HM Government

UK 5 Year Antimicrobial Resistance (AMR) Strategy 2013-2018

Annual progress report, 2016

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UK 5 Year Antimicrobial Resistance (AMR) Strategy 2013-2018

Third Annual progress report, 2016

Prepared by: The UK AMR Strategy High Level Steering Group

Contents

Foreword

2016 was a remarkable year at the mid-point of implementation of the UK 5 Year AMR Strategy. Not only did we see, as predicted in last year's report, a decrease in the quantity of antibiotics used in both human and animal sectors, we also witnessed significant developments at the international level. These included acknowledgement by leaders at the G20 summit of the need to tackle the economic consequences of AMR and a historic United Nations Declaration on AMR, agreed in 2016 by 193 countries, which put AMR high on the political agenda, and not only for Ministries of Health and Agriculture.

Lord O'Neill's review on AMR reported in May 2016. In response, the then Prime Minister announced a series of new ambitions for reducing antibiotic use and infections in the UK. We said in our last report that we would be emphasising local actions in 2016 and we worked to make data available to local health economies to enable them to benchmark their progress against other similar areas; these data are crucial in helping deliver the new ambitions. Our challenge in 2017 is to help local health economies to use their data and identify the interventions that will support them to contribute to the achievement of the national ambitions.

We are able to report that resistance in the isolates of the species that we monitor largely remained stable and that the total consumption of antibiotics by humans in the UK fell by 2% over the life of the strategy. Sales of antibiotics for food producing animals and horses fell by 10% to their lowest level in four years.

Although we have had many successes, we cannot slacken our resolve as infection rates continue to increase. While the new ambition to reduce healthcare associated Gram-negative bloodstream infections should help us address those infections that might have the greatest impact on resistance in human health, we should not tolerate any level of infection that might be preventable and must continue to promote messages around prevention and basic hygiene. Reducing the burden of infection overall will make the biggest contribution to our efforts to tackle AMR by reducing the number of individuals affected by resistant infections and the unnecessary use of antibiotics.

On the animal health side, once again we have seen positive outcomes. In particular, the 10% reduction in antibiotic use in animals between 2014 and 2015 has set us well on the way to achieving our ambition to reach a 20% reduction in the total quantity of antibiotics sold for use in farmed animals by 2018. This sends a clear message that the UK takes the issue of antibiotic resistance seriously and shows that we are working to preserve the efficacy of these precious medicines across disciplines. To ensure the long-term sustainability of action to tackle AMR in the farming sector, sector-specific antibiotic reduction targets are under development through collaborative industry/government groups. These are being tailored to the opportunities and challenges presented by different species and farming systems ensuring that targets promote the responsible use of antibiotics driven by minimising the incidence of disease.

In 2017 we are beginning to evaluate the impact of the actions we have taken to deliver the 2013-2018 strategy and starting to think about the priorities for the next five years, including how we widen our activities to specifically focus on AMR and the environment. On the global stage we must build on the achievement of the declaration on AMR at the UN and at the G20 summit in September 2016 and support the establishment of a strong follow up mechanism that will ensure that the Declaration is implemented. A summary of activity across the UK programmes is included in Annex A.

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Resistance

Published data

Data on resistance, antimicrobial use and hospital antimicrobial stewardship implementation in England are published in the English Surveillance Programme for Antimicrobial Utilisation and Resistance (ESPAUR) reports published in November each year ESPAUR 2016.[1]

Scotland publishes an annual surveillance report in August each year on antimicrobial use and resistance in humans This report will be replaced by the Scottish One Health AMR & AMU Report (SONAAR), to be published in November 2017.

A report on antimicrobial resistance in Northern Ireland will be published for the first time in 2017 and will be available from the the Public Health Agency website.

Wales continues to publish annual reports of antimicrobial resistance, and usage across primary and secondary care, along with data and quality measures from the annual all-Wales Point Prevalence Survey of antimicrobial use in secondary care. All are accessible via the Public Health Wales Antimicrobial Resistance programme website .

The report on Veterinary Antimicrobial Resistance and Sales Surveillance (VARSS) presenting 2015 data was published in November 2016: VARSS 2015

Drug Resistance - humans

A list of drug bug combinations is used to indicate resistance rates, though these infections contribute only a small portion of the overall resistance burden. A full table of the drug bug combinations can be found in Annex B.

The data show that the proportions of isolates of each species resistant to each antibiotic were generally stable between 2013, 2014 and 2015. As the incidence of blood stream infections has continued to increase, however, there has been a small increase in the actual numbers of resistant infections.

There are a number of caveats on the data, including that national surveillance of AMR involves collation of routinely generated antibiotic susceptibility test results from hospital microbiology laboratories. Variation in testing policies between the labs will therefore affect the results.

Our new ambition to reduce Gram-negative bloodstream infection is focusing in the first year on Escherichia coli (*E.coli)* bloodstream infections; the following provides an indication of resistance levels in *E.coli.*

AMR resistance for E. *coli*

Table 1

Bacteria	Antibiotic class	Metric	UK Baseline Resistance (2013) %	UK Resistance (2014) %	UK Resistance (2015)
E. coli	Cephalosporin	% NS to cefotaxime and/or ceftazidime	10	11	11
E. coli	Fluoroquinolones	% NS to ciprofloxacin	18	19	19

source: https://academic.oup.com/jac/article-lookup/doi/10.1093/jac/dkw018

[1] ESPAUR report 2017 was published 23 October 2017

Drug resistance animals - animals

The surveillance data showed that the proportion of isolates resistant to the antibiotics tested in the statutory programme was low; none were resistant to the 3rd generation cephalosporins, cefotaxime and ceftazidime, and 1% were resistant to ciprofloxacin, a fluoroquinolone antibiotic. More sensitive methods of testing[2] have revealed that *E. coli* with resistance to 3rd & 4th generation cephalosporins were present at high levels at slaughter. However, similar testing carried out by Food Standards Agency (FSA) at retail revealed that the level of these resistant bacteria in meat was considerably lower suggesting that control of cross-contamination during slaughtering and processing limits the spread of these resistant bacteria onto the food.

AMR resistance for Salmonella

In 2015, a total of 1594 *Salmonella* isolates from cattle, sheep, pigs, chickens and turkeys were tested as part of the clinical surveillance programme. Resistance to highest priority critically important antibiotics was stable and very low.

Table 2 Percentage of resistant isolates in all Salmonella from pigs, cattle, sheep, poultry and turkeys between 2013-2015 in England and Wales (clinical surveillance).

	2013 (n=1879) %	2014 (n=1358) %	2015 (n=1594) %
Fluoroquinolones	1.5	1.4	1.3
3rd and 4th Generation cephalosporins	0.1	0.0	0.1

Source: VARSS 2015

Food

The FSA's Chief Scientific Adviser published a report on AMR in the food chain in September 2016, which outlined the issues concerning the role that food plays in the problem of antimicrobial resistance. There is some published evidence that AMR bacteria are found in the UK food supply chain although it is not yet clear what contribution this makes to the overall burden of AMR on human health.

The FSA are funding research to further knowledge about AMR bacteria in the food chain. In 2016 this included:

- a systematic review of AMR bacteria in retail foods (pork, poultry meats, dairy products, seafood and fresh produce) which found that there is a lack of UK AMR data in these retail foods and that further surveillance is required (in particular for pork and chicken) to address this evidence gap.
- a survey on behalf of the European Commission which is testing retail meats (beef, pork and poultry) in the UK for resistant *E. coli*. Year 1 findings indicate that the prevalence of AmpC and ESBL-producing (types of resistance) *E. coli* in the pork and beef samples tested was very low (around 1%). Further information is available at:
- a survey of AMR *Campylobacter* contamination found in fresh, whole UK-produced chilled retail chicken. Year 1 of the study found that significant proportion (50%) of the *Campylobacter* isolates tested were resistant to ciprofloxacin.

