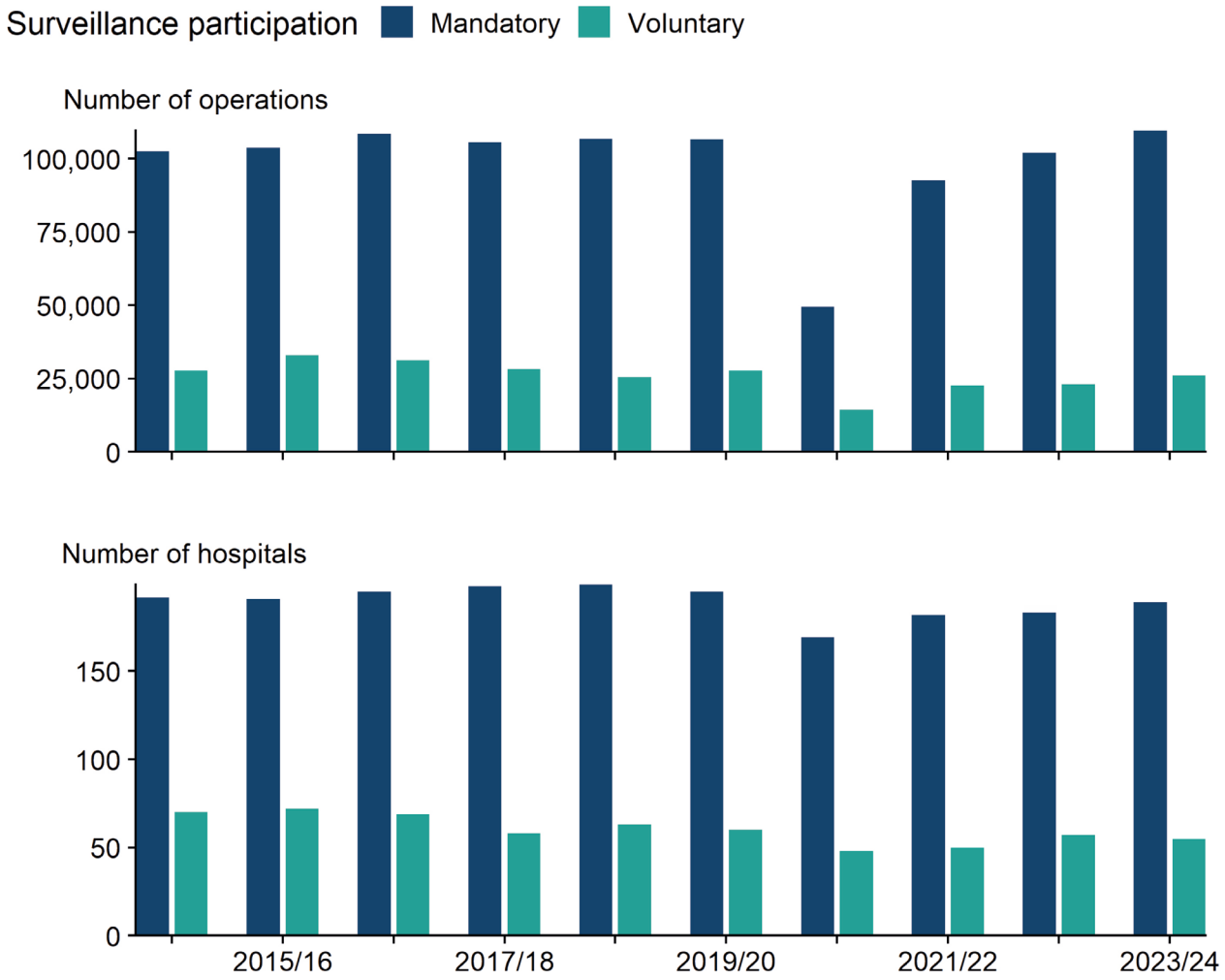
Hospitals are required to undertake surveillance to monitor the risk of patients developing infection after surgery. NHS trusts are mandated to undertake surveillance in at least one of 4 orthopaedic categories (hip replacement, knee replacement, reduction of long bone fracture or repair of neck of femur) for at least one quarter within a FY. Trusts can and do voluntarily carry out surveillance in an additional 13 surgical categories.[52]

SSI surveillance participation

Over 180 NHS hospitals participated in the UKHSA SSI surveillance each year apart from during the COVID-19 pandemic which had reduced participation due to disruption to delivery of planned care. There were year-on-year increases in the volume of reported operations since 2020 to 2021 (Figure 12).[53]

A large proportion of hospitals participate continuously with some variation by surgical category. The highest continuous participation in 2023 to 2024 was observed in coronary artery bypass graft (CABG) procedures (85% of hospitals participating in this category). During the same period, over half of hospitals participating in hip and knee replacement did so continuously (65% and 63%).

Figure 12: Annual participation in SSISS voluntary and mandatory surveillance, NHS hospitals, England, April 2014 to March 2024[54]



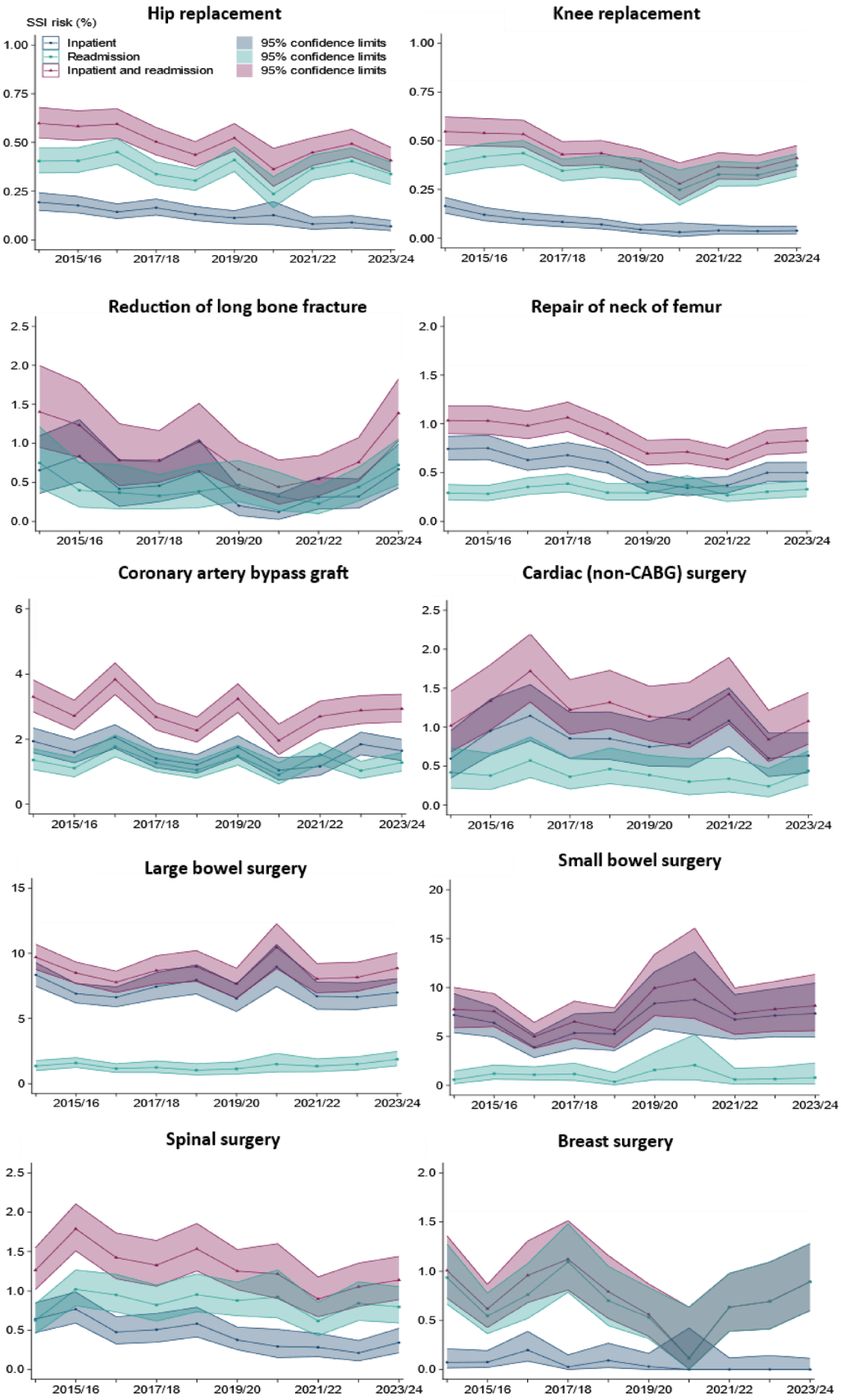
Source: Image by UKHSA, Surveillance of surgical site infections in NHS hospitals in England: 2023 to 2024 is licensed under Open Government Licence v3.0.

Trends and patterns in SSI risk

In 2023 to 2024, the surgical categories with the highest SSI risk were large bowel and small bowel surgery (8.5%). The lowest SSI risk was observed for hip (0.5%) and knee replacement surgery (0.4%). The risk of infection is affected by various risk factors. Patient-related factors include age, body mass index and comorbidities. Environmental and surgery-related factors such as operation duration, wound contamination and optimal use of antimicrobial prophylaxis, also affect the SSI risk.

The overall 10-year trends in inpatient and readmission SSI risk showed a decrease or remained stable for the majority of surgical categories. Eight out of 10 categories assessed showed small increases in the SSI risk between the last 2 FYs. A larger increase in the SSI risk was observed for the operative reduction of long bone fractures (from 0.8% to 1.4%) during the same period (Figure 13).

Figure 13: Trends in annual SSI risk in mandatory and voluntary surgical categories, NHS hospitals England, April 2014 to March 2024[55]



Source: Image by UKHSA, Surveillance of surgical site infections in NHS hospitals in England: 2023 to 2024 is licensed under Open Government Licence v3.0.

Microbiology

Hospitals are encouraged to record positive microbiological reports where available, which helps them to assess the effectiveness of their local antibiotic prophylaxis policy.

Among SSIs with accompanying microbiological confirmation, Enterobacterales continued to make up the highest proportion of causative organisms across all surgical categories in the last financial year for both superficial (29.9%) and deep incisional or organ/space (30.1%) SSIs.

The proportion of superficial SSIs caused by MRSA increased slightly from 2.1% in 2022 to 2023 to 2.3% in 2023 to 2024. However, the proportion of deep or organ/space SSIs caused by MRSA decreased from 2.5% to 2.4%. The proportion caused by MSSA decreased for both superficial (from 17.3% to 15.9%), and deep or organ/space infections (from 18.4% to 17.2%).

Economic impact of HCAIs

HCAIs cause a significant economic burden. However, heterogeneity within this group makes estimating the associated costs complex. Estimates in the literature are varied and adopt alternative approaches. For example, a 2020 study estimated that in 2016 to 2017 there were approximately 653,000 HCAIs among the 13.8 million adult inpatients in NHS general and teaching hospitals in England, with 22,800 patients dying as a result of their infection. Modelling costs across the patient pathway, these infections were estimated to have generated a £2.1 billion cost to the NHS. When adding NHS specialist hospitals to these calculations, there were an estimated 834,000 HCAIs, costing the NHS £2.7 billion.[56]

In a 2021 study,[57] estimates focused on costs of additional bed days due to HCAI alongside additional excess variable costs (such as diagnostic tests or IPC consumables). Using 2018 to 2019 data from a Scottish study, authors estimated total annual cost of HCAI in the UK to be £774 million (£328 million to £2,192 million), with BSI and pneumonia the costliest HCAI types per case.

While not specific to HCAI, a 2019 study estimated the costs of antibiotic-resistant and susceptible *E. coli* BSIs in English hospitals in 2011 to 2012 based on the costs of additional bed days.[58] Authors estimated that 14,000 cases, irrespective of susceptibility, cost the NHS £14 million annually. Antibiotic-resistant infections were associated with a higher number of additional bed days compared to susceptible infections, resulting in an extra cost of £100 to £500 per infection, depending on the antibiotic resistance.

Building on the above modelling approach,[59] we estimated the health and economic impact of healthcare-associated *E. coli* BSIs in English hospitals in 2019 to 2020, irrespective of susceptibility. An approximate total of 12,800 cases were associated with almost 50,000 additional hospital bed days and 1,600 deaths that would not have occurred without the infection. This equates to a total cost of £17.5 million to the NHS and a loss of 13,900 Quality-Adjusted Life Years (QALYs). Within this estimate, approximately half of the total costs and 60% of the QALYs lost are due to hospital-onset infections, with the proportion of community-onset cases based on 2023 reports.

These figures represent highly conservative estimates of impact as they only represent a fraction of the total burden that HCAI impose on the NHS and individuals. The health and cost consequences of infection are far wider than additional hospital days and attributable mortality and should also consider the impact of antibiotic resistance. Moreover, healthcare-associated *E. coli* BSIs represent a small proportion of total HCAIs. England's 2023 PPS, conducted in a representative sample of NHS trusts, estimated that BSIs represent only 7.6% of reported HCAIs, with approximately 14.8% involving *E. coli.*[60]

Ongoing work as part of the UK AMR NAP aims to establish a more comprehensive understanding of the costs and health burden of HCAI and AMR nationally, using robust, data-driven modelling approaches.

Mitigating the risk of HCAI

Assiduous implementation of IPC is key to reducing HCAI risks. The evidence-based national IPC manual (NIPCM) is for all those involved in care provision in England and should be used in NHS settings or settings where NHS services are delivered.[61] The dominant route of transmission of HCAI is via hands. Despite efforts to increase compliance, multiple systematic reviews conclude there are still low levels of optimal hand hygiene amongst healthcare workers (40% to 60%), patients and visitors.[62,63,64] Novel approaches to address these shortcomings are required. Estate design is another key factor to reducing infection transmission. Less than a quarter of beds in the NHS are currently in single rooms; the model for new hospitals is for all beds to be in single rooms. Until such improvements can be delivered, early identification of patients colonised/infected with potentially transmissible pathogens, including using targeted screening and subsequent timely isolation, is key. Measures to reduce overcrowding in Accident and Emergency departments and the need for corridor care are also needed to minimise pathogen transmission risks.

Conclusion

HCAIs continue to be a challenge in England and globally, causing significant morbidity and mortality, and are often associated with antimicrobial resistance. Despite the NHS making impressive reductions to HCAIs caused by MRSA and CDI in the last 15 years, prevalence of these and other HCAIs have been increasing since the COVID-19 pandemic. This emphasises the need for continued efforts to mitigate HCAI, ensuring we have the surveillance programmes to detect and monitor changes in epidemiology and the IPC specialists to act on these data.

References

1 UK Health Security Agency. Point prevalence survey on healthcare-associated infections, antimicrobial use and antimicrobial stewardship in England, 2023. [Internet] 2025. [Accessed 31 May 2025] Available from: https://assets.publishing.service.gov.uk/media/6827325d010c5c28d1c7e728/HCAI-AMU-PPS-2023-report.pdf

2 European Centre for Disease Prevention and Control. Point prevalence survey of healthcare-associated infections and antimicrobial use in European acute care hospitals 2022–2023. [Internet] 2024. [Accessed 31 May 2025] Available from: https://www.ecdc.europa.eu/sites/default/files/documents/healthcare-associated-point-prevalence-survey-acute-care-hospitals-2022-2023.pdf

3 European Centre for Disease Prevention and Control. Point prevalence survey of healthcare-associated infections and antimicrobial use in European acute care hospitals 2022–2023. [Internet] 2024. [Accessed 31 May 2025] Available from: https://www.ecdc.europa.eu/sites/default/files/documents/healthcare-associated-point-prevalence-survey-acute-care-hospitals-2022-2023.pdf

4 World Health Organization. Report on the burden of endemic health care-associated infection worldwide. [Internet] 2011. [Accessed 31 May 2025] Available from: https://www.who.int/publications/i/item/report-on-the-burden-of-endemic-health-care-associated-infection-worldwide

5 UK Health Security Agency. Mandatory enhanced MRSA, MSSA and Gram-negative bacteraemia, and Clostridioides difficile infection surveillance: protocol version 4.4. [Internet] 2021. [Accessed 25 May 2025] Available from: https://hcaidcs.ukhsa.gov.uk/ContentManagement/LinksAndAnnouncements/HCAIDCS_Mandatory_Surveillance_Protocol_v4.4.pdf?AspxAutoDetectCookieSupport=1

6 UK Health Security Agency. Quarterly epidemiological commentary: mandatory Gram-negative bacteraemia, MRSA, MSSA and C. difficile infections (data up to April to June 2025). [Internet] 2025. [Accessed 10 October 2025] Available from: https://www.gov.uk/government/statistics/mrsa-mssa-gram-negative-bacteraemia-and-cdi-quarterly-report

7 Wilson J, Smith R, Patel A, et al. Trends in critical care unit associated Gram-negative bloodstream infections and associated antibiotic resistance in England between 2017 and 2023: a data linkage study (abstract). European Scientific Conference on Applied Infectious Disease Epidemiology. [Internet] 2024. [Accessed 31 July 2025] Available from: https://www.escaide.eu/sites/default/files/documents/ESCAIDE-2024-Abstract-book_0.pdf

8 Wilson J, Smith R, Patel A, et al. Trends in critical care unit associated Gram-negative bloodstream infections and associated antibiotic resistance in England between 2017 and 2023: a data linkage study (abstract). European Scientific Conference on Applied Infectious Disease Epidemiology. [Internet] 2024. [Accessed 31 July 2025] Available from: https://www.escaide.eu/sites/default/files/documents/ESCAIDE-2024-Abstract-book_0.pdf

9 Wilson J, Smith R, Patel A, et al. Trends in critical care unit associated Gram-negative bloodstream infections and associated antibiotic resistance in England between 2017 and 2023: a data linkage study (abstract). European Scientific Conference on Applied Infectious Disease Epidemiology. [Internet] 2024. [Accessed 31 July 2025] Available from: https://www.escaide.eu/sites/default/files/documents/ESCAIDE-2024-Abstract-book_0.pdf

10 UK Health Security Agency. Annual epidemiological commentary: Gram-negative, MRSA, MSSA bacteraemia and C. difficile infections, up to and including financial year 2023 to 2024. [Internet] 2024. [Accessed 31 July 2025] Available from: https://www.gov.uk/government/statistics/mrsa-mssa-and-e-coli-bacteraemia-and-c-difficile-infection-annual-epidemiological-commentary

11 UK Health Security Agency. Annual epidemiological commentary: Gram-negative, MRSA, MSSA bacteraemia and C. difficile infections, up to and including financial year 2023 to 2024. [Internet] 2024. [Accessed 31 July 2025] Available from: https://www.gov.uk/government/statistics/mrsa-mssa-and-e-coli-bacteraemia-and-c-difficile-infection-annual-epidemiological-commentary

12 UK Health Security Agency. Annual epidemiological commentary: Gram-negative, MRSA, MSSA bacteraemia and C. difficile infections, up to and including financial year 2023 to 2024. [Internet] 2024. [Accessed 31 July 2025] Available from: https://www.gov.uk/government/statistics/mrsa-mssa-and-e-coli-bacteraemia-and-c-difficile-infection-annual-epidemiological-commentary

13 UK Health Security Agency. Mandatory enhanced MRSA, MSSA and Gram-negative bacteraemia, and Clostridioides difficile infection surveillance: protocol version 4.4. [Internet] 2021. [Accessed 25 May 2025] Available from: https://hcaidcs.ukhsa.gov.uk/ContentManagement/LinksAndAnnouncements/HCAIDCS_Mandatory_Surveillance_Protocol_v4.4.pdf?AspxAutoDetectCookieSupport=1

14 UK Health Security Agency. Mandatory enhanced MRSA, MSSA and Gram-negative bacteraemia, and Clostridioides difficile infection surveillance: protocol version 4.4. [Internet] 2021. [Accessed 25 May 2025] Available from: https://hcaidcs.ukhsa.gov.uk/ContentManagement/LinksAndAnnouncements/HCAIDCS_Mandatory_Surveillance_Protocol_v4.4.pdf?AspxAutoDetectCookieSupport=1

15 Mazzella A, Amin-Chowdhury Z, Andrews A, et al., Health inequalities in incidence of bacteraemias: a national surveillance and data linkage study, England, 2018 to 2022. Euro Surveill. 2025;30(9):pii=2400312. doi: 10.2807/1560-7917.ES.2025.30.9.2400312.

16 Mazzella A, Amin-Chowdhury Z, Andrews A, et al., Health inequalities in incidence of bacteraemias: a national surveillance and data linkage study, England, 2018 to 2022. Euro Surveill. 2025;30(9):pii=2400312. doi: 10.2807/1560-7917.ES.2025.30.9.2400312.

17 Mazzella A, Amin-Chowdhury Z, Andrews A, et al., Health inequalities in incidence of bacteraemias: a national surveillance and data linkage study, England, 2018 to 2022. Euro Surveill. 2025;30(9):pii=2400312. doi: 10.2807/1560-7917.ES.2025.30.9.2400312.

18 Mazzella A, Amin-Chowdhury Z, Andrews A, et al., Health inequalities in incidence of bacteraemias: a national surveillance and data linkage study, England, 2018 to 2022. Euro Surveill. 2025;30(9):pii=2400312. doi: 10.2807/1560-7917.ES.2025.30.9.2400312.

19 UK Health Security Agency. Annual epidemiological commentary: Gram-negative, MRSA, MSSA bacteraemia and C. difficile infections, up to and including financial year 2023 to 2024. [Internet] 2024. [Accessed 31 July 2025] Available from: https://www.gov.uk/government/statistics/mrsa-mssa-and-e-coli-bacteraemia-and-c-difficile-infection-annual-epidemiological-commentary

20 UK Health Security Agency. Annual epidemiological commentary: Gram-negative, MRSA, MSSA bacteraemia and C. difficile infections, up to and including financial year 2023 to 2024. [Internet] 2024. [Accessed 31 July 2025] Available from: https://www.gov.uk/government/statistics/mrsa-mssa-and-e-coli-bacteraemia-and-c-difficile-infection-annual-epidemiological-commentary

21 Infection in Critical Care Quality Improvement Programme (ICCQIP) [Internet]. [Accessed 31 July 2025] Available from: https://www.ficm.ac.uk/about-iccqip

22 UK Health Security Agency. Surveillance of bloodstream infections in critical care units, England: May 2016 to March 2024 report. [Internet] 2025. [Accessed 31 July 2025] Available from: https://www.gov.uk/government/statistics/surveillance-of-bloodstream-infections-in-critical-care-england/surveillance-of-bloodstream-infections-in-critical-care-units-england-may-2016-to-march-2024-report

23 UK Health Security Agency. Surveillance of bloodstream infections in critical care units, England: May 2016 to March 2024 report. [Internet] 2025. [Accessed 31 July 2025] Available from: https://www.gov.uk/government/statistics/surveillance-of-bloodstream-infections-in-critical-care-england/surveillance-of-bloodstream-infections-in-critical-care-units-england-may-2016-to-march-2024-report

24 UK Health Security Agency. Surveillance of bloodstream infections in critical care units, England: May 2016 to March 2024 report. [Internet] 2025. [Accessed 31 July 2025] Available from: https://www.gov.uk/government/statistics/surveillance-of-bloodstream-infections-in-critical-care-england/surveillance-of-bloodstream-infections-in-critical-care-units-england-may-2016-to-march-2024-report

25 Wilson J, Smith R, Patel A, et al. Trends in critical care unit associated Gram-negative bloodstream infections and associated antibiotic resistance in England between 2017 and 2023: a data linkage study (abstract). European Scientific Conference on Applied Infectious Disease Epidemiology. [Internet] 2024. [Accessed 31 July 2025] Available from: https://www.escaide.eu/sites/default/files/documents/ESCAIDE-2024-Abstract-book_0.pdf

26 Wilson J, Smith R, Patel A, et al. Trends in critical care unit associated Gram-negative bloodstream infections and associated antibiotic resistance in England between 2017 and 2023: a data linkage study (abstract). European Scientific Conference on Applied Infectious Disease Epidemiology. [Internet] 2024. [Accessed 31 July 2025] Available from: https://www.escaide.eu/sites/default/files/documents/ESCAIDE-2024-Abstract-book_0.pdf

27 Wilson J, Smith R, Patel A, et al. Trends in critical care unit associated Gram-negative bloodstream infections and associated antibiotic resistance in England between 2017 and 2023: a data linkage study (abstract). European Scientific Conference on Applied Infectious Disease Epidemiology. [Internet] 2024. [Accessed 31 July 2025] Available from: https://www.escaide.eu/sites/default/files/documents/ESCAIDE-2024-Abstract-book_0.pdf

28 UK Health Security Agency. Surveillance of bloodstream infections in critical care units, England: May 2016 to March 2024 report. [Internet] 2025. [Accessed 31 July 2025] Available from: https://www.gov.uk/government/statistics/surveillance-of-bloodstream-infections-in-critical-care-england/surveillance-of-bloodstream-infections-in-critical-care-units-england-may-2016-to-march-2024-report

29 Wilson J, Smith R, Patel A, et al. Trends in critical care unit associated Gram-negative bloodstream infections and associated antibiotic resistance in England between 2017 and 2023: a data linkage study (abstract). European Scientific Conference on Applied Infectious Disease Epidemiology. [Internet] 2024. [Accessed 31 July 2025] Available from: https://www.escaide.eu/sites/default/files/documents/ESCAIDE-2024-Abstract-book_0.pdf

30 UK Health Security Agency. Annual epidemiological commentary: Gram-negative, MRSA, MSSA bacteraemia and C. difficile infections, up to and including financial year 2023 to 2024. [Internet] 2024. [Accessed 31 July 2025] Available from: https://www.gov.uk/government/statistics/mrsa-mssa-and-e-coli-bacteraemia-and-c-difficile-infection-annual-epidemiological-commentary

31 UK Health Security Agency. Increase in Clostridioides difficile infections (CDI): current epidemiology, data and investigations – Technical report. [Internet] 2025. [Accessed 31 July 2025] Available from: https://www.gov.uk/government/publications/increase-in-clostridioides-difficile-infections-technical-report/increase-in-clostridioides-difficile-infections-cdi-current-epidemiology-data-and-investigations-technical-report

32 UK Health Security Agency. Quarterly epidemiological commentary: mandatory Gram-negative bacteraemia, MRSA, MSSA and C. difficile infections (data up to April to June 2025). [Internet] 2025. [Accessed 10 October 2025] Available from: https://www.gov.uk/government/statistics/mrsa-mssa-gram-negative-bacteraemia-and-cdi-quarterly-report

33 UK Health Security Agency. Annual epidemiological commentary: Gram-negative, MRSA, MSSA bacteraemia and C. difficile infections, up to and including financial year 2023 to 2024. [Internet] 2024. [Accessed 31 July 2025] Available from: https://www.gov.uk/government/statistics/mrsa-mssa-and-e-coli-bacteraemia-and-c-difficile-infection-annual-epidemiological-commentary

34 UK Health Security Agency. Clostridium difficile Ribotyping Network (CDRN) for England and Northern Ireland 2018 to 2023. [Internet] 2024. [Accessed 31 July 2025] Available from: https://www.gov.uk/government/publications/clostridium-difficile-ribotyping-network-cdrn-report

35 UK Health Security Agency. English surveillance programme for antimicrobial utilisation and resistance (ESPAUR) report 2023 to 2024. [Internet] 2024. [Accessed 31 July 2025] Available from: https://assets.publishing.service.gov.uk/media/6734e208b613efc3f1823095/ESPAUR-report-2023-2024.pdf

36 Jones CR, Neill C, Borman AM et al. The laboratory investigation, management, and infection prevention and control of *Candida auris*: a narrative review to inform the 2024 national guidance update in England. J Med Microbiol. 2024;73(5). doi: 10.1099/jmm.0.001820.

37 World Health Organization. WHO fungal priority pathogens list to guide research, development and public health action. [Internet] 2022. [Accessed 31 July 2025] Available from: https://www.who.int/publications/i/item/9789240060241

38 Jones CR, Neill C, Borman AM et al. The laboratory investigation, management, and infection prevention and control of *Candida auris*: a narrative review to inform the 2024 national guidance update in England. J Med Microbiol. 2024;73(52024;73(5). doi: 10.1099/jmm.0.001820.

39 UK Health Security Agency. HPR volume 19 issue 3: news (27 and 31 March 2025). [Internet] 2025. [Accessed 31 July 2025] Available from: https://www.gov.uk/government/publications/health-protection-report-volume-19-2025/hpr-volume-19-issue-3-news-27-march-2025

40 Schelenz S, Hagen F, Rhodes JL, et al. First hospital outbreak of the globally emerging Candida auris in a European hospital. Antimicrob Resist Infect Control. 2016;5:35. doi: 10.1186/s13756-016-0132-5.

41 Taori SK, Khonyongwa K, Hayden I, et al. Candida auris outbreak: mortality, interventions and cost of sustaining control. J Infect. 2019;79(6):601–611. doi: 10.1016/j.jinf.2019.09.007

42 UK Health Security Agency. Candidozyma auris. [Internet] 2025. [Accessed 31 July 2025] Available from: https://www.gov.uk/government/collections/candidozyma-auris

43 UK Health Security Agency. Changes to health protection notification regulations (NOIDs). [Internet] 2025. [Accessed 31 July 2025] Available from: https://ukhsa.blog.gov.uk/2025/03/11/changes-to-health-protection-notification-regulations/

44 UK Health Security Agency. Surveillance of respiratory syncytial virus: winter 2024 to 2025. [Internet] 2025. [Accessed 31 July 2025] Available from: https://www.gov.uk/government/publications/surveillance-of-respiratory-syncytial-virus-winter-2024-to-2025

45 Cane J, Sanderson N, Barnett S, et al. Nanopore sequencing of influenza A and B in Oxfordshire and the United Kingdom, 2022-23. J Infect. 2024 Jun;88(6):106164. doi: 10.1016/j.jinf.2024.106164

46 Cooper BS, Evans S, Jafari Y, et al. The burden and dynamics of hospital-acquired SARS-CoV-2 in England. Nature. 2023;623:132–138. doi: 10.1038/s41586-023-06634-z

47 Lumley SF, Constantinides B, Sanderson N et al. Epidemiological data and genome sequencing reveals that nosocomial transmission of SARS-CoV-2 is underestimated and mostly mediated by a small number of highly infectious individuals. J Infect. 2021;83:473–482. doi: 10.1016/j.jinf.2021.07.034

48 Cooper BS, Evans S, Jafari Y, et al. The burden and dynamics of hospital-acquired SARS-CoV-2 in England. Nature. 2023;623:132–138. doi: 10.1038/s41586-023-06634-z

49 Cooper BS, Evans S, Jafari Y, et al. The burden and dynamics of hospital-acquired SARS-CoV-2 in England. Nature. 2023;623:132–138. doi: 10.1038/s41586-023-06634-z

50 Abbas M, de Kraker MEA, Aghayev E et al. Impact of participation in a surgical site infection surveillance network: results from a large international cohort study. J Hosp Infect. 2019;102(3):267-76. doi: 10.1016/j.jhin.2018.12.003.

51 Lamagni T. Impact of hospital participation in national surveillance in prevention of surgical site infection, England. International Congress on Infectious Diseases (ICID); 2024 Dec 3-6; Cape Town, South Africa.

52 UK Health Security Agency. Protocol for the surveillance of surgical site infection. Version 6. [Internet] 2013. [Accessed 31 July 2025] Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/633775/surgical_site_infections_protocol_version_6.pdf

53 UK Health Security Agency. Surveillance of surgical site infection in HNS hospitals in England: 2023 to 2024. [Internet] 2025. [Accessed 21 May 2025] Available from: https://www.gov.uk/government/publications/surgical-site-infections-ssi-surveillance-nhs-hospitals-in-england.

54 UK Health Security Agency. Surveillance of surgical site infection in HNS hospitals in England: 2023 to 2024. [Internet] 2025. [Accessed 21 May 2025] Available from: https://www.gov.uk/government/publications/surgical-site-infections-ssi-surveillance-nhs-hospitals-in-england.

55 UK Health Security Agency. Surveillance of surgical site infection in HNS hospitals in England: 2023 to 2024. [Internet] 2025. [Accessed 21 May 2025] Available from: https://www.gov.uk/government/publications/surgical-site-infections-ssi-surveillance-nhs-hospitals-in-england.

56 Guest JF, Keating T, Gould D, Wigglesworth N. Modelling the annual NHS costs and outcomes attributable to healthcare-associated infections in England. BMJ Open. 2020;10(1):e033367. doi: 10.1136/bmjopen-2019-033367

57 Manoukian S, Stewart S, Graves N et al. Bed-days and costs associated with the inpatient burden of healthcare-associated infection in the UK. J Hosp Infect. 2021;114:43-50. doi: 10.1016/j.jhin.2020.12.027.

58 Naylor NR, Pouwels KB, Hope R, et al. The health and cost burden of antibiotic resistant and susceptible Escherichia coli bacteraemia in the English hospital setting: A national retrospective cohort study. PLoS One. 2019;14(9):e0221944. doi: 10.1371/journal.pone.0221944

59 Naylor NR, Pouwels KB, Hope R, et al. The health and cost burden of antibiotic resistant and susceptible Escherichia coli bacteraemia in the English hospital setting: A national retrospective cohort study. PLoS One. 2019;14(9):e0221944. doi: 10.1371/journal.pone.0221944

60 UK Health Security Agency. Mandatory enhanced MRSA, MSSA and Gram-negative bacteraemia, and Clostridioides difficile infection surveillance: protocol version 4.4. [Internet] 2021. [Accessed 25 May 2025] Available from: https://hcaidcs.ukhsa.gov.uk/ContentManagement/LinksAndAnnouncements/HCAIDCS_Mandatory_Surveillance_Protocol_v4.4.pdf?AspxAutoDetectCookieSupport=1

61 NHS England. National infection prevention and control manual (NIPCM) for England. [Internet] 2024. [Accessed 31 July 2025] Available from: https://www.england.nhs.uk/national-infection-prevention-and-control-manual-nipcm-for-england

62 Erasmus V, Daha TJ, Brug H, et al. Systematic review of studies on compliance with hand hygiene guidelines in hospital care. Infect Control Hosp Epidemiol. 2010;31(3):283-294. doi: 10.1086/650451

63 Mouajou V, Adams K, DeLisle G, Quach C. Hand hygiene compliance in the prevention of hospital-acquired infections: a systematic review. J Hosp Infect. 2022 Jan;119:33-48. doi: 10.1016/j.jhin.2021.09.016

64 Bredin D, O'Doherty D, Hannigan A, Kingston L. Hand hygiene compliance by direct observation in physicians and nurses: a systematic review and meta-analysis. J Hosp Infect. 2022 Dec;130:20-33. doi: 10.1016/j.jhin.2022.08.013

5 Responding to infections as a system

5.1 Strengthening infection services for a resilient future health system

Susan Hopkins – Chief Executive Officer, UKHSA; Honorary Consultant in Infectious Diseases and Microbiology, Royal Free London NHS Foundation Trust; Honorary Professor of Infectious Diseases and Health Security, UCL

David Partridge – Consultant Microbiologist and Director of Infection Prevention and Control, Sheffield Teaching Hospitals NHS Foundation Trust; President, British Infection Association 2023 to 2025

Rajeka Lazarus – Consultant in Infectious Diseases and Microbiology, Department of Infection Sciences, UKHSA Southwest Laboratory, University Hospital Bristol and Weston NHS Foundation Trust; President, British Infection Association 2025 to 2027

Martin Llewelyn – Professor of Infectious Diseases Brighton and Sussex Medical School, Consultant in Infection, University Hospitals Sussex; President, British Infection Association 2021 to 2023; Chair, Royal College of Physicians Joint Specialist Committee on Infection, 2020 to 2024

Nick Price – National Clinical Director for Infectious Diseases, Consultant in Infectious Diseases, Guy's and St Thomas' NHS Foundation Trust

Introduction

Historically, the UK healthcare system has demonstrated success in minimising the risk of epidemics for many infections through effective diagnosis, management, prevention and outbreak response. Today, the UK continues to face major infection threats from antimicrobial resistance (AMR), healthcare-associated infections (HCAIs), increases in vaccine-preventable diseases and the emergence of new pathogens.

The COVID-19 pandemic highlighted the importance of being able to rapidly mount a closely coordinated response between infectious disease specialists providing direct clinical care, laboratory-based microbiology and virology, general infection prevention and control (IPC) services, specialist diagnostic/IPC services, public health and epidemiology. These distinct aspects of a comprehensive 'infection service' are interdependent and vary in their levels of integration across different organisations across the system (Table 1). This contributes to a lack of resilience against increasingly complex pathogens and case presentations and is further

compromised by suboptimal NHS workforce planning. The latter is complicated by multipotency of infection trainees and uncertainty in the magnitude and complexity of future infection threats. Best practice standards for infection services in the UK[1] provide a useful blueprint for commissioners and providers to determine their local capabilities and requirements.

While containment of COVID-19 initially used the limited capacity of High-Consequence Infectious Diseases (HCID) facilities in the NHS, these bed numbers were rapidly exceeded. Diagnostic capabilities had to be scaled urgently and there was a period in which diagnostic capacity was not sufficient to meet need, with NHS laboratories ultimately providing a sustainable service. On the other hand, the UK led globally in genomic sequencing and clinical research, aided by academic networks embedded within frontline infection expertise.

As we continue to face a complex mix of endemic, emerging and climate-exacerbated infections, the healthcare system must evolve to be more sustainable over time and facilitate cross-sector, multi-disciplinary working in the context of global cooperation.

This chapter provides an overview of how the healthcare system in England is placed to prevent and manage infectious disease, reviewing strengths, gaps and strategic priorities for the coming decade.

Table 1: Role of different components of the health system in delivering infection services

Organisation/ Services	Role in the system
NHS primary care services	This includes GP, pharmacy and other community services who provide primary case infection management and treatment with advice available from secondary care and UKHSA; deliver life course vaccines and antimicrobials to local populations.
NHS Trusts	Delivery of secondary care infection diagnostics and treatment services, hospital IPC including case and contact management within hospital settings, antimicrobial stewardship including hospital formularies and local guidance.
NHS Integrated Care Boards (ICBs)	Commission local general and specialist infection services across clinical, pharmacy and laboratory domains (for diagnosis and treatment of infections, IPC) and out of hours pre- and post- exposure vaccination and treatment for local populations. From 2026, ICBs will commission primary care vaccination services.
NHS England	Commissions specialised infectious disease, HIV and vaccination services; supports pandemic preparedness.

Organisation/ Services	Role in the system
Local Authorities	Deliver community-level health protection services via public and environmental health teams; commission sexual health services which provide sexually transmitted infection (STI), HIV and Hepatitis detection, treatment and contact tracing. Varied levels of community IPC; play an assurance role for vaccinations and health protection related to NHS delivery through Health and Wellbeing Boards.
UKHSA	National and regional leadership for infectious disease surveillance, prevention, control and emergency response; provision of reference and specialist laboratory services to the NHS and for surveillance as well as the development of diagnostics for rare and emerging infectious diseases, pathogen relatedness including genome sequencing to detect clusters and outbreaks and antimicrobial resistance across viruses, bacteria, fungi and protozoa.
NICE	National guidelines related to infection, health technology assessment for new antimicrobials and diagnostics.
DHSC	Develop national policy and cross-government strategies to reduce or eliminate domestic transmission of infectious diseases; management of pandemic preparedness.

UKHSA = UK Health Security Agency
NICE = National Institute for Health and Care Excellence
DHSC = Department of Health and Social Care

General management of infection

Almost all healthcare staff are involved in the prevention and management of infection, by virtue of its frequency in the population.

General practice and Primary Care Network staff delivered approximately 367.5 million appointments in 2024; it is estimated that 1 in 5 of these attendances were related to infections.[2] In 2023, over 35 million NHS primary care antibiotic prescriptions were dispensed in community pharmacies; approximately 80% of the recorded total antibiotic use in England.[3]

The commonest reasons for consultation, emergency department attendance and hospital inpatient management continue to be respiratory infections and urinary tract infections (UTIs). Peak rates of consultation for influenza-like illness (ILI) were 20- to 40-fold higher over the winter months compared to summer months in 2024 to 2025.[4] During the financial year 2023 to 2024, there were 189,756 hospital admissions related to UTI in England, resulting in a total of 1.2 million NHS beddays.[5] This amounted to an average of 6 bed-days per infection, although a third of admissions were for less than a day.

Primary and secondary care clinicians, irrespective of speciality, spend significant proportions of their time assessing, diagnosing and treating individuals with infectious diseases. Staff in general practice also administer the majority of vaccines to prevent infectious diseases. Primary care services and emergency departments support individuals who have been exposed to infectious diseases by providing post-exposure treatment, vaccination and anti-toxin in certain scenarios; for example, antibiotics after meningococcal exposure, Hepatitis B vaccine after needlestick or sexual exposure or rabies vaccine after dog and animal bites in rabies endemic countries.

General services are supported by telephone advice and input predominantly from microbiology and virology services within acute hospital trusts. Infectious diseases and antimicrobial pharmacy services exist in some areas and can also provide specialist support through the delivery of virtual wards, outpatient parenteral and complex antimicrobial therapy, and access to same day emergency consultation.

Community pharmacy has developed substantial additional roles to support infection management over recent years including:

- delivery of seasonal influenza and COVID-19 vaccines – both for the NHS and privately
- provision of travel medicine advice and vaccination
- provision of protocolised management for common infections treated previously in primary care with pathways for escalation to general practitioners and hospitals through Pharmacy First;[6] the National Institute of Health and Care Research have funded an independent evaluation of this service[7]

Specialist management of infection

Across the country, specialist infection services covering laboratory diagnostics, infection prevention, antimicrobial stewardship, clinical infectious disease diagnosis and treatment, sexual health and HIV care are provided in diverse ways.

Within acute trusts, there is increasing integration of some of these services which may be further integrated with acute and general medicine services or super-specialist infection services (see below). In addition, infectious diseases, genitourinary medicine and HIV specialists deliver inpatient and outpatient HIV services. There are also a variety of delivery models for the diagnosis, treatment and management of tuberculosis and hepatitis, with services often co-located or aligned with those for respiratory, gastroenterology or hepatology specialist care.

Separately, genitourinary medicine clinicians, alongside specialist nurses and health advisors, deliver many of the outpatient HIV and sexual health services commissioned by local authorities through the public health grant.

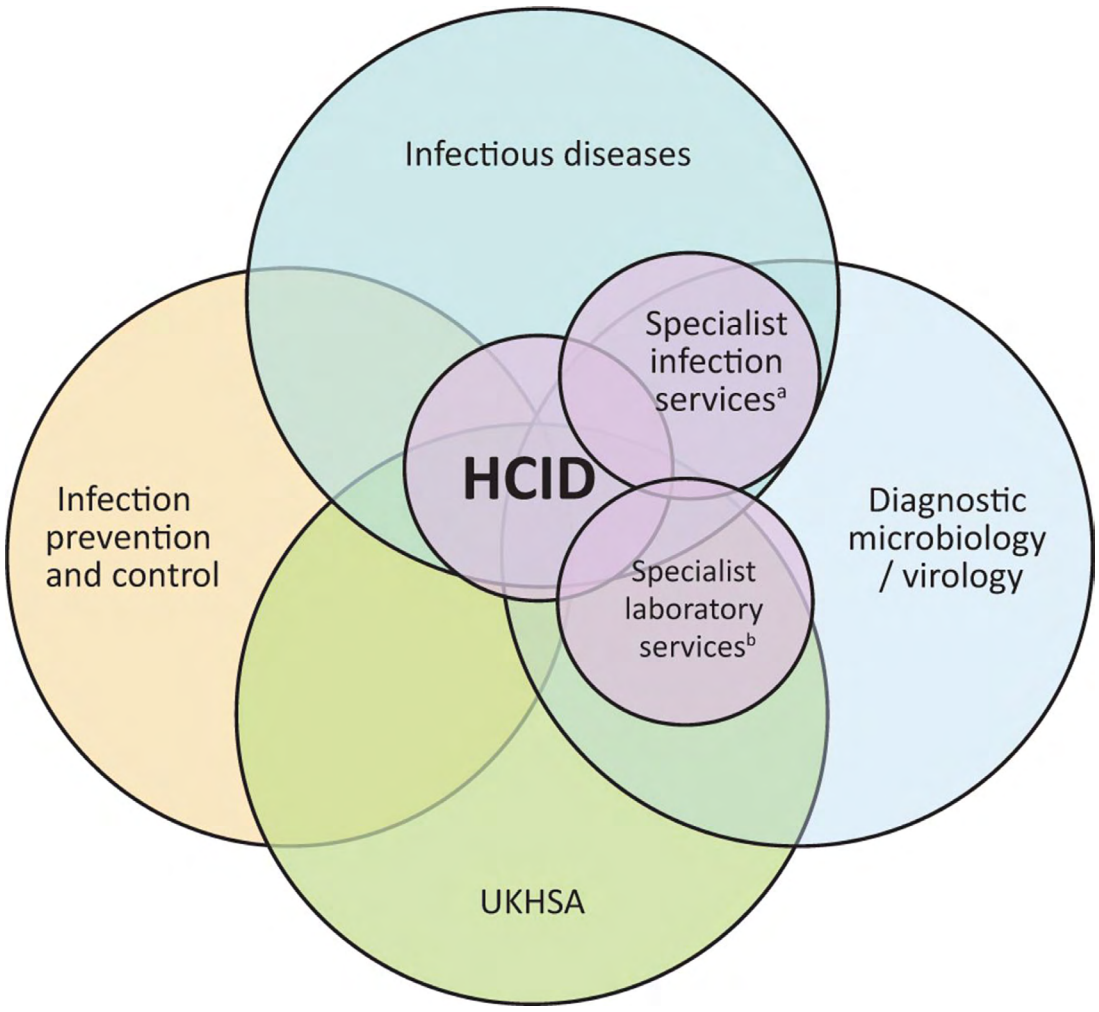
All secondary care acute hospitals have specialist IPC teams usually with representatives from clinical infectious diseases, virology, microbiology, pharmacists and IPC nurses. These teams have multifaceted responsibilities, including:

- detection, management and surveillance of healthcare associated infections and outbreaks
- provision of education and training to all staff on how to prevent and control infections
- implementation of local guidelines, audit and delivery plans related to hand hygiene, isolation, personal protective equipment (PPE) and decontamination procedures

Antimicrobial stewardship teams, which are also multidisciplinary, work closely with IPC teams to optimise anti-infective therapy and reduce AMR by providing guidelines and specialist resources and monitoring and auditing antibiotic use.

National IPC guidance to support local teams is produced by NHS England in collaboration with UKHSA (for example, the National IPC manual for England). Integrated Care Boards (ICBs) and local authorities work with healthcare providers and social care to ensure consistent IPC practices; however, IPC capabilities remain fragmented with differential offers to non-acute hospitals and the community.

Figure 1: Co-dependency of infection services and expertise in the NHS[8]



[a] for example, HIV, genitourinary medicine, tropical medicine, and bone and joint infection.

[b] for example, Rare and Imported Pathogens Laboratory and Malaria Reference Laboratory.

Source: Image from Llewelyn, M J, Price, N, Ratnaraja, N, et al., Where now for infection services in the NHS? How lessons from the pandemic should drive long-overdue integration of microbiology and infectious diseases, 2022, Clinical Medicine, is under a Creative Commons license.

Microbiology and virology clinical and laboratory services

Usually based in hospital pathology laboratories, NHS microbiology services provide diagnostic services to inform clinical management of infection and for surveillance. The laboratories identify pathogens including bacteria, viruses, fungi and parasites from clinical samples from patients presenting to primary and secondary healthcare facilities. They also perform antimicrobial susceptibility testing to guide treatment and track resistance patterns. Additionally, these services play a role in controlling spread of infection by identifying emerging clusters of disease and multi-drug-resistant pathogens.

Consolidation and mergers of pathology services since the 2006 Carter Review[9] have been associated with a sharp decline in on-site hospital laboratories and microbiologists, the traditional providers of local infection management expertise and IPC in most hospitals without ID clinical services. Microbiology and virology provision within hospitals has been altered, with significant workforce shortages – for example, 20% of consultant posts are vacant.[10]

Pathology partnerships, including those that are public-private, have centralised services with on-site hot laboratories to improve throughput, sample flow and turnaround time, and standardised tests. These partnerships also often have unified laboratory information management systems that integrate with electronic health records and provide electronic communication of results to primary and secondary care clinicians. However, challenges remain, with some services remaining fragmented, high vacancy rates and differential service provision. In addition, different commissioning approaches mean that test availability is not consistent across all services around the country.

Although NHS England has established 29 Pathology Networks to enhance efficiency, resilience, standardisation and quality across diagnostic services, these objectives have not been uniformly achieved and outstanding work remains. Whilst many functions of microbiology can be carried out remotely via telephone or electronic systems, some aspects of clinical advice, outbreak management and IPC are optimally performed in person and this is more challenging if the department is located in a distant hub. Optimised transport between centres and shared information technology systems for requesting tests and reporting results are pre-requisites to timely and reliable clinical management of infection – this is more challenging to implement in some areas due to geography and existing contracts.

Laboratory consolidation and automation, and the management of many communicable diseases within outpatient settings, means that the traditional medical microbiologist role has shifted from laboratory to more patient facing. The decreasing numbers of inpatient beds needed to manage communicable diseases (outside of a pandemic) means that some infectious disease physicians are able to provide more general medical care and other activities that are not ward based. This has resulted in an increased number of consultants who are able to deliver outpatient services such as ambulatory care and clinics, bed-side consults, antimicrobial stewardship and contribute to multidisciplinary meetings. Clinical scientists may support both laboratory and clinical activities.

Funding for pathology services remains based on sampling rates. However, most microbiology and virology services do not have patients directly under their care and a large proportion of

clinical advice, antimicrobial stewardship and IPC is not contingent on sampling, unlike in other pathology disciplines. Furthermore, there is no clinical reference group (CRG) to advise on commissioning priorities for pathology across the NHS and no integrated diagnostic strategy underpinning interdependent specialities and services such as infectious diseases (ID) and IPC.

At regional and national levels, integrated working with clinical and reference laboratory services for rare and/or complex conditions is often needed. The UK Health Security Agency (UKHSA) provides specialist national laboratory services such as the Rare and Imported Pathogens Laboratory (RIPL) and the Emerging Infection & Zoonoses team.

Super-specialist (nationally commissioned) management of infection

In England, ID is a relatively small speciality. There are 24 commissioned adult ID services across England, mostly concentrated in city teaching hospitals. A core service specification has been in place since 2013 and was updated in 2024 – commissioned adult providers are now designated as 'Specialised Regional ID Centres' (SRIDCs). The number of paediatric ID (PID) services is smaller still – these are commissioned separately from adult services and do not have a core service specification.

ID consultants account for less than 2% of all consultant physicians. The specialty attracts high calibre, motivated resident doctors. There are 2 ID dual-training programs leading to consultant accreditation: ID combined with either General (internal) Medicine (GIM) or microbiology-virology (MMV). An increasing number of ID-MMV consultants combine traditional diagnostic with patient-facing clinical expertise. In several trusts, ID-GIM consultants have taken up Acute Medicine roles.

Resident doctors frequently undertake research leading to MD and PhD qualifications during their post-graduate training before becoming a consultant. Accordingly, within large teaching hospitals associated with universities, a significant proportion of ID consultants have joint NHS-university or NHS-UKHSA appointments with research and educational responsibilities.

Since many infections are multi-organ conditions, ID services are also commissioned by other specialities or CRGs – for example, gastroenterology (viral hepatitis), HIV, orthopaedics (bone and joint infection), respiratory medicine (mycobacterial and fungal infections).

Historically, due to the small number of specialist providers and since most acute hospitals lack on-site ID altogether, it has been challenging to achieve equity of patient access. This was a major reason for creation of a national SRIDC network in 2024, with a 'hub and spoke' configuration supporting delivery of high-quality, local specialist care. Where possible, the emphasis is on provision of remote expert support by commissioned, national specialist services such as Tropical Medicine & Parasitology 'hubs' (see below). There is strong appetite for accessing remote clinical expertise through an expert multi-disciplinary team (for example, multi-drug-resistant tuberculosis, MDR-TB) and UKHSA also provides this role by convening the 'Imported Fever Service'.

Table 2: Nationally commissioned ID services

Service description	Number of commissioned services
High consequence Infectious Diseases, Special Isolation Unit (Airborne) Adult	**7**
High consequence Infectious Diseases, Special Isolation Unit (Airborne) Children (16 years and under)	**5**
High Security Infectious Disease Unit/ HCID-contact (All ages) B07/S/b	**5**
Specialised services for Infectious Diseases (Adults) B07/S/a	**24**
Operational Delivery Networks for Hepatitis C care in Adults	**22**
Tropical Medicine (All ages) B07/S/c	**2**
Human T-cell Lymphotropic Virus Type 1 and 2 (HTLV 1/2) (All ages) B07/S/d	**3**
Bone and Joint Infections (Adult) B07/S/e	**8**
MDR-TB Bedaquiline & Delamanid	**24**

Source: NHSE National Programmes of Care (Blood & Infection): Infectious Diseases

Specialised regional ID centres (SRIDCs)

There are currently 24 SRIDCs in England. All have the expertise to manage the whole range of community and hospital-acquired infections including non-endemic or imported conditions. Whilst individual clinical delivery models vary in emphasis and expertise, there is necessarily a greater clinical focus on the management of severe, complex or rarer conditions. This may involve direct patient care or supporting clinical management provided by a non-infection speciality.

Typical infections and related issues representing core activity common to all ID units include the following:

- pathogens resistant to standard anti-microbial therapy
- mycobacterial infections (for example, multi-drug-resistant tuberculosis (MDR-TB) and non-tuberculous mycobacteria)
- complex bone and joint infection (for example, osteomyelitis, septic arthritis, diabetic foot infection)

- infection of implanted prostheses (for example, joints, vascular grafts, heart valves)
- neurological infection (for example, meningitis, encephalitis)
- endovascular infection (for example, endocarditis, vascular graft infection)
- opportunistic infections in immune supressed patients (for example, HIV, organ transplant, haematological malignancy or lymphoproliferative disorders)
- 'Fever of unknown origin'
- infections of the returning traveller, 'Tropical Medicine' and parasitological infections (for example, malaria, schistosomiasis, leishmaniasis)
- Lyme disease
- infections in vulnerable or underserved populations such as migrant refugees or people who are homeless (for example, 'Find-and-Treat' services for tuberculosis or Hepatitis C, skin and soft tissue infections in people who inject drugs)

All SRIDCs provide in-patient care, including admission to negative-pressure isolation rooms to prevent transmission of airborne pathogens such as tuberculosis (TB) and respiratory viruses. In addition to 'general' ID clinics, all SRIDCs provide a range of more specialist out-patient services depending upon the individual unit. Examples of these out-patient services include those for TB, viral hepatitis, HIV, antenatal infection, chronic fatigue syndrome or pre-travel medicine.

Moreover, SRIDCs must reach effectively across the complete range of organ/system-specific specialties (for example, medical, surgical, maternity, haematology-oncology, transplant, neurosurgery, vascular and orthopaedic surgery). To facilitate this, ID physicians take a lead role in local multi-disciplinary team meetings alongside microbiology colleagues for infection related concerns. Several SRIDCs have regional, multi-regional or national reach, including for endocarditis, parasitology, infectious/tropical histopathology, encephalitis, hyperinflammation, chronic fatigue and Long-COVID services.

High Consequences Infectious Disease (HCID) services

HCIDs comprise a list of rare, acute infections characterised by:

- high case fatality
- lack of effective prophylaxis or treatment
- difficulty with rapid diagnostic detection
- ability to spread within the community and healthcare settings
- requirement of a system-wide response to manage effectively

In England, management of HCIDs are delivered by 2 overlapping 'Highly Specialised' national networks, defined by the primary route of pathogen transmission – 'airborne' (covering, for example, Middle East respiratory syndrome (MERS), Avian Influenza) or 'contact' (covering, for

example, Lassa fever, Ebola). The networks are made of 7 SRIDCs partnered with PID services, aiming to provide all-age coverage. Since commissioning requirements specify admission of confirmed HCID cases within 6 hours, each service must ensure appropriately trained clinical staff are always available. The Health and Safety Executive monitors compliance across all aspects of the service, including specialist PPE, comprehensive staff training, processes for laboratory samples, waste disposal, security and emergency contingencies.

Figure 2: Simulation exercise at Newcastle HCID centre

Source: Image courtesy Danny Morland via Brendan Payne, The Newcastle Upon Tyne Hospitals NHS Foundation Trust

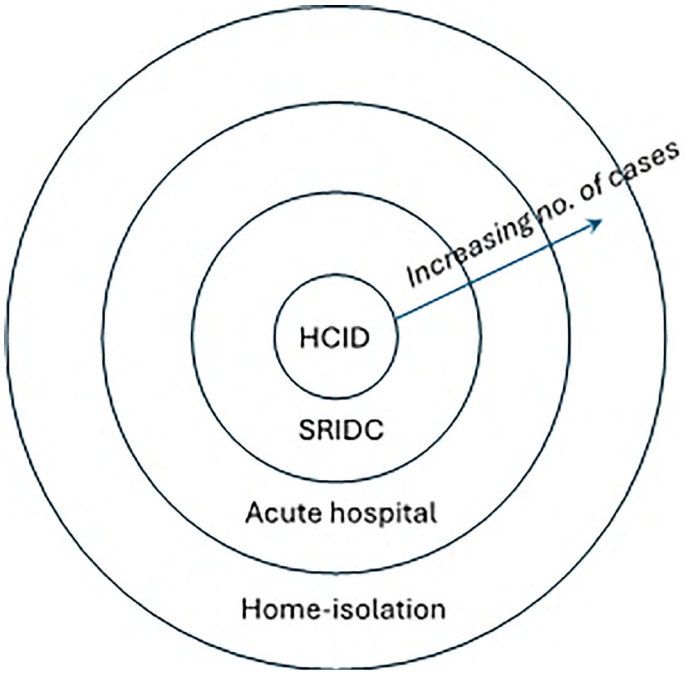
The HCID networks were originally designed for rare, infrequent cases and therefore have approximately 20 to 25 beds but have needed to adapt to unforeseen circumstances in the last 5 years. In early January 2020, reflecting concern about its uncertain virulence and unquantified potential for human-to-human spread, SARS-CoV-2 was designated an airborne HCID (HCID-a). In accordance with UK government policy for strict containment, all confirmed cases were urgently transferred to one of the then 5 HCID-a treatment centres. Access for the devolved nations was agreed and the HCID-a network served as the UK's exclusive patient treatment facility from the end of January until early March 2020. This highly publicised strategy was designed to provide public confidence and procure the greatest time for wider NHS preparations and planning effective counter measures.

In 2025, based on learning from the initial phase of the COVID-19 pandemic, a national SRIDC network was formally created to rapidly increase HCID 'surge' capacity if the need arose again. In the future, guided by high-level decision making and following first response from HCID providers, activation of the entire SRIDC network can potentially provide over 150 specialist beds in urgent response to an exceptional national incident.

Work to define links between HCID, SRIDC and PID providers on a geographic basis, and map all non-specialist acute hospitals to a local SRIDC, aims to coordinate resources and establish a specialist support infrastructure. This model was successfully tested during the Mpox outbreak in 2022; despite over 3,500 confirmed HCID cases, there were no reported patient deaths or known instances of healthcare worker transmission following occupational exposure.

The schematic below shows a 'layered' emergency specialist response for emerging and HCIDs. The strategic aim is for transition from the most specialist to non-specialist providers and finally home isolation, without abrupt loss of containment (which would lead to unpredictable consequences for disease spread) and ensuring the most severe cases are still managed in specialist settings.

Figure 3: Layered emergency specialist response for emerging and high consequence infectious diseases[11]



Source: Image by NHS England, Specialised Services for Infectious Diseases (Adult) Service Specification, 2025

Tropical Medicine and Parasitology

Tropical Medicine & Parasitology services are delivered through 2 highly specialist SRIDC 'Hubs' in Liverpool and London. Services support local providers of care, apart from for exceptionally rare or complex conditions needing to be managed directly by the Hubs. Clinical services provided by the Hubs include emergency assessments (for example, GP referral, 'walk-in'/ self-referral), diagnostics (the UK's only accredited parasitology laboratories), 24-hour telephone access for expert clinical advice, specialist clinics (for example, pre-travel, leprosy), multi-disciplinary team meetings (for example, to manage cases of echinococcosis, Chagas diseases, leishmaniasis) and in-patient treatment including intra-hospital transfers in exceptional circumstances.

In addition to providing access to specialist expertise and diagnostics, these services aim to improve early recognition of new and emerging infectious diseases. There is therefore important overlap with HCID services, which also involves close working with UKHSA reference laboratories and specialist clinical teams.

Due to some relatively successful global elimination programmes (for example, filariasis, trypanosomiasis), some 'tropical' infections are increasingly rare. The Hubs therefore aim to maintain an important national repository of specialist diagnostic and clinical expertise. Accordingly, both Hubs are co-located with internationally renowned Schools of Tropical Medicine in London and Liverpool, facilitating delivery of high-quality research and training.

Infectious disease control for public health

Surveillance of infectious disease to track incidence, outbreaks and trends enables prompt action to reduce population spread and informs population-level prevention policies such as those around vaccination. UKHSA conducts surveillance for notifiable diseases and organisms using a variety of methods, including through:

- in-house syndromic and laboratory surveillance, including through reference laboratories providing genomic analysis
- sentinel surveillance for influenza-like-illnesses[12]
- notifications from clinicians in primary and secondary care (statutory requirement)[13]
- ad hoc data from academic and environmental sources

Action to reduce the spread of infectious disease in the population includes:

- outbreak control (for example, in response to foodborne illness or emerging infectious diseases) led by UKHSA regional Health Protection Teams (see chapter 5.2)
- major incident response (for example, pandemic influenza or COVID-19) co-ordinated by UKHSA, NHS England and Local Resilience Forums
- national vaccination programmes which are delivered by the NHS primarily through GP practices, pharmacies and school-based services and evaluated by UKHSA to inform policy (see chapter 3.5)
- population-level screening and detection programmes for infectious diseases, including antenatally (see chapter 3.2), HIV testing in emergency departments, TB screening for high-risk migrants (see chapter 6.2)

Local authorities are responsible for environmental health protection – especially that related to contaminated food, decontamination of infective material and implementation of infection control advice in community settings. They also commission sexual health services and facilitate voluntary, community and social enterprise (VCSE) sector support in infectious disease outbreaks and incidents. Directors of Public Health and their teams play a role in

supporting outbreak response especially in relation to local population inequalities and vulnerabilities.[14]

However, shared responsibility has led to blurred lines. Infection management is often reactive and strategic prevention deprioritised. Joint working structures (for example, Health Protection Boards) vary in maturity. The VCSE sector, despite its reach, is rarely involved in outbreak governance.

Priorities for the future

These are the views of the chapter authors.

Primary care

Strengthening infectious disease control in primary care begins with improving access to diagnostic tools and the use of decision support tools potentially optimised by artificial intelligence. Expanding the use of point-of-care tests – such as CRP and rapid strep-A diagnostics – can reduce inappropriate antibiotic use and enable earlier detection of communicable diseases. The UK AMR Strategy 2019 to 2024 emphasises diagnostics as a pillar of antimicrobial stewardship.[15]

General practices and pharmacies should continue to embed robust antimicrobial stewardship using the TARGET tools available from the Royal College of General Practitioners. This includes routine audit and feedback mechanisms, education and alignment with national prescribing guidelines. The O'Neill Review on AMR calls for global AMS standards that are applicable at the community level.[16]

IPC must also be designed into primary care estate infrastructure, from ventilation and patient flow to personal protective equipment. During the COVID-19 pandemic, inspection reports from the Care Quality Commission highlighted considerable variation in IPC standards.

Secondary care

Getting it Right First Time (GIRFT) reviews[17] and NHS England led collaboratives have shown that embedded specialist teams can significantly reduce hospital-acquired infections and support safe antimicrobial use.

With the updating of the NHS operating model, there is an opportunity for ICBs and NHS regional boards to ensure through effective secondary care commissioning that every acute hospital and community site has 24/7 access to integrated infection teams – whether through on-site teams or virtual networks.

These integrated infection teams – ID physicians, clinical microbiologists and virologists, clinical scientists, pharmacists and IPC nurses provide bench to bedside care with a role that extends beyond case management to education, policy development and outbreak coordination across hospital boundaries and within the developing neighbourhood health services.

IPC governance should continue to be fully integrated into trust-level safety and quality boards. New hospital builds and estate upgrades with optimised topography, ventilation, water systems and increased single rooms will improve infection resilience.

Specialist services

There is a pressing need to further develop ID clinical services for children. Fortunately, SARS-CoV-2 and subsequently the UK Mpox outbreak in 2022 caused relatively less severe disease in children compared with adults, but future pandemic planning cannot rely on this always being the case. PID services should therefore be commissioned identically to their adult specialist counterparts, with formal establishment of a national PID network. HCID PICU bed capacity, coupled with specialist paediatric transfer arrangements, is also poorly resourced compared to adult ITU transport and facilities. Infections do not respect age boundaries and commissioning en-suite isolation facilities that cater for both parents and their children together for a protracted period of hospital admission is needed.

Whilst integrated infection training has come a long way, there is a need to go further, to meet the needs of the modern NHS. A 2025 British Infection Association national survey evidenced strong support for re-thinking traditional boundaries and developing innovative ways of integrated working between infection specialities. This should embrace a variety of service delivery models to suit specific circumstances and has significant implications for the delivery of specialist training. For example, an ID-GIM physician working alongside a microbiologist or ID-MMV consultant in a District General Hospital could provide a high-quality in-patient training environment, especially operating as a satellite of a local SRIDC. Ultimately, the aim should be to extend ID specialist services into District General Hospitals, where it is largely absent at present.

There is strong support for closer integration between NHS infection services and UKHSA, including joint posts, training and shared outbreak response structures. National workforce strategies must address shortages in ID physicians, genitourinary medicine specialists, public health specialists, microbiologists, virologists, infection control nurses and antimicrobial pharmacists.

A system blueprint for IPC and antimicrobial stewardship to facilitate specialists to work across organisational boundaries would improve management of incidents and outbreaks and reduce AMR in care homes, other community settings and hospitals.

In addition, infrastructure gaps (for example, isolation capacity, diagnostics) and over-centralisation remain key risks.

Laboratories and diagnostics

A modern, coordinated laboratory network is foundational to infectious disease control. A national network with shared protocols, surge capacity and data interoperability would enable faster detection of outbreaks and coordinated responses. In addition, the ability of laboratories to roll out rapidly developed tests in emergencies with the support of UKHSA and the Medicines and Healthcare products Regulatory Agency (MHRA) will be essential to increase

capacity and capability within the system. UKHSA delivers specialist and reference microbiology services and could further support the NHS to enhance the microbiology pathology networks linked to SRIDCs.

Specialist workforce for laboratories with medical and clinical scientists working alongside specialist laboratory scientists and bioinformaticians with experts in microbiology, virology and mycology linked to the SRIDCs is required. There is a need to consider the specialist needs of paediatrics, immunologists and vaccinologists in these services.

Ongoing digital and technical transformation is required to achieve full compliance with digital diagnostic standards, improve interoperability and to enable a national diagnostics dashboard to determine equity of access.

Diagnostics continue to evolve through investment in metagenomics for diagnostics automated platforms with liquid handling systems and AI-supported interpretation. Application of the NHS metagenomics programme to wider infections will identify emerging infectious disease threats through sharing of genomic data. However, this could go further with an NHS platform for translational evaluation of diagnostics in microbiology and virology.

Real-time lab data integration of all microbiological and virological tests (positive and negative) to UKHSA will improve situational awareness, supporting earlier intervention at local and national levels.

Health protection

Health protection teams (HPTs) are the frontline of community outbreak detection and response. Linking UKHSA national and regional expertise in community health protection, national experts field epidemiology, behavioural science and contact tracing expertise to the SRIDCs enables an integrated end to end delivery of complex infection management.

There is national guidance for ICBs highlighting the importance of joint co-developed outbreak frameworks involving UKHSA, ICBs, local authorities, and NHS providers and clarifies the roles and responsibilities of ICBs in outbreak response including the delivery of emergency diagnostics, therapeutics and vaccination.[18] Joint exercises and shared protocols enable the system to be ready to respond and reduce delays in the delivery of life saving prophylactic vaccines, prophylaxis and treatment.

Cross-cutting priorities

The whole healthcare system in England needs to integrate infection specialist clinical care pathways, laboratory services, surveillance, outbreak management and emergency preparedness. The importance of coordinating such a multifaceted response was highlighted by the COVID-19 pandemic, but a similar integrated specialist approach is needed to maximise responses to other national threats from infectious diseases, for example, related to climate change, global travel or immigration, and AMR. This must be supported by a sustainable workforce plan and long-term capital investment, tailored to the needs of vulnerable and underserved populations.

There is a particular need for stronger leadership and coordination of specialist resources at the regional level. With this need foremost in mind, the NHS England ID CRG has proposed formation of 'Regional Infection Groups' (RIG) on Regional footprints (or ICB 'clusters'), comprising senior leaders from integral specialities/services including NHS Regional Teams, Regional Pathology Networks, UKHSA, IPC, and NHS Emergency Preparedness, Resilience & Response (EPRR). In an evolving pandemic and supported by a dedicated consultant infection specialist, RIGs could provide regional leadership when transition from central command-and-control becomes necessary, whilst ensuring implementation of national strategy. For example, this might involve maximising local laboratory capacity and targeting diagnostic outputs, standardising regional IPC practice, benchmarking performance and learning from best practice, and developing risk-based IPC decisions based on UKHSA epidemiological data.

In the non-pandemic scenario, RIGs could improve equity by defining service standards for essential diagnostic tests (for example, 24/7 access to cerebro-spinal fluid examination or malaria blood test) or specialist ID referral pathways. Each RIG should contain at least one SRIDC, which has a commissioned responsibility to non-specialist providers in their locality. RIGs should promote strategies to improve patient access or extend specialist 'reach' into non-specialist settings, and define links between local adult ID and PID services to provide a coordinated clinical response across all ages. In collaboration with UKHSA, local data-driven interventions might include working across community and secondary care boundaries on comprehensive antimicrobial stewardship initiatives. RIGs should ensure ICBs prioritise pandemic preparedness and work with regional EPRR teams to conduct simulated exercises to test integrated pandemic responses.

Table 3: Summary of priorities

Theme	Current Challenge	Proposed Recommendations
Roles & Responsibilities	Overlap	Define clear roles in a national to local coordination framework and improved commissioning of core infectious diseases, microbiology and virology services with shared accountability
Service Integration	Fragmentation	Further develop Regional Infection Networks with UKHSA including microbiology and virology networks to reduce inequitable access to diagnostics and improve acceleration of cost effective diagnostic adoption
Surveillance & Data	Siloed data	Utilise cloud based infrastructure to integrate all available data and link to public facing dashboards with real time information.

Theme	Current Challenge	Proposed Recommendations
IPC Across All Settings	Variable across system	Standardise IPC leadership and training across all care settings with ICB boards providing a system overview for community and hospitals
Workforce Capacity	Shortage of specialists (ID, microbiology, virology, public health)	National workforce strategy and cross-disciplinary training

References

1 Ratnaraja NV, Davies AP, Atkins BL et al. Best practice standards for the delivery of NHS infection services in the United Kingdom. Clinical infection in practice. 2021;12:100095. doi: 10.1016/j.clinpr.2021.100095.