These findings show that AMR bacteria can be found on raw meats sold in the UK. It is important that good hygiene practices are in place to minimise the risk of spreading AMR bacteria to other foods or surfaces. Thoroughly cooking meat will eliminate bacteria that may be present including those that are resistant. Following these practices should reduce the risk of acquiring AMR bacteria from food.

[2] Selective methods are used to detect low numbers of resistant *E. coli* which may be present as a minor component of the total flora.

Preventing infections

Human Health

While the proportion of isolates of a given species resistant to a particular antibiotic may remain stable, the increasing incidence of bloodstream infections, particularly those caused by Gram-negative bacteria such as *E. coli* and *Klebsiella pneumoniae* means that the burden of resistance, as measured by the numbers of resistant infections, continues to increase.

Gram-negative bacteria are increasingly resistant to most available antibiotics. Infections they cause include pneumonia, urinary tract infections, bloodstream infections, wound or surgical site infections, and meningitis. These bacteria have built-in abilities to find new ways to become resistant and can pass along genetic materials that allow other bacteria to become resistant to antimicrobial drugs as well.

In England, cases of *E. coli* bloodstream infections increased by 18% in the four years to 2015/16. In May 2016, the then Prime Minister announced an ambition to halve healthcare associated Gram-negative bloodstream infections by 2020. All four countries are aiming to achieve this ambition.

Tackling Gram-negative infections

England: In November 2016, the Secretary Of State for Health announced the appointment of Ruth May, Executive Director of Nursing at NHS Improvement, as national Infection Prevention and Control lead for England to co-ordinate work to deliver the infection control ambition.

Assessment of the reduction in healthcare associated Gram-negative infections will use data from the end of 2016/2017 as the baseline. Data on bacteraemia caused by *Klebsiella* spp and *Pseudomonas aeruginosa* is currently reported on a voluntary basis but this will be mandated

In the first year, 2017-18, the goal is a 10% reduction in *E. coli* infections; this is being supported through the Clinical Commissioning Group (CCG) Quality Premium (QP) scheme. These three pathogens cause about 75% of all Gram-negative bloodstream infections.

Information on hospital and community onset *E. coli* cases will be available and these cases will be reviewed to identify if they are healthcare related. This will enable focused interventions to be implemented with the aim of reducing infections/ patient harm. This data is now shared with the Care Quality Commission (CQC) to strengthen their assessments and help drive up standards across health and social care providers.

Scotland: Achieving a reduction of 50% in Gram-negative healthcare associated bacteraemia by 2020/1, by reducing the commonly reported Gram-negative bacteraemia (*E.coli*, *K.pneumoniae*, *P.aeruginosa*). Reporting of *E.coli* bacteraemia is now a mandatory requirement. Healthcare associated *E.coli* bacteraemia account for approximately 50% of all *E coli* bacteraemia. Work is underway to identify the proportion of the selected Gram-negatives that are healthcare associated.

Health Protection Scotland are monitoring hospital and community *E. coli,* Klebsiella, and Pseudomonas bloodstream infections per 1000 patient bed days and infections per 1000 population respectively in 2017/18. Reporting quarterly on the combined group of Gram-negative organisms.

Northern Ireland: The PHA Healthcare Associated Infection and Antimicrobial Stewardship Improvement Board was established in June 2016. Work is underway to prevent Gram-negative blood stream infections through antimicrobial stewardship and infection prevention and control

initiatives, including revisions to formularies, implementation of guidance about the investigation and management of suspected urinary tract infection in public and private care homes and the development of information systems that will collect data from, and provide intelligence to, Health and Social Care organisations and professionals.

Wales: Wales has endorsed the commitment to significantly reduce Gram-negative bloodstream infections by 2020-21 and has published an all Wales reduction expectation rate of *E. coli* bacteraemia of 67/100,000 population to be achieved by March 2018. This represents a 10% reduction on the rate for 2015/16. This is supported by a package of activities aimed at reducing the impact of urinary infections that include an educational learning package for catheterisation, standardisation of catheter passports, improved sampling and diagnostics in acute and community settings, and new national antimicrobial prescribing guidance for primary care and acute care. These activities are linked to the development of key standards in reducing urinary infections.

Animal health

The joint European Food Safety Authority (EFSA) and European Medicines Agency (EMA) opinion on how to Reduce Overall Need of use of Antimicrobials in Food-producing Animals (RONAFA) group, co-chaired between the Veterinary Medicines Directorate (VMD) and Public Health England (PHE), reviewed measures taken in the EU to reduce the need for and use of antimicrobials in food-producing animals as well as the impacts on antimicrobial resistance. The EFSA-EMA opinion was published in December 2016.

Guidance on the handling of slurry and manure to help reduce the spread of antibiotic resistant bacteria was published in August 2016. Guidance on how to reduce the chance of LA-MRSA infection for people who works in abattoirs followed the previous guidance for people who work with livestock.

Scotland has developed and published phase 1 of the www.scotlandshealthyanimals.scot website in collaboration with animal health stakeholders. Current content focuses on biosecurity guidance for farmers and veterinary professionals across animal sectors.

Protecting the antibiotics that we have

Human Health

Rates of prescribing provide some indication of progress in improving the stewardship of antimicrobials. In May 2016, the then Prime Minister announced the ambition to halve inappropriate prescribing of antibiotics. Reductions in prescribing are likely to indicate, at least in part, reductions in inappropriate prescribing. Reducing the use of broad-spectrum antibiotics, including carbapenems, will support good stewardship

While the accepted measure of antibiotic use is the Defined Daily Dose (DDD) per 1000 thousand head of population, we also collect the number of prescription items. Guidance on the appropriate dose of antibiotics to treat specific illnesses changes from time to time and can affect the total Defined Daily Dose measure. The number of items provides an indicator of how often clinicians are prescribing.

Table 3

Total antibiotic consumption expressed as DDD per 1000 inhabitants per day, UK, 2013-2015.
Source: Data submitted from UK countries to ESAC-net

	Year			Change
Sector	**2013 (baseline)***	**2014***	**2015***	**2013-2015**
Hospital Inpatient	2.39	2.57	2.52	5.2%
Community	20.90	21.08	20.31	-2.9%
Total	23.30	23.64	22.84	-2.0%

* including hospital outpatients to ensure comparability with ECDC countries

Table 3 Shows that the total consumption of antibiotics has reduced over the life of the strategy until the end of 2015 despite an increase in 2014.

It is difficult to draw comparisons with other countries due to the different nature of their health systems and disease burden but for illustrative purposes, the total consumption figures for antibiotics in 2015 (community and hospital) for a selection of European countries is included in table 4

Table 4

Country	DDD per 1000 population
France	32.1
Belgium	30.9
Italy	29.9
United Kingdom	22.6
Norway	17.2
Sweden	14.0
Netherlands	11.7

source: ESAC website ESAC website

Table 5

UK total antibiotic prescriptions and population, 2013 – 2015				
	Year			Change
	2013 (baseline)	2014	2015	2013-2015
UK population	64,105,600	64,596,700	65,110,000	1.5%
Total antibiotic items	50,108,946	50,372,884	47,255,406	-6.0%
Antibiotic prescriptions dispensed per head of population	0.78	0.78	0.73	-6.8%

Table 5 shows that in total 3,117,478 fewer antibiotic items were prescribed between 2014 and 2015 and the number of prescription items dispensed per head of population has decreased by 6.8%.

England: Prescribing data for England for 2015 were published in the third ESPAUR annual report in November 2016. The 2015 data show prescribing of antibiotics continuing to decrease with total consumption decreasing by 4.3% between 2014 and 2015.

The NHS England Quality Premium (QP) is intended to reward improvements in the quality of the services that are commissioned by Clinical Commissioning Groups (CCGs) in primary care and associated improvements in health outcomes and Commissioning for Quality and Innovation (CQUIN) promotes improvements in the secondary care sector. These were used in 2015/16 to incentivise improvements in antimicrobial stewardship and the management of sepsis.

The 2016/17 CQUIN provided incentives for acute providers to reduce total antibiotic consumption and consumption of certain broad-spectrum antibiotics (carbapenem and piperacillin-tazobactam) by 1% or more; and promote antimicrobial stewardship by ensuring that patients have an antibiotic review within 72 hours of commencement of treatment.

The QP scheme for AMR 2016/17 rewards CCGs for a reduction in the number of antibiotics prescribed in primary care and a reduction in the proportion of broad spectrum antibiotics prescribed in primary care (quinolones, cephalosporins and co-amoxiclav are broad-spectrum antibiotics for primary care). Almost 2.7 million fewer antibiotics were dispensed in primary care in 2015/16 compared with 2014/15 with a significant decline in both items per 1000 population and items per STAR-PU[3]. Broad spectrum antibiotic prescriptions reduced by 600,000, a 16% reduction from the previous year. The CCG AMR QP is supported by CCG performance reporting on the NHS England web site which publishes an antibiotic monitoring dashboard monthly. Primary care antimicrobial stewardship activity continues to be supported by the PrescQIPP Antimicrobial Stewardship Hub

Other activity including launch of the AMR local indicators profile on the PHE fingertips portal in April 2016, behavioural change work and preparation for a pilot awareness campaign, is included in Annex A.

Scotland: Prescribing data published in August 2016 in the Scottish Antimicrobial Use and Resistance in Humans report showed that in 2015 primary care total antibiotic use was 2.4% lower than 2014 and marked the third successive annual reduction. This followed a number of

[3] Specific Therapeutic group Age-sex Related Prescribing Units [STAR-PU] - antibiotic prescriptions in primary care, measured as the number of prescriptions dispensed, adjusted for the age and sex distributions in the population.

stewardship interventions including a national quality indicator introduced in 2013 using a 'best in class' approach. Antibiotic use, expressed in items/1000patients/day in at least 50% of practices in each NHS board will be at or below the 25th percentile of Scottish practices or will have made the minimum acceptable reduction toward that level using January-March 2013 as the baseline.

Prescribing data for 2015 showed that, unlike in primary care, hospital antibiotic use continued to increase and several contributing factors have been suggested for this e.g. implementation of the Sepsis 6[4] increased use of combination therapy to preserve the effectiveness of board and ultra-broad spectrum agents. However, to optimise prescribing there has been ongoing development of quality indicators for antimicrobial prescribing which began in 2009 to underpin the Health Efficiency Access and Treatment target for reduction of *Clostridium difficile* infection. These quality indicators have evolved year on year to increase the number of measures collected and since 2015 these measures have focused on documentation of duration and review of antibiotic treatment to avoid unnecessarily long courses.

To support increased public awareness of AMR for European Antibiotic Awareness Day (EAAD) 2016 new "Stop Antimicrobial resistance" resources with an image of 'scary bacteria' was developed. These featured as the national Community Pharmacy Public Heath campaign in the month preceding EAAD and were also distributed to all health boards for use in hospital and community settings.

Wales: Has been working with primary care through education and national prescribing indicators, and usage data for primary care shows an annual decrease in antimicrobial use of 5.1% in 2015, and a further decrease of 2.6% in 2016.

To promote appropriate antimicrobial use through improved diagnostics, the Welsh Government published guidance for GP practices for the introduction and use of C - reactive protein (CRP) testing. A working group within the Welsh AMR Delivery plan implementation group is evaluating the use of procalcitonin for the support of prescribing decisions in intensive care units.

A working group is evaluating, through an audit, the current use of back up prescribing strategies to improve antimicrobial use. This group will provide guidance of when and how GPs should instigate back up prescribing.

A national campaign is planned for public awareness of antimicrobial resistance and appropriate prescribing.

Northern Ireland: Antimicrobial consumption data for primary and secondary care settings will be published during 2017.

The Healthcare-associated Infection and Antimicrobial Stewardship Improvement Board work-stream for secondary care antimicrobial stewardship includes work to ensure the full implementation of 'Start Smart Then Focus', ward checklists, harmonisation of therapeutic drug monitoring across the Health and Social Care Trusts and making antimicrobial consumption data available at a local level to inform behaviour change. A major regional project to harmonise outpatient and home parenteral antimicrobial therapy governance and availability is underway.

The Improvement Board work-stream for primary care antimicrobial stewardship includes the employment of practice-based pharmacists, a locally enhanced service for antimicrobial stewardship champions and a pilot of point-of-care CRP testing for respiratory infections. The regional primary care antimicrobial formulary will be updated during 2017.

[4] a bundle of medical therapies/ interventions designed to reduce mortality of patients from sepsis.

The Health and Social Care Board is leading the development of a Medicines Optimisation Dashboard for primary care, which will include antimicrobial stewardship measures. A regional project, under the auspices of the Improvement Board, will implement and evaluate the use of a decision aid for the investigation and management of suspected urinary tract infection in all care homes.

Animal health

Sales have remained relatively stable in the UK over five years taking into account changes in animal demographics but a reduction was achieved in 2015. The mg/PCU figure for all food producing species decreased by 8% (5 mg/PCU) between 2014 and 2015. Veterinary sales of highest priority critically important antibiotics (HP-CIAs) remained low, representing just over 1% of all antibiotic sold for use in animals in 2015, and were little changed compared with 2014.

Table 6

Milligrams (mg) of active ingredient of antibiotic sold for food producing species per Population Correction Unit (PCU) 2013-2015

	2013	2014	2015	%change 2014 - 2015
UK	62	62	57	- 8%

Source: VARSS 2015[5]

Voluntary-led action by the veterinary profession and in the key livestock species sectors in collaboration with government contributed to the 8% reduction of antibiotic sales during 2015.

Highlights include:

- Livestock sectors have progressed in their work to provide antibiotic usage data. The poultry sector is leading the way with usage data already available. The pig and cattle sector are currently developing the tools that will support the collection of usage data to ensure future reductions of antibiotic use are greatest where there is most scope and to allow farms to benchmark their antibiotic use with similar farm types across the country.
- The British Poultry Council reported that use of antibiotics by members of its Antibiotic Stewardship Scheme in 2015 reduced by 27% compared with 2014, including a 52% reduction in the use of fluoroquinolones.
- The Agriculture and Horticulture Development Board for pork launched its system for recording antibiotic use– the electronic medicine book “e-MB” for pigs in April 2016 and have reported that, by January 2017, 971 sites had signed up to their online reporting system, eMB-Pigs, covering 22% of national pig production for 2016.
- The Cattle Health and Welfare Group completed a scoping study to investigate current data recording systems and has developed a proposal for an antibiotic use data capture system that should be operational by the end of 2017.

Diagnostics

NHS England, through the Chief Scientific Officer’s team, is putting a programme in place that will ensure that we have patient-focused diagnostics across the UK, providing clarity about what tests should be undertaken in specific clinical and health care settings. They are working with NICE to ensure that tests are used where appropriate and effective to support clinician decision making,

[5] VARSS 2016 was published 27 October 2017

using existing commissioning and contractual levers.

Improvements in our use of diagnostics will be critical in the delivery of the new ambitions to halve inappropriate prescribing and Gram-negative infections and will be given equal priority to other initiatives aimed at delivering the new ambitions. Lord O'Neill's 2016 report brought a welcome focus to the issue of diagnostics

Forward Look

The first step in delivery of the government's ambition of halving inappropriate prescribing in people by 50% by 2020/21 was to establish a clear baseline of how much of the current prescribing can be classified as inappropriate. Data analyses and modelling began in 2016 to quantify inappropriate prescribing of antibiotics with a focus on primary care. Estimates of the levels of inappropriate prescribing, focusing on overprescribing, have been made, however, uncertainties remain, in part due to lack of recording of diagnoses or imprecisely recorded diagnoses. The NHS BSA prescription information services are supporting delivery of the AMR strategy in England with an Antimicrobial Stewardship dashboard for primary care antibiotic prescribing data built into the new ePACT2 reporting system, facilitating antimicrobial stewardship activity in primary care

The government also announced an ambition to reduce the level of antibiotic sales for use in farmed animals by 20% to 50 mg/kg by 2018, based on the 2014 baseline of 62mg/kg. The 10% reduction seen between 2014 and 2015 has taken us half way to achieving this commitment in the first year of the four year period and puts us well on track for meeting this target by 2018.