2 Royal College of General Practitioners. Key general practice statistics and insights Key general practice statistics for England [Internet]. 2025. [Accessed 24 June 2025] Available from: https://www.rcgp.org.uk/representing-you/key-statistics-insights

3 UK Health Security Agency. English surveillance programme for antimicrobial utilisation and resistance (ESPAUR) Report 2022 to 2023. [Internet] 2023. Available from: https://www.gov.uk/government/publications/english-surveillance-programme-antimicrobial-utilisation-and-resistance-espaur-report

4 UK Health Security Agency. Influenza in the UK, annual epidemiological report: winter 2024 to 2025. [Internet] 2025. [Accessed 24 June 2025] Available from: https://www.gov.uk/government/statistics/influenza-in-the-uk-annual-epidemiological-report-winter-2024-to-2025/influenza-in-the-uk-annual-epidemiological-report-winter-2024-to-2025

5 UK Health Security Agency. Understanding the burden of UTI hospitalisations in England. [Internet] 2025. Available from: https://www.gov.uk/government/publications/understanding-the-burden-of-uti-hospitalisations-in-england/understanding-the-burden-of-uti-hospitalisations-in-england

6 NHS England. Pharmacy First. [Internet]. [Accessed 25 August 2025]. Available from: https://www.england.nhs.uk/primary-care/pharmacy/pharmacy-services/pharmacy-first/

7 London School of Hygiene and Tropical Medicine. Pharmacy First Evaluation. [Internet]. [Accessed 25 August 2025]. Available from: https://www.lshtm.ac.uk/research/centres-projects-groups/pharmacy-first-evaluation

8 Llewelyn MJ, Price N, Ratnaraja N, Atkins B, Partridge D, Jeffery K. Where now for infection services in the NHS? How lessons from the pandemic should drive long-overdue integration of microbiology and infectious diseases. Clin Med (Lond). 2022;22(6):586-589. doi: 10.7861/clinmed.2022-0251.

9 Lord Carter. Report of the Review of NHS Pathology Services in England. 2006. Available from: https://www.bipsolutions.com/docstore/pdf/14047.pdf

10 Lawrence S, Aggarwal D, Davies A, Partridge D, Ratnaraja N, Llewelyn MJ. The state of hospital infection services in the UK: national workforce survey 2021. Clinical Infection in Practice. 2022;15:100151. doi: 10.1016/j.clinpr.2022.100151

11 NHS England. SCHEDULE 2 – THE SERVICES A. Service Specifications Specialised Services for Infectious Diseases (Adult). [Internet]. 2025. Available from: https://www.england.nhs.uk/wp-content/uploads/2025/02/Specialised-services-for-infectious-diseases-adult-service-specification.pdf

12 UK Health Security Agency. Surveillance of influenza and other seasonal respiratory viruses in the UK, winter 2023 to 2024. [Internet]. 2025. Available from: https://www.gov.uk/government/statistics/surveillance-of-influenza-and-other-seasonal-respiratory-viruses-in-the-uk-winter-2023-to-2024/surveillance-of-influenza-and-other-seasonal-respiratory-viruses-in-the-uk-winter-2023-to-2024

13 UK Health Security Agency. Notifiable diseases and how to report them. [Internet]. 2025. Available from: https://www.gov.uk/guidance/notifiable-diseases-and-how-to-report-them

14 UK Health Security Agency. Communicable disease outbreak management guidance. [Internet]. 2025. Available from: https://www.gov.uk/government/publications/communicable-disease-outbreak-management-guidance

15 Department of Health and Social Care. UK 5-year action plan for antimicrobial resistance 2019 to 2024. [Internet]. 2019. Available from: https://www.gov.uk/government/publications/uk-5-year-action-plan-for-antimicrobial-resistance-2019-to-2024

16 Review on Antimicrobial Resistance. Tackling Drug-Resistant Infections Globally: Final Report and Recommendations. [Internet]. 2016. Available from: https://amr-review.org/

17 NHS England. Getting It Right First Time (GIRFT). [Internet]. Available from: https://gettingitrightfirsttime.co.uk/

18 NHS England. Clinical response to local incidents and outbreaks of infectious disease: Commissioning guidance for ICBs. [Internet] 2025. Available from: https://www.england.nhs.uk/long-read/clinical-response-outbreaks-of-infectious-disease-commissioning-guidance-icbs/

5.2 Regional case studies in health protection

Megan Evans – Specialty Registrar, Health Protection in Regions, UKHSA

Simon Walker – Head of Regional Strategy, Engagement and Insight, Health Protection in Regions, UKHSA

Tristan Childs – Specialty Registrar, Health Protection in Regions, UKHSA

William Welfare – Director, Health Protection in Regions, UKHSA

Introduction

Health protection is a 'set of functions to protect individuals and populations through an integrated approach to infectious diseases, radiation, chemical and environmental hazards'.[1] The UK Health Security Agency (UKHSA) provides these functions through leadership and operational support to the NHS, local authorities and other organisations. Here, we focus on health protection as it applies to infectious diseases.

Nine regional UKHSA health protection teams across England receive reports of notifiable cases of infectious disease (Table 1), exposed persons and causative agents from laboratories and healthcare professionals, as well as associated queries from a range of stakeholders and members of the public. These are triaged and risk assessed to inform appropriate public health action to reduce transmission. Action may include, for example, identification of the source of infection, or vaccination to reduce onward transmission. In practice, effective control of infectious diseases, including investigations and interventions, is dependent on close partnerships between UKHSA, the NHS, local authorities and wider partners including businesses and communities. Systematic and continuous collection, analysis and interpretation of data to understand local infectious disease risks allows for timely detection, risk assessment and acute response to outbreaks and incidents.

The following case studies illustrate examples of co-ordinated action to prevent and mitigate the impact of outbreaks of infectious diseases in England.

Vaccine preventable disease

Vaccines are one of the most important advances in health, allowing people to live longer and healthier lives. Vaccine preventable diseases are a growing concern in the UK and other countries, with a resurgence in infections like measles due to declining vaccination rates. During outbreak response, targeted vaccination programmes, especially in underserved communities, interrupt transmission, protect communities and save lives.

Vaccination rates have been falling since 2014, and 2023 saw the start of a resurgence of measles with 362 laboratory confirmed cases reported in England[2] compared to just 47 in 2022.[3] In 2024, a total of 2,911 measles cases were reported, mainly in the first 6 months of the year, with most cases in children under 10 years old.[4]

Inequalities in vaccination uptake across England have been well documented,[5] and under-vaccinated communities are disproportionately affected by measles outbreaks. Population susceptibility estimates have shown sustained measles transmission would be possible in particular age groups (for example, people born between 1998 to 1999 and 2003 to 2004) and areas of low vaccine coverage (including parts of London).[6]

Case study: measles outbreak in the West Midlands

Authors: Carol Chatt, Katie Spence, Emma Booth, Hannah Jary, Caroline Harris

Between October 2023 and April 2024 there was a significant measles outbreak in Birmingham with over 400 cases.

Figure 1: UKHSA provided public information on measles via social media

Source: UKHSA

UKHSA West Midlands worked with partners through an Incident Management Team (IMT) to tackle the outbreak. This included case finding, investigation and management, contact tracing, advice to settings, and surveillance. In addition, communication activities including vaccination campaigns were undertaken to improve both overall uptake and uptake in the most susceptible communities. Some of the largest increases in vaccine uptake occurred within some ethnic minority groups. Seventeen percent of cases were of Black or Black British – African ethnic background. The rate of measles in this group was 8 times higher than the White British population (86.3 per 100,000 population compared to 10.8 per 100,000). Through focused work with communities, there was a 1.1% increase in vaccine coverage amongst people of Black or Black British - African ethnic background (348 additional doses) in the outbreak period compared with the previous period. The White British population had a 0.2% increase in coverage (261 additional doses).

The IMT sought to ensure rapid testing pathways for people with suspected measles as required, supported those with measles to isolate and provided specialist and tailored advice to settings such as schools and prisons. This was enabled by an established understanding of local communities and built upon existing trusted relationships.

Following this outbreak, UKHSA worked closely with Birmingham Children's Hospital to understand the impact of the outbreak on the hospital's emergency department (ED). During the outbreak, 366 children who attended the ED were tested for measles. 161 (44%) tested positive and, of those, 46 (29%) required admission to hospital. A quarter of confirmed cases were too young to have been offered the Measles, Mumps and Rubella (MMR) vaccine routinely. Nearly 2,400 individuals were identified as having had contact with a confirmed case within the hospital and were followed up. This study highlighted the challenges in responding effectively to a large community outbreak in already busy services. The lessons identified included the need for prompt implementation of infection, prevention and control (IPC) measures in EDs to reduce the risk of further transmission, and clear and timely messaging on symptoms for the public and clinicians to aid in early identification. Point of care testing and a streamlined notification process may reduce the time taken to confirm cases and ensure effective use of isolation. Early negative results can also reduce parent/carer anxiety as well as the need for isolation.

There are complex reasons for inequalities in vaccine coverage. Addressing such issues requires joint working with communities and system partners to develop tailored solutions that support, motivate and enable people from all population groups to be vaccinated. An UKHSA led evaluation showed that the national MMR catch up campaign and regional and local tailored interventions have been successful at reaching key under vaccinated communities but more needs to be done to sustain progress and prevent further outbreaks from occurring.[7]

Emerging infectious disease

Emerging infectious diseases disproportionately affect particular communities, pose risks to national health security and place significant strain on NHS resources. Factors such as climate change and increased global travel further increase this risk. Early detection, surveillance and preparedness are essential to prevent outbreaks and reduce harm.

Case study: swine flu in Yorkshire & Humber

Authors: Andrew Lee and Simon Padfield

Influenza viruses in swine (pigs) are genetically diverse. There is a risk that variant viruses may be transmitted to humans and pose a potential pandemic threat if there is sustained human-to-human transmission.

UKHSA undertakes community respiratory virus surveillance with the Royal College of General Practitioners (RCGP) Research and Surveillance Centre. In November 2023, an influenza A-positive sample from routine RCGP surveillance was confirmed as subtype H1N2. The sample was from an older adult in northern England who had gone to their GP with a respiratory illness. Further testing showed swine influenza A(H1N2)v.

Building on existing plans and strong local working relationships, UKHSA Yorkshire & Humber investigated this incident and implemented control measures alongside system partners including local authorities, the NHS and the veterinary sector. Although the index case lived in a region of the country with a high density of pigs, no animal contact with the case or their household was identified. Contact tracing identified four individuals with exposure to the index case. None of them tested positive for influenza A. One of the contacts was a healthcare worker who had seen the index case at a healthcare appointment for an unrelated condition. As a precaution, secondary contact tracing was initiated around the healthcare worker and 198 contacts were identified. 149 (75%) were tested, none of which detected swine influenza A(H1N2)v.

Extensive case finding was undertaken, including increased testing of those presenting to GPs with acute respiratory infection, based on an established sentinel respiratory virus surveillance scheme. There were no unusual spikes of viral respiratory infections in and around the affected areas and no further cases of swine influenza A(H1N2)v were identified. The incident was stood down in December 2023.

Case study: Mpox in London

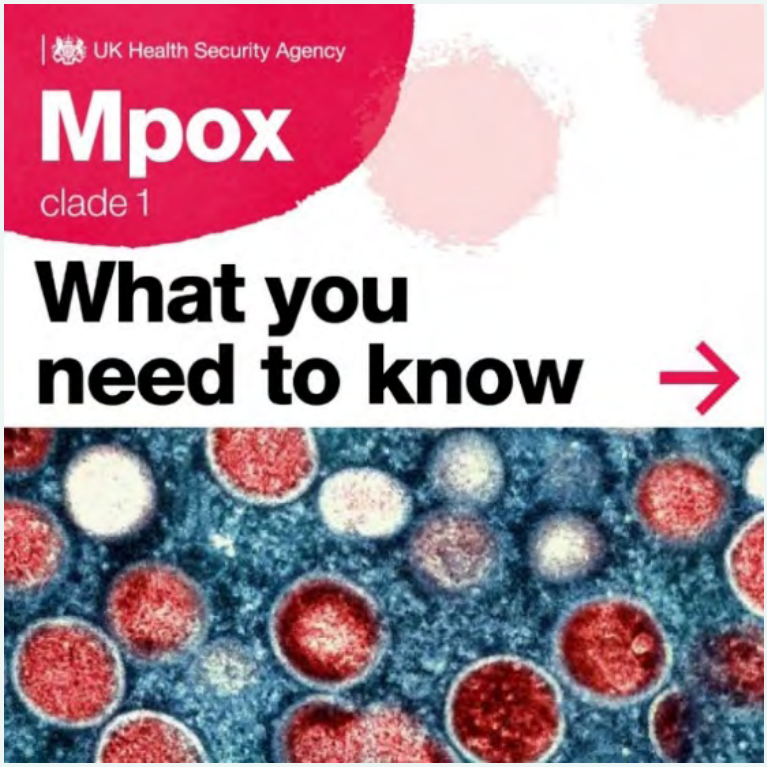
Authors: Charlotte Jackson, Yimmy Chow, Robert Sookoo, Marina Sanchez-Perez, Patricia Chesters

Mpox is a viral zoonotic disease, first identified in humans in 1970 and endemic in parts of Central and West Africa. Mpox spreads through close person-to-person contact or materials contaminated with the virus. Like many diseases caused by a virus, Mpox has different types or 'clades'. There are 2 distinct clades of the virus: clade I (with subclades Ia and Ib) and clade II (with subclades IIa and IIb). The symptoms of Mpox include a skin rash with blisters, spots or ulcers that can appear anywhere on the body (including genitals), fever, headaches, backache, muscle aches, joint pains and swollen glands.

In the summer of 2022, an outbreak of Mpox clade IIb was identified in the UK, primarily among gay, bisexual and other men who have sex with men (GBMSM) and not associated with a history of travel to an endemic country. Linked outbreaks were subsequently identified across Europe and globally. Following the first confirmed cases in England, the UKHSA implemented extensive public health measures (which included active case finding, extensive contact tracing and decontamination advice) to control transmission and secured vaccines for those at highest risk. As a result of coordinated action in raising awareness, promoting safe sex practices and messaging by partners including the UKHSA, NHS and voluntary and community organisations, cases declined significantly, and the outbreak was successfully controlled. Following this outbreak response and with recommendations by the Joint Committee on Vaccination and Immunisations (JCVI), a routine Mpox immunisation programme was set up to protect those at highest risk of exposure. This is delivered via sexual health services and is a key mechanism to prevent future large outbreaks.

In September 2023, a novel clade Ib strain of Mpox was identified in the Democratic Republic of Congo and subsequently spread to neighbouring countries. In August 2024, Mpox clade Ib was detected outside Africa for the first time and the World Health Organization (WHO) declared a Public Health Emergency of International Concern. By October 2024, the first case was confirmed in the UK, with 4 further cases by the end of November 2024. UKHSA London, in collaboration with national UKHSA teams, NHS and partner organisations, worked together in response to the first cases of Mpox Clade Ib.[8]

Figure 2: UKHSA provided public information on Mpox via social media



Source: UKHSA

A regional incident management team was established to co-ordinate the local response, including:

- Management and investigation of the cases, with designated single points of contact for each case.
- Identification and management of contacts, including vaccination where appropriate, and active monitoring of contacts at higher risk.
- Clinical referral and testing pathways for symptomatic contacts.
- Decontamination in community settings.

A precautionary approach was taken to the management of the initial individuals with Mpox clade Ib in the UK. At the time, Mpox clade I (Ia and Ib) infections were considered as high consequence infectious disease (HCID) in the UK and managed with HCID protocols in healthcare settings. This included consideration of admission of all confirmed cases to specialist NHS centres for observation and isolation and stringent IPC protocols. Since March 2025, clade Ia and Ib Mpox are no longer classified as HCID following a review of available evidence by the Advisory Committee on Dangerous Pathogens.

Nearly 150 contacts were followed up, with transmission being detected only within a family household setting and no transmission identified in healthcare or community contacts. Building on trusted relationships and the history of joint working between UKHSA regional teams and partner organisations enabled pragmatic problem solving. This included collaboration with local authority partners to resolve a housing issue to enable adherence to self-isolation guidance. UKHSA London adapted national guidance and community IPC protocols to address specific complex community exposures such as how to decontaminate a household and car.

In addition, UKHSA Border Health worked with partners to introduce several precautionary measures at UK borders to reduce the risk of international spread of Mpox. These included announcements on aircraft, provision of public health information to arriving passengers and crew, electronic bulletin boards, General Aircraft Declaration (GAD) forms, and rapid assessment of symptomatic passengers. These actions relied on existing working arrangements and collaboration with airports, the airline industry and Department for Transport for successful implementation.

The coordinated efforts of UKHSA, NHS and partner organisations ensured an efficient response to Mpox clade Ib, highlighting the effectiveness of collaboration in outbreak management. As of June 2025, 12 cases of Mpox clade Ib have been reported in the UK and all of these cases have direct or indirect links to travel to countries where Mpox clade Ib is circulating.

Gastrointestinal infections

Gastrointestinal infections are of significant public health concern in the UK, affecting millions annually and placing a heavy burden on the NHS. Gastrointestinal infections can lead to widespread illness, hospitalisations and lost productivity.[9] There are an estimated 17 million cases of gastrointestinal infections annually, with foodborne illness costing the NHS £60m per year.[10] These infections disproportionately impact vulnerable populations, including the elderly and people living in deprived areas. Effective surveillance, hygiene practices, and public awareness of risks and mitigations, are essential to reduce transmission. Clusters and outbreaks of gastrointestinal infections are rapidly detected and investigated so that control measures can be implemented promptly to prevent further spread. Control measures vary depending on the causative pathogen and the most likely source (for example, food or animal) but may include collection and sampling of potential food sources or communications to the public with warn-and-inform advice, for example. As outbreaks of GI infection may be associated with complex food supply chains or water distribution with response roles and responsibilities shared across a number of key partners, early collaboration and communication across UK government agencies and partners, including the NHS and private/business sector, is crucial for the protection of public health, reducing healthcare costs, and ensuring food safety.

Cryptosporidium is a parasite that causes cryptosporidiosis. It can be found in the intestines and faeces of infected humans and animals, and may contaminate water (including swimming pools), food (especially raw milk and fresh produce) and objects such as farm gates or outdoor boots. Most outbreaks are linked to animal contact or swimming pools. UKHSA supports prevention initiatives by engaging relevant industry partners such as the National Farm Attraction Network and National Farmers Union to provide health advice and promote safe visiting in advance of 'Open Farm Sunday' in June 2025.

Case study: cryptosporidium in the South West

Authors: Sarah Bird, Nick Young, Dominic Mellon, Gemma Fear

In May 2024, four confirmed cryptosporidium cases were initially reported in South Devon, quickly followed by many more, with public social media posts and GPs reporting high numbers of local residents with sickness and diarrhoea. UKHSA South West worked with local authority public health and environmental health teams, NHS partners, the Drinking Water Inspectorate and the water company to identify and control the source of infection and prevent further cases.

Testing found cryptosporidium contamination in parts of the water network and a boil water notice was immediately issued to 17,000 properties, and later reduced to 2,500 properties once the likely source was identified. Local businesses including restaurants, holiday accommodation and swimming pools, as well as schools and care homes, were given advice to help them operate safely.

Anyone with symptoms was advised not to attend school or work until 48 hours after symptom resolution, to avoid swimming for at least 2 weeks and to follow infection control measures, including handwashing, to prevent spread. GPs in the area tested anyone who presented with severe or prolonged diarrhoea for the parasite. The water company undertook an intensive programme to identify and address the source of the contamination, clean the network and provide additional protections. Following this, a phased lifting of the boil water notice was completed in July 2024. The water company continued water sampling and published results to reassure the public that decontamination had been effective.

The outbreak investigation led by UKHSA South West identified 126 laboratory-confirmed linked cases of cryptosporidium. Case numbers rapidly declined following public health interventions. Following the outbreak, UKHSA conducted a research study in the affected area to investigate risk factors, compliance with public health measures and the overall impact of the outbreak.

Healthcare associated infections and antimicrobial resistance

Antimicrobial resistance occurs when medicines used to treat infections lose their effectiveness because the organisms they target, whether bacteria, fungi, viruses or parasites, have evolved or adapted to survive. Sustained action is required to curb the inappropriate use of antibiotics and transmission of resistant bacteria.[11]

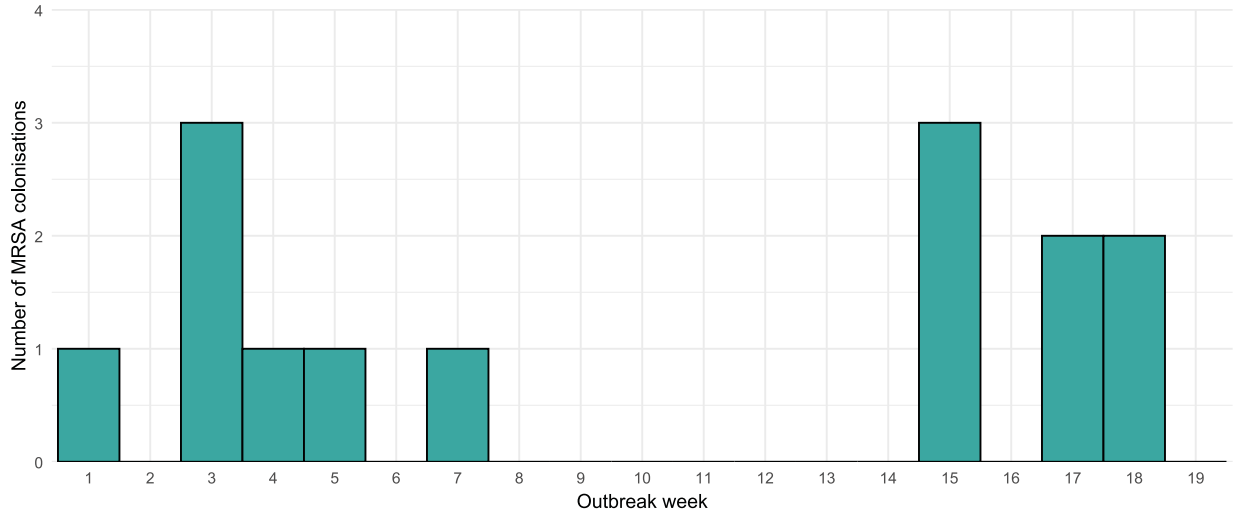
Healthcare associated infections contribute significantly to patient morbidity, prolonged hospital stays and increased healthcare costs. They are also a major driver of antimicrobial resistance and account for a substantial proportion of hospital acquired complications.[12] These infections are largely preventable.

Case study: MRSA in the East of England

Authors: Ellen Heinsbroek, Smita Kapadia, David Edwards, Katie Thorley

In 2023, routine methicillin-resistant *Staphylococcus aureus* (MRSA) screening at an NHS neonatal unit in the East of England detected an infant with MRSA colonisation. Further testing showed transmission had occurred and an outbreak was declared. Several infants and 2 staff tested positive within a linked cluster. The outbreak occurred in 2 waves, with very limited overlap in cases.

Figure 3: Epidemiological Curve of detections of MRSA colonisation by week



Source: UKHSA

Neonatal units are challenging environments for outbreak control due to the vulnerable population group and complex care required. MRSA is a recognised cause of neonatal sepsis and a frequent cause of neonatal unit outbreaks.[13,14] Controlling and preventing outbreaks of MRSA is therefore important to prevent disease among vulnerable newborn infants.

The incident management team comprised the neonatal unit, hospital IPC team, UKHSA and Integrated Care Board. UKHSA East of England supported the NHS neonatal unit and hospital IPC team with the outbreak investigation which identified potential MRSA in the environment and colonised staff. An extensive bundle of control measures was implemented including screening, enhanced cleaning, review of IPC practices, reducing admission capacity and structural renovations. The latter included replacement and addition of handwashing sinks. Parental screening was undertaken, and staff screening was introduced in the second wave.

The outbreak was successfully controlled through the strong collaboration, detailed investigation and timely action between UKHSA East of England, the NHS neonatal unit and the IPC team. The structural renovations were key as the two waves of cases suggested the possibility of a persistent environmental reservoir.

UKHSA conducted an analytical (cohort) study on this outbreak that contributed to understanding transmission and targeting control measures. Findings were consistent with other literature[15] showing low birthweight, younger gestational age and exposure to medical procedures may be risk factors for MRSA.

Case study: carbapenemase-producing Enterobacterales in the North West

Authors: Claire Roach, Caroline Rumble, Will Morton, Merav Kliner

Enterobacterales are bacteria that usually live harmlessly in the gut of humans and animals but are also some of the most common causes of urinary tract infections. Carbapenemases are enzymes produced by these bacteria that destroy carbapenem antibiotics and prevent them from working.

There was an outbreak of carbapenemase-producing Enterobacterales (CPE) within the cardiac unit of a hospital in Greater Manchester.[16] CPE can be spread from one person to another by direct contact or through the environment. Despite extensive control measures, including the temporary closure and refurbishment of the unit, early environmental sampling after reopening indicated CPE was still present on the unit. This suggested the presence of persistent environmental reservoirs contributing to ongoing transmission.

To investigate the transmission dynamics and reservoirs, a study was conducted across 6 wards over 12 months. This involved systematic sampling of 349 wastewater sites (totalling 4,488 samples) and screening of 5,601 patients. Genomic sequencing was performed to assess strain diversity and transmission pathways. The study revealed substantial presence of CPE at wastewater sites, with 29% testing positive for CPE. Notably, certain sites such as shower/bath drains and sluice/mop sinks had higher positivity rates, indicating specific environmental conditions that facilitated bacterial persistence.

Genes that cause carbapenem resistance can quickly spread between and within species because they are carried on mobile genetic elements, such as transposons and plasmids. Therefore, surveillance and control needed to cover a number of different species.

The findings underscore the complexity of CPE transmission within healthcare settings, emphasising the role of environmental reservoirs in sustaining and spreading resistance mechanisms. The study demonstrated that standard infection control measures, including plumbing replacement, may be insufficient without addressing other environmental conditions.

Surveillance, environmental sampling, genomic analysis and IPC interventions were pivotal in understanding and mitigating further impact from this outbreak. The integration of advanced genomic tools allowed for precise tracking of transmission pathways, informing targeted strategies to disrupt the persistence and spread of CPE.

Conclusion

Almost all actions to protect public health from infections are essentially local, happening where people live and work. Data are collated and interpreted at local, regional and national level but remain informed by local insight and understanding. Health protection must be tailored to individuals and local communities.

There are considerable differences between communities and groups in society both in terms of the risk of exposure to infectious disease, their susceptibility to poor outcomes when exposed and their resilience. Recognising this, UKHSA regional teams continue to take a people and place approach to health protection, targeting those most at risk to reduce avoidable harm and improve health security outcomes for all.

References

1 Public Health England. Chapter 7: current and emerging health protection issues. 2018 [Internet] [Accessed 03 July 2025] Available from: https://www.gov.uk/government/publications/health-profile-for-england-2018/chapter-7-current-and-emerging-health-protection-issues

2 UK Health Security Agency. Confirmed cases of measles in England by month, age and region: 2023 [Internet]. 2024. [Accessed 5 June 2025]. Available from: https://www.gov.uk/government/publications/measles-epidemiology-2023/confirmed-cases-of-measles-in-england-by-month-age-and-region-2023

3 UK Health Security Agency. Measles, mumps and rubella: lab-confirmed cases in England 2022 [Internet]. 2023. [Accessed 5 June 2025]. Available from: https://www.gov.uk/government/publications/measles-mumps-and-rubella-lab-confirmed-cases-in-england-2022

4 UK Health Security Agency. Confirmed cases of measles in England by month, age, region and upper tier local authority: 2024 [Internet]. 2024. [Accessed 5 June 2025]. Available from: https://www.gov.uk/government/publications/measles-epidemiology-2023/confirmed-cases-of-measles-in-england-by-month-age-region-and-upper-tier-local-authority-2024

5 Public Health England. National Immunisation Programme: health equity audit [Internet]. 2021. [Accessed 24 June 2025] Available from: https://assets.publishing.service.gov.uk/media/60183a8de90e07128e743b85/immnstn-equity_AUDIT_v11.pdf

6 Jary H, Pullen A, Howett D et al. Sociodemographic inequalities in the epidemiology and vaccine uptake within a large outbreak of measles in Birmingham, England, 2023 to 2024. Euro Surveill. 2025;30(16). doi: 10.2807/1560-7917.ES.2025.30.16.2400652.

7 UK Health Security Agency. Infectious diseases impacting England: 2025 report [Internet]. 2021. [Accessed 24 June 25]. Available from: https://assets.publishing.service.gov.uk/media/67fe0e08712bf73dea13541d/Infectious_diseases_impacting_England_2025_report_2.pdf

8 Alvi MI, Kliner M, Welfare W et al. Case series of the first five human infections with monkeypox virus clade Ib and report on the public health response, United Kingdom, October to November 2024. Euro Surveill. 2025 Mar 13;30(10).doi: 10.2807/1560-7917.ES.2025.30.10.2500131.

9 UK Health Security Agency. Gastrointestinal infections and outbreak statistics for England. [Internet]. 2025 [Accessed 16 June 2025]. Available from: https://www.gov.uk/government/publications/gastrointestinal-infections-in-england

10 Murrell L, Clough H, Gibb R et al. Understanding the impact funding cuts on Environmental and regulatory services and gastrointestinal infections: a longitudinal ecological study. NIHR Open Res. 2024, 3:41 doi: 10.3310/nihropenres.13426.2

11 UK Health Security Agency. Healthcare-associated infections [Internet]. 2024. [Accessed 16 June 2025]. Available from: https://ukhsa-dashboard.data.gov.uk/healthcare-associated-infections-hcai/healthcare-associated-infections

12 Cleminson J, Austin N, McGuire W. Prophylactic systemic antifungal agents to prevent mortality and morbidity in very low birth weight infants. Cochrane Database of Syst Rev. 2015;2015. doi: 10.1002/14651858.CD003850.pub5.

13 Williams KH, Hopkins S, Turbitt D et al. Survey of neonatal unit outbreaks in North London: identifying causes and risk factors. J Hosp Infect. 2014;88(3):149–55. doi: 10.1016/j.jhin.2014.06.012

14 Washam M, Woltmann J, Haberman B, Haslam D, Staat MA. Risk factors for methicillin-resistant Staphylococcus aureus colonization in the neonatal intensive care unit: A systematic review and meta-analysis. Am J Infect Control. 2017;45(12):1388–93. doi: 10.1016/j.ajic.2017.06.021.

15 Washam M, Woltmann J, Haberman B, Haslam D, Staat MA. Risk factors for methicillin-resistant Staphylococcus aureus colonisation in the neonatal intensive care unit: A systematic review and meta-analysis. Am J Infect Control. 2017;45(12):1388-93. doi: 10.1016/j.ajic.2017.06.021.

16 Stoesser N, George R, Aiken Z et al. Genomic epidemiology and longitudinal sampling of ward wastewater environments and patients reveals complexity of the transmission dynamics of blaKPC-carbapenemase-producing Enterobacterales in a hospital setting. JAC Antimicrob Resist. 2024;6(5):dlae140. doi: 10.1093/jacamr/dlae140.

6 Vulnerable populations

6.1 Homelessness and infection

Andrew Hayward – UK Health Security Agency National Lead for Inclusion Health, UCL Professor of Infectious Disease Epidemiology and Inclusion Health

Alistair Story – Clinical Lead University College London Hospitals NHS Trust, Find&Treat programme, UCL Professor of Inclusion Health

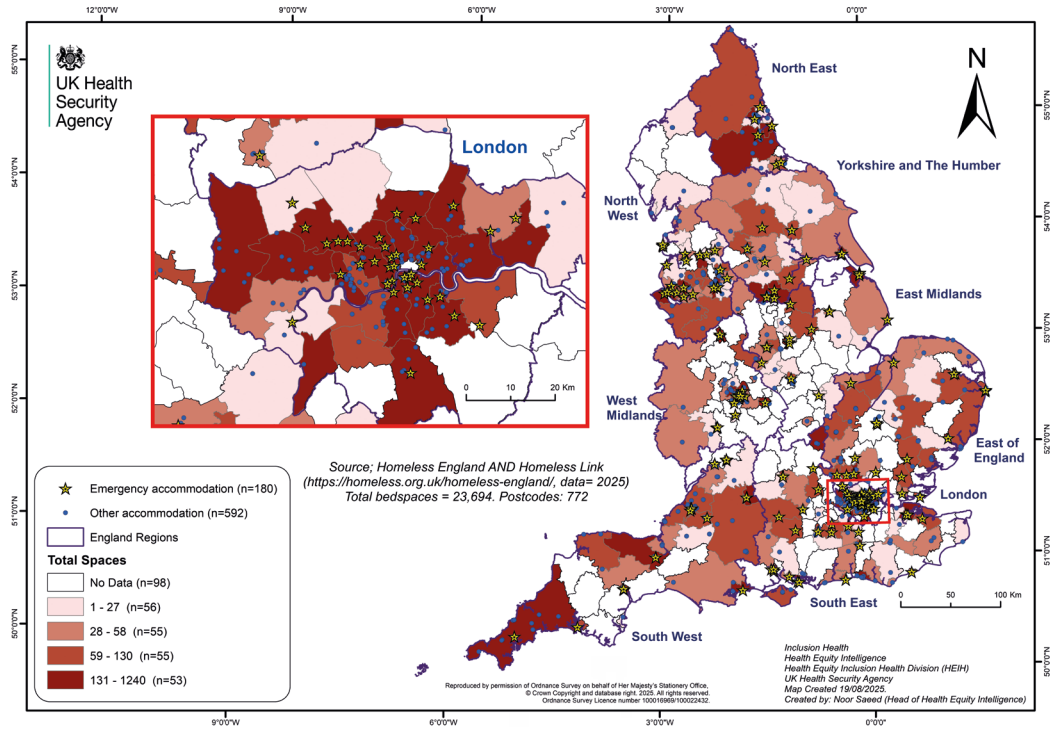
Contributors: Esther Robinson, Monica Desai, Noor Saeed, Steve Willner

Introduction

The most extreme form of housing inequality is not having a home. Homelessness encompasses a spectrum of living situations, from insecure or inadequate housing, to temporary emergency accommodation in shelters, to people sleeping on the street.[1] Homelessness in all its forms is harmful to health but those sleeping outdoors or using homeless hostels experience the most severe health harms.[2]

Homelessness can occur anywhere but, along with services for people experiencing homelessness, tends to be more concentrated in urban areas (Figure 1).

Figure 1: Lower tier local authority level distribution of accommodation projects for single people who are homeless, England, 2025



Source: Homeless Link – Homeless England Database of Homelessness Services. Map created with permission of Homeless Link.

There is a high degree of overlap between people experiencing homelessness, drug use and imprisonment. People experiencing homelessness, people who inject drugs and prisoners have substantially increased mortality rates for infection and many other health problems (Table 1).

Table 1: Standardised mortality rates in people experiencing homelessness, people who inject drugs and prisoners (based on a meta-analysis of international studies)[3]

Condition	Standardised Mortality Rate*
Overall mortality males	8
Overall mortality females	12
Infection mortality	11
Cardiovascular disease	2.9
Respiratory system disease	4.7
Digestive system disease	7.3
Cancer	2.2

* Standardised mortality rates show how much more likely these groups are to die compared to the general population after accounting for differences in age.

Source: Data from Aldridge RW, Story A et al. Morbidity and mortality in homeless individuals, prisoners, sex workers, and individuals with substance use disorders in high-income countries: a systematic review and meta-analysis. The Lancet.[4]

Further details on the risks of infection in people who inject drugs and prisoners can be found in other comprehensive reports, including the CMO report on 'The health of people in prison, on probation, and in the secure NHS estate in England'.[5]

Homelessness increases risk of severe infections through multiple mechanisms including living in overcrowded communal conditions, high levels of chronic disease, poor access to healthy food, barriers to health services including primary care, mental health and addiction services, poor access to clean injecting supplies, poor access to laundry and washing facilities and increased exposure to environmental hazards including traffic pollution, extreme heat and cold and wet weather conditions (Figure 2).

Figure 2: Homelessness increases infection risk through multiple mechanisms

Source: Image created using Canva software license.