It also committed to work with the veterinary profession and farming industry to set sector specific targets for sustainable reductions of antibiotic use in animals. The founding principles of this commitment were that future reductions should be greatest where there is most scope, and that they would be underpinned by improvements in animal husbandry, stockmanship, biosecurity practices and disease prevention measures including through vaccine use, and that animal health and welfare would be safeguarded. These targets are set to be announced in autumn 2017.[6]

[6] On 27 October 2017, targets for further reducing, refining or replacing antibiotic use across the key livestock sectors were published. The sector-specific targets were developed over the past year by a 'Targets Task Force', facilitated by the Responsible Use of Medicines in Agriculture (RUMA) Alliance. The headline targets for the eight sectors include a reduction in use of antibiotics in pigs by over 60% between 2015 and 2020.

Promoting the development of new drugs

The independent review

The independent review on AMR was commissioned in 2014 to analyse the global problem of AMR and propose concrete actions to tackle it internationally. The Review was chaired by Lord Jim O'Neill and its final recommendations were published on 19 May 2016. The report set out a broad package of actions on AMR, addressing the question of how to reduce the demand for antimicrobials, for example, via use of rapid diagnostics, as well as how global action can support and incentivise the development of new antibiotics through the establishment of a global payer incentive system offering 'market entry rewards'. It emphasised that the solution needs to be framed around access; any new drugs need to be affordable and accessible for use when clinically appropriate.

The response

The then Prime Minister announced a set of new ambitions at the G7 summit in Ise-Shima, Japan in response to the Review. The full Government response was published on 16 September 2016 and confirmed the UK government's support for action to address market failure through market entry rewards and welcomed the commitment made by the German G20 presidency to consider solutions to address market failure. While the UK is not wedded to a particular approach, we want to work with the global finance community to develop a global system that rewards companies that develop new, successful antibiotics.

A Global Innovation Fund

The UK has committed £50m over the next 5 years to set-up the Global AMR Innovation Fund. The Fund aims to increase investment to stimulate global early stage research in AMR for the benefit of low and middle income countries.

A new UK-China AMR Innovation Collaboration was agreed in December 2016. This will fund joint research and innovation projects led by research organisations, higher education institutions, companies and enterprises within the two countries. The Chinese Government will provide matching funding to the UK Government's commitment of up to £10m. An Expert Advisory Board has been appointed to advise the government on how best to take this fund forward. This work is being supported by the UK's Science and Innovation Network in potential partner countries.

Work with international organisations

The response to the independent Review on AMR included a commitment to work with international partners to incentivise pharmaceutical companies to produce effective new drugs. The G20 summit in China secured an agreement by leader's to task a group of international organisations on options "to prevent and mitigate resistance and unlock R&D into new and existing antimicrobials".
G20 Leaders communique

To measure progress and improve industry performance in AMR, DfID has funded the creation of a new biennial Anti-Microbial Resistance Index. This index will monitor and rank the leading pharmaceutical companies using a set of indicators that measure progress against many of the commitments made in this roadmap. The Index will be created by the Access to Medicine Foundation and published in January 2018.

National purchasing arrangements

The O'Neill Report made it clear that interventions to stimulate the antimicrobials market should be administered at a global level. However, it also highlighted the importance of better national-level purchasing arrangements that conserve antimicrobials and do not incentivise unnecessary use. A joint government/ industry AMR working group is considering innovative reimbursement models that delink prices from volume for new antimicrobials sold to improve national purchasing arrangements. In 2017 a feasibility study is looking at the implications for the NICE technology appraisal programme of an insurance-based approach to the reimbursement of antimicrobials, de-linking reimbursement from volumes sold.

The Longitude Prize

Launched in 2014, the Longitude Prize is a five-year challenge with a £10m prize fund to reward a transformative diagnostic test that helps solve the problem of global antibiotic resistance. It is being run by Nesta and supported by Innovate UK as funding partner.

In May 2016, Nesta launched the Discovery Awards, a seed funding programme to help promising teams that need financial support to progress their ideas for the Longitude Prize. After reviewing more than 70 applications, seed funding was awarded (funded by pharmaceutical company GSK and BIRAC, an initiative from the Government of India) to 12 teams from India, the UK and the US at the Royal Society in November. New funding from pharmaceutical company MSD (also known as Merck & Co. in the US and Canada), enabled a second round of Discovery Awards to be announced in January 2017.

Forward Look

We will continue to work with other G20 countries and the International Organisations to implement the commitment made in response to Lord O'Neill's review, ensuring the various financing solutions provide good value for money and strong incentives for the market to adapt while considering the needs of developing nations, who have previously had insufficient access to medicines.

Underpinning work programmes

Surveillance

Human health

In England, 2016 focused on making local health economy surveillance data available via Fingertips. By the end of 2016 data for more than 70 indicators were available for acute Trusts, clinical commissioning groups and GP practices. Improvements in the quality and quantity of data have been made over the life of the strategy.

An enhanced reporting system for carbapenemase-producing organisms (CPO) was also launched, enabling PHE to collect risk factor data to help understand how these organisms are acquired and transmitted, and support NHS-Trusts in preventing the spread of these infections.

The ESPAUR programme began to look at fungal resistance, antifungal consumption and stewardship. This is an emerging area of concern, highlighted by the increasing numbers of *Candida auris* infections detected in England and elsewhere. The granularity of dental prescribing data was also increased in 2016.

In Scotland, the annual surveillance report on antimicrobial use and resistance in humans detailing trends in hospital and primary care antibiotic use and resistance in key organisms has been produced since 2010. In 2016 there were two additional key antimicrobial use surveillance activities; phased implementation of providing quarterly personalised feedback reports to GP Practices benchmarking their prescribing with regional and national rates; and completion of several antimicrobial data linkage studies to inform clinical decision support work to optimise prescribing.

In 2016, Scotland developed and implemented an enhanced CPO surveillance system. This surveillance system identified risk factors via linkage of CPO infection data with morbidity, mortality, and prescribing datasets. Information on patient travel history is also collected. The system allows monitoring and epidemiological analyses of carbapenemase-producing bacteria to inform control measures and prevent the spread of these bacteria in the healthcare setting.

A review of national human, animal and environmental AMR and antimicrobial use data sets was also undertaken to improve data quality with the aim of establishing a One-Health surveillance approach.

In Wales, a national implementation and roll-out of ICNet across all Health Boards to support both local and national delivery and surveillance of healthcare associated infections was initiated. This includes nationally configured modules focused on surveillance of multi-drug resistant organisms, support for point prevalence surveys, and outbreaks. In addition, annual reports of antimicrobial resistance and usage across primary and secondary care continue to be published. A web portal is under development that will give access to the underlying data at local levels. A web-based audit tool for quality of prescribing in secondary care that will integrate with the national annual Point Prevalence Survey is under development.

In Northern Ireland, during 2016 a new surveillance team was established to focus on AMR and Gram-negative blood stream infection ambitions. Significant progress on data access and sharing of primary and secondary care prescribing data, healthcare-associated infections data will continue. Development of a web portal for this information is underway. A number of research projects concerning antimicrobial stewardship have been conducted in collaboration with academics at Queen’s University Belfast.

Animal health

The UK has two distinct surveillance programmes to monitor the prevalence of resistant bacteria in animals: the EU Harmonised Monitoring which is a mandatory surveillance programme carried out by Member States across Europe using representative sampling, and a clinical surveillance programme monitoring resistance in veterinary pathogens which is reliant on the submission of diagnostic samples to APHA veterinary investigation centres. The two forms of surveillance are complementary.