People experiencing homelessness have high levels of chronic disease that predispose them to developing severe infections.[6,7]

People experiencing homelessness experience multiple barriers to health care including stigma and discrimination, poor experience of care, lack of trust, high mobility, challenges in registration, competing needs including prioritising food and security over healthcare, lower health literacy, low literacy, language barriers and lack of integrated, flexible and accessible services tailored to their complex needs.[8]

These barriers contribute to delayed and acute presentations, very high levels of emergency care use, challenges engaging with long term treatment and low levels of access to and uptake of preventative interventions.[9] For example, in the last year, 48% of people experiencing homelessness had used Accident and Emergency services at least once, 38% had used ambulances and 38% had been admitted to hospital. Fifty-five percent of those admitted to hospital said they had been discharged to unsuitable accommodation including 24% who were discharged to the street.[10]

Poor access to care extends to drug and alcohol services and needle and syringe programmes. For example, only 39% of people experiencing homelessness who used drugs felt they were receiving care that met their needs.[11] Despite the fact that needle and syringe programmes have been shown to be cost saving due to reductions in transmission of blood borne viruses,[12] a recent survey showed 34% of people who inject drugs felt they had inadequate access to needle and syringe provision.[13]

People experiencing homelessness who are rough sleeping or using hostels often have minimal or no access to laundry facilities which can contribute to dermatological conditions, infestations and skin and soft tissue infections. An international systematic review of skin complaints in people experiencing homelessness[14] found prevalence of body lice between 0.15% and 30%, headlice (4.5% to 4.9%), scabies (0.4% to 6.5%), foot infections (3.2% to 38%), skin trauma or injuries (13% to 19.7%) and high levels of cellulitis, abscesses and impetigo. Bacterial skin infections are common reasons for emergency department visits and hospital admissions, particularly among people experiencing homelessness who also inject drugs and have poor access to facilities for personal hygiene. Presentation is often at a late stage or with severe invasive manifestations such as septicaemia or endocarditis. Homelessness is associated with increased risk of methicillin resistant *Staphylococcus aureus* infection (MRSA) and a higher incidence of invasive Group A Streptococcal infections (iGAS) manifesting as cellulitis or necrotizing fasciitis, with higher mortality in people experiencing homelessness. An outbreak of cutaneous toxigenic diphtheria in people experiencing homelessness in Germany has recently been reported.[15] In the UK, an outbreak of non-toxigenic diphtheria causing severe endocarditis in people experiencing homelessness and using drugs has been reported.[16]

Poor access to clean water for drinking and washing, combined with limited access to free public toilets, may affect risk of water, sanitation and hygiene (WASH) related infections including gastrointestinal infections,[17] Hepatitis A and respiratory infections. Poor opportunities for personal hygiene also contribute to stigma and reluctance to use health services. A study of injecting drug users in London, 78% of whom had experienced homelessness, highlighted how lack of access to sterile or clean water for injection preparation led to people seeking alternatives including puddle water, water from toilet cisterns, soft drinks and saliva. The study noted that limited access to free public toilets exacerbated this problem and concluded these barriers to access are likely to contribute significantly to very high rates of bacterial and fungal infections.[18]

Air pollution increases risk of chronic disease and respiratory infections. People experiencing homelessness and sleeping near roads in urban areas will have increased exposure to traffic pollutants.[19] Although this exposure may be reduced for people staying in supportive accommodation, most night-shelters and some hostels do not allow people to stay during the day .

Lack of shelter leaves people exposed to extreme weather conditions, cold and damp that have been associated with increased risk of respiratory infections. Severe Weather Emergency Protocols are used by most local authorities to open up emergency accommodation during periods of extreme cold and some local authorities also have plans in place for extreme heat events.[20] Extremes of both heat and cold increase hospitalisation risk in people experiencing homelessness but the risk appears to be higher in periods of extreme heat.[21] The UK Health Security Agency (UKHSA) has produced guidance to support local authorities and others to plan and respond to extreme heat events to protect people experiencing homelessness.[22]

Overcrowding within households is one of the most significant factors affecting infection risk for a wide variety of infections (see chapter 7.2). Night-shelters often have crowded dormitory style communal airspace accommodation, increasing the risk of acute respiratory infections,

tuberculosis (TB) and skin infections.[23] Hostels often include shared bedrooms and communal airspace that is also likely to increase risk of transmission. Measures such as self-isolation in response to infections can be difficult to implement in such settings. UKHSA has produced guidance to support control of respiratory infections in high-risk settings such as homeless hostels.[24] In March 2020, at the start of the COVID-19 pandemic, the "Everyone In" approach led to closure of communal night-shelter accommodation and provided own-room, own bathroom hotel accommodation for people experiencing homelessness. In the first wave of the pandemic alone this has been estimated to have prevented 21,092 infections, 266 deaths, 1,164 hospital admissions and 338 intensive care unit (ICU) admissions among the homeless population.[25] The Office for National Statistics (ONS) reported only a small number of deaths from COVID-19 in people experiencing homelessness during this first wave[26] and overall deaths in people experiencing homelessness decreased in 2020 for the first time since records began.[27]

UKHSA health protection teams regularly attend incidents and outbreaks at homeless accommodation venues. Recent analysis of reported incidents conducted for this report (May 2024 to April 2025) show that TB accounts for 37% of these incidents, streptococcal infections 27%, scabies 18% and other infections 18%.

Having explored some of the mechanisms by which homelessness affects risk of multiple infections we now focus on some specific infections of high public health importance and on examples of interventions that can address these risks.

Tuberculosis

Analyses of national surveillance data from England estimate the rate of TB in people experiencing homelessness in 2021 was 30 per 100,000 – this compares to 1.4 per 100,000 for the UK-born White British population.[28] Analysis of London surveillance data showed 19% of TB cases in people experiencing homelessness were resistant to isoniazid (adjusted odds ratio 1.9 compared to housed patients) and 5% had multidrug resistant TB (adjusted odds ratio 2.9) and 58% were smear positive (infectious) (adjusted odds ratio 1.8). Almost half of people experiencing homelessness were known to be poorly adherent to treatment (adjusted odds ratio 10.2) and only 72% completed treatment.[29] A London screening project of people experiencing homelessness showed 16.5% prevalence of latent TB infection (LTBI).[30] This was similar to the prevalence of LTBI seen in the new entrant screening programme for people from high TB incidence countries.[31]

There are a range of interventions that have been shown to be effective in addressing TB in people experiencing homelessness. UKHSA has produced a toolkit for TB to support control in homeless and other vulnerable populations.[32] The National Institute for Health and Care Excellence (NICE) recommends people experiencing homelessness should be screened for TB using active case finding.[33] This approach has been shown to be highly cost effective in London,[34] but this is the only part of the country where mobile X-ray screening for people experiencing homelessness is routinely conducted. The National TB Action Plan includes a recommendation to strengthen prevention, detection and treatment of active TB and/or LTBI in people experiencing homelessness but does not include specific recommendations on radiographic screening for people experiencing homelessness.[35] Homeless migrants with no

recourse to public funds are not eligible for housing assistance which can make completion of TB treatment highly challenging. In London, a residential respite model of supported accommodation for people with TB with no recourse to public funds has been established (Olallo house). An evaluation showed that, after adjusting for social risk factors, people in the facility were nearly 3 times more likely to complete treatment and 3 times less likely to die during treatment.[36] Directly observed therapy (DOT) is where a responsible adult observes each dose of treatment. Internationally, this has been widely used to support TB treatment adherence, particularly in groups known to have poor adherence. However, regular face-to-face observation can be highly inconvenient for patients and take up considerable staff time. The UK conducted the first randomised controlled trial of smartphone enabled video observed therapy (VOT) targeting those at high risk of poor adherence. Those randomised to VOT were substantially more likely to accept observation and more than twice as likely to complete scheduled treatment observations compared to those on DOT.[37] The intervention was cheaper than DOT and preferred by patients. VOT is now offered as a national service, but in many areas of the country DOT remains the default mode of observing treatment. In 2023, 59% of those offered DOT to support adherence received it.[38]

Hepatitis C

Around 85% of chronic Hepatitis C cases in England are in people who have injected drugs.[39] A survey of people experiencing homelessness in London found 18% had a history of injecting drug use.[40] This risk increases with duration of homelessness.[41] Globally, 25% of people who inject drugs are estimated to have recently experienced homelessness or unstable housing.[42] The 2022 unlinked anonymous survey of people who inject drugs in England found 41% had experienced homelessness in the last year, 22% of whom reported sharing needles in the last month.[43] Qualitative research in London and Bristol suggests that homeless hostels can act as a "safe-haven" from street-based drug use but can also act as a "risk-environment", facilitating drug use and risk networks and transitions to new patterns of use, including increased frequency of injecting.[44] International evidence suggests that people who inject drugs who are homeless are 1.65-fold more likely to acquire Hepatitis C virus (HCV) than those who are stably housed.[45] In 2021 in England the prevalence of chronic HCV infection in people who inject drugs and who have experienced homelessness was 1.4-fold higher than in those who have not (19% vs 14%).[46] Recent screening of homeless populations in the UK has found an overall prevalence of HCV of around 10%, rising to around 24% in those who have reported injecting drug use.[47] Analysis of the unlinked anonymous survey shows more than half of people who inject drugs and have chronic Hepatitis C infection are unaware of their infection.[48] People with recent experience of homelessness comprise the majority (77%) of those who are unaware of their HCV infection. People who have experienced homelessness also comprise the great majority (92%) of those who report being infected with HCV more than once.[49]

As with TB, a range of interventions have been shown to be effective and cost-effective for addressing HCV in people experiencing homelessness.[50,51,52,53] Evaluation of a London-based, mobile, peer-supported Hepatitis C screening programme for people experiencing homelessness found the intervention to be highly cost-effective.[54] The involvement of peers in supporting engagement with treatment initiation and treatment completion has been

demonstrated in the national Hepatitis C programme where services using peers had 12% higher rates of treatment initiation and treatment completion rates that were over 2 times higher than services not using peers.[55] A recent analysis compared the care cascade in people diagnosed with Hepatitis C who were diagnosed in drug treatment services and received no peer support to those diagnosed and supported through the Hepatitis C peer support programme. For those supported by peers 65% were linked to treatment services, compared to 20% for those without peer support. Of these, 74% initiated treatment with peer support, compared to 37% of those without peer support.[56] Overall, these findings show a very high risk of Hepatitis C in people experiencing homelessness, primarily related to injecting drug use. The majority of HCV remains undiagnosed and amongst those diagnosed many are not treated. Reinfection is also common. Outreach of screening to people experiencing homelessness, including peer support to link to care, are well evidenced interventions that can dramatically improve engagement with care and have been demonstrated to be cost effective. This, combined with improved access to drug treatment and needle and syringe programmes, are critical to elimination of Hepatitis C.

Other blood borne viruses

A London screening project of people experiencing homelessness showed past Hepatitis B (10.4%), current Hepatitis B (1.4%), chronic Hepatitis C (10.4%), HIV (1.0%), and low levels of Hepatitis B immunity (59.5% non-immune).[57] A more recent outreach screening programme for people experiencing homelessness in London found 45% had never been tested for HIV and 3.2% were found to be living with HIV.[58] This compares to around 0.07% of those tested for HIV in emergency department opt-out testing in high prevalence areas.[59]

Influenza and pneumonia

Recent evidence submitted to the Joint Committee for Vaccination and Immunisation demonstrated the very high risk of hospitalisation from influenza and *Streptococcus pneumoniae* in people experiencing homelessness.[60] For example, in New York influenza hospitalisation rates in the homeless were 14- to 20-fold higher than in the housed population.[61] A study in Canada showed that hospitalisation rates for bacteraemic pneumococcal pneumonia in people experiencing homelessness were 27-fold higher than in the general population.[62] Based on this evidence and the high levels of chronic disease in people experiencing homelessness, the committee agreed it was reasonable to have a universal offer of influenza and pneumococcal vaccination rather than a programme that only targets those with clinical risk factors or who are over the age of 65.[63] This recommendation is currently under review by the Department of Health and Social Care. Universal influenza and *S.pneumoniae* vaccination to people sleeping rough and using night-shelters and homeless hostels would reduce the burden of infections in this vulnerable population.

Addressing the poor health of people experiencing homelessness

The extremely high burden of disease and early mortality in people experiencing homelessness underlines the importance of preventing and ending homelessness. The recent Kerslake Commission was convened to learn the lessons from the 'Everyone In' initiative.[64] Unfortunately, the report shows that despite dramatic reductions during the pandemic, levels of rough sleeping and statutory homelessness are now the highest since records began. The report makes a wide range of recommendations to address this problem. The NHS Framework for Action on Inclusion Health[65] and the NICE guidance on Integrated Health and Social Care[66] for people experiencing homelessness both provide detailed recommendations for improving healthcare in people experiencing homelessness. Key aspects of care include high levels of accessibility, including through outreach, integration of care to minimise the need to attend multiple services and utilisation of peer workers to support engagement with care. With some notable exceptions, evidence suggests Integrated Care Boards have made limited progress on implementing recommendations from these reports with many attributing this to financial constraints and multiple competing priorities.[67] This chapter also highlights a wide range of effective and cost-effective interventions to address the very high risk of infections in people experiencing homelessness.

Conclusion

Homelessness can have serious health consequences including infections. A wide range of cost-effective health interventions are available to address the high risks of infection in people experiencing homelessness but there is widespread unmet need. Developing integrated and accessible services, including to needle and syringe programmes and drug treatment services and the use of peers to improve engagement, can better address infection in people experiencing homelessness, reducing reliance on expensive emergency care.[68]

References

1 FEANTSA. ETHOS – European Typology on Homelessness and Housing Exclusion. [Internet] 2005. Available from: https://www.feantsa.org/what-is-homelessness

2 Department of Health and Social Care. Chief Medical Officer's annual report 2024: health in cities. [Internet] 2024. Available from: https://www.gov.uk/government/publications/chief-medical-officers-annual-report-2024-health-in-cities

3 Aldridge RW, Story A, Hwang SW et al. Morbidity and mortality in homeless individuals, prisoners, sex workers, and individuals with substance use disorders in high-income countries: a systematic review and meta-analysis. Lancet. 2018;391(10117):241-50. doi: 10.1016/S0140-6736(17)31869-X.

4 Aldridge RW, Story A, Hwang SW et al. Morbidity and mortality in homeless individuals, prisoners, sex workers, and individuals with substance use disorders in high-income countries: a systematic review and meta-analysis. Lancet. 2018;391(10117):241-50. doi: 10.1016/S0140-6736(17)31869-X.

5 Department of Health and Social Care. The health of people in prison, on probation and in the secure NHS estate in England. [Internet] 2025. Available from: https://www.gov.uk/government/publications/the-health-of-people-in-prison-on-probation-and-in-the-secure-nhs-estate-in-england

6 Surrey J, Veitch M, Rogers S et al. Cardiovascular Disease Screening in Homeless Individuals: A Feasibility Study. J Am Heart Assoc. 2024;13(8). doi: 10.1161/JAHA.124.034413

7 Homeless Link. The Unhealthy State of Homelessness – Homeless Health Needs Audit Report (2022). [Internet] 2022. Available from: https://homelesslink-1b54.kxcdn.com/media/documents/Homeless_Health_Needs_Audit_Report.pdf

8 National Institute for Health and Care Excellence. Integrated health and social care for people experiencing homelessness. [Internet] 2022. Available from: https://www.nice.org.uk/guidance/ng214/evidence/c-views-and-experiences-of-health-and-social-care-for-people-experiencing-homelessness-pdf-11006949999

9 National Institute for Health and Care Excellence. Integrated health and social care for people experiencing homelessness. [Internet] 2022. Available from: https://www.nice.org.uk/guidance/ng214/evidence/c-views-and-experiences-of-health-and-social-care-for-people-experiencing-homelessness-pdf-11006949999

10 Homeless Link. The Unhealthy State of Homelessness – Homeless Health Needs Audit Report (2022). [Internet] 2022. Available from: https://homelesslink-1b54.kxcdn.com/media/documents/Homeless_Health_Needs_Audit_Report.pdf

11 Homeless Link. The Unhealthy State of Homelessness – Homeless Health Needs Audit Report (2022). [Internet] 2022. Available from: https://homelesslink-1b54.kxcdn.com/media/documents/Homeless_Health_Needs_Audit_Report.pdf

12 National Institute for Health and Care Excellence. Integrated health and social care for people experiencing homelessness. [Internet] 2022. Available from: https://www.nice.org.uk/guidance/ng214/evidence/c-views-and-experiences-of-health-and-social-care-for-people-experiencing-homelessness-pdf-11006949999

13 Slater L, Edmundson C, Emanuel E et al. Inadequate needle and syringe coverage among people who inject psychoactive drugs across England and Wales. Drugs: Education, Prevention and Policy. 2024;31(3):358-68. doi: 10.1080/09687637.2023.2191811

14 Adly M, Woo TE, Traboulsi D, Klassen D, Hardin J. Understanding Dermatologic Concerns Among Persons Experiencing Homelessness: A Scoping Review and Discussion for Improved Delivery of Care. J Cutan Med Surg. 2021;25(6):616-26 doi: 10.1177/12034754211004558

15 Haller J, Berger A, Dangel A et al. Diphtheria Outbreak among Persons Experiencing Homelessness, 2023, Linked to 2022 Diphtheria Outbreak, Frankfurt am Main, Germany. Emerg Infect Dis. 2025;31(3). doi: 10.3201/eid3103.241217.

16 Patel T, Anwar T, Mavrogiorgou E et al. Fulminant infective endocarditis with toxin-negative Corynebacterium diphtheriae in people with substance use experiencing homelessness, England, 2024 to 2025. Euro Surveill. 2025;30(13). doi: 10.2807/1560-7917.ES.2025.30.13.2500148.

17 Waddell CJ, Saldana CS, Schoonveld MM et al. Infectious Diseases Among People Experiencing Homelessness: A Systematic Review of the Literature in the United States and Canada, 2003-2022. Public Health Rep. 2024;139(5). doi: 10.1177/00333549241228525.

18 Harris M, Scott J, Hope V, Wright T, McGowan C, Ciccarone D. Navigating environmental constraints to injection preparation: the use of saliva and other alternatives to sterile water among unstably housed PWID in London. Harm Reduct J. 2020;17(1) doi: 10.1186/s12954-020-00369-0

19 Zachary VT, Jennifer K V, Ariane M, Kristin M F. Concurrent Heat and Air Pollution Exposures among People Experiencing Homelessness. Environmental Health Perspectives. 2024;132(1). doi: 10.1289/EHP13402

20 Museum of Homelessness. Severe Weather Emergency. [Internet] 2023. Available from: https://static1.squarespace.com/static/623b05f9825aa34cda99921f/t/6423301d2f6abf0202364811/1680027696562/Severe+Weather+Emergency+a+Museum+of+Homelessness+Investigation+2023.pdf

21 Hajat S, Sarran CE, Bezgrebelna M, Kidd SA. Ambient Temperature and Emergency Hospital Admissions in People Experiencing Homelessness: London, United Kingdom, 2011-2019. Am J Public Health. 2023;113(9):981-4. doi: 10.2105/AJPH.2023.307351

22 UK Health Security Agency. Supporting vulnerable people before and during hot weather: people experiencing homelessness and sleeping rough. [Internet] 2024. Available from: https://www.gov.uk/guidance/supporting-vulnerable-people-before-and-during-hot-weather-people-experiencing-homelessness-and-sleeping-rough

23 UK Health Security Agency. Communal accommodation settings: infectious disease transmission. [Internet] 2024. Available from: https://www.gov.uk/government/publications/communal-accommodation-settings-infectious-disease-transmission

24 UK Health Security Agency. Acute respiratory infections: outbreaks in higher-risk communal accommodation settings. [Internet] 2024. Available from: https://www.gov.uk/guidance/acute-respiratory-infections-outbreaks-in-higher-risk-communal-accommodation-settings

25 Lewer D, Braithwaite I, Bullock M et al. COVID-19 among people experiencing homelessness in England: a modelling study. Lancet Respir Med. 2020;8(12):1181-91. doi: 10.1016/S2213-2600(20)30396-9

26 Office for National Statistics. Coronavirus and deaths of homeless people, England and Wales: deaths registered up to 26 June 2020. [Internet] 2020. Available from: https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/deaths/articles/coronavirusanddeathsofhomelesspeopleenglandandwalesdeathsregisteredupto26june2020/2020-07-10

27 Office for National Statistics. Deaths of homeless people in England and Wales: 2021 registrations. [Internet] 2022. Available from: https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/deaths/bulletins/deathsofhomelesspeopleinenglandandwales/2021registrations#deaths-among-homeless-people-in-england-and-wales

28 UK Health Security Agency. Tackling TB in inclusion health groups: a toolkit for a multi-agency approach. [Internet] 2024. Available from: https://www.gov.uk/government/publications/tackling-tb-in-inclusion-health-groups-toolkit-for-a-multi-agency-approach/tackling-tb-in-inclusion-health-groups-a-toolkit-for-a-multi-agency-approach

29 Anderson C, Anderson SR, Maguire H, Hayward AC, Story A. Tuberculosis in London: the convergence of clinical and social complexity. Eur Respir J. 2016;48(4):1233-6. doi: 10.1183/13993003.00749-2016.

30 Aldridge RW, Hayward AC, Hemming S et al. High prevalence of latent tuberculosis and bloodborne virus infection in a homeless population. Thorax. 2018;73(6):557-64. doi: 10.1136/thoraxjnl-2016-209579

31 UK Health Security Agency. Tuberculosis prevention, England, 2023. [Internet] 2025. Available from: https://www.gov.uk/government/publications/tuberculosis-in-england-2024-report/tuberculosis-prevention-england-2023#:~:text=The%20number%20of%20new%20entrant,with%202019%20(79%2C944%20individuals).

32 UK Health Security Agency. Tackling TB in inclusion health groups: a toolkit for a multi-agency approach. [Internet] 2024. Available from: https://www.gov.uk/government/publications/tackling-tb-in-inclusion-health-groups-toolkit-for-a-multi-agency-approach/tackling-tb-in-inclusion-health-groups-a-toolkit-for-a-multi-agency-approach

33 National Institute for Health and Care Excellence. Tuberculosis: Who should be screened for tuberculosis? [Internet] 2023. Available from: https://cks.nice.org.uk/topics/tuberculosis/diagnosis/screening/

34 Jit M, Stagg HR, Aldridge RW, White PJ, Abubakar I. Dedicated outreach service for hard to reach patients with tuberculosis in London: observational study and economic evaluation. BMJ. 2011;343(sep13 5):d5376-d. doi: 10.1136/bmj.d5376

35 UK Health Security Agency. NHS England. Tuberculosis (TB): action plan for England, 2021 to 2026. [Internet] 2021. Available from: https://www.gov.uk/government/publications/tuberculosis-tb-action-plan-for-england/tuberculosis-tb-action-plan-for-england-2021-to-2026

36 Crosby L, Lewer D, Appleby Y, Anderson C, Hayward A, Story A. Outcomes of a residential respite service for homeless people with tuberculosis in London, UK: a cross-sectional study. Perspect Public Health. 2023;143(2):89-96. doi: 10.1177/17579139221093544.

37 Story A, Aldridge RW, Smith CM et al. Smartphone-enabled video-observed versus directly observed treatment for tuberculosis: a multicentre, analyst-blinded, randomised, controlled superiority trial. Lancet. 2019;393(10177):1216-24. doi: 10.1016/S0140-6736(18)32993-3

38 UK Health Security Agency Tuberculosis in England, 2024 report. Supplementary data tables: TB Treatment and outcomes, England, 2023. [Internet] 2024. Available from: https://view.officeapps.live.com/op/view.aspx?src=https%3A%2F%2Fassets.publishing.service.gov.uk%2Fmedia%2F674c65f82ac8a6da30723b10%2FTuberculosis-in-England-2023-Treatment.xlsx&wdOrigin=BROWSELINK

39 UK Health Security Agency. Hepatitis C in England 2024. [Internet] 2024. Available from: https://www.gov.uk/government/publications/hepatitis-c-in-the-uk/hepatitis-c-in-england-2024

40 Aldridge RW, Hayward AC, Hemming S et al. High prevalence of latent tuberculosis and bloodborne virus infection in a homeless population. Thorax. 2018;73(6):557-64. doi: 10.1136/thoraxjnl-2016-209579

41 Crisis. Home and dry? Homelessness and substance use in London. [Internet] 2002. Available from: http://drugsandhousing.co.uk/homeanddrycrisis.pdf

42 Degenhardt L, Webb P, Colledge-Frisby S et al. Epidemiology of injecting drug use, prevalence of injecting-related harm, and exposure to behavioural and environmental risks among people who inject drugs: a systematic review. Lancet Glob Health. 2023;11(5):e659-e72. doi: 10.1016/S2214-109X(23)00057-8.

43 UK Health Security Agency. Unlinked Anonymous Monitoring (UAM) Survey of HIV and viral hepatitis among people who inject drugs (PWID): 2024 report. [Internet] 2024. Available from: https://www.gov.uk/government/publications/people-who-inject-drugs-hiv-and-viral-hepatitis-monitoring/unlinked-anonymous-monitoring-uam-survey-of-hiv-and-viral-hepatitis-among-people-who-inject-drugs-pwid-2024-report

44 Briggs D, Rhodes T, Marks D, Kimber J, Holloway G, Jones S. Injecting drug use and unstable housing: Scope for structural interventions in harm reduction. Drugs: Education, Prevention and Policy. 2009;16(5):436-50. doi: 10.1080/09687630802697685

45 Arum C, Fraser H, Artenie AA et al. Homelessness, unstable housing, and risk of HIV and hepatitis C virus acquisition among people who inject drugs: a systematic review and meta-analysis. Lancet Public Health. 2021;6(5):e309-e23. doi: 10.1016/S2468-2667(21)00013-X

46 Department of Health and Social Care. Chief Medical Officer's annual report 2024: health in cities. [Internet]2024. Available from: https://www.gov.uk/government/publications/chief-medical-officers-annual-report-2024-health-in-cities

47 Public Health England. Evaluation of hepatitis C test and treat interventions targeted at homeless populations (outside London) in England during the COVID-19 pandemic, 2020 report. [Internet] 2021. Available from: https://assets.publishing.service.gov.uk/media/5ffc9a85e90e07639fd8d4b9/Evaluation_of_initiatives_to_test_and_treat_the_housed_homeless_2020_report.pdf

48 UK Health Security Agency. Hepatitis C in England 2024. [Internet] 2024. Available from: https://www.gov.uk/government/publications/hepatitis-c-in-the-uk/hepatitis-c-in-england-2024

49 UK Health Security Agency. Unlinked Anonymous Monitoring (UAM) Survey of HIV and viral hepatitis among people who inject drugs (PWID): 2024 report. [Internet] 2024. Available from: https://www.gov.uk/government/publications/people-who-inject-drugs-hiv-and-viral-hepatitis-monitoring/unlinked-anonymous-monitoring-uam-survey-of-hiv-and-viral-hepatitis-among-people-who-inject-drugs-pwid-2024-report

50 National Institute for Health and Care Excellence. Integrated health and social care for people experiencing homelessness. [Internet] 2022. Available from: https://www.nice.org.uk/guidance/ng214/evidence/c-views-and-experiences-of-health-and-social-care-for-people-experiencing-homelessness-pdf-11006949999

51 Ward Z, Campbell L, Surey J et al. The cost-effectiveness of an HCV outreach intervention for at-risk populations in London, UK. J Antimicrob Chemother. 2019;74(Supplement_5):v5-v16. doi: 10.1093/jac/dkz451.

52 Jugnarain DV, Halford R, Smith S, Hickman M, Samartsidis P, Foster GR. Role of peer support in a hepatitis C elimination programme. J Viral Hepat. 2022;29(1):43-51. doi: 10.1111/jvh.13626

53 International Network on Health and Hepatitis in Substance Users. Comparing the HCV cascade of care between a peer-support program and drug treatment services. [Internet] 2024. Available from: https://www.inhsu.org/resource/comparing-the-hcv-cascade-of-care-between-a-peer-support-program-and-drug-treatment-services/

54 Ward Z, Campbell L, Surey J et al. The cost-effectiveness of an HCV outreach intervention for at-risk populations in London, UK. J Antimicrob Chemother. 2019;74(Supplement_5):v5-v16. doi: 10.1093/jac/dkz451.

55 Jugnarain DV, Halford R, Smith S, Hickman M, Samartsidis P, Foster GR. Role of peer support in a hepatitis C elimination programme. J Viral Hepat. 2022;29(1):43-51. doi: 10.1111/jvh.13626

56 International Network on Health and Hepatitis in Substance Users. Comparing the HCV cascade of care between a peer-support program and drug treatment services. [Internet] 2024. Available from: https://www.inhsu.org/resource/comparing-the-hcv-cascade-of-care-between-a-peer-support-program-and-drug-treatment-services/

57 Aldridge RW, Hayward AC, Hemming S et al. High prevalence of latent tuberculosis and bloodborne virus infection in a homeless population. Thorax. 2018;73(6):557-64. doi: 10.1136/thoraxjnl-2016-209579

58 Sultan BS, J; Gibbons, J; Francis, M et al. A. High prevalence of HIV among people who experience homelessness in London: results of an innovative peer-centred outreach bloodborne virus testing service initiated at the start of the COVID-19 pandemic. HIV Medicine.22(52).

59 Department of Health and Social Care, NHS England, Atkins, V. New research into expansion of life-saving HIV testing programme. [Internet] 2023. Available from: https://www.gov.uk/government/news/new-research-into-expansion-of-life-saving-hiv-testing-programme

60 Joint Committee on Vaccination and Immunisation. Joint committee on vaccination and immunisation meeting 05/06/2024. [Internet] 2024. Available from: https://app.box.com/s/iddfb4ppwkmtjusir2tc/file/1593103191626

61 Miyawaki A, Hasegawa K, Tsugawa Y. Lessons from Influenza Outbreaks for Potential Impact of COVID-19 Outbreak on Hospitalizations, Ventilator Use, and Mortality Among Homeless Persons in New York State. J Gen Intern Med. 2020;35(9):2781-3. doi: 10.1007/s11606-020-05876-1.

62 Shariatzadeh MR, Huang JQ, Tyrrell GJ, Johnson MM, Marrie TJ. Bacteremic pneumococcal pneumonia: a prospective study in Edmonton and neighboring municipalities. Medicine (Baltimore). 2005;84(3):147-61. doi: 10.1097/01.md.0000164302.03972.d7.

63 Joint Committee on Vaccination and Immunisation. Joint committee on vaccination and immunisation meeting 05/06/2024. [Internet] 2024. Available from: https://app.box.com/s/iddfb4ppwkmtjusir2tc/file/1593103191626

64 The Kersklake Commission on Homelessness and Rough Sleeping. Turning the Tide on Rising Homelessness and Rough Sleeping. [Internet] 2023. Available from: https://usercontent.one/wp/www.commissiononroughsleeping.org/wp-content/uploads/2023/09/Turning-the-Tide-on-Homelessness-and-Rough-Sleeping-Kerslake-Commission-2023-Report.pdf

65 NHS England. A national framework for NHS – action on inclusion health. [Internet] 2023. Available from: https://www.england.nhs.uk/long-read/a-national-framework-for-nhs-action-on-inclusion-health/

66 National Institute for Health and Care Excellence. Integrated health and social care for people experiencing homelessness. [Internet] 2022. Available from: https://www.nice.org.uk/guidance/ng214/evidence/c-views-and-experiences-of-health-and-social-care-for-people-experiencing-homelessness-pdf-11006949999

67 Pathway. Beyond Pockets of Excellence: Integrated Care Systems for Inclusion Health. [Internet] 2023. Available from: https://www.pathway.org.uk/resources/beyond-pockets-of-excellence-integrated-care-services-for-inclusion-health/

68 The King's Fund. The government's 10-year plan for health and care. [Internet] 2025. Available from: https://www.kingsfund.org.uk/insight-and-analysis/projects/governments-long-term-plan-health-and-care

6.2 Infections and migrant health

Kate Yorke – Consultant in Public Health, Health Equity and Inclusion Health, UKHSA
Lianne Straus – Public Health Manager, Health Equity and Inclusion Health, UKHSA
Leonora Weil – Interim Deputy Director, Health Equity and Inclusion Health, UKHSA

Contributors: Chloe Dyer, Andrew Hayward, Noor Saeed, Cathie Railton, Anna Hartley

Introduction

Throughout history, England has been shaped by both inward and outward migration which can bring many benefits, including staff who support the NHS and other health and social care services.[1,2] Most migrants to the UK are typically healthier than the general population in the UK due to the 'healthy migrant effect', meaning people in a better state of health are more likely to migrate.[3,4] However, global inequalities in the distribution of infections such as tuberculosis, Hepatitis B and HIV mean that some migrants arrive from countries where they are more likely to have been exposed to these diseases. In addition, people arriving from countries or regions with weak or damaged health infrastructure may not have been able to access preventative interventions (for example, vaccination) or treatment, increasing their susceptibility to infections and leading to poorer health outcomes. Initiatives to control infections such as tuberculosis and HIV at a global level will also contribute to decreased levels of infection in high income countries.

It is important that the risk of infection both to the individual migrant and to the general population is not exaggerated; it is usually low to the individual migrant and very low to the general UK population.[5] Risk of infection before or during migration to individuals making a long overland journey may be increased compared to the general UK population, but this risk is relatively short-lived for most infectious diseases and new presentations of most bacterial and viral diseases such as typhoid or Mpox will be very rare. There are some parasitic infections where presentation may be later, such as malaria or schistosomiasis, which can cause diagnostic challenges to UK doctors not used to seeing them, but most of these are very unlikely to be transmitted to the wider population.

Once people are in the UK, barriers to accessing healthcare can create missed opportunities for prevention, including screening for chronic infections such as TB, HIV and Hepatitis B and C. Migrants in vulnerable circumstances, including people seeking asylum, can face additional barriers even where the right to access healthcare for free is made clear.

Migrant populations

The term 'migrant' can be interpreted in many ways and there is no single agreed definition.[6] Box 1 outlines key terms associated with migration.

Box 1: Terms and definitions related to migration[7,8,9]

Migrant: a generic term for anyone moving to another country with the intention to stay for a minimum period of time, including permanent or temporary migrants with a valid visa or permit, people seeking asylum, refugees and undocumented migrants.

Refugee: a person who has fled their country to escape conflict, violence or persecution and have sought safety in another country. People can arrive in the UK with refugee status already granted through dedicated resettlement routes or be granted refugee status following a successful claim for asylum.

Person seeking asylum: an individual who has sought international protection from dangers in their home country and has formally applied for asylum in another country, but whose claim for refugee status is still pending.

Undocumented migrant: a person without a valid residence permit or visa and who does not have the right to remain in the UK. Undocumented migrants can include people who have had their asylum claims rejected.