Currently the most accurate data on use of veterinary antibiotics are the sales of antibiotics active ingredient data. These are supplied annually by Marketing Authorisation Holders to the VMD where they are collated and validated. The data do not take into account wastage, imports or exports of veterinary medicines and do not allow accurate attribution of sales by animal species, but they serve as the best currently available approximation of the quantity of antibiotics administered to animals in the UK. To address the recognised drawbacks when it comes to interpretation, the VMD worked in partnership with key livestock sectors to develop, facilitate and coordinate collection systems for the priority livestock species (poultry, pigs and cattle). Capturing antibiotic usage data by species will provide a baseline against which trends and the effect of interventions can be measured.

In the VARSS-UK report 2015 the older UK methodology was replaced with a newer methodology which is harmonised across Europe. This was in line with national and global policy commitments to harmonise surveillance methodology where possible.

Forward look: Once species specific antibiotic usage data collection systems are in place, it will be possible to cross-check against the sales data received from pharmaceutical companies. Comparing usage data reported for particular products with the known sales of these products will then be a key validation step where discrepancies can be identified and scrutinised. Crucially, these usage systems will provide accurate data back to farmers and vets and will also be used to inform sector-specific goals on antibiotic reduction within different species.

Research

The AMR Funders Forum, led by the Medical Research Council, brings together major research funders and government departments to promote joint action to understand and tackle AMR through a ‘One-Health’ approach. The forum has been a platform to identify gaps and opportunities in our understanding of AMR and has established unprecedented levels of research collaboration together with increased investment. Commitments made in 2016 include:

The AMR cross research council initiative: £8m commitment by the research councils, led by MRC, to support research that will accelerate therapeutics and diagnostics development (this includes small molecules, alternative therapies as well as diagnostics), £6.5m commitment by the research councils, led by NERC, to understand AMR and its interaction with the real world (the outdoor environment and the microbiome), £13m commitment by the research councils, led by ESRC, in partnership with DH, DEFRA and VMD to understand AMR and behavioural change within and beyond the health care setting and a £2m commitment by the research councils, led by AHRC, looking at AMR in the indoor and built environment

The Newton Fund: £4.5m by the research councils under the Newton Fund, led by MRC, with matched funding from the National Natural Science Foundation of China (NSFC) to support six new research partnerships that will foster collaboration across borders and between diverse disciplines to help tackle AMR.

The Joint Programming Initiative on AMR: €3m by the MRC towards an ERA-Net co-fund of a total of €28m to support trans-European research projects to bridge the knowledge gap on AMR transmission mechanisms. €100k by the MRC towards a €650k call to support AMR Networks/Working groups across Europe.

NIHR Biomedical Research Centres (NIHR BRCs) Four centres are conducting research on AMR. These are partnerships between England's leading NHS organisations and universities to conduct translational research to transform scientific breakthroughs into life-saving treatments for patients.

Forward look: further planned research calls include:

- AMR Cross council initiative in partnership with DH, £10m call led by MRC examining drivers of AMR in a global context, to launch May 2017 with grants starting in April 2018
- UK-Brazil Newton call, BBSRC-led, £2.5m UK funds matched by Brazil, will focus on agricultural (crop and farmed animal) AMR including non-bacterial pathogens, to launch July 17 with grants starting April 2018
- UK-India Newton call, cross councils and ESRC led, £6.5m UK funds matched by India, to launch mid 2017 with grants starting mid 2018
- UK-China Newton call, cross councils and MRC led, £8m UK funds matched by China, to launch late 2017 with grants starting in 2019
- MRC AMR target identification and validation, a £4m call, launched late 2017 with support starting in 2018

International work

2016 saw strengthening of the commitment to tackle AMR at a global level with two major global commitments and the advancement of international programmes to tackle AMR.

The United Nations General Assembly (UNGA): in 2016, engagement through global forums and partnerships such as the G7, G20 and the Global Health Security AMR Action Package, were instrumental in building support for the UNGA AMR High Level Meeting (HLM) and informing the content of the declaration. The HLM focussed attention on AMR at the highest political level. Leaders met on 21 September 2016 to adopt the UN declaration on AMR. The declaration, agreed by 193 countries, gives renewed political impetus to implementation of the Global Action Plan (GAP) 18 months on from its agreement and follow-up was agreed for two years' time.

The G7: led by Japan, agreed new stronger commitments on AMR to preserve effective antibiotics, improve access where needed, strengthen surveillance and consider potential incentives to promote R&D. The Japanese G7 presidency also established the G7 Chief Veterinary Officers' forum, the inaugural meeting of which focused on AMR and established veterinary AMR laboratory networks and a technical veterinary AMR working group

Under the Chinese Presidency, the G20 agreed at the leaders' summit in Hangzhou that AMR posed a serious threat to public health, growth and global economic stability. They also acknowledged the need to work with the WHO, FAO, OIE and OECD on options to address the economic consequences. This provided a basis for a more detailed focus under the German Presidency on collective action by the G20.

Codex Alimentarius: the UK hosted and co-chaired a four day meeting in London in December 2016 to agree project documents for the Codex AMR Task Force. This task force will revise the Code of Practice to Minimize and Contain Antimicrobial Resistance, and will also develop Guidelines on Integrated Surveillance of Antimicrobial Resistance. The Codex Alimentarius Commission is an international food standard setting organisation established by the World Health

Organisation and the Food and Agriculture Organisation of the United Nations to protect consumer health and promote fair practices in food trade.

The Fleming Fund: is one of a range of activities underway to support lower and middle income countries with Overseas Development Assistance (ODA) funding. In 2016 it supported development of a tiered set of protocols for AMR surveillance that can be used specifically in low resource settings. This work was undertaken by the London School of Hygiene and Tropical Medicine and has been used as a tool to discuss resource requirements and AMR surveillance models with potential Fleming Fund investment countries. Grants were agreed for the World Health Organisation, the Food and Agriculture Organisation and the World Organisation for Animal Health, to provide tripartite support to countries as they develop their AMR National Action Plans. Each organisation has also been granted a secondment to support this work.

In October 2016 a management agent and independent evaluation supplier were selected and began work on finalising the design of the Fleming Fund grants. A regional conference on AMR surveillance, organised by the UK's Science and Innovation Network, was held in South Africa where both the South African Director General for Health and the UK High Commissioner to South Africa addressed neighbouring countries and donors.

Forward Look

The government is continuing to prioritise AMR on the international stage and will focus on implementing commitments made in the G20, United Nations and the UK response to the Independent Review on AMR.

The Government will continue to work with a range of international and domestic partners, to build support for collective action and cooperation to increase global investment in AMR research and innovation. Supporting research collaborations with partner countries such as Brazil, China, India and South Africa, is a priority for the UK's Science and Innovation Network, jointly run by the FCO and BEIS.

In 2017 the Fleming Fund piloted its approach in four early investment countries and will finalise the design for rolling out the project in up to thirty countries across Sub-Saharan Africa, South and South-East Asia. Opportunities for aligning with other partners and donors will be sought. With civil society engagement, we will move from National Action Plans to implementing AMR surveillance and assessing the burden of AMR in low income settings.

Focus in 2017

For the remaining two years of the five year strategy, the UK AMR programme has been restructured around four core programmes to deliver the ambitions set out in the government's response to the O'Neill review.

Programme 1: to reduce healthcare associated Gram-negative bloodstream infections in England by 50% by 2020/21; led by the Executive Director of Nursing, NHS Improvement.

Programme 2: to reduce inappropriate antibiotic prescribing by 50% with the aim of being a world leader in reducing antibiotic prescribing by 2020/21; led by the Chief Pharmaceutical Officer, NHS England.

Programme 3: to ensure that diagnostic tests or epidemiological data are used to support clinical decision making, implement our vision and delivering high quality diagnostics in the NHS in support of the other ambitions; led by the Chief Scientific Officer, NHS England.

Programme 4: to reduce use of antibiotics in livestock and fish farmed for food to a multispecies average of 50mg/kg by 2018; to agree sector specific targets for the animal sectors by the end of 2017, and to set agreed rules for use of antibiotics which are most critically important for human health; led by the Chief Executive of the Veterinary Medicines Directorate, an executive agency of Defra.

Supporting work streams:

1 - promoting new drugs and diagnostics and working with the global finance and health community to develop a global system that rewards companies that develop new, successful antibiotics and make them available to all who need them; led by DH
2 - surveillance, behavioural change and other evidence based interventions; led by PHE
3 - education and training; led by HEE.

Delivery of these programmes is being overseen by a new Portfolio Board. The High Level Steering Group, chaired by the government's CMO will retain oversight of all continuing strategy related activity across all partners and will focus on both evaluating the impact of the current strategy while considering the next steps beyond 2018.

Annexes

Annex A - summary of key work and achievements in 2016

A detailed implementation plan was published in the first annual progress report. In 2016 the plan was revised to focus on local action, diagnostics and behaviour change. The following is a summary of the key pieces of work that have been completed and achievements in 2016.

Infection Prevention and Control (IPC) practices in human and animal health,

In March, the Secretary of State for Health gave prominence to IPC and AMR at the Patient Safety Summit to promote good hygiene and infection prevention and control across primary and secondary care.

On 5 April, PHE launched the AMR local indicators profile on "Fingertips". By the end of 2016 there were over 70 indicators providing data at Trust, CCG and GP level covering resistance, prescribing, healthcare associated infections, infection prevention and control and antimicobial stewardship. Fingertips is easily accessible by healthcare professionals and members of the public alike. AMR local indicators

In November, the Secretary of State for Health held an infection prevention and control summit where he announced a package of measures to halve healthcare associated Gram-negative bloodstream infections.

In 2016/17 *Leading Change Adding Value*, England's framework for nursing, midwifery and care staff committed to address public health challenges including AMR and Stewardship in order to meet the challenge of antimicrobial resistance. Specifically, the framework will promote a culture where improving the population's health is a core component of the practice of all nursing, midwifery and care staff; understand the causes and actions needed to address AMR including Infection Prevention and Control (IPC) and Antimicrobial Stewardship (AMS).

In July PHE Chief Nurse introduced the updated *All Our Health*. It is a PHE led 'Call to Action' for **all** health and care professionals to embed and extend prevention, health protection and promotion of wellbeing and resilience into practice. *All Our Health* provides a framework and tools and resources to support this 'health promoting practice' with quick links to evidence and impact measures and top tips on what works. There is a specific chapter entitles' AMR Applying All Our Health'.

Scotland

In May, HPS published the 'Toolkit for the early detection, management and control of carbapenemase-producing Enterobacteriaceae in Scottish acute settings', which provides guidance on the two-step clinical risk assessment based screening policy. This includes clinical risk assessment on admission to acute care, which identifies a subset of patients at high risk of CPE colonisation, who are then tested for CPE.

Animals

In November, Guidance on management of manure/slurry was published on www.gov.uk

In December the BETA version of www.scotlandshealthyanimals.scot– national biosecurity guidance for livestock

farmers was launched.

In April, publication of a leaflet describing steps to take to reduce the chance of infection with LA-MRSA (Livestock associated Meticillin resistant Staphylococcus aureus) for both people who work with livestock and in abattoir. https://www.gov.uk/government/publications/la-mrsa-information-for-people-who-work-with-livestock

Optimising prescribing practice

On 4 January the CMO sent letters on their antibiotic use to over 1500 GP practices which were in the top 20% highest prescribers. This was a second PHE behavioural Insights trial that recruited 200 GP practices in several clinical commissioning groups (CCGs) across the country.

In May, a paper was published in the Journal of Antimicrobial Chemotherapy (JAC) following a national survey to assess variance between antimicrobial prescribing and stewardship activities across primary care, combining primary and secondary care survey data. The analysis will inform future projects. The results highlighted that the majority of healthcare organizations in primary and secondary care had reviewed the national AMS toolkits (Start Smart then Focus - secondary care and TARGET - primary care); however, implementation of the toolkits, through the development of action plans to deliver AMS interventions, required improvement. https://www.ncbi.nlm.nih.gov/pubmed/26869693

To support local implementation of antimicrobial stewardship in secondary care, an antimicrobial stewardship surveillance system including tools to support stewardship audits in acute trusts developed and rolled out. These were used as part of the CQUIN (Commissioning for Quality and Innovation) in 2016/17.

Two short introductory films about the risks associated with overusing antibiotics were produced. The first film, published in July, a guide for GPs on antimicrobial resistance, supports a range of educational materials for GPs and other primary-care prescribers called the TARGET toolkit developed by PHE. This film also introduces a short informative but simple animation, first used in February that can be used by GPs and other health professionals when speaking with patients about the risks of antibiotic resistance and misuse. The animation had over 3000 views by the end of the year

Across the year, there were over 1000 logins to the introductory AMR e-learning package, with over 600 completing the module.

In November, a dental antimicrobial stewardship tool kit was rolled out in collaboration with the Faculty of General Dental Practice and the British Dental Association. https://www.gov.uk/guidance/dental-antimicrobial-stewardship-toolkit

On 26 January the Health Protection Research Unit at Imperial College in collaboration with ARC@Imperial hosted the Nursing Summit on Antimicrobial Stewardship, an event focused on progressing the debate on the nursing contribution to the prudent use of antimicrobials and the latest developments worldwide on this emerging area.

In September, the Board of NHS England approved a CQUIN for AMR and sepsis. Improving the management of serious infections; Reducing Gram-Negative Bloodstream Infections (GNBSIs) and an inappropriate antibiotic prescribing in at risk groups CCG QP for 2017 to 2019 in support of delivery of the new ambitions.

In July 2016, the Longitude prize team launched Superbugs, a free mobile game that aims to educate young people about antibiotic resistance (and how to use antibiotics responsibly) through a fun and engaging format. Throughout 2016, they showcased the game at a number of events, including Science Museum's Lates and New Scientist Live. Superbugs won Silver in the Healthcare category at the International Serious Play Awards 2016 and, by the end of 2016, had been played more than 46,000 times. Developed by Preloaded, Superbugs is available to download for

Android and iOS phones and tablets.

In November, the longitude prize team launched their second interactive data visualisation, which shows how antibiotic resistance levels vary across Europe, with data from the European Centre for Disease Prevention and Control (ECDC).

Across the year, 92 new teams registered to compete in the Longitude Prize. Seven teams went on to submit a full application to win the prize, five of which were approved for panel review.

Scotland

In August a national Antimicrobial Companion app. providing a range of features including MHRA approved dosage calculators for gentamicin and vancomycin was launched. The app includes functionality for inclusion of local antibiotic guidance and an audit tool to support hospital quality indicators.

Update of SAPG guidance on use of alternative Gram-negative agents to preserve carbapenems and the final part of a quality improvement programme on carbapenems involving interviews with clinicians on prescribing behaviours was completed in 2016. Outputs from this programme will inform national recommendations to improve the use of carbapenems and alternative Gram negative agents.

Completion of a successful feasibility study of using C-reactive protein point-of-care testing in GP Practices and Out-of-hours settings to reduce unnecessary use of antibiotics for respiratory tract infection.

Wales

National prescribing indicators for primary care were published by the All-Wales Medicines Strategy Group.

For the first time the All-Wales Medicines Strategy Group published a national prescribing indicator for secondary care that focuses on the quality of prescribing of prophylaxis for colorectal surgery.

Guidance was published by Welsh Government on how CRP testing should be implemented and delivered across primary care.

Public Health Wales endorsed (and translated into Welsh) the TARGET leaflets for the public education regarding self-management of upper respiratory tract infections and urinary infections.

Northern Ireland

In January, the HSCB distributed revised Management of Infection Guidelines for primary and community care.

In 2016/17, 123 (95 whole time equivalent) Practice-Based Pharmacists, whose role includes supporting GP practices re AMS were recruited. A third wave of recruitment will take place in early 2017/18.