Migrants in vulnerable circumstances: migrants who have higher health needs because of their experiences before, during or after migration. Migrants in vulnerable circumstances include:

- People seeking asylum and unaccompanied asylum-seeking children (UASC)
- Refugees
- People who have been trafficked
- Undocumented migrants
- Low-paid migrant workers including those that have a right to work but "no recourse to public funds" (NRPF), and therefore cannot access most welfare or housing benefits

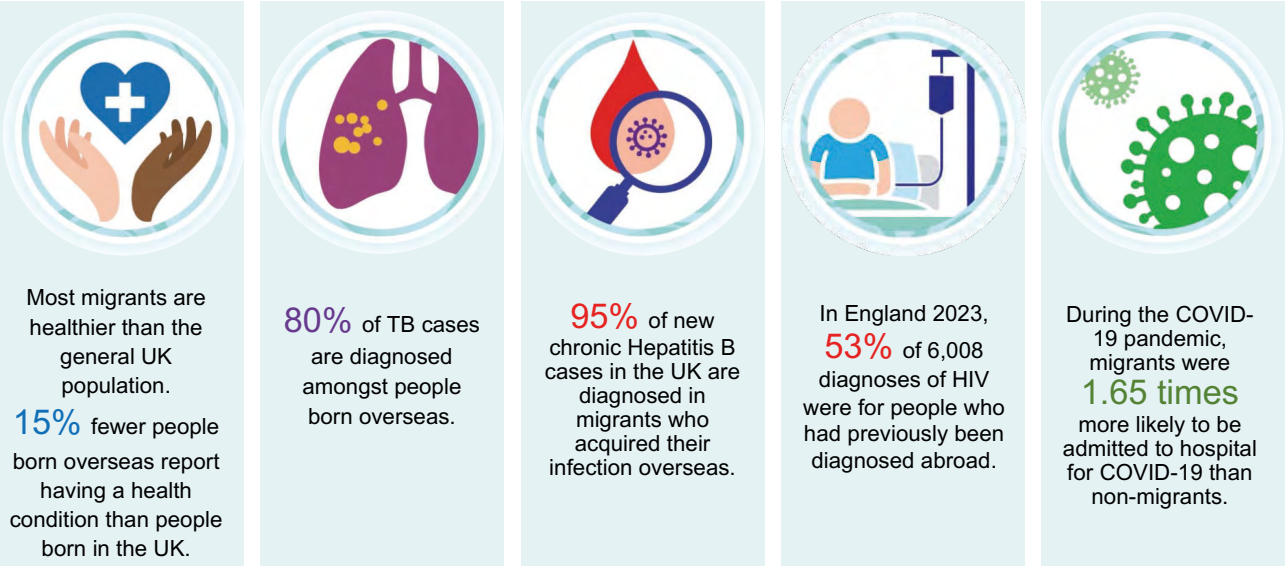
Migration patterns to the UK have changed over the last 5 years, with non-European Union (non-EU) migration increasing sharply between 2021 to 2023,[10] including an increase in people arriving from countries with a higher incidence of some chronic infectious diseases, such as TB.[11]

As well as migration for work, study or family reasons, a small proportion of migrants come to the UK for humanitarian reasons as refugees or to seek asylum. A person has the right to seek asylum due to a well-founded fear of persecution because of their race, religion, nationality or membership of a particular social group or political opinion.[12] In 2019, 6% of new arrivals came as refugees or to seek asylum compared to 14% in 2023 (around 177,000 people).[13] This includes through formal resettlement schemes such as "Homes for Ukraine" and those supporting Afghan refugees. In 2024, 108,000 people claimed asylum in the UK, with 38,900 of them arriving by small boat.[14,15] There can be increased risk of infection in some cohorts of refugees and people seeking asylum, particularly in situations where people have had long journeys and have been living in crowded conditions.[16]

Current epidemiology

Data suggests that the chronic infectious disease burden amongst migrants to the UK is largely focused on tuberculosis and blood-borne viruses, which usually reflects the higher prevalence in the country of origin. Gaps in vaccination coverage, especially amongst populations experiencing conflict or complex emergency, also suggest some migrant populations in England may be at higher risk of vaccine preventable diseases such as diphtheria. There is limited data on migration and sexually transmitted infection (STI) risk in the UK, but most new STI diagnoses in England occur in UK-born individuals. People born outside the UK may present with STIs less commonly seen in the UK.[17] Figure 1 shows a summary of infection epidemiology of migrants in the UK.

Figure 1: Summary of infection epidemiology for migrant populations in the UK[18,19,20,21]



Source: Image by Inclusion Health Team, UKHSA.

International migration from countries with a higher prevalence of antimicrobial resistance (AMR) to countries with a lower prevalence is thought to be one of many factors contributing to increases in AMR burden globally and in the UK. However, the lack of any research screening programme for carriage of multidrug-resistant bacteria makes the extent of this difficult to assess.[22] Migrants are also more likely to seek medical care in their country of origin where risk of resistance may be higher, potentially contributing to increased risk post-migration. AMR is discussed in more detail in chapter 4.4.

The sections below summarise current epidemiology for priority infections and outline opportunities for improved screening and vaccination.

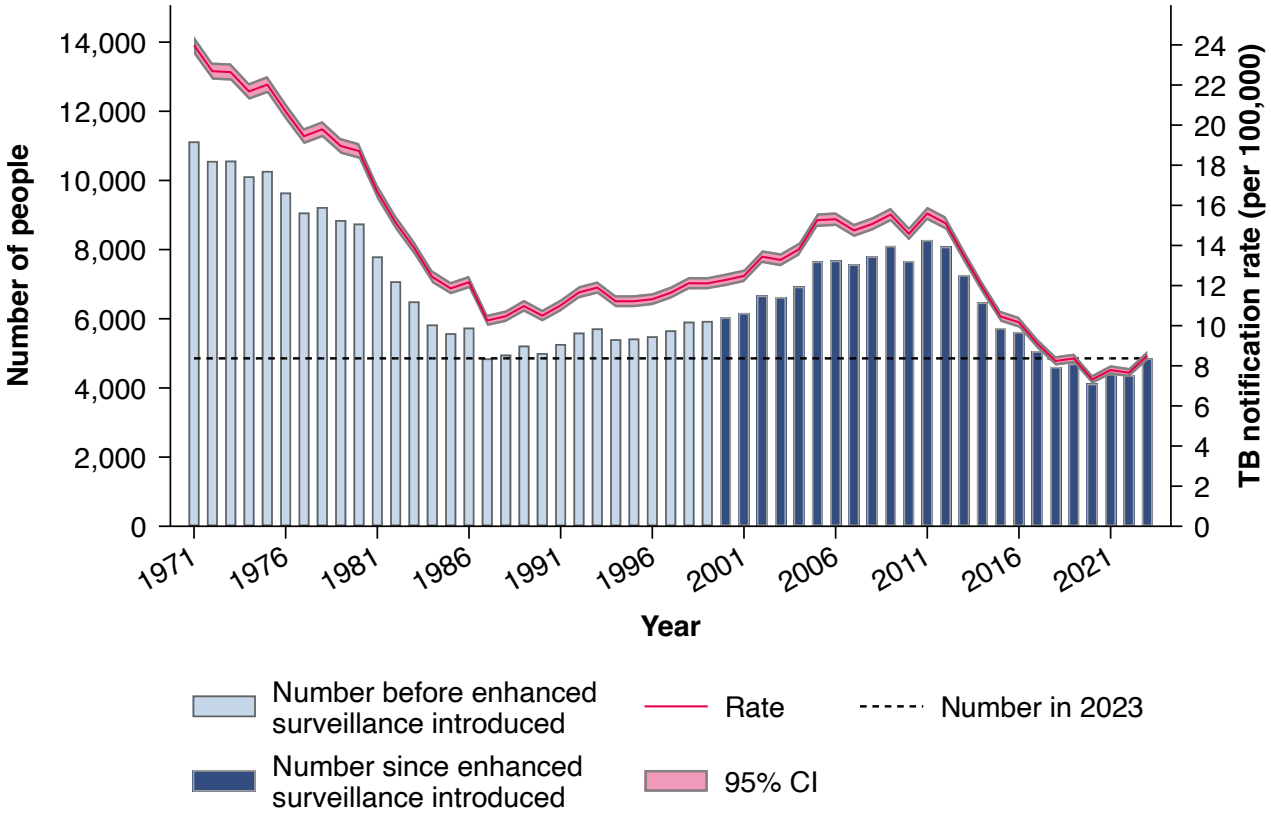
Tuberculosis

It is estimated that a quarter of the world's population is infected with *Mycobacterium tuberculosis*, with 5% to 10% of people infected developing tuberculosis disease (TB) over their lifetime.[23] People infected with *Mycobacterium tuberculosis* but with no active disease

(asymptomatic and not infectious) have latent TB. This can convert to active TB which commonly presents as a respiratory infection but can affect other parts of the body. Globally, *Mycobacterium tuberculosis* kills more people than any other single infectious organism (1.25 million in 2023).[24] TB is curable and active pulmonary TB can be diagnosed early through radiographic testing and treated with antibiotics. It can also be prevented by testing and treatment for latent TB.

TB notifications from 1971 to 2023 are shown in Figure 2. In 2024, 5,480 cases of TB were notified in England at a rate of 9.5 per 100,000 population.[25] Notifications of TB disease increased by 11% in 2023 and by 13% in 2024, which was the largest annual percentage increase since 1971. This rise was largely accounted for by cases of TB in people who had migrated to England from countries with high incidence rates of TB on skilled worker or student visas, and to a lesser extent in people seeking asylum. The proportion of individuals born outside the UK who were notified with TB within 5 years of entry to the UK rose from 25.7% to 35.9% between 2019 and 2023, and the number of individuals notified within 1 to 2 years of entry nearly doubled. UKHSA is currently reviewing options for addressing the overall increase in TB.[26]

Figure 2: Number of TB notifications and TB notification rate per 100,000, England, 1971 to 2023[27]



Source: Image by UKHSA, Tuberculosis in England, 2024 report; Tuberculosis incidence and epidemiology, England, 2023 updated 29 May 2025 is licensed under the Open Government Licence v3.0.

In 2023, the most common social risk factor for people not born in the UK with TB was seeking asylum (7.9%; 278 individuals).[28] TB can be more serious in children and adolescents. Of 259 cases of TB reported in under 18-year-olds in 2023, 143 (60.6%) were in children born outside

the UK, including 49 children (20.5%) that were reported as seeking asylum.[29] Two-thirds of children who reported a history of homelessness were also seeking asylum (15 out of 23 children).[30]

The majority of people with multidrug resistant TB (MDR-TB) were born outside the UK (92% of 71 people with MDR-TB in 2023) with it being likely that infection with this strain occurred before arrival to England and then reactivated.[31] This proportion has been stable over the past decade.[32] People with TB who were born outside the UK are less likely to have social risk factors that may increase risk and complicate management of TB, such as drug use, alcohol misuse, homelessness, prison history and mental health needs, than those born in the UK.

Pre-entry testing and treatment for active pulmonary TB and completion of treatment is required for long-term visa applicants from high-incidence countries (over 40 TB cases per 100,000 population). There is evidence that in-country treatment of active TB prior to migration reduces importation of active disease and minimises onward transmission in the UK.[33] In 2023, 505 people were diagnosed through the pre-entry testing and treatment programme.[34]

Latent TB infection testing and treatment can reduce the risk of developing active TB by more than 80%.[35] New entrant migrants from countries with a high TB incidence (over 150 per 100,000 population) and aged between 16 to 35, are eligible for testing for latent TB infection. However, the Latent TB Testing and Treatment programme is only currently funded in two-thirds of Integrated Care Board (ICB) areas (those with relatively high incidence), though some ICB areas may also choose to commission a local service depending on available resources. The number of people eligible for testing through this programme increased nearly 4-fold between 2019 (79,944 individuals) and 2023 (302,782 individuals). Testing of eligible new migrants has increased since 2021 but is still low at 11.5% of eligible new entrant migrants being tested in 2023.[36] Based on available data, treatment uptake among those diagnosed is low despite international evidence that high uptake is possible.[37,38] Increasing availability and access to latent TB infection testing and treatment represents an opportunity to prevent TB.

The Migrant Health Guide advises that migrants who arrive through irregular routes should be offered active TB testing and treatment as soon as possible after arrival.[39] However, access to testing can be challenging due to barriers to accessing care, staff capacity within TB services and the high degree of movement between asylum seeker accommodation sites which can impact continuity of care.

The BCG vaccination is offered to individuals at higher risk of TB including those from high TB incidence countries. Parents and their infants should be risk assessed during pregnancy or shortly after birth for eligibility.[40]

Blood-borne viruses

Since 2015, HIV surveillance has included a category of first diagnosis in England or previously diagnosed abroad. In 2023, 53% of 6,008 diagnoses of HIV were for people diagnosed abroad before continuing care in England. This is a 110% rise from 1,524 in 2022 and a 202% rise from 1,058 in 2019. This could be due to changing patterns of migration.[41]

Ninety-six percent of those previously diagnosed abroad were linked to care in England within 3 months and 70% had their HIV under control.[42] People diagnosed with HIV before continuing care in England are extremely unlikely to pass on HIV in England. Pre-exposure prophylaxis (PrEP) is highly effective in preventing HIV in high-risk groups.[43] This is cost-effective for HIV risk reduction, including transmission to others.[44,45] In 2022, the UK had the highest number of migrants on PrEP for HIV in Europe (4,641).[46]

Viral hepatitis caused 1.3 million deaths globally in 2022.[47] An estimated 304 million people are living with Hepatitis B and C, with 10 countries accounting for nearly two-thirds of the global burden.[48,49] Internationally, only 13% of people living with chronic Hepatitis B infection and 35% of people living with Hepatitis C are diagnosed.[50] Hepatitis B is vaccine preventable and Hepatitis C is curable with a short course of antiviral treatment. Both infections are usually asymptomatic, but if left untreated can lead to severe liver disease including cancer.[51,52]

The UK is working towards the World Health Organization goal of eliminating viral hepatitis by 2030. Ninety-five percent of new chronic Hepatitis B diagnoses are made in migrants, with most having acquired the infection abroad. However, half of the estimated 270,000 people in England with Hepatitis B remain undiagnosed.[53] Injecting drug use is the primary route of Hepatitis C transmission in the UK. While data on injecting drug use among migrant populations is limited, people may acquire Hepatitis C through non-injecting routes, such as medical procedures or blood products in high prevalence countries.[54]

Blood-borne virus (BBV) testing is recommended based on country of origin and other risk factors as part of the health check for any new patient (including migrants) when registering with a GP.[55] Other opportunities for early identification of BBVs include the introduction of opt-out testing in emergency departments and antenatal screening programmes.[56] Emergency department testing has increased detection but there is no data on how many of those diagnosed in emergency departments are migrants.[57] Up to 40% of migrants acquire HIV after arrival in England. Testing should be offered to people who are from high prevalence countries (>2 in 1,000), are newly registering with a GP or have not been tested in the last year.[58,59] Universal antenatal screening for Hepatitis C is not recommended, but opportunistic screening is targeted at those with risk factors, including country of birth. Studies show African-born women are more likely to be diagnosed post-childbirth, suggesting that current risk-based antenatal testing approaches need to be optimised in the absence of a universal approach.[60]

Whilst there is guidance for multi-pathogen screening, there is a lack of data on the cost-effectiveness or best approach. Combining latent TB infection and BBV testing may be efficient and more effective, as many high TB prevalence countries also have high BBV rates.[61]

Vaccine preventable diseases

Migrants may come from countries with different vaccination schedules, lower immunisation rates or higher prevalence of vaccine preventable diseases.[62] Routes to the UK, and barriers to accessing services once in the UK, may increase the risk of vaccine preventable diseases (Case study 1).[63] Some migrant communities in the UK can experience more outbreaks of certain vaccine preventable diseases than the general population.[64]

Case Study 1: Diphtheria incident

Diphtheria is a bacterial infection rarely seen in England since national vaccination for it was introduced in the 1940s.[65] It is largely spread by droplets although cases can also result from the consumption of raw dairy products and contact with animals.[66] The incubation period is relatively short (10 days).[67] Globally, incidence remains higher in South-East Asia and some parts of Africa.[68]

Between 2022 and 2023, there were 85 confirmed and one probable cases of toxigenic *Corynebacterium diphtheriae* amongst people seeking asylum. In the decade prior to 2022, the number of diphtheria cases in England averaged between 2 to 10 cases per year (with the exception of 2020). Cases in 2022 to 2023 were predominantly among young males presenting with skin lesions, but cases of respiratory diphtheria were also identified.

Mapping of clusters of cases in Europe demonstrated a clear epidemiological pattern, indicating that cases of diphtheria were occurring across the Central Mediterranean migration route. Given that the diphtheria vaccine is highly effective at preventing diphtheria, this outbreak indicated under-vaccination in this cohort.

In autumn 2022, overcrowding and long stays were reported at the reception site for small boat arrivals on the south coast. For those moved off site, many were dispersed rapidly across the country. This made usual public health interventions, including case isolation and contact tracing, challenging. UKHSA set up a national incident management team in response to this situation which ran from March 2022 to January 2024. In response to the incident, arrivals by small boat were offered antibiotic prophylaxis and vaccination in the early part of the outbreak, and vaccination was offered throughout the period of the national incident.

Early and systematic access to health checks can reduce the risk of similar future outbreaks for people arriving by small boat. Improvements in data sharing on where people are based in the asylum accommodation system would also support local health protection response and local health systems to understand interventions that people have received in an accommodation system where people are frequently moved to new locations.

Data on vaccination coverage of migrants is not routinely collected. However, a study of migrants in 2 London boroughs showed that 86% (49 of 57 migrants presenting to study sites) were missing measles, mumps and rubella (MMR) vaccine doses and, even when referred for catch-up, coverage was very low.[69] Between January 2018 and October 2019, a study of refugees who had a pre-entry health assessment showed 81% (5,556 of 6,870) had at least one measles vaccine dose and 84% (5,798 of 6,870) at least one polio dose. However, only 11% (764 of 6,870) were fully aligned with the UK schedule for polio, 34% (2,338 of 6,870) for measles and 6% (380 of 6,870) for diphtheria and tetanus.[70]

All migrants are entitled to free vaccinations to ensure they are immunised in line with the UK vaccination schedule, with catch-up doses recommended for those missing immunisations or with unknown vaccination status.[71] This protects both them and the wider population.

Newly arrived migrants should be offered any missing vaccinations when they register with a GP as part of a new patient health check. Migrants that access pre-entry screening may also be offered vaccinations before arrival to the UK. Evidence suggests poor vaccination coverage in some migrant groups[72] could be due to language barriers, access issues (including difficulty registering with a GP) and vaccine hesitancy in some communities.[73] Case study 2 describes the Safe Surgeries programme which supports migrants with GP registration and their entitlements for care.

Case Study 2: Safe Surgeries, Doctors of the World[74]

Marina Davidson – Advocacy Manager (Primary Care Lead), Doctors of the World

Across the UK, Doctors of the World (DOTW) supports individuals who face exclusion from healthcare. One of their initiatives is the Safe Surgeries programme, which helps GP practices create a welcoming and inclusive environment for everyone, regardless of their background or immigration status.

Many migrants encounter significant barriers when trying to access NHS care. These include incorrect refusals of care due to lack of identification or proof of address documents, which are not required to register with a GP but are often requested during the registration process. Many migrants in vulnerable circumstances, such as people seeking asylum, often do not have access to these documents. They may also have limited knowledge of their entitlements and how to navigate the NHS and translated or accessible information on their rights is not always available. These barriers can lead to delayed diagnoses and treatment, including of communicable diseases, which has wider public health implications. Individuals who are not registered with a GP are excluded from vaccination and screening programmes and may miss opportunities for catch-up immunisations that would typically be delivered in primary care.

Launched in 2018, Safe Surgeries equips GP practices with knowledge and tools to offer inclusive care in line with NHS England guidance.[75] By signing up as a Safe Surgery, GP practices commit to removing barriers and ensuring that all patients can receive the care they need and are entitled to. This includes empowering frontline staff with training and an inclusive registration policy, not insisting on proof of address or ID, never asking to see proof of immigration status and displaying welcoming posters.

Member practices can access training for clinical and non-clinical staff on NHS entitlements, common challenges faced by migrants and best practice for improving access to care. Additionally, they become part of a supportive national network and receive practical resources such as the Safe Surgeries Toolkit, simple guides to NHS entitlement and translated patient-facing posters.[76]

Safe Surgeries exist in every ICB area, with many regions achieving over 50% coverage. The network continues to grow, with 2,500 GP practices (representing over 25% of all practices in England) signed up.

System strengthening

The Migrant Health Guide provides recommendations to healthcare practitioners for assessing and treating migrants in the UK, covering infection screening and immunisation.[77] Screening recommendations differ by country, type of infection and patient level risk factors. For migrants newly registering with a GP, a basic patient health check should be offered as for all new patients. This should include consideration of communicable disease risks based on their country of origin and other risk factors.

Early access to treatment for infections is good for the individual migrant and in some cases reduces the risk to the wider population. Migrants in the UK have the right to access certain free NHS services, including primary care, maternity care, accident and emergency services and infectious disease treatment for notifiable diseases. Access to other healthcare services depends on residency status. Refugees and people seeking asylum are entitled to full NHS care.[78]

Despite these rights, many migrants face barriers to accessing healthcare, including language, transport barriers, difficulties registering with NHS services,[79] lack of awareness or confusion about their entitlements and fear of costs or repercussions, especially for undocumented migrants.[80,81] Some may avoid seeking care due to concerns about their immigration status being exposed or healthcare data being used outside of medical settings. Stigma and discrimination can also affect healthcare access for migrants.[82] All of these factors impact on opportunities for early detection of infections and preventative interventions such as vaccination.

A recent survey of GP staff in London found that 69% of respondents wanted more support in engaging with people seeking asylum and refugees.[83] Culturally competent healthcare training can improve access, awareness and treatment adherence among migrant populations.[84] Moreover, co-ordination between health and wider partners can enable effective planning and delivery of health and wider support services including through improved data sharing, clearer safeguarding escalation and recognising the role of the voluntary, community, faith and social enterprise sector (VCSE). Case study 3 describes how partners in Yorkshire and Humber have worked together to provide stronger systems support around vaccination for migrants in the region.

Case study 3: Guidance to support immunisation of migrants in vulnerable circumstances in the North East and Yorkshire and Humber Region

Kathy Wakefield – Principal Screening and Immunisation Manager, Public Health Programme Team, NHSE North East & Yorkshire

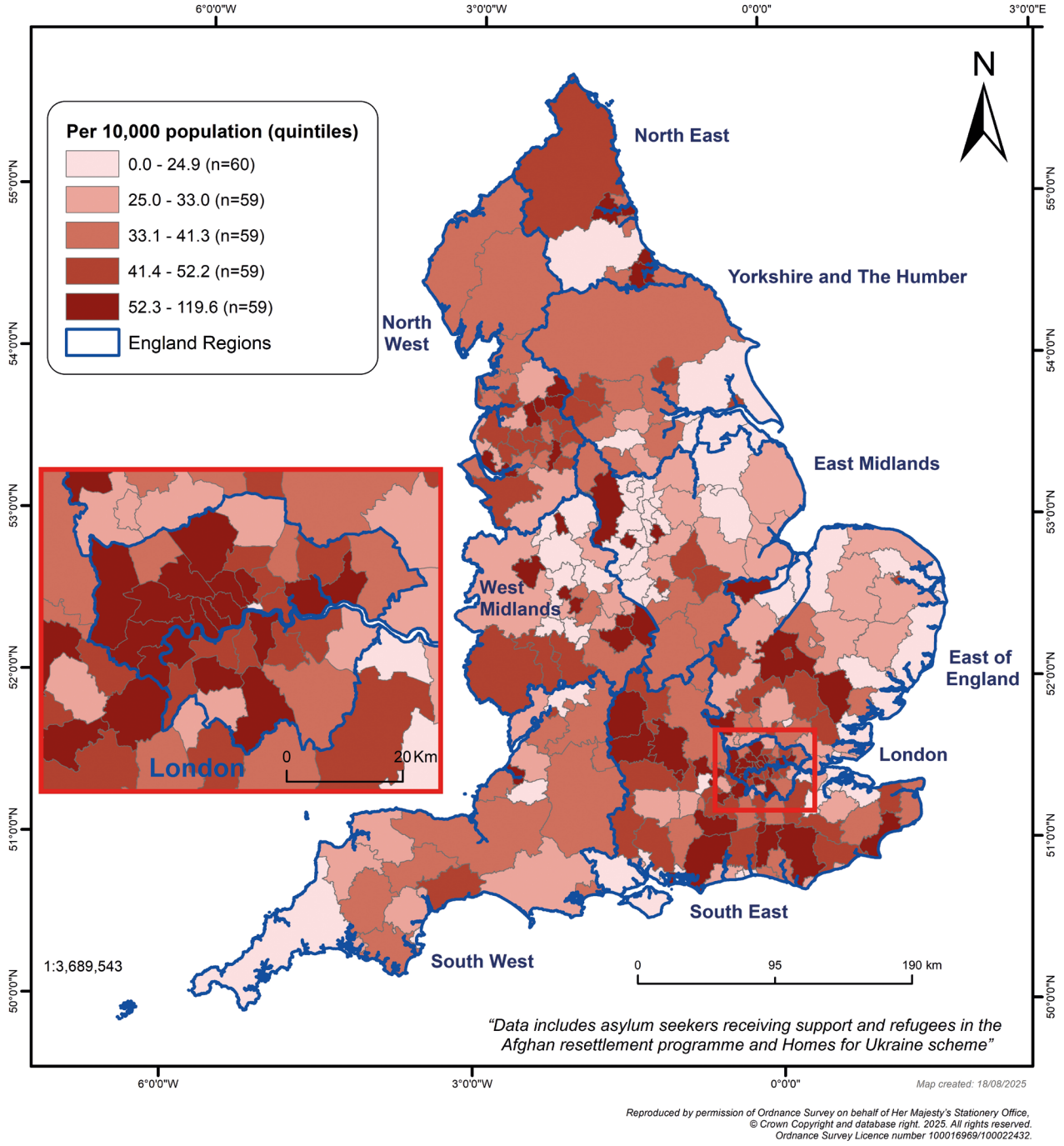
Cathie Railton – Programme Manager (Inclusion Health), OHID Yorkshire and Humber

A Migrant Health Network for the North East and Yorkshire and Humber is attended by a wide range of stakeholders including NHS services and commissioners, local authorities, government departments, the police, people with lived experience of migration, arm's length NHS bodies, academics and strategic migration partnerships.[85]

Members work collaboratively to develop resources across different topics to support organisations in their work with migrants. This includes specific guidance for NHS commissioners and providers to develop and deliver strategies and action plans to improve uptake of immunisations for migrants.[86] The guidance outlines why it is important to assess vaccination history amongst migrants in more vulnerable circumstances and how to utilise existing assets to improve uptake. It provides case study examples and clarifies the contractual requirements and incentives in relation to the immunisation of migrants. Case studies include a peer support model, working with VCSEs to deliver vaccination, outreach vaccination, health champions and collecting insights to support uptake.

For diagnostic and treatment services for infectious diseases to be available and accessible to migrant populations, geographic spread, which includes rural areas, needs to be taken into account in planning and commissioning. London is the most common destination for migrants while Northern Ireland, the North East and Wales are the least.[87] Figure 3 shows geographical variation of supported asylum and resettlement schemes per 10,000 people for local authorities in England in December 2024, representing where people have been placed rather than chosen to live.

Figure 3: Number of people seeking asylum and on resettlement schemes per 10,000 population by Local Authority in England (December 2024)[88,89]



Data source: Map based on "Regional and local authority data – Immigration groups, year ending December 2024. https://www.gov.uk/government/statistical-data-sets/immigration-system-statistics-regional-and-local-authority-data.

Population Estimates; Source for the mid-year 2023 population estimates for England and Wales (Mid-2023: 2023 local authority boundaries, table MYE4) https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/datasets/estimatesofthepopulationforenglandandwales.

Map created using ArcGIS version 10.8.2 by Noor Saeed, UKHSA Health Equity and Inclusion Health Division.

Some migrant populations experience higher levels of movement within England. For example, people seeking asylum are frequently moved to new locations in the accommodation system. As the NHS and other partners often operate within local geographies, providing continuity of

care for diagnostic, screening and treatment services to transient populations can mean follow-up care requires enhanced co-ordination. This becomes particularly important when systems need to respond to infectious disease outbreaks or when co-ordination is required between multiple levels and partners. Recent guidance to ICBs highlights their role as Category 1 responders under the Civil Contingencies Act 2004 in anticipating and managing outbreaks, including for sites hosting migrants in vulnerable circumstances managed by government departments.[90]

Some services offer tailored care for migrants in vulnerable circumstances (case study 4). Alternative models such as these illustrate opportunities to provide more accessible and comprehensive care.

Case Study 4: RESPOND integrated health service for people seeking asylum and refugees, University College London Hospital[91]

Allison Ward – Consultant Paediatrician, Camden Integrated Service for Children

Many people seeking asylum are placed in temporary accommodation. The needs of this highly mobile population, who can face complex health and social challenges alongside significant barriers to accessing care, are not easily met by traditional health service models. People seeking asylum can therefore experience poor health outcomes, whilst the potential for public health consequences of undiagnosed and untreated infections persists.

RESPOND unites health, local authority and voluntary, community, faith and social enterprise (VCSE) teams to deliver inclusive care. People seeking asylum of all ages are offered trauma-informed, holistic health assessments in hospital and community settings. Screening for infections occurs alongside a tailored assessment of wider biopsychosocial needs. The most complex cases are supported by a virtual expert multidisciplinary team. Service users receive a bespoke health summary and care plan document.

RESPOND through its component services has cared for more than 3,500 people since 2021. Service users are referred by professionals (of any discipline); prior models have included outreach with proactive identification. Infections have been identified and treated in a third of individuals seen through the service, including latent TB, Hepatitis B and gastrointestinal parasites. More than a tenth had more than one infection. The service continues to evolve, with the active participation of people with lived experience in its development. It is hoped that this inclusion health model can be adapted to reach other marginalised populations with positive impact on personal and public health.

To inform more tailored and inclusive approaches to healthcare design and delivery it is important to engage with migrant communities, recognising the diversity and intersectionality within populations. Working towards co-production with communities can help overcome barriers to health services, reduce stigma, build trust and address health inequalities. Co-producing tailored guidance and advice through partnership working can increase the

relevance and acceptability of public health advice in both proactive and reactive health protection scenarios.[92]

Data linkage can support better surveillance. The Million Migrants study has linked data from the pre-entry TB screening datasets to surveillance systems in the UK and has been used to assess COVID-19 vaccine uptake in migrants.[93,94] This is an example of how using existing known information on migrants can be linked to strengthen understanding of epidemiology and evaluation of healthcare interventions within existing surveillance.

Conclusion

Most migrants are healthier than the general UK population. However, global infection patterns mean some migrants experience higher rates of infectious diseases exacerbated by various factors including barriers to healthcare access once in England. Migration patterns in the UK have changed in recent years, with more arrivals from non-EU countries, where prevalence of some infections may be higher than in England. It is therefore important that services can meet the need of migrant patients, particularly those in vulnerable circumstances, and provide opportunities for early identification of infection and appropriate links to follow-up care.

TB rates are rising in the UK and a large proportion of people are living with undiagnosed chronic Hepatitis B (many of whom are migrants), making access to infection screening a key priority for migrants from high-prevalence countries. Support of global initiatives to reduce infection rates in high incidence countries can reduce transmission at this level and contribute to reducing rates elsewhere.

It is important to enable early access to healthcare and to support migrants to overcome barriers to registering in primary care so that health needs can be supported and identified in the period after arrival, when infection risk can be greater. NHS orientation and support to register with a GP should be an embedded part of health pathways for migrant groups, especially services working with migrants in vulnerable circumstances. Improved access includes supporting primary care to offer missing vaccinations and infectious disease testing as set out in the Migrant Health Guide as part of health assessments when people first register with a GP. Expansion of testing for latent TB could help to address rising numbers of TB cases for all migrants from very high-incidence TB countries.

Local community and council initiatives also play a role in supporting well-being during infectious disease incidents. Outbreak and pandemic response planning should consider access to healthcare, susceptibility to infection and increasing the ability to benefit from interventions for migrants.

Finally, healthcare professionals have highlighted a need for additional training to understand the differing infectious disease risks in migrant communities and provide trauma-informed and culturally appropriate care. Understanding lived experiences is important for developing effective services, reducing stigma and improving access to healthcare.

References

1 Quak, E. The effects economic integration of migrants have on the economy of host countries. [Internet] 2019. Available from: https://assets.publishing.service.gov.uk/media/5d41b51e40f0b60a85e75468/571_Economic_Impacts_International_Migration_Host_Countries.pdf.

2 International Monetary Fund. World Economic Outlook, April 2020: The Great Lockdown. [Internet] 2020. Available from: https://www.imf.org/en/Publications/WEO/Issues/2020/04/14/weo-april-2020#Statistical%20Appendiex.

3 Aldridge RW, Nellums LB, Bartlett S et al. Global patterns of mortality in international migrants: a systematic review and meta-analysis. Lancet. 2018;392(10164):2553-66. doi: 10.1016/S0140-6736(18)32781-8

4 The Migrant Observatory. The health of migrants in the UK. [Internet] 2020. Available from: https://migrationobservatory.ox.ac.uk/resources/briefings/the-health-of-migrants-in-the-uk/.

5 WHO Europe Region. The health of refugees and migrants in the WHO European Region. [Internet] 2023. Available from: https://www.who.int/europe/news-room/fact-sheets/item/the-health-of-refugees-and-migrants-in-the-who-european-region

6 The Migrant Observatory. Who Counts as a Migrant? Definitions and their Consequences. [Internet] 2024. Available from: https://migrationobservatory.ox.ac.uk/resources/briefings/who-counts-as-a-migrant-definitions-and-their-consequences/.

7 The UN Refugee Agency. Who We Protect: Refugees. [Internet] 2025. Available from: https://www.unhcr.org/uk/about-unhcr/who-we-protect/refugees.

8 The UN Refugee Agency. Who We Protect: Asylum-seekers. [Internet] 2025. Available from: https://www.unhcr.org/uk/about-unhcr/who-we-protect/asylum-seekers.

9 Office for Health Improvement and Disparities. Vulnerable migrants: migrant health guide. [Internet] 2017. Available from: https://www.gov.uk/guidance/vulnerable-migrants-migrant-health-guide.

10 The Migrant Observatory. Net migration to the UK. [Internet] 2025. Available from: https://migrationobservatory.ox.ac.uk/resources/briefings/long-term-international-migration-flows-to-and-from-the-uk/.

11 International Organization for Migration. World Migration Report 2024. [Internet] 2024. Available from: https://worldmigrationreport.iom.int/msite/wmr-2024-interactive/.

12 Article 14 of the Universal Declaration of Human Rights (1948). The Human Rights Act 1998.

13 Sturge G. Asylum statistics. [Internet] 2025. Available from: https://researchbriefings.files.parliament.uk/documents/SN01403/SN01403.pdf.

14 Home Office. How many people claim asylum in the UK? [Internet] 2025. Available from: https://www.gov.uk/government/statistics/immigration-system-statistics-year-ending-december-2024/how-many-people-claim-asylum-in-the-uk.

15 Home Office. Migrants detected crossing the English Channel in small boats. [Internet] 2025. Available from: https://www.gov.uk/government/publications/migrants-detected-crossing-the-english-channel-in-small-boats/migrants-detected-crossing-the-english-channel-in-small-boats-last-7-days.

16 UK Health Security Agency. Communal accommodation settings: infection transmission risk. [Internet] 2024. Available from: https://www.gov.uk/government/publications/communal-accommodation-settings-infectious-disease-transmission

17 UK Health Security Agency. Sexually transmitted infections (STIs): migrant health guide. [Internet] 2025. Available from: https://www.gov.uk/guidance/sexually-transmitted-infections-stis-migrant-health-guide.

18 The Migrant Observatory. The health of migrants in the UK. [Internet] 2020. Available from: https://migrationobservatory.ox.ac.uk/resources/briefings/the-health-of-migrants-in-the-uk/.

19 UK Health Security Agency. Tuberculosis incidence and epidemiology, England, 2023. [Internet] 2025. Available from: https://www.gov.uk/government/publications/tuberculosis-in-england-2024-report/tuberculosis-incidence-and-epidemiology-england-2023.

20 UK Health Security Agency. Hepatitis B: migrant health guide. [Internet] 2025. Available from: https://www.gov.uk/guidance/hepatitis-b-migrant-health-guide.

21 UK Health Security Agency. HIV testing, PrEP, new HIV diagnoses and care outcomes for people accessing HIV services: 2024 report. [Internet] 2024. Available from: https://www.gov.uk/government/statistics/hiv-annual-data-tables/hiv-testing-prep-new-hiv-diagnoses-and-care-outcomes-for-people-accessing-hiv-services-2024-report.

22 Nellums LB, Thompson H, Holmes A et al. Antimicrobial resistance among migrants in Europe: a systematic review and meta-analysis. Lancet Infect Dis. 2018;18(7):796-811. doi: 10.1016/S1473-3099(18)30219-6.

23 World Health Organization. Tuberculosis. [Internet] 2025. Available from: https://www.who.int/news-room/fact-sheets/detail/tuberculosis.

24 World Health Organization. Global tuberculosis report 2024. [Internet] 2024. Available from: https://www.who.int/publications/i/item/9789240101531.

25 UK Health Security Agency. National quarterly report of tuberculosis in England: quarter 4, 2024, provisional data. [Internet] 2025 Available from: https://www.gov.uk/government/statistics/tuberculosis-in-england-national-quarterly-reports/national-quarterly-report-of-tuberculosis-in-england-quarter-4-2024-provisional-data.

26 UK Health Security Agency. Tuberculosis incidence and epidemiology, England, 2023. [Internet] 2025. Available from: https://www.gov.uk/government/publications/tuberculosis-in-england-2024-report/tuberculosis-incidence-and-epidemiology-england-2023.

27 UK Health Security Agency. Tuberculosis in England, 2024 report. [Internet] 2024. Available from: https://www.gov.uk/government/publications/tuberculosis-in-england-2024-report

28 UK Health Security Agency. Tuberculosis incidence and epidemiology, England, 2023. [Internet] 2025. Available from: https://www.gov.uk/government/publications/tuberculosis-in-england-2024-report/tuberculosis-incidence-and-epidemiology-england-2023.

29 UK Health Security Agency. Tuberculosis in children aged 0 to 17 years, England, 2023. [Internet] 2025. Available from: https://www.gov.uk/government/publications/tuberculosis-in-england-2024-report/tuberculosis-in-children-aged-0-to-17-years-england-2023.

30 UK Health Security Agency. Tuberculosis in children aged 0 to 17 years, England, 2023. [Internet] 2025. Available from: https://www.gov.uk/government/publications/tuberculosis-in-england-2024-report/tuberculosis-in-children-aged-0-to-17-years-england-2023.

31 UK Health Security Agency. Tuberculosis in England, 2024 report. [Internet] 2025. Available from: https://www.gov.uk/government/publications/tuberculosis-in-england-2024-report.

32 UK Health Security Agency. Tuberculosis incidence and epidemiology, England, 2023. [Internet] 2025. Available from: https://www.gov.uk/government/publications/tuberculosis-in-england-2024-report/tuberculosis-incidence-and-epidemiology-england-2023.

33 Aldridge RW, Zenner D, White PJ et al. Tuberculosis in migrants moving from high-incidence to low-incidence countries: a population-based cohort study of 519 955 migrants screened before entry to England, Wales, and Northern Ireland. Lancet. 2016;388(10059):2510-8. doi: 10.1016/S0140-6736(16)31008-X.

34 UK Health Security Agency. Tuberculosis prevention, England, 2023. [Internet] 2025. Available from: https://www.gov.uk/government/publications/tuberculosis-in-england-2024-report/tuberculosis-prevention-england-2023.

35 Berrocal-Almanza LC, Harris RJ et al. Effectiveness of nationwide programmatic testing and treatment for latent tuberculosis infection in migrants in England: a retrospective, population-based cohort study. Lancet Public Health. 2022;7(4):e305-e15. doi: 10.1016/S2468-2667(22)00031-7.

36 UK Health Security Agency. Tuberculosis prevention, England, 2023. [Internet] 2025. Available from: https://www.gov.uk/government/publications/tuberculosis-in-england-2024-report/tuberculosis-prevention-england-2023.

37 UK Health Security Agency. Tuberculosis prevention, England, 2023. [Internet] 2025. Available from: https://www.gov.uk/government/publications/tuberculosis-in-england-2024-report/tuberculosis-prevention-england-2023.

38 Rustage K, Lobe J, Hayward SE et al. Initiation and completion of treatment for latent tuberculosis infection in migrants globally: a systematic review and meta-analysis. Lancet Infect Dis. 2021;21(12):1701-12. doi: 10.1016/S1473-3099(21)00052-9.

39 UK Health Security Agency. Migrant Health Guide: Tuberculosis. [Internet] 2025. Available from: https://www.gov.uk/guidance/tuberculosis-tb-migrant-health-guide.

40 UK Health Security Agency. Tuberculosis: the green book, chapter 32. [Internet] 2018. Available from: https://www.gov.uk/government/publications/tuberculosis-the-green-book-chapter-32.

41 UK Health Security Agency. HIV testing, PrEP, new HIV diagnoses and care outcomes for people accessing HIV services: 2024 report. [Internet] 2024. Available from: https://www.gov.uk/government/statistics/hiv-annual-data-tables/hiv-testing-prep-new-hiv-diagnoses-and-care-outcomes-for-people-accessing-hiv-services-2024-report.

42 UK Health Security Agency. HIV testing, PrEP, new HIV diagnoses and care outcomes for people accessing HIV services: 2024 report. [Internet] 2024. Available from: https://www.gov.uk/government/statistics/hiv-annual-data-tables/hiv-testing-prep-new-hiv-diagnoses-and-care-outcomes-for-people-accessing-hiv-services-2024-report.

43 Brown AE, Shah A, Martin V, Chau C, Djuretic T. People diagnosed with HIV before continuing care in England are extremely unlikely to pass on HIV in England. HIV Med. 2025;26(10):1626-1627 doi: 10.1111/hiv.70084

44 Ong KJ, Desai S, Field N et al. Economic evaluation of HIV pre-exposure prophylaxis among men-who-have-sex-with-men in England in 2016. Euro Surveill. 2017;22(42). doi: 10.2807/1560-7917.ES.2017.22.42.17-00192.

45 Sullivan AK, Saunders J, Desai M et al. HIV pre-exposure prophylaxis and its implementation in the PrEP Impact Trial in England: a pragmatic health technology assessment. Lancet HIV. 2023;10(12):e790-e806. doi: 10.1016/S2352-3018(23)00256-4.

46 European Centre for Disease Prevention and Control. HIV and migrants – Monitoring the implementation of the Dublin Declaration on partnership to fight HIV/AIDS in Europe and Central Asia: 2022 progress report. [Internet] 2022. Available from: https://www.ecdc.europa.eu/en/publications-data/hiv-and-migrants-monitoring-implementation-dublin-declaration-partnership-fight.

47 World Health Organization. Global hepatitis report 2024: action for access in low- and middle-income countries. [Internet] 2024. Available from: https://www.who.int/publications/i/item/9789240091672.

48 World Health Organization. Elimination of hepatitis by 2030. [Internet] 2025. Available from: https://www.who.int/health-topics/hepatitis/elimination-of-hepatitis-by-2030#tab=tab_1.

49 World Health Organization. Global hepatitis report 2024: action for access in low- and middle-income countries. [Internet] 2024. Available from: https://www.who.int/publications/i/item/9789240091672.

50 World Health Organization. Global hepatitis report 2024: action for access in low- and middle-income countries. [Internet] 2024. Available from: https://www.who.int/publications/i/item/9789240091672.

51 World Health Organization. Hepatitis. [Internet] 2025. Available from: https://www.who.int/data/gho/data/themes/chronic-viral-hepatitis#:~:text=An%20estimated%201.3%20million%20people,with%20viral%20hepatitis%20each%20day.

52 World Health Organization. Global hepatitis report 2024: action for access in low- and middle-income countries. [Internet] 2024. Available from: https://www.who.int/publications/i/item/9789240091672.

53 UKHSA. Hepatitis B in England, 2024: reducing incidence and prevalence of hepatitis B. [Internet] 2025. Available from: https://www.gov.uk/government/publications/hepatitis-b-in-england/hepatitis-b-in-england-2024#reducing-incidence-and-prevalence-of-hepatitis-b.

54 UK Health Security Agency. Migrant health guide. [Internet] 2025. Available from: https://www.gov.uk/guidance/hepatitis-c-migrant-health-guide.

55 Office for Health Improvement and Disparities. Assessing new patients from overseas: migrant health guide. [Internet] 2021. Available from: https://www.gov.uk/guidance/assessing-new-patients-from-overseas-migrant-health-guide

56 UK Health Security Agency. Emergency department bloodborne virus opt-out testing: 12-month interim report 2023. [Internet] 2024. Available from: https://www.gov.uk/government/publications/bloodborne-viruses-opt-out-testing-in-emergency-departments/emergency-department-bloodborne-virus-opt-out-testing-12-month-interim-report-2023.

57 UK Health Security Agency, Public Health Evaluation of BBV opt-out testing in emergency departments. [Internet] 2025. Available from: https://www.gov.uk/government/publications/bloodborne-viruses-opt-out-testing-in-emergency-departments/public-health-evaluation-of-bbv-opt-out-testing-in-eds-in-england-24-month-interim-report.

58 Yin Z, Brown AE, Rice BD et al. Post-migration acquisition of HIV: Estimates from four European countries, 2007 to 2016. Euro Surveill. 2021;26(33):2000161. doi: 10.2807/1560-7917.ES.2021.26.33.2000161

59 UK Health Security Agency. Migrant Health Guide: HIV. [Internet] 2025. Available from: https://www.gov.uk/guidance/hiv-migrant-health-guide

60 Vusirikala A, Threadgold G, Roche R et al. Understanding current antenatal Hepatitis C testing and care in maternity services in England. J Perinat Med. 2024;52(5):515-519. doi: 10.1515/jpm-2023-0508.

61 Baggaley R, Vegvari C, Dimala C et al. Health economic analyses of latent tuberculosis infection screening and preventive treatment among people living with HIV in lower tuberculosis incidence settings: a systematic review. Wellcome Open Res. 2023;6(51). doi: 10.12688/wellcomeopenres.16604.2.

62 Cherri Z, Lau K, Nellums LB et al. The immune status of migrant populations in Europe and implications for vaccine-preventable disease control: a systematic review and meta-analysis. J Travel Med. 2024;31(6). doi: 10.1093/jtm/taae033.

63 Mipatrini D, Stefanelli P, Severoni S, Rezza G. Vaccinations in migrants and refugees: a challenge for European health systems. A systematic review of current scientific evidence. Pathog Glob Health. 2017;111(2):59-68. doi: 10.1080/20477724.2017.1281374.

64 Public Health England. National Immunisation Programme: health equity audit. 2021. [Internet] Available from: https://assets.publishing.service.gov.uk/media/60183a8de90e07128e743b85/immnstn-equity_AUDIT_v11.pdf.

65 UK Health Security Agency. The green book. Chapter 15: Diphtheria. [Internet] 2025. Available from: https://assets.publishing.service.gov.uk/media/683d87d481deb72cce2680a4/Diphtheria-green_book-chapter-15-30-05-2025.pdf.

66 UK Health Security Agency. The green book. Chapter 15: Diphtheria. [Internet] 2025. Available from: https://assets.publishing.service.gov.uk/media/683d87d481deb72cce2680a4/Diphtheria-green_book-chapter-15-30-05-2025.pdf.

67 UK Health Security Agency. Diphtheria: public health control and management in England. 2025. Available from: https://www.gov.uk/government/publications/diphtheria-public-health-control-and-management-in-england-and-wales.

68 World Health Organization. Diphtheria reported cases and incidence. [Internet] 2024. Available from: https://immunizationdata.who.int/global/wiise-detail-page/diphtheria-reported-cases-and-incidence?GROUP=WHO_REGIONS+Countries&YEAR=.

69 Crawshaw AF, Goldsmith LP, Deal A et al. Driving delivery and uptake of catch-up vaccination among adolescent and adult migrants in UK general practice: a mixed methods pilot study. BMC Med. 2024;22(1). doi: 10.1186/s12916-024-03378-z.

70 Deal A, Hayward SE, Crawshaw AF et al. Immunisation status of UK-bound refugees between January, 2018, and October, 2019: a retrospective, population-based cross-sectional study. Lancet Public Health. 2022;7(7):e606-e15. doi: 10.1016/S2468-2667(22)00089-5.

71 UK Health Security Agency. Vaccination of individuals with uncertain or incomplete immunisation. [Internet] 2024. Available from: https://www.gov.uk/government/publications/vaccination-of-individuals-with-uncertain-or-incomplete-immunisation-status.

72 Crawshaw AF, Goldsmith LP, Deal A et al. Driving delivery and uptake of catch-up vaccination among adolescent and adult migrants in UK general practice: a mixed methods pilot study. BMC Med. 2024;22(1). doi: 10.1186/s12916-024-03378-z.

73 Crawshaw AF, Farah Y, Deal A et al. Defining the determinants of vaccine uptake and undervaccination in migrant populations in Europe to improve routine and COVID-19 vaccine uptake: a systematic review. Lancet Infect Dis. 2022;22(9):e254-266. doi: 10.1016/S1473-3099(22)00066-4.

74 Doctors of the World. Safe Surgeries. [Internet] Available from: https://www.doctorsoftheworld.org.uk/safesurgeries/.

75 NHS England. Primary medical services policy and guidance manual (PGM). [Internet] 2017. Available from: https://www.england.nhs.uk/publication/primary-medical-care-policy-and-guidance-manual-pgm/.

76 Doctors of the World. Safe Surgeries Toolkit. [Internet] Available from: https://www.doctorsoftheworld.org.uk/safesurgeries/safe-surgeries-toolkit/.

77 Office for Health Improvement and Disparities. Assessing new patients from overseas: migrant health guide. [Internet] 2021. Available from: https://www.gov.uk/guidance/assessing-new-patients-from-overseas-migrant-health-guide#trauma-informed-practice.

78 British Medical Association. Refugee and asylum seeker patient health toolkit: Overcoming barriers. [Internet] 2025. Available from: https://www.bma.org.uk/advice-and-support/ethics/refugees-overseas-visitors-and-vulnerable-migrants/refugee-and-asylum-seeker-patient-health-toolkit/overcoming-barriers-to-refugees-and-asylum-seekers-accessing-care.

79 Office for Health Improvement and Disparities. NHS entitlements: migrant health guide. [Internet] 2023. Available from: https://www.gov.uk/guidance/nhs-entitlements-migrant-health-guide.

80 Equality and Human Rights Commission. Access to healthcare for people seeking and refused asylum in Great Britain. [Internet] 2018. Available from: https://www.equalityhumanrights.com/sites/default/files/research-report-121-people-seeking-asylum-access-to-healthcare-evidence-review.pdf

81 Winters M, Rechel B, de Jong L, Pavlova M. A systematic review on the use of healthcare services by undocumented migrants in Europe. BMC Health Serv Res. 2018;18(1):30. doi: 10.1186/s12913-018-2838-y.

82 Equality and Human Rights Commission. Access to healthcare for people seeking and refused asylum in Great Britain. [Internet] 2018. Available from: https://www.equalityhumanrights.com/sites/default/files/research-report-121-people-seeking-asylum-access-to-healthcare-evidence-review.pdf

83 Mujong D, Harrod-Rothwell L, Nortley-Meshe A, Weil L. Enhancing general practice care for asylum seekers and refugees in the community. BMJ. 2024;387:q2766 doi: 10.1136/bmj.q2766.

84 Office for Health Improvement and Disparities. Assessing new patients from overseas: migrant health guide. [Internet] 2021. Available from: https://www.gov.uk/guidance/assessing-new-patients-from-overseas-migrant-health-guide#trauma-informed-practice.

85 NEY&H Migrant Health Network. [Internet] 2024. Available from: https://www.yhphnetwork.co.uk/links-and-resources/coi/migrant-health/neyh-migrant-health-network/.

86 NEY Migrant Health Network. Immunisations for migrants in vulnerable circumstances. [Internet] 2023. Available from: https://www.yhphnetwork.co.uk/media/213932/migrants-in-vulnerable-circumstances-and-immunisations-guidance-for-icss-and-providers-in-ney-june-2023-final.pdf.

87 The Migrant Observatory. Where do migrants live in the UK? [Internet] 2025. Available from: https://migrationobservatory.ox.ac.uk/resources/briefings/where-do-migrants-live-in-the-uk/.

88 Home Office, Ministry of Housing, Communities and Local Government. Regional and local authority data on immigration groups. [Internet] 2025. Available from: https://www.gov.uk/government/statistical-data-sets/immigration-system-statistics-regional-and-local-authority-data.

89 Office for National Statistic. Open Geography Portal. [Internet] 2025. Available from: https://geoportal.statistics.gov.uk/.

90 NHS England. Clinical response to local incidents and outbreaks of infectious disease: Commissioning guidance for ICBs. [Internet] 2025. Available from: https://www.england.nhs.uk/long-read/clinical-response-outbreaks-of-infectious-disease-commissioning-guidance-icbs/

91 Hospital UCL. RESPOND integrated refugee health service. [Internet] Available from: https://www.uclh.nhs.uk/our-services/find-service/tropical-and-infectious-diseases/htd-outpatient-services/specialist-services-hospital-tropical-diseases/respond-integrated-refugee-health-service

92 Burns R, Stevenson K, Miller A, Hargreaves S. Migrant-inclusive healthcare delivery in the UK: Lessons learned from the COVID-19 Pandemic. Lancet Reg Health Eur. 2022;21:100505. doi: 10.1016/j.lanepe.2022.100505

93 Burns R, Wyke S, Eyre MT, et al. COVID-19 vaccination coverage for half a million non-EU migrants and refugees in England. Nat Hum Behav. 2024;8(2):288-299. doi:10.1038/s41562-023-01768-6

94 Burns R, Pathak N, Campos-Matos I, et al. Million Migrants study of healthcare and mortality outcomes in non-EU migrants and refugees to England: Analysis protocol for a linked population-based cohort study of 1.5 million migrants. Wellcome Open Res. 2019;4:4. doi:10.12688/wellcomeopenres.15007.1

7 Wider determinants of infectious disease

7.1 Climate change and infections

Thomas Waite – Deputy Chief Medical Officer for England

Jolyon Medlock – Head of Medical Entomology & Zoonoses Ecology, Centre for Climate & Health Security, UK Health Security Agency

Lea Berrang Ford – Deputy Director, Head, Centre for Climate and Health Security (CCHS), UK Health Security Agency

Introduction

Climate affects health directly by affecting ambient temperatures, by interacting with the distribution of water and through the impacts of severe weather. All of these can alter the likelihood of exposure to infectious diseases via the 5 main routes of transmission and so may affect the future trend of infections in the UK. Indeed, the impact on disease risk of high and low temperatures, drought and flooding, are not new. For example, some winter infections are linked to temperature (amongst other factors) whilst an increased frequency of flooding or inundation of water and sanitation facilities due to extreme levels of precipitation may lead to increases in a range of common viral, bacterial and parasitic gastrointestinal infections.

At the intersection of water distribution and temperature there are a range of diseases spread between people by vectors of disease such as mosquitoes. Precipitation and standing water are major drivers of the availability of suitable breeding locations for biting insects, while winter temperatures govern the likelihood of successful survival of colonies or eggs over winter.

In many countries outside of the UK, the effects of climate change will be much more rapid and substantial than they will be here; the impact, including on infectious disease incidence, will be serious and is already being seen. Impacts are particularly acute in countries that already have fragile health systems, high existing infectious disease burden and high vulnerability to extreme weather. A 2023 review found that, of 375 infectious diseases examined, 218 (58%) would be exacerbated on a global basis by climate change.[1]

Climate change will alter global human population movements in future, in response to sea-level rise, food insecurity or extreme weather events. Migrating populations may be exposed to endemic diseases to which they have limited resistance or bring infectious agents to new territories which may spread easily in immune naïve populations. This can include drug resistant infections which can spread easily in the dense urban populations to which migrant groups are often drawn. This issue was considered in the CMO annual report on Health in Cities (2024).[2]

In this chapter, we consider the available evidence on the impact of climate change in England on commonly occurring infections which are linked to climate and weather and that spread by respiratory transmission, food and water, and vectors such as mosquitoes and ticks.

The UK's climate is classified as temperate and is heavily influenced by its location in the mid-latitudes, leading to mild winters, warm summers and high rainfall. This influences the seasonality of many outbreaks and epidemics of infectious disease, principally those transmitted by the respiratory route such as influenza and respiratory syncytial virus (RSV), or the food and waterborne routes including *Salmonella*, *Campylobacter* and a range of *Vibrio* species.

Food and waterborne diseases

Water-related diseases include those that are waterborne (via ingestion, contact with or inhalation of drinking or recreational water), water-based (in which the lifecycle of a parasite requires water from which it is transmitted via food or drink) or water-washed (in which poor access to water or hygiene can result in infection).

Whilst climate change has the potential to impact on all of these pathways, there are long-standing engineering solutions that separate clean water from wastewater in many countries, including the UK. Separating faeces from drinking water has been one of the greatest public health interventions of the last 200 years and is often taken for granted. When bacteria from human faeces (coliforms) are ingested, it increases the risk of many infections, including from antibiotic resistant bacteria. Keeping human faeces out of water so that people do not ingest it remains a public health priority. When extreme weather such as storms or intense rain leads to the sewerage system being overwhelmed, raw sewage may be discharged or overflow into rivers and waterways which are also used for recreation. This can occur even in countries with well-developed water treatment systems such as the UK. The risk of gastrointestinal infection can therefore be strongly influenced by weather conditions.

Food borne infections are those which are principally spread via consumption of animal or plant-based food and so can be influenced by the distribution of animal-to-animal or animal-to-human zoonotic infections. Increased water temperature, changes to patterns of rainfall, flooding and drought, can alter the distribution, transmission and persistence of food and waterborne pathogens in the environment. These factors thereby influence the incidence and spread of infections which can occur via ingestion of contaminated water or food, skin contact or inhalation of water droplets.

More frequent and intense precipitation and flooding events in future will likely lead to increased agricultural runoff into recreational water, potentially introducing additional opportunities for human exposure to gastrointestinal pathogens.

There is little robust data on the relationship between temperature (and other climate variables) and incidence of infection. This is despite many gastrointestinal infections being caused by a wide range of pathogens that are environmentally mediated and likely to be climate sensitive, including viruses such as norovirus, rotavirus and Hepatitis A, and bacteria such as

toxin-producing *E. coli*, *Salmonella* spp., and *Campylobacter* spp., or parasites such as *Cryptosporidium* spp. A few exceptions exist. There is robust modelling data on the relationships between some weather variables and pathogen incidence, such as *Salmonella*, *Campylobacter* and *Vibrio* spp. which all demonstrate sensitivity to climate variability. There is also some evidence suggesting that UK disease risk could increase in future. Data from outside of the UK and our understanding of transmission pathways suggests, however, that a wider range of pathogens are likely to be influenced either directly or indirectly by weather and climate-induced environmental or social change.

Campylobacter and *Salmonella* infections are usually caught by eating contaminated food, including poultry, meat, eggs, raw fruit or vegetables, and unpasteurised milk products. Infection may also occur through close contact with people with the infection – particularly in household settings – and by cross-contamination in the kitchen, for example when utensils are used for both cooked and uncooked foods.

Campylobacter peaks in England between May and August each year. Cases have increased by 17.1% from 60,055 in 2023 to 70,352 in 2024, reaching 121.9 reports per 100,000 population. This represents the highest number of cases recorded in the past decade. Adults aged 50 to 79 years account for 44% of all reports.[3] Similarly, *Salmonella* infections reached a decade high with a 17.1% increase from 2023, rising from 8,872 cases in 2023 to 10,388 cases in 2024.[4] Children under 10 years old were particularly affected, accounting for 21.5% of cases.

Potential explanations for the seasonality of *Campylobacter* infections include fluctuating infection rates in poultry (caused either by a direct impact of temperature on *Campylobacter* growth rates or indirect effects such as changes in contamination sources) and changes in exposure due to human behaviour, such as frequency of barbecues.[5] One modelling study has suggested *Campylobacter* cases in Nordic countries could increase by 25% by the end of the 2040s, with a climate related extension to the duration of high incidence until November. Conversely, observational data has shown that *Campylobacter* incidence decreases during heatwaves in Europe and Australia and so despite the evidence of association of *Campylobacter* trends with different climate variables, the overall impact of climate change on common enteric pathogens in the UK remains uncertain.

Respiratory diseases

Much of the seasonality of infectious disease is linked to human behaviour. For example, common respiratory viruses such as influenza and RSV transmit much more commonly in winter and lead to annual seasonal epidemics in large part because we spend much more time indoors sharing air with our friends, families and strangers, which facilitates widespread transmission. These infections lead to seasonal pressures on healthcare services and are a significant contributor to excess winter mortality.

There is limited evidence from the USA that during warmer winters fewer people were infected with influenza, however that impact was offset by earlier and more severe outbreaks the following year.[6]

Whilst modelled estimates show that climate change is likely to reduce the overall burden of cold related mortality, the overall level including from common respiratory infections will remain high until at least the end of this century.[7] The impact of climate on temperature thus may have only a limited impact on winter respiratory disease in the UK in the coming decades.

Impact of climate change on vector-borne disease in the UK

The recent *Health Effects of Climate Change* report identified a number of vector-borne disease issues of concern for UK public health.[8] Vector-borne diseases (VBD) include a range of viral, bacterial and protozoal pathogens that are transmitted by the bite of an arthropod vector (for example, mosquitoes, ticks, biting midges, sand-flies and fleas).

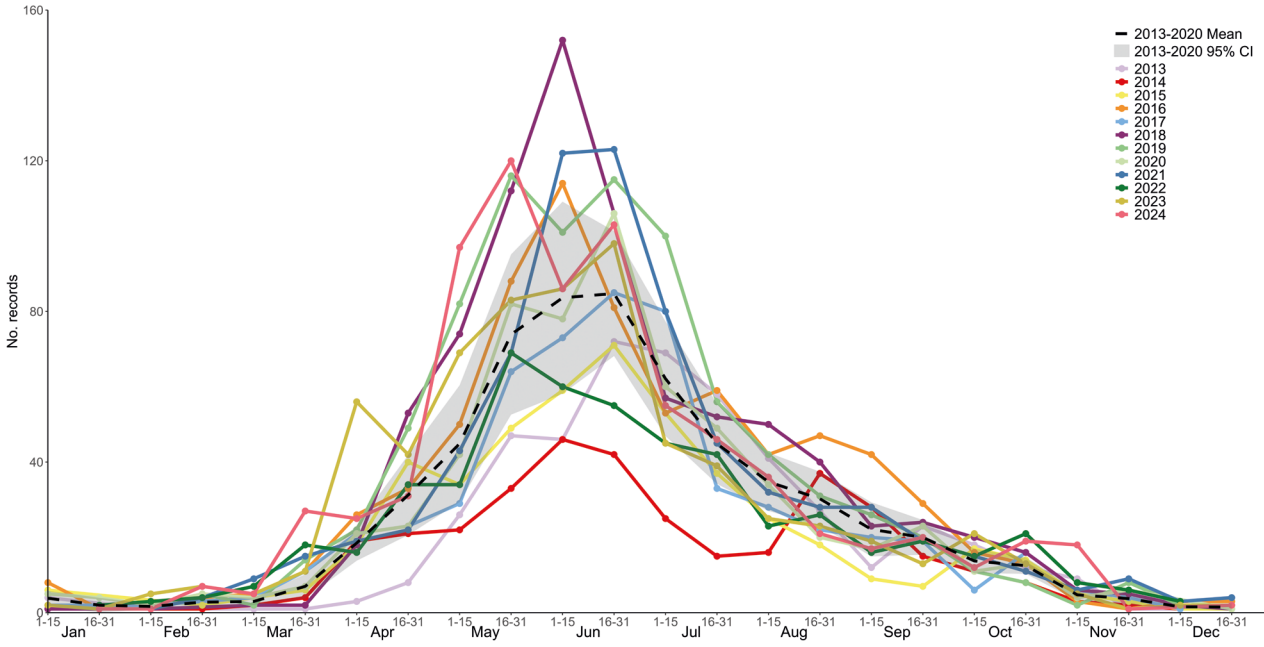
In the UK, the most common VBD is the tick-transmitted bacterial pathogen *Borrelia burgdorferi* s.l., the causative agent of Lyme disease. The disease causes up to 1,500 laboratory confirmed cases in England and Wales each year and between 1,000 to 4,000 additional clinical cases. Additionally, the recent detection of tick-borne encephalitis virus (TBEV) in ticks in England and 3 probable or confirmed cases of TBEV between 2019 and April 2023 confirms an additional medically important pathogen.[9] UK ticks are also infected with a number of other potential human pathogens including Louping ill virus, *Babesia* sp., *Anaplasma phagocytophilum*, various species of *Rickettsia*, as well as *Spiroplasma*.

Until recently, there was no evidence of locally transmitted mosquito-borne arboviruses in the UK. However, the detection of Usutu virus in birds and mosquitoes in south-east England in 2020 has highlighted a growing trend for the expansion of these arboviruses through northern Europe. The recent detection of West Nile virus in mosquitoes in the UK suggests that mosquitoes that carry potential infection is now a very distinct future possibility. With climate change, the incidence of local transmission will be an ever-increasing risk for UK public health as temperatures increase. As a future threat, the continued incursions of non-native, invasive mosquitoes (for example, *Aedes albopictus*) into the UK from continental Europe present a future scenario for local transmission of dengue, chikungunya and Zika viruses in the UK. Much as we now see today in continental Europe, the UK may face increasing cases of locally acquired dengue virus, as has become increasingly regular in France, Italy and Spain over the last 3 years. Similarly notable outbreaks of chikungunya have been documented in France and Italy more recently (2025) and previously also rare local transmission of Zika.

The UK has 20 tick species. Although many are specialist parasites of wildlife, several species can cause biting in humans, as well as concerns for veterinary health. The most common and ubiquitous *Ixodes ricinus* tick is a vector of all of the known and potential tick-borne pathogens listed above. A UK-wide tick surveillance scheme has been recording tick distribution over the last 20 years (Figure 1). Its distribution is limited by microclimatic factors and the availability of animal hosts upon which to feed. It occurs through the UK, so is not limited latitudinally, but its climatic restrictions are a limiting factor at high altitude. Recent surveillance data and species distribution modelling (for England and Wales) has identified large areas of southern England, the North York Moors, Thetford Forest, Cumbria and North Wales as highly suitable areas for

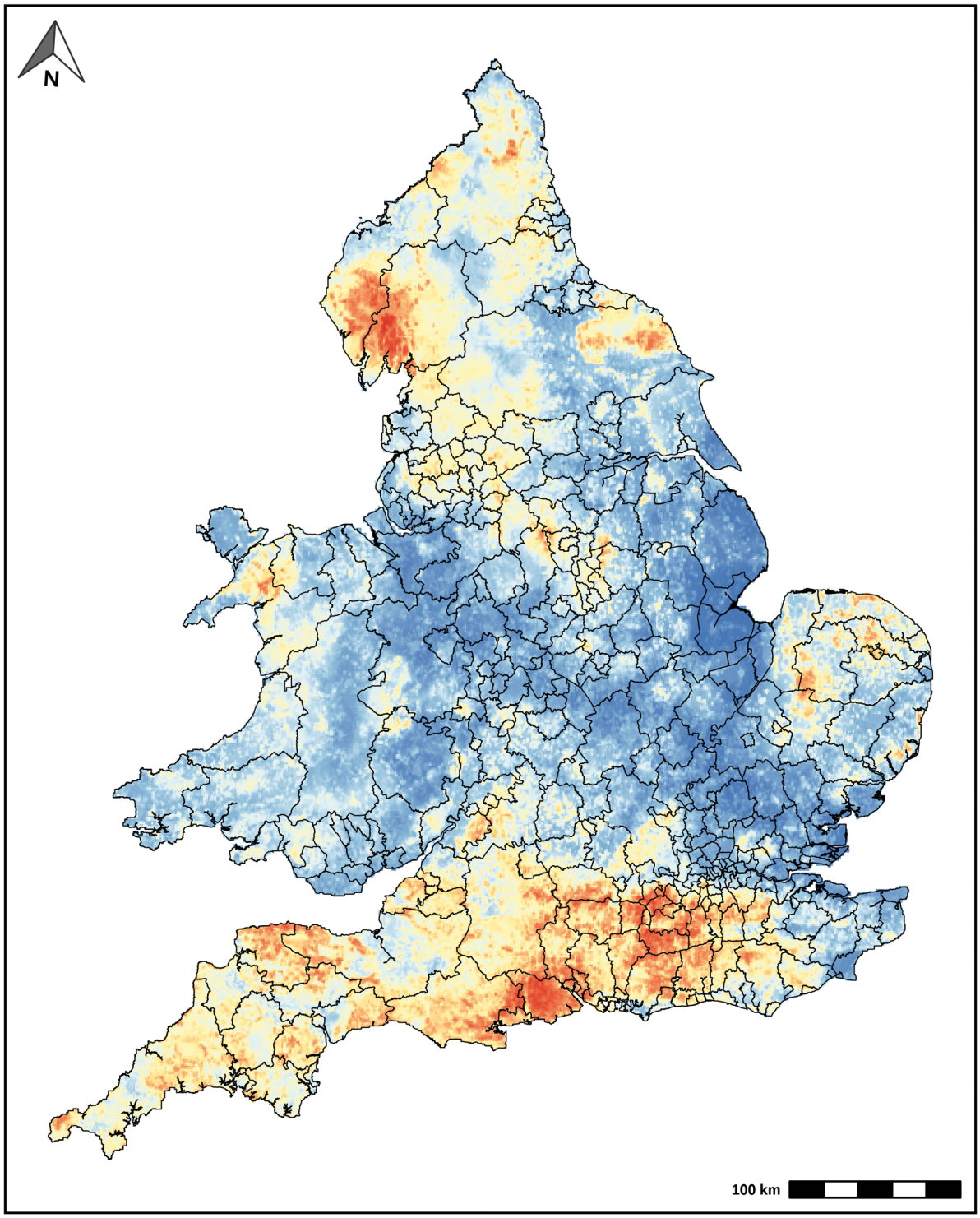
tick encounters. The distribution of roe deer and rough grazing with sheep and cattle are key factors in determining their survival and are the primary drivers for change in distribution, something that will be increasingly challenging in urban greenspace. Milder winters will lead to a shift in the seasonal activity of *Ixodes ricinus*, with extreme weather such as drought or floods potentially reducing their activity. As these ticks are acutely affected by microclimate, weather patterns and climate that favour wetter and warmer weather will promote their habitat suitability.

Figure 1: Seasonality of submissions of ticks to UKHSA tick surveillance programme, 2013 to 2024



Source: UKHSA data dashboard, ticks (Ixodes ricinus). Unpublished data.[10]

Figure 2: Current species distribution model for principal Lyme and TBEV tick vector, *Ixodes ricinus* in England and Wales[11]

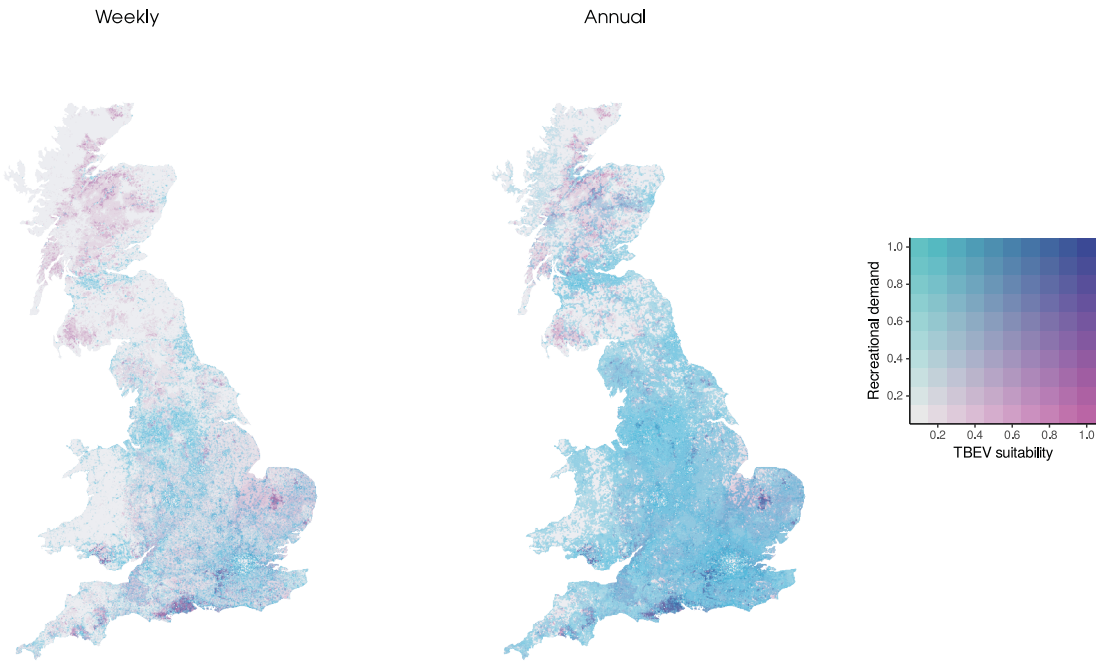


Source: Image from Burdon, M. G., Ayling, M., Jamieson N., et al., Modelling the distribution of the tick Ixodes ricinus in England and Wales using passive surveillance data from citizen science reports, 2025, PLOS Neglected Tropical Diseases is licensed under the Creative Commons Attribution License.