In December 2016, a Locally Enhanced Service to support a named Antibiotic Champion to undertake audit and identify

actions was introduced, and 170 general practices (out of 344) had signed up by the end of March 2017.

A baseline assessment of stewardship (NICE NG15) by the Northern Ireland Antimicrobial Pharmacists' Network with microbiologists was undertaken. The combined assessments will help to prioritise achievable goals for the region and individual Trusts.

Animals

In December, guidance for vets, farmers and animal keepers on what the mg/PCU means and how it is calculated was published.

In June the VMD published a summary of their work to promote responsible use of antibiotics in animals. https://www.gov.uk/government/publications/antibiotic-resistance-what-work-is-the-vmd-doing

Improved education, training and public engagement.

A trial was undertaken in 200 GP practices to provide evidence for an innovative, low-cost approach to reduce antibiotic prescribing in GP practices that could be scaled-up. GPs provided photos and signatures for commitment posters to improve stewardship and facilitate discussions with patients. This was tested in addition to automated messages for patients that encourage visits to pharmacy and self-care where appropriate.

Local AMR workshops (Antibiotic Guardian workshops) were held in three locations across the country and TARGET webinarshttp://www.target-webinars.com/ were developed and published for healthcare professionals in primary care. In November 2016, all chief professional officers wrote to Deans of all healthcare schools to recommend that antimicrobial resistance and stewardship is included in undergraduate and postgraduate curricula, and CPD courses alongside infection prevention and control which is already well embedded within curricula. Two national workshops supported the introduction of the NHS England incentives schemes.

In July, Health Education England published the full report of its assessment of antimicrobial prescribing and stewardship competencies . It included information about some of the resources available to support learning, and what gaps in provision need to be filled. From those who responded, 67% of Health Education institutions have reported implementation of all antimicrobial prescribing and stewardship competencies.

Process and outcome evaluations for the Antibiotic Guardian campaign www.antibioticguardian.com were performed and published which showed the wide reach of the campaign and its success in increasing commitment to tackling AMR in both healthcare professionals and members of the public, through increased self- reported knowledge and changed self-reported behaviour.

For World Antibiotic Awareness Week and European Antibiotic Awareness Day 2016, the pledges were translated into Dutch, French and Russian following requests from the WHO/Europe and the Belgian Antibiotic Policy Coordination Committee (BAPCOC). As of 31 December 2016, there were 42,457 pledges on the Antibiotic Guardian website.

Scotland

In collaboration with Glasgow Caledonian University, conducted primary research and a systematic review to identify effective interventions to change antimicrobial prescribing behaviours in the veterinary practice setting and to improve understanding and awareness of the issue in companion animal owners and the general public.

In 2016 a quantitative evaluation of the impact of the Scottish Reduction of Antimicrobial resistance (ScRAP) education programme on primary care antimicrobial prescribing rates was completed and will be published in due course. Engagement with this facilitated learning resource focused on respiratory infections was associated with reduced prescribing rates. A refresh of the resource and addition of content on urinary tract infections has been completed for launch in 2017.

In June an educational event on innovation in data utilisation and visualisation was held and in November an event on optimising antimicrobial prescribing in primary care.

In November, national and local activities were undertaken to support Antibiotic Guardian and European Antibiotic Awareness Day including the display of new design materials in all Community Pharmacies for one month as a Public Health Campaign topic.

Wales

Through 2016 Public Health Wales and partners supported a range of initiatives including: the Antibiotic Guardian campaign and European Antibiotic Awareness Day; a bi-annual Antimicrobial Stewardship Forum to share good practice and education between clinicians, pharmacists, microbiologists, and Infection Control practitioners; 3 times yearly Infection Control Forum to share good practice and education between clinicians, microbiologists, and Infection Control practitioners.

Northern Ireland

During 2016 PHA and HSCB supported European Antibiotic Awareness Day and also the Antibiotic Guardian Campaign, with an additional focus on primary care. Early in 2017 the PHA Health Protection Service held a regional symposium for health professionals with a strong focus on antimicrobial resistance and stewardship. The improvement board has established a workstream to work on the design and delivery of an information campaign that uses social media and on line platforms

Animals

In October, Defra and VMD hosted a live twitter chat with the CVO and FSA to discuss with the general public the use of antibiotics in animals, the government response to O'Neill and how consumer protection through safer meat can be improved.

In November, infographics around common misconceptions to do with antibiotic use in farming were developed and put out on the Defra twitter account during World Antibiotic Awareness Week. A poster "are you antibiotic aware" was developed in collaboration with the BVA, BMA and PHE.
https://www.bva.co.uk/uploadedFiles/Content/News,_campaigns_and_policies/Policies/Medicines/BVA-Antibiotic-poster.pdf

Developing new drugs, treatments and diagnostics.

In April the role of the Rapid Review Panel, established to assess the utility of products to reduce HCAIs was reviewed and new guidance published online.

Dfid announced the new UK Government funded AMR index that will rank the world's leading pharmaceutical companies on things like R&D investment into new antibiotics.

In November, an Expert Advisory Board was established to advise the government on how best to work with global partners to fund innovative initiatives to tackle drug resistant infections. The board will provide critical advice on aspects such as the precise scope of the fund, scientific objectives and investment opportunities.

In December, Secretary of State Jeremy Hunt signed a Memorandum of Understanding to launch a new UK-China Global AMR Innovation Fund Collaboration.

Better access to and use of surveillance, human and animal

In March, "30-day all-cause fatality subsequent to MRSA, MSSA and *E .coli* bacteraemia and *C. difficile* infection' was published on www.gov.uk. The data is assessed by quarter to assess for variation due to seasonality.

In June, trend data for the key drug/bug combinations from England and the Devolved Administrations and for the UK as a whole were published in a peer-reviewed journal[7].

In April, the Imperial College HPRU was commissioned to develop and implement methods to monitor any unintended consequences (increased morbidity and/ or mortality) associated with reduced prescribing of antibiotics. Imperial College HPRU started work on unintended consequences of reduced antibiotic prescribing in April 2016.

June saw the launch of an upgraded electronic reporting system for Carbapenemase-producing Enterobacteriaceae. Enterobacteriaceae are a large family of bacteria that usually live harmlessly in the gut and commonly cause urinary tract infections, intra-abdominal and bloodstream infections. Carbapenemases are enzymes that destroy carbapenem antibiotics, conferring resistance. Carbapenems are a valuable family of antibiotics normally reserved for serious infections caused by drug-resistant Gram-negative bacteria. Over the last five years, we have seen a rapid increase in the incidence of infection and colonisation by multi-drug resistant carbapenemase-producing organisms.

Data entry recording blood stream infections (BSI) for the voluntary surveillance of infections within intensive care units (ICUs) commenced in December 2016. This will enable, for the first time nationally, determination of both the prevalence of ICU-onset BSIs identification of those cases associated with an intravenous catheter. This programme will also provide a denominator for intravenous line use in ICUs and information on the presence or manipulation of lines at or two days prior to the positive blood sample being taken. From this information it will be possible to determine which infections are device associated and calculate a device related rate. No other national surveillance of HCAI can determine device-associated infections and produce a device-related rate.

Animals

In April the UK electronic medicine book for pigs (eMB pigs) which allows pig farmers to upload antibiotic sales and animal numbers was launched? The number of sites uploading usage data for 2015 and 2016 onto the system has increased every month since. The system was developed by the Agriculture and Horticulture Development Board (AHDB) Pork with government financial support. The system is linked to the VMD authorised products database and the ambition is to share anonymised usage data for inclusion in the VARSS report to be published in 2017.

[7] Guy R, Geoghegan L, Heginbothom M, Howe R, Muller-Pebody B, Reilly JS, Wilson J, Wiuff C, Wyatt T, and Johnson AP. Non-susceptibility of *Escherichia coli*, *Klebsiella* spp., *Pseudomonas* spp., *Streptococcus pneumoniae* and *Staphylococcus aureus* in the UK: temporal trends in England, Northern Ireland, Scotland and Wales J. Antimicrob. Chemother. 2016;71: 1564-1569.