Infection rates in ticks with Lyme-causing bacteria *B. burgdorferi* s.l. vary geographically and inter-annually, depending upon the impacts of weather and climate on both tick densities and the densities of competent reservoir animal hosts. The effects of climate change are therefore indirect and complex. Production of tree masting can impact small mammal populations, which are important in infecting ticks with *B. afzelii*. Wild bird and gamebird populations, linked to *B. garinii* fluctuate both naturally in response to weather and climate, but are also subject to anthropogenic factors, which can exacerbate pathogen prevalence. Over the last 10 years, mean *Borrelia* infection rates in ticks have varied between 4% and 8%, with some recent evidence of an upward trend.

Tick-borne encephalitis virus is highly focal in its distribution, with spring warming and milder winters coupled with the presence of high deer densities and coniferous woodland considered major determinants of TBEV hot spots. Weather impacts on co-incident feeding of tick stages, together with these other ecological factors, will drive a change in TBEV transmission in the future. Other non-native tick species, such as *Hyalomma marginatum* (vector of Crimean-Congo Haemorrhagic fever virus) and *Rhipicephalus sanguineus* (vector of *Rickettsia*) are being imported on migratory birds and imported dogs, with both species likely to be able to survive in a warming UK climate. Imported dogs are also infected with sand-fly transmitted *Leishmania* and mosquito-borne *Dirofilaria*, both of which will benefit from climate warming, particularly if sand-flies continue to spread northwards in mainland Europe.

Figure 3: Map of recreational demand and suitability for Tick-borne encephalitis virus in Great Britain

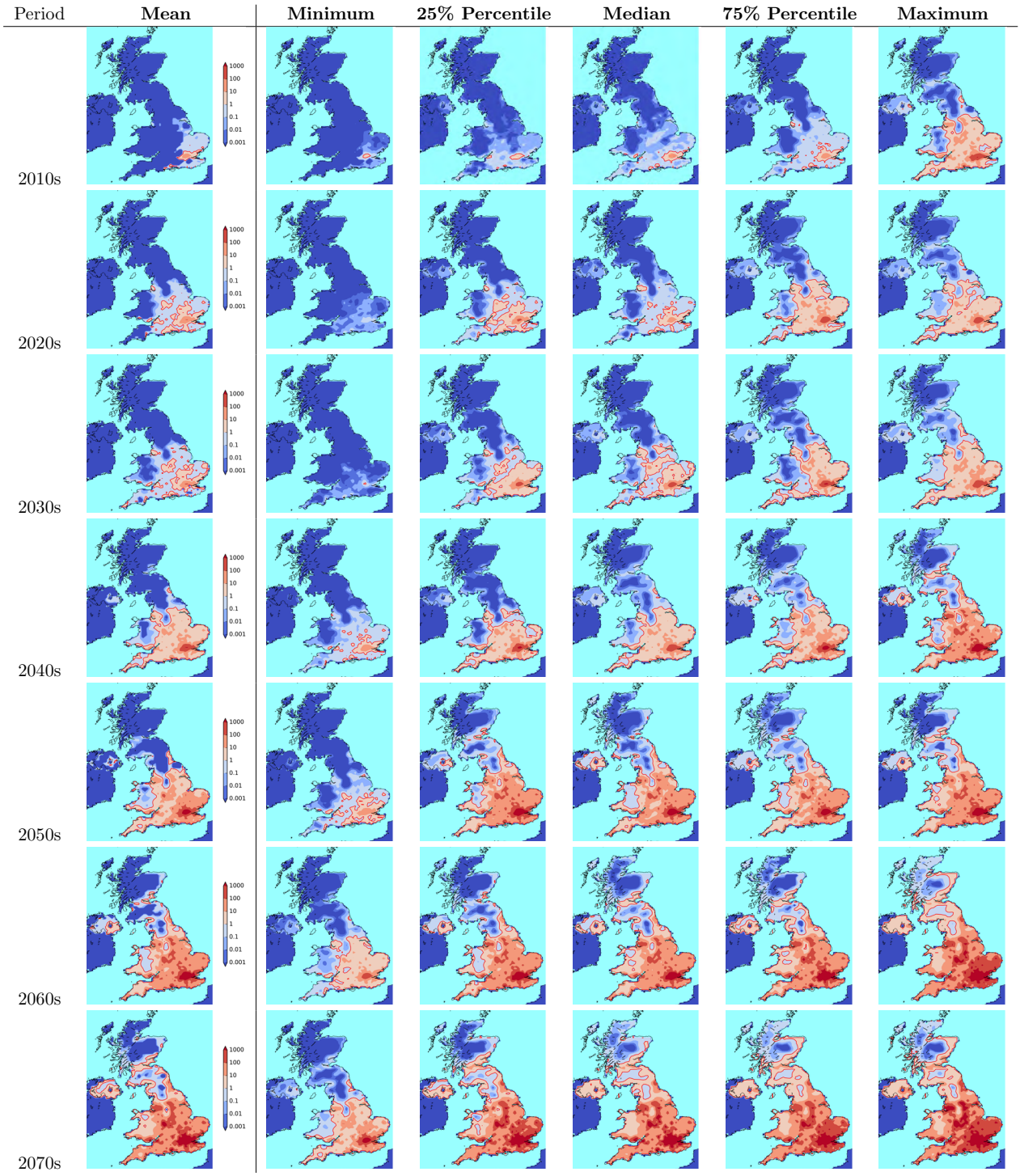


Source: Image taken from Hassall et al., Identifying hotspots and risk factors for tick-borne encephalitis virus emergence at its range margins to guide interventions, Great Britain, 2025, Eurosurveillance,[12] available under a Creative Commons Attribution 4.0 International License.

The Tiger mosquito (*Aedes albopictus*) was first detected in Italy in 1990, and has now spread to around 30 European countries, with a number of detections in the UK. The species is widely established in France. Its ability to enter winter egg diapause and survive freezing has enabled a

more temperate distribution. Climate change modelling confirms that parts of south-east England and London are currently suitable for the mosquito, with wider suitability by 2050 (Figure 4). Once established in the UK, the potential for local transmission of dengue, chikungunya and Zika is a real risk particularly in projected warmer summers, as seen in France, with notable transmission of 2 of these arboviruses in Paris.

Figure 4: Predicted suitability of the invasive tiger mosquito, *Aedes albopictus* (potential vector of dengue, chikungunya and Zika viruses) in the UK under future climate scenarios



Source: Image from UKHSA, Health Effects of Climate Change (HECC) in the UK: 2023 report, Chapter 8. Direct and indirect effects of climate change on vectors and vector-borne diseases in the UK, is licensed under the Open Government Licence v3.0.

The emergence of Usutu virus in the UK in 2020 has led to an impact on wild birds (for example, blackbird). It is transmitted by a common house mosquito, *Culex pipiens*, with evidence of the virus in a range of other species. This species is common in urban areas and benefits from how we store water in urban areas. The virus has now become widely distributed across southern and central England in just 5 years. Whilst Usutu virus is not considered a serious zoonotic infection, it is often the precursor of the more serious and zoonotic West Nile virus. Climate-based modelling has shown UK suitability by mid-century for sustained endemic transmission, however the potential for detection of the virus exists already when there are hot summers, particularly if the frequency of infected migratory birds increases. This threat was highlighted by the detection of West Nile virus in mosquitoes in the UK in 2023, suggesting evidence of local mosquitoes having bitten an infected migratory bird. A number of key *Culex* species in the UK and other nuisance biting mosquito species (for example, *Aedes*) also present risk for human transmission as they can transmit similar arboviruses. The impacts of extreme summer flooding can considerably impact mosquito densities, the incidence of nuisance mosquitoes and the arboviruses they can transmit.

Vaccines for vector borne diseases in England

Whilst there is no current need for routine vaccination against vector borne diseases in England, travellers to areas of higher risk are advised to protect themselves against a range of key infections including Yellow Fever, TBEV and Japanese encephalitis. Travellers from the UK can now also protect themselves against chikungunya with the introduction of 2 licenced vaccines in 2025. These are recommended by the JCVI for those travelling to regions with active chikungunya virus outbreaks, those long term or frequent travellers to regions with chikungunya virus transmission in the past 5 years and laboratory staff working with chikungunya virus.

In 2024, a dengue vaccination programme was introduced in the UK. Individuals who are infected for the second time with dengue are at greater risk of severe disease and so the objective of the UK programme is to provide those travellers who are at risk of dengue and have already experienced dengue infection in the past with protection against a secondary (and potentially more severe) infection.

Globally, malaria remains a leading cause of preventable disease and mortality and in 2023 there were an estimated 263 million malaria cases and 597,000 deaths across 80 countries.[13] The recent introduction of malaria vaccines for the prevention of P. falciparum malaria in children living in endemic areas has the potential to save many lives. In the past, the UK has experienced endemic and locally transmitted malaria incidence, and continues to see small numbers of imported malaria cases from people travelling and getting infected abroad before returning to the UK. Over the past decades, there have been no cases of confirmed malaria transmitted by local mosquitoes, though climate warming, increasing international travel and invasive mosquito risk increases the likelihood of possible localised and limited malaria transmission in the future. Malaria vaccines are only currently indicated for children living in endemic areas and are not recommended for UK travellers to malaria endemic regions.

Conclusion

Globally, climate change is already affecting health and infectious disease risk by influencing weather conditions. These negative impacts for health are not equally distributed around the world. In England, the effect on transmission of infections apart from vector borne disease are not yet as clear cut as in other parts of the world, particularly Africa, Asia and Latin America.

England, like Europe, is seeing changes in distribution of a range of vectors for infectious disease. This will require adaptation of surveillance systems for vectors and infections, preparedness for outbreaks of disease and continued development of medical countermeasures such as vaccines.

References

1 Mora C, McKenzie T, Gaw I et al. Over half of known human pathogenic diseases can be aggravated by climate change. Nat Clim Chang. 2022;12(9):869-875. doi: 10.1038/s41558-022-01426-1

2 Department of Health and Social Care. Chief Medical Officer's annual report 2024: Health in Cities. [Internet] 2024. Available from: https://www.gov.uk/government/publications/chief-medical-officers-annual-report-2024-health-in-cities

3 UK Health Security Agency. Campylobacter data 2015 to 2024. [Internet] 2025. [Accessed 8 October 2025]. Available from: https://www.gov.uk/government/publications/campylobacter-infection-annual-data/campylobacter-data-2015-to-2024

4 UK Health Security Agency. Non-typhoidal Salmonella data 2015 to 2024. [Internet] 2025. [Accessed 8 October 2025]. Available from: https://www.gov.uk/government/publications/salmonella-national-laboratory-and-outbreak-data/non-typhoidal-salmonella-data-2015-to-2024

5 Rushton S, Sanderson R, Diggle P et al. Climate, human behaviour or environment: individual-based modelling of Campylobacter seasonality and strategies to reduce disease burden. J Transl Med. 2019;17(1):34 doi: 10.1186/s12967-019-1781-y.

6 UK Health Security Agency. Health Effects of Climate Change (HECC) in the UK: 2023 report. Chapter 7. Effect of climate change on infectious diseases in the UK. [Internet] 2025. [Accessed 8 October 2025]. Available from: https://assets.publishing.service.gov.uk/media/65708777746930001248892l/HECC-report-2023-chapter-7-infectious-diseases.pdf

7 Kovats S, Brisley R. UK Climate Risk Independent Assessment (CCRA3). Technical Report. Chapter 5: Health, Communities and the Built Environment. [Internet] 2021. Available from: https://www.ukclimaterisk.org/wp-content/uploads/2021/06/CCRA3-Chapter-5-FINAL.pdf

8 UK Health Security Agency. Health Effects of Climate Change (HECC) in the UK: 2023 report. [Internet] 2025. [Accessed 8 October 2025]. Available from: https://assets.publishing.service.gov.uk/media/659ff6a93308d200131fbe78/HECC-report-2023-overview.pdf

9 UK Health Security Agency. Press Release. Tick-borne encephalitis detection in England. [Internet] 2025. [Accessed 8 October 2025]. Available from: https://www.gov.uk/government/news/tick-borne-encephalitis-detection-in-england

10 UK Health Security Agency. UKHSA data dashboard. Ticks (Ixodes Ricinus). [Internet] 2025. [Accessed 8 October 2025]. https://ukhsa-dashboard.data.gov.uk/vectors-and-vector-borne-diseases/ticks#seasonality

11 Burdon MG, Ayling M, Jamieson N et al. Modelling the distribution of the tick Ixodes ricinus in England and Wales using passive surveillance data from citizen science reports. PLOS Negl Trop Dis. 2025;19(10):e0013520. doi: 10.1371/journal.pntd.0013520.

12 Hassall R, Holding M, Medlock J et al. Identifying hotspots and risk factors for tick-borne encephalitis virus emergence at its range margins to guide interventions, Great Britain. Euro Surveill. 2025;30(13):pii=2400441. doi: 10.2807/1560-7917.ES.2025.30.13.2400441.

13 World Health Organisation. Fact Sheet. Malaria. [Internet] 2024. [Accessed 8 October 2025]. Available from: https://www.who.int/news-room/fact-sheets/detail/malaria

7.2 Housing and infection

Andrew Hayward – UKHSA National Lead for Inclusion Health, UCL Professor of Infectious Disease Epidemiology and Inclusion Health

Introduction

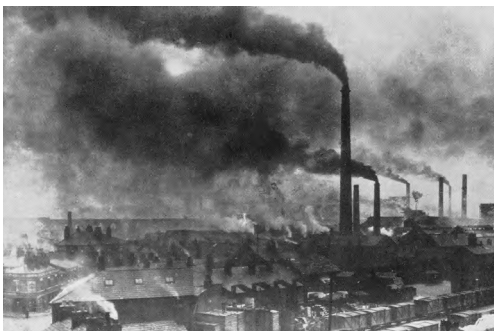
Housing is a fundamental social determinant of physical and mental health. It affects morbidity, including respiratory conditions, cardiovascular disease, mental health, infectious disease risk, and mortality.[1] This chapter focuses on how housing conditions affect the risk of infection. Before considering the role of modern housing conditions on infection, it is useful to briefly consider how historical living conditions influenced infections which in the 19th century were the leading cause of death, and how public health and societal initiatives dramatically reduced these risks.

Historical perspectives on housing and infection

Although we often take a decent home with modern amenities, including access to clean water and sanitation, for granted in high income countries, this is one of our main lines of defence against infection. Thomas McKeown (1912 to 1988) highlighted how, during the 19th century, major declines in deaths from infections such as tuberculosis, typhus, typhoid, scarlet fever, diphtheria and pneumonia preceded the introduction of specific medical interventions such as vaccinations and antibiotics.[2] For example, mortality from tuberculosis dropped by about 75% prior to the introduction of streptomycin. He hypothesised that changes in nutrition, sanitation and housing quality had a greater influence than modern medical interventions on the decline in infections.[3]

Rapid urbanisation during the Industrial Revolution led to increases in overcrowded households, increasing the risk of spread from respiratory and touch diseases. For example, in Oliver Twist,[4] Dickens describes a slum area of London in the 1830s – Folly Ditch on Jacobs Island – to have "*... rooms so small, so filthy, so confined, that the air would seem too tainted even for the dirt and squalor which they shelter*" (Figure 1). Lack of mains sewerage meant use of outdoor privies or emptying faecal waste into cesspools which could overflow, seep into houses and contaminate water supplies, increasing the risk of faeco-orally transmitted infections. Most houses had no indoor water supply and relied on street water pumps that were often contaminated with sewage. The Industrial Revolution also led to extensive air pollution in cities from factories and coal-burning household fires. This air pollution in and around houses greatly increased susceptibility to respiratory infections. In December 1952, climatic conditions and air pollution from industrial and domestic coal burning and road traffic caused the Great Smog in London, leading to around 12,000 deaths, mainly from respiratory infections.[5]

Figure 1: 19th century living conditions contributing to risk of infection



Sources:

Left: Jacob's Island, Folly's Ditch at Mill Lane – Circa 1840; in the public domain.

Top right: Monster soup commonly called Thames water, being a correct representation of that precious stuff doled out to us!!!. Wellcome Collection. Licensed under CC BY-NC 4.0.

Bottom right: Photograph of Widnes in the late 19th century showing the effects of industrial pollution. This work is in the Public Domain WikiMedia.

The first major public health action to dramatically reduce infection risk was the provision of clean water and sanitation through major engineering projects such as the building of the London sewer system. This was commissioned after the work of John Snow showing how cholera was caused by sewage contaminated water and, perhaps more influentially, by the "Great Stink".[6] During a hot, dry spell in the summer of 1858, overflowing sewage in the River Thames caused a pervasive stench[7] forcing the Houses of Parliament to close and people were urged to leave the city. The situation highlighted the dire state of London's sanitation and spurred action, leading to the construction of a modern sewage system, led by Joseph Bazalgette. Built in the 1860s, this still forms the backbone of London's sewage system. As similar engineering initiatives were emulated around the world, cholera pandemics and epidemics subsided.

The world's first Clean Air Act was passed in the UK in 1956 (4 years after the Great Smog in London). This gave local authorities the power to control emissions of smoke, grit, dust and fumes from industrial premises and furnaces, and to set up smoke control zones where coal burning fires were banned.[8] This led to dramatic improvements in air quality in and around houses, reducing the risk from respiratory infections.[9]

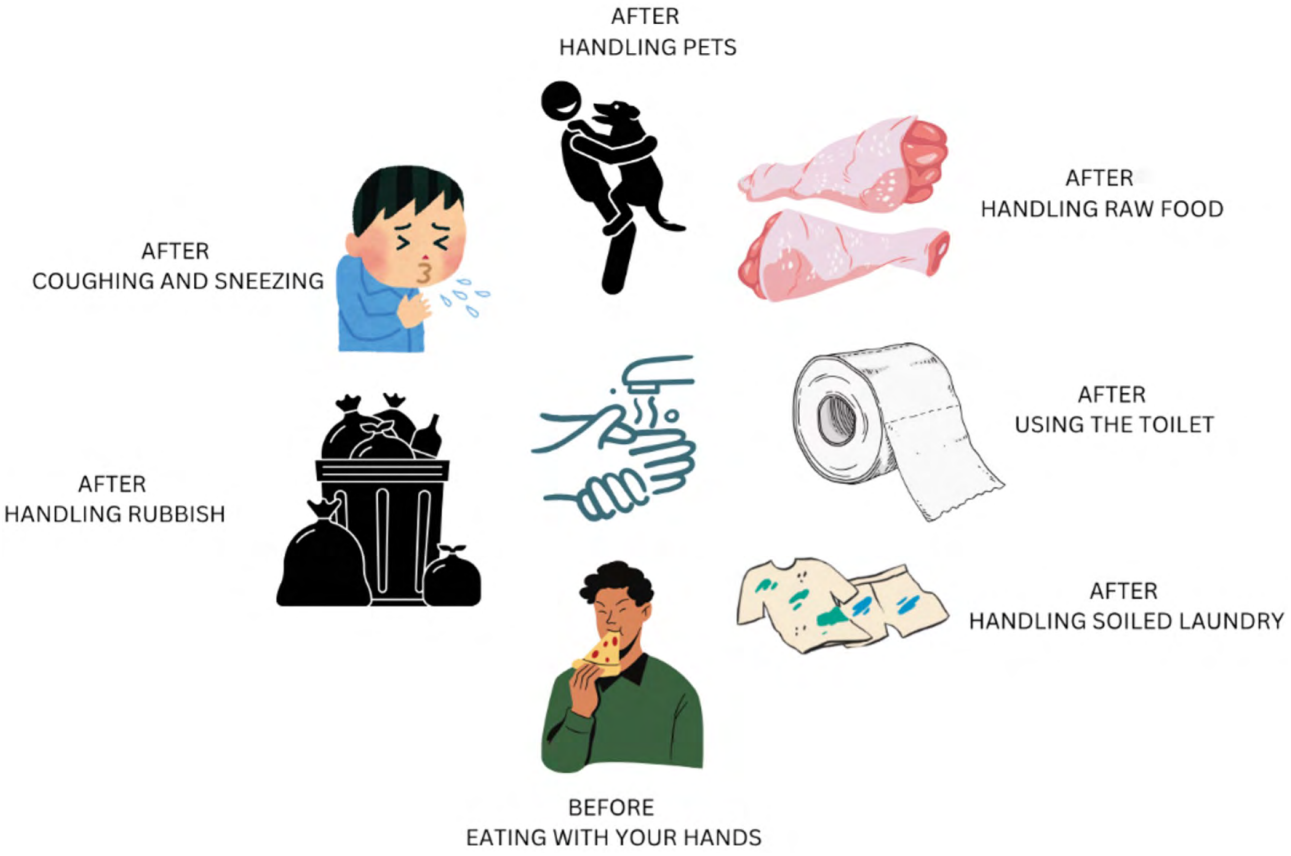
We can see how historical living conditions influenced infections and how improvements in sanitation and air quality led to major reductions in risk – but how do modern housing conditions influence the risk of infection?

Infections in the modern household

Microbes are introduced continually into the home by people, food and pets, but also sometimes in water, via insects, rodents or in the air. In many homes there will be at least one person who is more susceptible to infections and a range of household factors increase susceptibility to infections.

Figure 2 illustrates key moments when hand hygiene interventions in the home can help break chains of transmission.[10] Other domestic hygiene measures include cleaning surfaces that are regularly touched by hands or food, appropriate cooking and storage of food, cleansing of cleaning equipment which can become heavily contaminated with microbes, regular laundry of clothes and linen, respiratory hygiene and ventilation, and toilet cleaning. In practice, it can be difficult to remember or enact all of these hygiene measures.

Figure 2: Key moments for hand hygiene

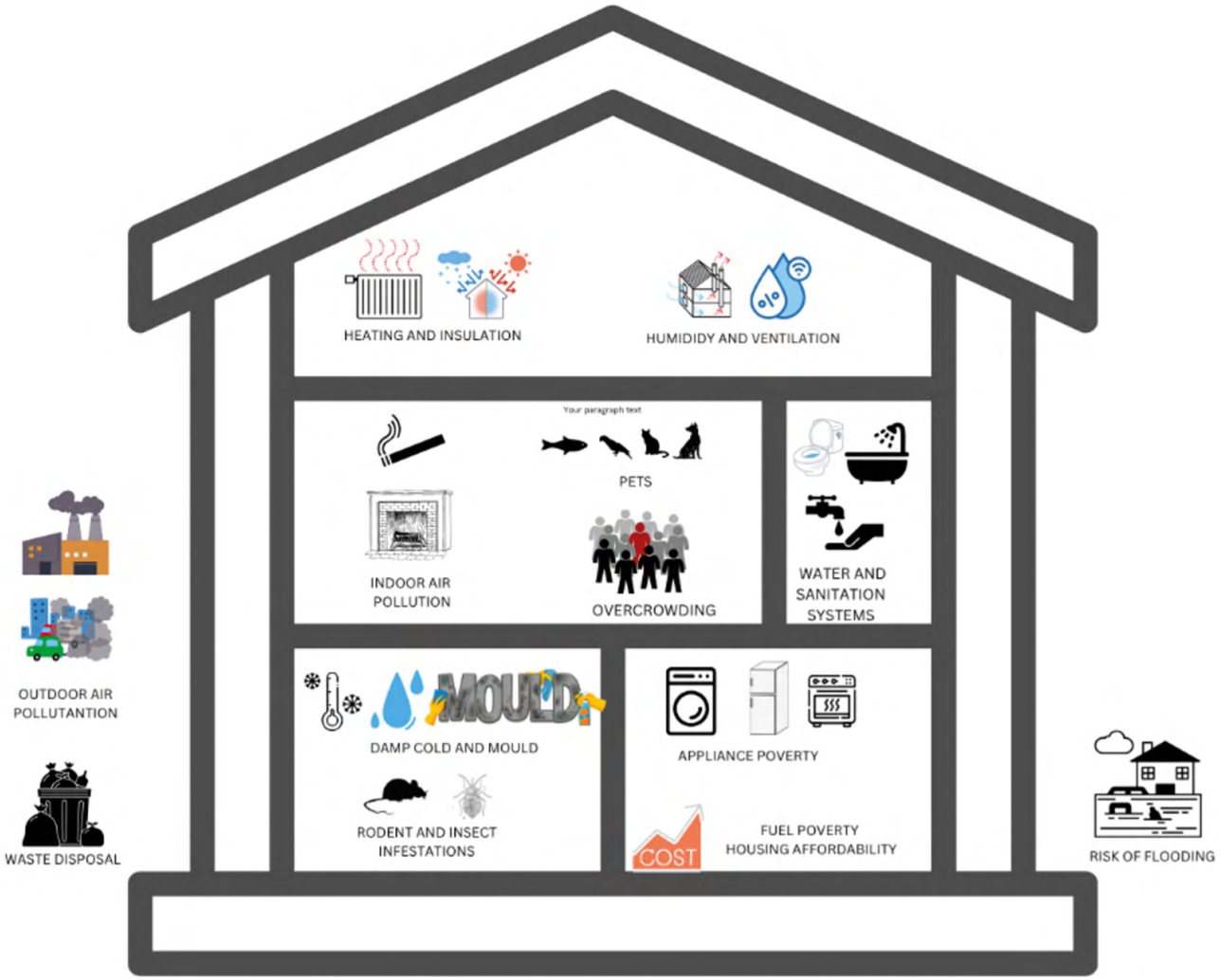


Source: Household characteristics influencing risk of infection. Image created using Canva software license.

How does housing impact the risk of infection?

Sanitation, ventilation and overcrowding are the main housing-related factors associated with infection risk, as well as damp and mould. Figure 3 illustrates a wider range of housing characteristics that may affect risks from infection.

Figure 3: Household characteristics influencing risk of infection



Source: Household characteristics influencing risk of infection. Image created using Canva software license.

Water and sanitation systems

Water and sanitation systems are the cornerstone of prevention of so-called water, sanitation and hygiene (WASH) infections spread through the faeco-oral route – including gastrointestinal and helminth infections.[11] They also enable hand hygiene which can reduce transmission of respiratory infections.

Domestic water systems can harbour *Legionella pneumophila* if hot water is stored below 60°C and cold water above 20°C, increasing risk of Legionnaire's disease, a severe form of pneumonia – particularly in those with underlying chronic diseases. The proportion acquired through domestic water systems is unknown.[12]

Flooding of households and disruption of sewage water systems can increase the risk of gastrointestinal infections, wound infections, leptospirosis and tetanus. Climate change and building in flood zones is making flooding more common.[13]

Ventilation

Ventilation is the process of bringing in fresh air from outside and removing indoor air which may contain pollutants including infectious particles. Good ventilation can reduce levels of indoor air pollution and the risk of airborne transmission of infections such as measles, tuberculosis, influenza, COVID-19 and other respiratory viruses. Good ventilation has also been linked to health benefits such as better sleep and concentration, and fewer sick days off from work or school.[14]

A variety of modelling approaches have been developed to investigate the impact of ventilation rates on risk of infections. Most notably, the Wells-Riley model developed in the 1970s predicts the risk of infection based on the number of infectious cases, the number of susceptible individuals, the breathing rate of individuals, the rate of production of infectious particles, the exposure duration and the room air exchange rate. Models based on these and similar approaches consistently show that increasing ventilation reduces the risk of spread of respiratory infections.[15]

Empirical observational studies of the effect of different ventilation rates on risk of infection are primarily based in settings such as schools, workplaces, hospitals, dormitories or prisons rather than people's homes. While these studies tend to show more poorly ventilated spaces are associated with increased infection risk (and that air conditioning systems that recirculate air without filtration can increase risk), such studies often have challenges in controlling for the multiple other factors affecting infection risk.[16]

In addition to its importance for health, ventilation can cause heat loss which can account for up to 50% of the heat loss from a well-insulated building.[17] There is concern that more modern energy efficient or retrofitted buildings can reduce ventilation levels as houses are better sealed to prevent heat loss. This can also increase levels of condensation and resulting damp and mould. To address this, there are building regulation standards for ventilation within domestic residences.[18]

Home ventilation systems are categorized as Natural Ventilation, where air flows passively through openings like windows, trickle vents, airbricks and unintentional gaps and cracks in buildings and Mechanical Ventilation, which uses fans to control air movement. Mechanical systems further break down into Exhaust Ventilation (for example, bathroom and kitchen extractor fans) that remove stale air, Supply Ventilation that pushes fresh air in, and Balanced Ventilation (including mechanical ventilation heat recovery (MVHR) systems) which manage both incoming and outgoing air for optimal air quality and energy efficiency. A 2022 survey found that 71% of homes did not meet minimum ventilation standards of having extractor fans in bathrooms and kitchens and trickle vents on windows, and only 2% of homes had MVHR. However, with increasing airtightness and higher energy standards, MVHR systems are becoming more common in new builds.[19] UKHSA have provided advice on managing domestic ventilation to reduce the transmission of respiratory infections while maintaining comfortable indoor temperatures.[20]

Indoor humidity

The optimum indoor relative humidity for prevention of respiratory virus infections is between 40% to 60%.[21] Lower humidity environments increase duration of respiratory virus survival and decrease mucocilliary clearance – the process by which cilia (tiny hair-like structures) in our airways trap and remove particles and pathogens. Low humidity also causes rapid evaporation of virus-containing droplets, transforming them into lightweight particles that remain airborne for longer, potentially increasing transmission risk. Higher humidity environments can promote mould growth. Indoor heating systems can reduce humidity levels increasing risk of infection. In theory, air humidifiers can be used to counteract this effect but may have little or no impact on risk of infection.[22] Increasing household ventilation reduces respiratory virus infection risk.[23]

Air pollution

Indoor air pollution can increase vulnerability to respiratory infections. In 2017, low and middle income countries lost around 60.8 million disability adjusted life years from indoor air pollution compared to 0.09 million lost in high income countries.[24] Much of this is through increased risk of respiratory infection related to burning of biomass fuels indoors.[25] Smoking and use of wood and coal burning fires are the main causes of particulate-matter indoor air pollution in high income countries. Gas cookers and heaters can increase levels of nitrogen dioxide, which is also associated with increased respiratory infection risk. While household ventilation can reduce exposure to air pollutants generated indoors, it may increase exposure to air pollutants generated outdoors.

Overcrowding

Household overcrowding is an important risk factor for multiple infectious diseases (Table 1).[26]

During the pandemic, overcrowding also increased risk of COVID-19 (OR 2.45 for PCR confirmed infection, 3.32 for COVID-19 antibodies).[27] Multigenerational households (including at least 3 generations), which are also more likely to be overcrowded, were found to have increased risk of severe COVID-19 infection during the pandemic in England, in White and South Asian households, particularly in older adults.[28] Staying in dormitories increases the risk of acute respiratory infection, tuberculosis and skin infections. Improved ventilation, for example through opening windows or use of extractor fans, can significantly reduce the concentration of airborne pathogens[29] and is particularly important in overcrowded settings.[30]

Table 1: Increased risk of infection from household overcrowding

Infection	Risk Ratio (RR) or Odds Ratio (RR)
Droplet or airborne transmission routes	RR 1.35
Enteric transmission routes	RR 1.49
Direct contact transmission routes	OR 1.54
Viral infections	OR 1.72
Meningococcal disease	OR 2.47
Helicobacter pylori	OR 1.71
Tuberculosis	OR 2.47
Other bacterial infections	OR 1.88
Respiratory infections	OR 1.84
Skin and soft tissue infections	OR 2.08

Source: Kvalsvig A, Rentta NN, Teng A, Hodwn-Chapman P, Baker M. Effect of Household Crowding on Infectious Disease Risk: Systematic Review and Meta-Analysis. SSRN. 2023.

Damp and mould

Living in a damp and/or mouldy home is associated with development of respiratory infections.[31] A meta-analysis showed the risk of a wide range of upper and lower respiratory tract infections and otitis media are 44% more common in those living in damp and/or mouldy homes.[32] Modelling based on the English Housing Survey suggests at least 8,500 lower respiratory tract infections may be attributable to living in damp and/or mouldy homes but that the true number could be much higher because the survey only records "significant problems" seen on the day of inspection rather than any presence of damp or mould.[33] Cold indoor environments promote damp and mould.

Housing as a driver of health inequalities

Poor quality, overcrowded housing has been estimated to cost the NHS £1.4 billion per year and is a significant driver of health inequalities.[34] There are marked inequalities in housing quality and overcrowding.

In 2022 to 2023, 1 million households (4%) in England lived in a home with significant damp problems.[35] England has one of the oldest housing stocks in Europe. Older homes often have poorer energy efficiency, insulation and structural integrity which can lead to heat loss,

condensation, damp and mould. Based on the English Housing Survey, in 2023 5% of dwellings in England (1.3 million dwellings) had a problem with damp. Self-reported prevalence of problems with condensation, damp or mould were much higher (29% of households). Damp has increased across all housing sectors since 2019, and was more prevalent in the private rented sector (9% on inspection, 44% self-reported), compared to the social rented sector (7% on inspection, 39% self-reported) and owner occupied sector (4% on inspection, 22% self-reported).[36] Overcrowded households, households with children, lower income households, households lived in by people of Black ethnicity, households with someone living with a long-term illness or disability and households with unemployed people, are more likely to be damp. Houses in the private rental sector are more likely to have significant damp problems (10%) than social housing (7%) or owner occupied housing (2%).[37]

Private and social landlords have a range of legal duties to address damp and mould. The tragic death of a child (Awaab Ishak) living in substandard private rented accommodation was the result of a severe respiratory condition due to prolonged exposure to mould in a home with inadequate ventilation. This has prompted further guidance on addressing this risk.[38]

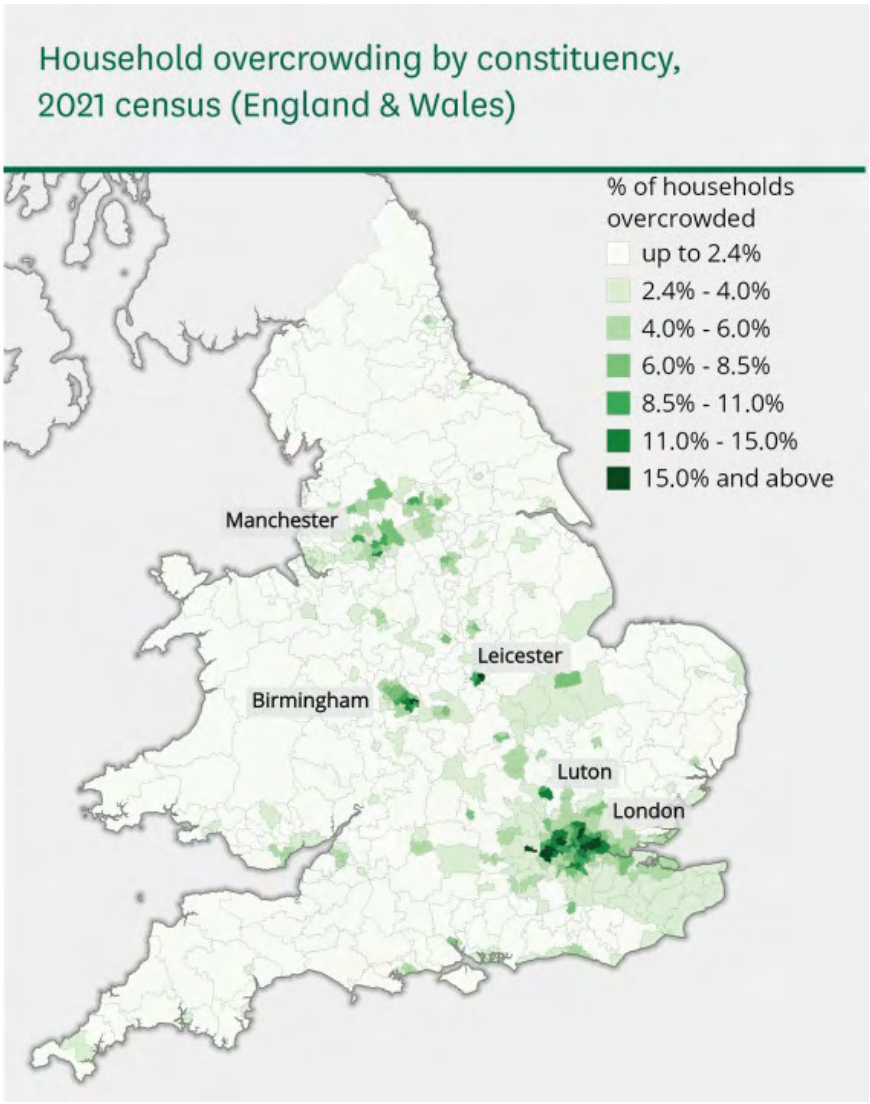
The water industry act of 1999 made water and sewerage disconnections illegal, ensuring access to clean water and sanitation in all households. However, water metering may restrict use particularly in poorer households. Some accommodation types such as caravans and boats are not connected to mains water and sewerage increasing the risk of infections. Following planning guidance for water and sanitation in Gypsy, Roma and Traveller sites can reduce this risk.[39]

Legionella species are more likely to be found in older properties, older showers and infrequently used showers.[40] Risk assessments for Legionnaires' disease are mandatory for UK landlords.[41] In 2019, a UK housing association was fined £1.8 million after Legionella was detected in showers due to neglected water tank cleaning.[42] In 2023, the Bibby Stockholm barge which was used for housing asylum seekers was evacuated due to identification of high levels of *Legionella pneumophila* in the water supply.[43]

In England there has been a gradual increase in the percentage of homes that are overcrowded.[44] Social renters are most likely to live in overcrowded conditions due to limited availability of suitably sized accommodation. Based on the 2021 Census the lowest levels of overcrowding were seen in the White British group. Highest levels of overcrowding were seen in London (11.1%) and lowest levels in the North East of England (2.0%). Thirteen percent of children in lone parent families are living in overcrowded housing compared to 7% of children living in couple families and 38% of children living in other household types (mainly families living with other adults such as lodgers or extended family).[45]

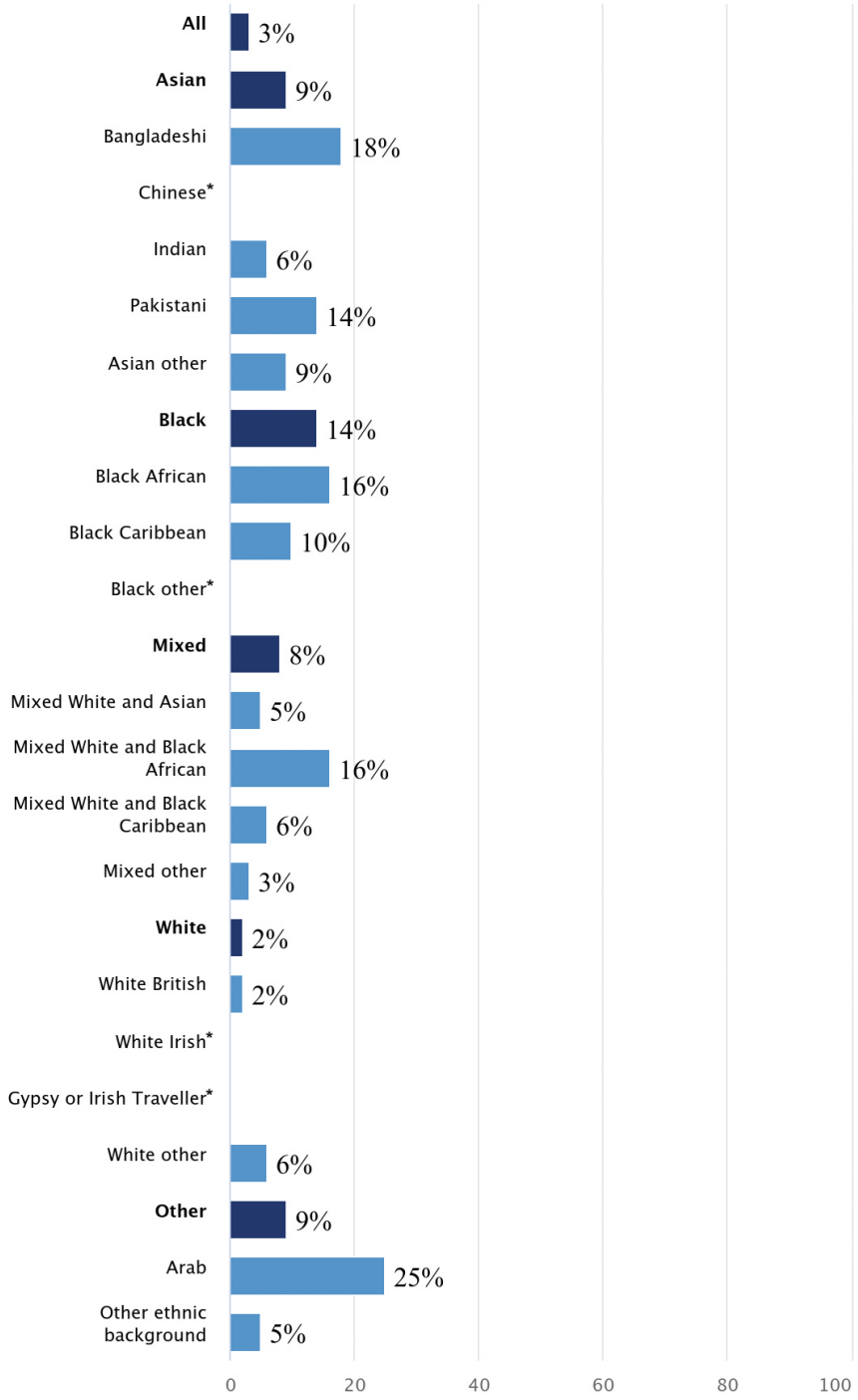
Figure 4: Overcrowding in England

a) Household overcrowding by constituency



Source: Image from Wilson, W., Barton, C., Carthew, H., Overcrowded Housing (England), 2023, House of Commons Library is licensed under Open Parliament Licence v3.0.

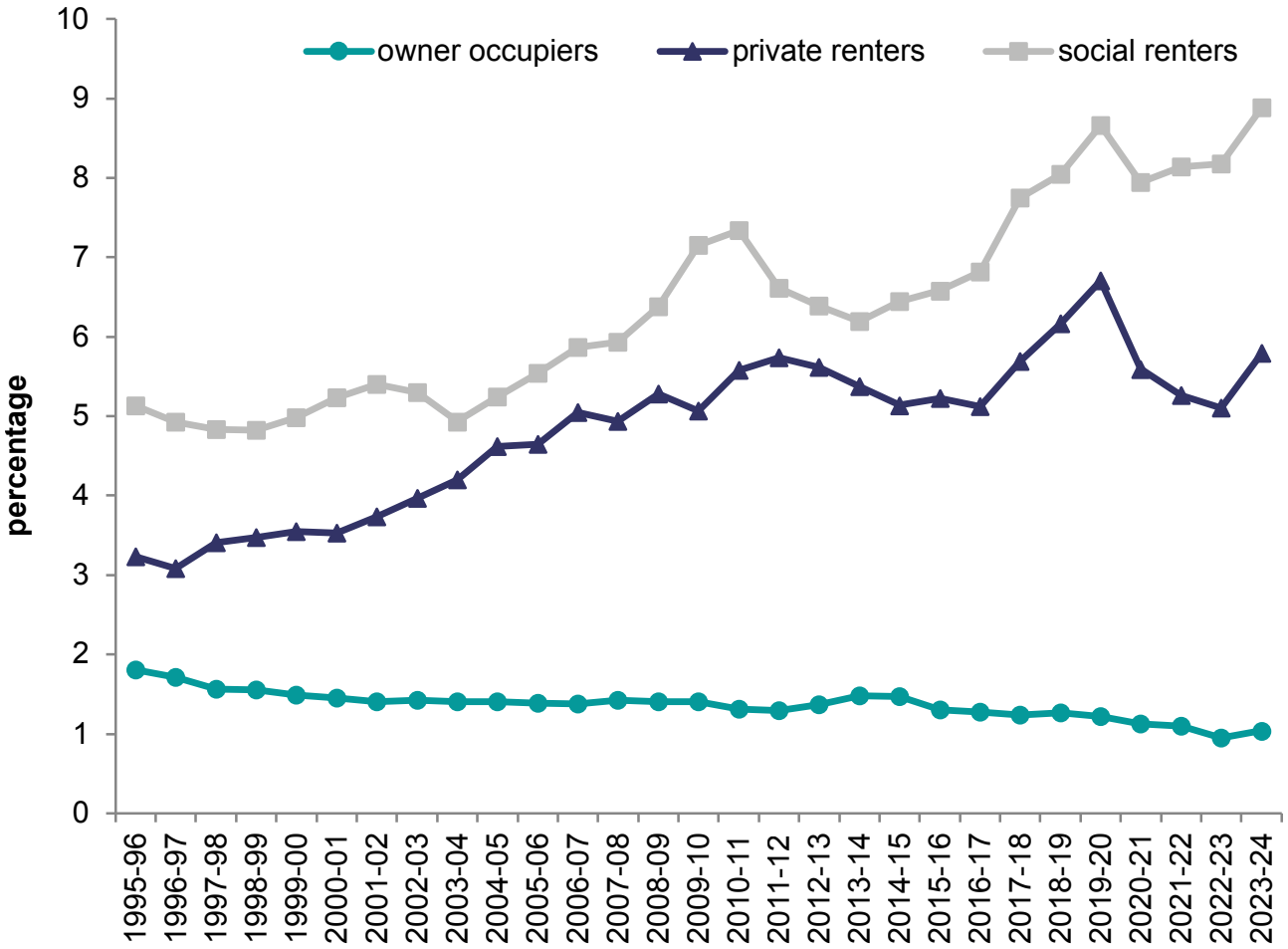
b) Percentage of households that were overcrowded, by ethnicity, England, April 2020 to March 2023 (3 years combined)



*data withheld due to small sample sizes making the results unreliable.

Source: Image from GOV.UK., Overcrowded households, 2025 is licensed under the Open Government Licence v3.0.

c) Overcrowding by tenure, 1995 to 1996 to 2023 to 2024



Source: Image from Ministry of Housing, Communities and Local Government, Chapter 1: Housing quality, Chapters for English Housing Survey 2023 to 2024: Headline findings on housing quality and energy efficiency, 2025, is licensed under the Open Government Licence v3.0.

Conclusion

Historical initiatives addressing water and sanitation, air pollution and slums, have transformed living conditions and had major impacts on both communicable and non-communicable diseases. However, poor quality, damp, cold and overcrowded houses, often located in areas with high air pollution, remains an important contributor towards inequalities for multiple diseases including infections, both in pandemic and non-pandemic periods.

References

1 House of Commons Library. The role of homes and buildings in levelling up health and wellbeing. [Internet] 2022. Available from: https://commonslibrary.parliament.uk/research-briefings/cdp-2022-0170/

2 Bynum B. The McKeown thesis. Lancet. 2008;371(9613):644-5

3 Bynum B. The McKeown thesis. Lancet. 2008;371(9613):644-5

4 Charles Dickens. Oliver Twist. 1837

5 Historic England. The Story of the Great Smog of London. [Internet] 2022. Available from: https://heritagecalling.com/2022/12/01/the-great-smog-of-london-1952/

6 Historic England. The Great Stink - How the Victorians Transformed London to Solve the Problem of Waste. [Internet] 2025. Available from: https://historicengland.org.uk/images-books/archive/collections/photographs/the-great-stink/#:~:text=The%20Great%20Stink%20%2D%20How%20the,as%20%27The%20Great%20Stink%27

7 Historic England. The Great Stink - How the Victorians Transformed London to Solve the Problem of Waste. [Internet] 2025. Available from: https://historicengland.org.uk/images-books/archive/collections/photographs/the-great-stink/#:~:text=The%20Great%20Stink%20%2D%20How%20the,as%20%27The%20Great%20Stink%27

8 The Clean Air Act. Chapter 52. HMG. [Internet] 1956. Available from: https://www.legislation.gov.uk/ukpga/Eliz2/4-5/52/enacted

9 The Clean Air Act. Chapter 52. HMG. [Internet] 1956. Available from: https://www.legislation.gov.uk/ukpga/Eliz2/4-5/52/enacted

10 International Scientific Forum on Home Hygiene. Breaking the chain of infection in our homes and everyday lives: a practical approach to encourage effective targeted hygiene. [Internet] 2022. Available from: https://ifh-homehygiene.org/online-learning/breaking-chain-infection-our-homes-and-everyday-lives-practical-approach-encourage/

11 World Health Organization. Burden of disease attributable to unsafe drinking-water, sanitation and hygiene. [Internet] 2019. Available from: https://iris.who.int/bitstream/handle/10665/370026/9789240075610-eng.pdf?sequence=1

12 UK Health Security Agency. Legionellosis in residents of England and Wales: 2017 to 2023 report. [Internet] 2024. Available from: https://www.gov.uk/government/statistics/legionellosis-in-residents-of-england-and-wales-2017-to-2023/legionellosis-in-residents-of-england-and-wales-2017-to-2023-report

13 European Centre for Disease Prevention and Control. Risk of infectious diseases in flood-affected areas from the European Union. [Internet] 2021 Available from: https://www.ecdc.europa.eu/en/news-events/risk-infectious-diseases-flood-affected-areas-european-union

14 National Institute for Health and Care Excellence. Indoor Air Quality at Home. NICE Guideline 149. [Internet] 2020. Available from: https://www.nice.org.uk/guidance/ng149

15 Sze To GN, Chao CY. Review and comparison between the Wells-Riley and dose-response approaches to risk assessment of infectious respiratory diseases. Indoor Air. 2010;20(1):2-16. doi: 10.1111/j.1600-0668.2009.00621.x.

16 Luongo JC, Fennelly KP, Keen JA, Zhai ZJ, Jones BW, Miller SL. Role of mechanical ventilation in the airborne transmission of infectious agents in buildings. Indoor Air. 2016;26(5):666-78. doi: 10.1111/ina.12267

17 B. Jones, P. Das, Z. Chalabi et al. Assessing uncertainty in housing stock infiltration rates and associated heat loss: English and UK case studies. Build Environ. 2015;92:644-656 doi: 10.1016/j.buildenv.2015.05.033

18 HM Government. The Building Regulations 2010. [Internet] 2010. Available from: https://www.legislation.gov.uk/uksi/2010/2214/contents

19 Cairan Van Rooyen, Tim Sharpe. Ventilation provision and use in homes in Great Britain: A national survey. Build Environ. 2024;257:111528 doi: 10.1016/j.buildenv.2024.111528

20 UK Health Security Agency. Ventilation to reduce the spread of respiratory infections, including COVID-19. [Internet] 2022. Available from: https://www.gov.uk/guidance/ventilation-to-reduce-the-spread-of-respiratory-infections-including-covid-19

21 Wolkoff P. Indoor air humidity revisited: Impact on acute symptoms, work productivity, and risk of influenza and COVID-19 infection. Int J Hyg Environ Health. 2024;256:114313. doi: 10.1016/j.ijheh.2023.114313.

22 Byber K, Radtke T, Norbäck D et al. Humidification of indoor air for preventing or reducing dryness symptoms or upper respiratory infections in educational settings and at the workplace. Cochrane Database Syst Rev. 2021;12(12):CD012219 doi: 10.1002/14651858.CD012219.pub2.

23 Aganovic A, Bi Y, Cao G, Kurnitski J, Wargocki P. Modeling the impact of indoor relative humidity on the infection risk of five respiratory airborne viruses. Sci Rep. 2022;12(1). doi: 10.1038/s41598-022-15703-8.

24 Lee KK, Bing R, Kiang J et al. Adverse health effects associated with household air pollution: a systematic review, meta-analysis, and burden estimation study. Lancet Glob Health. 2020;8(11):e1427-e34. doi: 10.1016/S2214-109X(20)30343-0.

25 M.R. Pandey KRS, J.S.M. Boleij, E.M. Wafula. Indoor air pollution in developing countries and acute respiratory infection in children. Lancet. 1989;333(8635):427-9. doi: 10.1016/s0140-6736(89)90015-9.

26 Kvalsvig A, Rentta NN, Teng A, Hodwn-Chapman P, Baker M. Effect of Household Crowding on Infectious Disease Risk: Systematic Review and Meta-Analysis. SSRN. 2023. doi: 10.2139/ssrn.4598965

27 Aldridge RW, Pineo H, Fragaszy E et al. Household overcrowding and risk of SARS-CoV-2: analysis of the Virus Watch prospective community cohort study in England and Wales. Wellcome Open Res. 2021;6:347. doi: 10.12688/wellcomeopenres.17308.1.

28 Wing K, Grint DJ, Mathur R et al. Association between household composition and severe COVID-19 outcomes in older people by ethnicity: an observational cohort study using the OpenSAFELY platform. Int J Epidemiol 2022;51(6):1745-60. doi: 10.1093/ije/dyac158.

29 UK Health Security Agency. Communal accommodation settings: infectious disease transmission. [Internet] 2024. Available from: https://www.gov.uk/government/publications/communal-accommodation-settings-infectious-disease-transmission

30 World Health Organization. Housing and Health Guidelines. [Internet] 2018. Available from: https://pubmed.ncbi.nlm.nih.gov/30566314/

31 UK Health Security Agency. Spotlight on: The Burden of Disease caused by Damp and Mould in English Housing. [Internet] 2025. Available from: https://research.ukhsa.gov.uk/our-research/damp-and-mould/

32 Fisk WJ, Eliseeva EA, Mendell MJ. Association of residential dampness and mold with respiratory tract infections and bronchitis: a meta-analysis. Environ Health. 2010;9:72. doi: 10.1186/1476-069X-9-72.

33 Clark SL, HCY; Goode, EJ; Marczylo, EL; Exley, KS; Dimitroulopoulou. The Burden of Respiratory Disease from Formaldehyde, Damp and Mold in English Housing. Environments. 2023;10(136). doi: 10.3390/environments10080136

34 Building Research Establishment. The cost of poor housing in England. [Internet] 2021. Available from: https://bregroup.com/news/bre-report-finds-poor-housing-is-costing-nhs-1.4bn-a-year

35 Ministry of Housing, Communities and Local Government. English Housing Survey 2022 to 2023: housing quality and condition. [Internet] 2024. Available from: https://www.gov.uk/government/statistics/english-housing-survey-2022-to-2023-housing-quality-and-condition/english-housing-survey-2022-to-2023-housing-quality-and-condition

36 Ministry of Housing, Communities and Local Government. English Housing Survey 2023 to 2024: headline findings on housing quality and energy efficiency. [Internet] 2025. Available from: https://www.gov.uk/government/collections/english-housing-survey-2023-to-2024-headline-findings-on-housing-quality-and-energy-efficiency

37 Department for Levelling Up, Housing and Communities. English Housing Survey 2021 to 2022: housing quality and condition. [Internet] 2023. Available from: https://www.gov.uk/government/statistics/english-housing-survey-2021-to-2022-housing-quality-and-condition/english-housing-survey-2021-to-2022-housing-quality-and-condition

38 Ministry of Housing, Communities and Local Government; Department of Health and Social Care; UK Health Security Agency. Understanding and addressing the health risks of damp and mould in the home. [Internet] 2024. Available from: https://www.gov.uk/government/publications/damp-and-mould-understanding-and-addressing-the-health-risks-for-rented-housing-providers/understanding-and-addressing-the-health-risks-of-damp-and-mould-in-the-home--2

39 Communities and Local Government. Designing Gypsy and Traveller Sites: Good Practice Guide. [Internet] 2008. Available from: https://assets.publishing.service.gov.uk/media/5a79e68040f0b670a8026416/designinggypsysites.pdf

40 Samuel Collins DS, Allan Bennett, Jimmy Walker. Occurrence of Legionella in UK household showers. Int J Hyg Environ Health. 2017;220(2):401-6. doi: 10.1016/j.ijheh.2016.12.001.

41 Health and Safety Executive. Legionella and landlords' responsibilities. [Internet] 2025. Available from: https://www.hse.gov.uk/legionnaires/legionella-landlords-responsibilities.htm

42 Weightmans. Legionnaires disease – fine of almost £1 million for Housing Association. [Internet] 2024. Available from: https://www.weightmans.com/media-centre/news/legionnaires-disease-fine-of-almost-1-million-for-housing-association/

43 Home Office. Statement on the Bibby Stockholm – 11/08/2023. [Internet] 2023. Available from: https://homeofficemedia.blog.gov.uk/2023/08/11/statement-on-the-bibby-stockholm-11-08-2023/

44 Ministry of Housing, Communities and Local Government. English Housing Survey 2023 to 2024: headline findings on housing quality and energy efficiency. [Internet] 2025. Available from: https://www.gov.uk/government/collections/english-housing-survey-2023-to-2024-headline-findings-on-housing-quality-and-energy-efficiency

45 Office for National Statistics. Overcrowding and under-occupancy by household characteristics, England and Wales: Census 2021. [Internet] 2023. Available from: https://www.ons.gov.uk/peoplepopulationandcommunity/housing/articles/overcrowdingandunderoccupancybyhouseholdcharacteristicsenglandandwales/census2021

Appendix: advisory committees: coordination, reform and accountability

Lewis Peake – Consultant in Health Protection, UKHSA

Carolina Arevalo – Deputy Director, Research, Evidence and Knowledge, UKHSA

Susan Hopkins – Chief Executive Officer, UKHSA; Honorary Consultant in Infectious Diseases and Microbiology, Royal Free London NHS Foundation Trust; Honorary Professor of Infectious Diseases and Health Security, UCL

Background

The delivery of a skilled, measured and evidence-informed response to an infectious disease that may pose a threat to public health requires a co-ordinated and transparent process for government to receive expert advice (including from professionals outside the Civil Service, such as academia and industry). Such advice is typically offered through an expert committee which formalises (and where possible reaches consensus on) recommendations for policy and ministerial decision making.

The government (at both UK-wide and devolved administration geographies) maintains a broad ecosystem of sponsored advisory committees, expert advisory groups and expert advisory panels across a range of disciplines.[1] Many of those with a Science Advisory Committee (SAC) status are focused on health, and particularly the management of infectious disease (owing to the eminence of 'pandemic' and 'outbreak of an emerging infectious disease' on the National Risk Register). Importantly, the role of these committees is advisory and independent – they do not perform a technical operational function (such as leading the delivery of any response), which would fall to standing expertise within the government's arm's length bodies such as the UK Health Security Agency (UKHSA) and other organisations.

The functions and membership of some of these advisory committees were given extra prominence during the COVID-19 pandemic, where they provided substantial value; however, post-pandemic reviews[2,3] identified opportunities for transparency, integration and public engagement.

Current architecture

Many of the committees that currently play a role in advising the UK government (and/or devolved administrations) on matters related to the assessment and management of infectious diseases are sponsored by the Department of Health and Social Care (or its Arm's Length Bodies, such as UKHSA), but some also sit within other government departments. A lead

government department for a committee typically provides the secretariat support necessary for the forum to function. All such SACs must follow an established Code of Practice.[4]

Committees may have a permanent advisory role and standing status (Table A) or be established only at times of significant or emergency public health threat (Table B). Their variation in focus, meeting frequency, and membership size, source (Civil Service, academia, etc) and tenure is necessitated by the functions they perform.

Opportunities to strengthen the landscape of independent scientific advice on infectious disease

Although the value and expertise these varied committees bring to the management of infectious diseases across the UK is clear, there are opportunities to strengthen the governance, co-ordination and breadth of this advice as received through SACs and similar.

Co-ordination

There is no single mechanism to systematically integrate advice across health committees which may lead to fragmented guidance for horizon scanning for complex health challenges.

Risk of duplication

In some areas, there are a range of committees working on similar components. For example, the Advisory Committee on Antimicrobial Prescribing, Resistance and Healthcare Associated Infection focuses only on healthcare associated infections, and is insufficiently integrated with environmental, animal health, and international sectors. The Human Animal Infections and Risk Surveillance group and UK Zoonoses, Animal Diseases and Infections Group have similar but incomplete oversight, however, these are not formal advisory committees.

Transparency

Most advisory groups can be perceived as operating behind closed doors or communicating only via government departments, which has the potential to contribute to mistrust and confusion during crises and undermine how the independent nature of any advice is received. This is of particular importance in the current global political climate of increased scrutiny of science and the rise of mis- and dis-information.

The COVID-19 pandemic exemplified how – where scientific advice is perceived to be driven by political agendas – alternative structures can emerge (such as the government-unaffiliated, scientist-led 'independent SAGE').

The publication of minutes is often helpful to make clear these committees are undertaking rigorous, technical work.

Forward-look

Most committees are reactive or tactically focused (for example, new threats, vaccine rollout), and although some (such as the Joint Committee on Vaccination and Immunisation, JCVI) may focus on immediate horizon scanning, there is no dedicated advisory body that focuses on long-term infectious disease risks, such as the trajectory of antimicrobial resistance, climate-driven vector-borne threats to the UK population and pathogen evolution.

Policy impacts on populations

While in emergencies the Independent Scientific Pandemic Insights Group on Behaviours (SPI-B) reporting to the Scientific Advisory Group for Emergencies (SAGE) covers behavioural science, there is no standing committee focusing on community engagement, equity and vulnerable populations, public health and social measures, or the lived experience of infectious disease control (for example, vaccine uptake in marginalised groups, trust in public health).

Further, there is limited structured feedback and input from local public health systems, Integrated Care Boards (ICBs), NHS trusts, local resilience forums or Directors of Public Health into national advisory structures.

Balance of scope and membership

Most committees have a very narrow focus with highly specialist membership to provide rapid expert assessments and advice particularly during emergencies. Ensuring multidisciplinarity in the membership ensures that the advice provided is balanced and considers new and emerging information.[5]

Other gaps in existing committee structures

Gaps are also found in advice provision on surveillance methods (to inform new approaches and technology for surveillance activities), data systems (to support streamlining of data sharing) and health economics (to support the understanding and mitigation of economic impacts of infectious diseases).

Recommendations

These are the views of the chapter authors.

1. Consider establishing an annual meeting of chairs from all infectious diseases related advisory committees with the Department of Health and Social Care as sponsor, UKHSA as secretariat and supported by the Office of the Chief Medical Officer. This would:
    a. maintain a list of all SACs whose remits may include communicable disease and advise where there may be duplication and/or risk of conflict
    b. ensure consistency in the operation of all such committees (for example, standardised Terms of Reference, publication of meeting minutes, roles of sponsor versus secretariat)

   c. appraise the membership of such committees to include eligibility, duration of appointments, process for training and onboarding members, monitoring of attendance, review of gaps in specialisms and knowledge, and transparency in declaration of conflicts of interest
   d. advise on gaps in the existing committee ecosystem to recommend new committees or independent bodies (some suggestions included below)
   e. coordinate outputs from specialist committees and in doing so provide joined-up, cross-cutting recommendations across disease and intervention areas
   f. evaluate their performance through regular reviews of individual committees and publishing of an annual transparency report outlining key advisory outputs, the inclusion of inputs from the public and the impact on policy decision making of the UK government
   g. support committees in the dissemination of outputs, mobilisation of advice beyond senior government officials, publication of papers and increasing public, government and stakeholder awareness of the work of the committees
2. Drive new expectations on memberships for advisory committees, including:
   a. consideration of more diverse inclusion of subject matter experts such as from regional academia and emerging leaders in particular topics to avoid considerable overlap of membership across multiple committees and groupthink (red teaming)
   b. inclusion of a specific role for local Directors of Public Health into national advisory committees (for example, JCVI) with a requirement for their involvement in SAGE and sub-committees in infectious diseases emergencies
   c. ensure membership includes perspectives on health equity and inclusion, in support of including voices from marginalised groups, vulnerable population groups, and diaspora communities to ensure any advice considers impact of government policy and unintended consequences
3. Given the changing threats, regular review of gaps in advisory committees, for example:
   a. consider how formal One Health frameworks are integrated across all infectious diseases advisory groups
   b. utilise the council to develop considerations on foresighted infectious threats, drawing on UKHSA, Met Office, climate scientists, medical entomologists and international public health experts with potential remit to include horizon scanning, scenario planning and early strategic policy development
   c. improve the clarity of the role of all advisory committees on infection prevention and control for new and emerging infectious diseases, with strong links with the Advisory Committee on Dangerous Pathogens (ACDP) to inform guidance development within healthcare and community settings
   d. improve the remit of the advisory committees to consider how new and emerging technologies such as metagenomics, artificial intelligence, novel vaccine platforms may be considered in future policy options for infectious disease control

4. Formalise independent science spokespeople selected from advisory groups to explain rationale, uncertainties and updates during outbreaks and publish summaries of all committee minutes and recommendations in real time, with public question and answer opportunities. Consider whether a portion of committee meetings should be held in public outside emergencies.

Table A: Select UK Government Advisory Committees, Panels and Expert Groups related to infectious disease, with a standing status (regular meeting cadence). ToR = Terms of Reference.

Name	Acronym	ToR	Sponsor department	Primary focus	Considerations
Advisory Committee on Dangerous Pathogens	ACDP	Link	DHSC	Pathogen classification and biosafety	Has a deep technical expertise which is critical to guiding laboratory precautions for workplace safety, including for new and emerging pathogens. However, this role does not extend to consider necessary precautions outside of a laboratory setting (for example implications for infection prevention and control in hospital or community settings).
Advisory Committee on the Microbiological Safety of Food	ACMSF	Link	FSA		
Advisory Committee on Antimicrobial Prescribing, Resistance and Healthcare Associated Infection	APRHAI	Link	DHSC	Antimicrobial resistance and healthcare-associated infections	Provides a critical function in the delivery of a long-term AMR strategy, especially in the **context of healthcare associated infections**, but has a relatively low profile and should be supported to develop its recommendations and ensure they have impact.

Name	Acronym	ToR	Sponsor department	Primary focus	Considerations
DEFRA Antimicrobial Resistance Coordination Group	DARC	Link	DEFRA	Antimicrobial Resistance in animal health	A specialist multi-agency group with explicit links to the UK AMR National Action Plan where these relate to the **anti-microbial use in animals**. The group undertakes horizon scanning and identifies gaps in evidence.
Human Animal Infections and Risk Surveillance group	HAIRS	Link	UKHSA	Zoonotic and emerging animal-human infections	Takes a cross-sector, One Health approach to the identification of potential infectious hazards of both humans and animals (zoonoses), and instigation of a risk assessment and early warning. This requires close working with other committees such as ACDP and UKZADI.
Joint Committee on Vaccination and Immunisation	JCVI	Link	DHSC	Vaccination policy and immunisation schedules	Evidence-based; longstanding credibility; transparent decisions. Has a statutory function in England
New and Emerging Respiratory Virus Threats Advisory Group	NERVTAG	Link	DHSC	New and emerging respiratory virus threats	Specialist focus; rapid assessment of novel viruses Narrow scope (respiratory only); limited public visibility outside emergencies

Name	Acronym	ToR	Sponsor department	Primary focus	Considerations
National Strategic Group for Viral Hepatitis	NSGVH	Link	UKHSA	Provide strategic direction and advice around viral hepatitis in England.	Not a formal SAC; supports development of evidence-informed policy and considers the development of guidance, surveillance methods and the uptake of diagnostics.
UK Advisory Panel for Healthcare Workers Living with Bloodborne Viruses	UKAP	Link	UKHSA	Advice and guidance on HCWs living with HIV, Hepatitis B and Hepatitis C. The panel also provides support for local incident management teams.	Evidence-based; provision of consensus advice. Narrow scope.
UK Malaria Expert Advisory Group	UKMEAG	Link	UKHSA	Formulate guidelines on malaria prevention in the UK	Not a SAC, reviews and assesses information and evidence to develop advice for medical professionals and travel advisors. Narrow scope.
UK Vaccine Network	UKVN	Link	DHSC	Advises DHSC on priorities for R&D investment in development of vaccines and vaccine technology for infectious diseases.	Operates via working groups; funded by UK ODA.
UK Zoonoses, Animal Diseases and Infections Group	UKZADI	Link	DEFRA	Independent Committee providing advice on trends and observations for animal and public health.	Could improve clarity on operation and outcomes

Table B: Select UK Government Advisory Committees related to infectious disease, established in times of significant need. May have some standing capacity. ToR = Terms of Reference.

Name	Acronym	ToR	Sponsor department	Primary focus	Considerations
Scientific Advisory Group for Emergencies	SAGE	Link	COBR	Emergency scientific advice during national crises. In infectious emergencies co-chaired by GCSA and CMO.	Strategic, multidisciplinary expertise; mobilises quickly Reactive only; coordination and transparency need to be balanced with confidential nature of policy making
Scientific Pandemic Infections group – Behaviours	SPI-B	Link	DHSC	Behavioural science in emergencies	Essential for public compliance strategies; cross-disciplinary Limited role outside of emergencies via reporting to SAGE
Scientific Pandemic Infections group – Modelling	SPI-M	Link	DHSC	Modelling science in emergencies	Essential for public compliance strategies; cross-disciplinary Limited role outside of emergencies via reporting to SAGE
Moral and ethical advisory group	MEAG	Link	DHSC	Moral, ethical and faith considerations on health and social care related issues	The group's input was used in the development of the ethical framework for adult social care, and in the guidance for managing a funeral during the coronavirus pandemic.

References

1 Environment Agency and Met Office. Flood Forecasting Centre. Science Advisory Committee. [Internet] Available from: https://embed.kumu.io/de7376f73bb025dfb0cb8f9b884b0ed3#government-sacs-albs-map/ffc

2 Hallett H. UK Covid-19 Inquiry: Module 1 – The resilience and preparedness of the United Kingdom. Full Report. [Internet] 2024 Available from: https://covid19.public-inquiry.uk/reports/module-1-report-the-resilience-and-preparedness-of-the-united-kingdom/

3 House of Commons. Science and Technology Committee. The UK response to covid-19: use of scientific advice First Report of Session 2019–21. [Internet] 2020 Available from: https://committees.parliament.uk/publications/4165/documents/41300/default/

4 Government Office for Science. Code of Practice for Scientific Advisory Committees and Councils: CoPSAC 2021. [Internet] 2024. Available from: https://www.gov.uk/government/publications/scientific-advisory-committees-code-of-practice/code-of-practice-for-scientific-advisory-committees-and-councils-copsac-2021

5 Behdinan A, Gunn E, Baral P, Sritharan L, Fafard P, Hoffman SJ. An overview of systematic reviews to inform the institutional design of scientific advisory committees. Glob Chall. 2018;2(9):1800019. doi: 10.1002/gch2.201800019

Acknowledgements

We are very grateful to all the authors and contributors who gave their time and expertise in shaping the contents of this report including colleagues across the Department of Health and Social Care (DHSC), UK Health Security Agency (UKHSA), National Institute for Health and Care Research (NIHR), Foreign Commonwealth and Development Office (FCDO), the Newcastle Upon Tyne Hospitals NHS Foundation Trust, North East Ambulance Service, the Royal Free London NHS Foundation Trust and Functional Fungal Genomics (F2G).

We are also especially thankful to everyone in the CMO's Private Office for their work and support:

Timo Taal, Alison Rostron, Natalie Hickman, Izzy Rollason, Maisha Syed, Danny Duffield, Marc Masey and Jeanelle de Gruchy.