In April the British Poultry Council, representing 90% of the poultry meat production in the UK, published a report of their antibiotic usage and made these data available for inclusion in the Veterinary Antibiotic Resistance and Sales Surveillance (VARSS) report 2016.

In May, the European Surveillance of Veterinary Antimicrobial (ESVAC) species Expert Advisory Group (EAG) discussed the guidance documents for the collection of antibiotic usage data in livestock species. A concept note was then published on the European Medicines Agency (EMA) website in June for public consultation, introducing the parameters that will be included in the guidance. The draft guidance document circulated is going through the consultation process until September 2017.

As at December 2016 11 cases had been through the Res-alert process and been acted upon. The process allows experts to discuss and deliver an informed decision on actions to take in the event of resistant bacteria of concerns to human health found in animals.

In October, CHAWG (Cattle health and Welfare group) representing the cattle sector presented a proposal for a data capture system developed following a scoping study to investigate current data recording systems. It is hoped to be operational by the end of 2017.

In November, the VARSS report was launched at the BVA congress in the London Vet Show. This was covered in the media. VARSS highlights leaflet were produced and distributed

Scotland

A total of 4 reports for phased implementation of providing quarterly personalised feedback reports to GPs focused on total antibiotic use plus antibiotics in various age groups (April 2016), antibiotics for urinary tract infections (UTI) (July 2016),use of broad spectrum antibiotics (October 2016) and skin and soft tissue infections (February 2017). Initial phase in 50% of Practices in 4 board areas prior to evaluation and national roll-out.

Antimicrobial data linkage studies were completed. The evidence from these studies will be used to develop exemplar clinical decision support tools to optimise prescribing initially focused on empiric treatment of UTI and sepsis.

Wales

National implementation and roll-out of ICNet across all Health Boards to support both local and national delivery and surveillance of Healthcare-associated infections was initiated.

The annual all-Wales Point Prevalence Survey of antimicrobial use in secondary care was performed in November 2016 and included additional questions around quality of prescribing. Data on quality indicators have been feedback locally.

Better identification and prioritisation of AMR research.

The AMR Cross Council Initiative ran calls under themes 2, 3. Details of awards available here https://www.mrc.ac.uk/research/initiatives/antimicrobial-resistance/tackling-amr-a-cross-council-initiative/

In April the ESRC, in partnership with DH, AHRC, MRC, Defra and VMD supported projects under theme 4 of the Cross Council initiative on the topic of behaviour relating to AMR. Details of awards available here

https://www.mrc.ac.uk/research/initiatives/antimicrobial-resistance/tackling-amr-a-cross-council-initiative/

UK – China Newton Call– details of funded projects can be found here https://www.mrc.ac.uk/news/browse/4-5m-from-newton-fund-for-collaborations-that-will-tackle-antimicrobial-resistance/

The results of a UK-China research collaboration supported through the Newton Call were pivotal to informing a ban on the use of the antibiotic colistin as a feed additive for animals in China, resulting in the withdrawal of 8,000 tonnes of colistin https://www.mrc.ac.uk/news/browse/uk-china-collaboration-informs-animal-feed-antibiotic-ban/

UK Minister of State for Universities, Science, Research and Innovation Jo Johnson MP and Indian Union Minister for Science Harsh Vardhan launch the RCUK-India Strategic Group on AMR, which will agree priority areas for RCUK-India research in AMR and develop collaborative approaches to tackle AMR.

JPIAMR – Details of UK supported networks and transmission dynamics awards can be found here http://www.jpiamr.eu/third-joint-callresult/ http://www.jpiamr.eu/fourth-joint-callresult/

Scotland

In June, the Scottish AMR Research Consortium (SARC) held a transdisciplinary research workshop. The group put forward recommendations on research priorities in AMR and proposed a delivery model for their coordinated delivery in Scotland. Adopting a transdisciplinary, “One Health” approach, opportunities for collaboration have been identified across human, animal and environmental research domains.

Strengthened international collaboration

In May, the UK hosted a Global Leaders event to set the issue of One-Health and AMR in a political, scientific and economic context with attendance by representatives from low and middle income countries as well as major developed countries. The meeting raised awareness and allowed participants to share examples of what has worked well, promoting collaboration between health and agriculture colleagues and building support for the High Level Meeting at the United Nations.

On 4 -5 September at the G20 summit in Hangzhou, leaders committed to looking at how to promote further R&D into new antimicrobials

On 20 September, the UK co-hosted a high profile ministerial side event with Argentina, Australia, Japan, Kenya and South Africa in the margins of the United Nations General Assembly (UNGA).

On the 21 September, leaders met at the UNGA for a High Level Meeting on AMR. A formal declaration on AMR was adopted by 193 member states.

On 17 and 18 November the Fleming Fund sponsored and delivered a regional conferenced in South Africa. This event brought together neighbouring countries to discuss AMR National Action Plans, how to collaborate as a region to improve surveillance and how to engage with the Fleming Fund.

In November: G7 CVOs forum and symposium on actions for combating AMR in the veterinary sector.

Annex B - outcome against drug bug combinations in 2015, UK.

Bacteria	Antibiotic class	Metric	Humans Resistance				Animals Resistance			Infections monitored in surveillance
			UK Baseline 2013	UK 2014	UK 2015		UK Baseline 2013	UK 2014	UK 2015	
Klebsiella pneumonia	Cephalosporin	% NS to cefotaxime and/or ceftazidime	11.1%	11.3%	11.0%					Bloodstream infections for humans, mastitis in cattle for animals
	Carbapenem	% NS to imipenem and/or meropenem	0.8%	1.3%	1.0%					
	Aminoglycoside	% NS to gentamicin	7.9%	7.2%	8.4%					
	Fluoroquinolone	% NS to ciprofloxacin	10.7%	10.5%	10.8%					
Escherichia coli	Cephalosporin	% NS to cefotaxime and/or ceftazidime	10.3%	10.9%	11.2%	Pigs Chickens Turkeys	0.6%	0.0% 0.0%	0.0%	Bloodstream infections for humans. For animals - all E.coli cases reported are from the EU harmonised monitoring programme which collect samples from healthy animals and therefore less likely to be pathogenic strains
	Carbapenem	% NS to imipenem and/or ceftazidime	0.1%	0.1%	0.1%	Pigs			0.0%	
	Fluoroquinolones	% NS to ciprofloxacin	18.3%	18.8%	18.6%	Pigs Chickens Turkeys	1.3%	3.8% 7.1%	0.7%	
	Aminoglycosides	% NS to gentamicin	9.6%	9.8%	10.0%	Pigs Chickens Turkeys	2.5%	19.5% 4.2%	6.7%	
Pseudomonas spp.	Cephalosporin	% NS to ceftazidime	6.8%	7.1%	6.7%					Bloodstream for humans. Mastitis in cattle for animals.
	Carbapenem	% NS to imipenem and/or meropenem	8.9%	11.3%	9.1%					
Neisseria gonorrhoeae	Cephalosporin	% NS to ceftriaxone	0.2%	0.0%	0.0					Gonorrhoeae
	Macrolide	% NS to azithromycin	1.6%	1.0%	9.8					
Streptococcus pneumoniae	β-lactam	% NS to penicillin	4.0%	4.3%	5.1%					Bloodstream infections for humans

Combined outcome for 2014 for animals and humans
* Figures in blue are for England and Wales; Figures in red have changed since previous publication. Where no figures are shown the infections were either not tested or tested on too few cases to give reliable estimates of the % resistant.

The data show that the proportions of isolates of each species resistant to each antibiotic are generally stable between 2013 and 2015 (either the same or a marginal increase). However, as the incidence of bacteraemia has continued to increase, the denominator for the proportions increases giving an increase in the actual numbers of resistant infections. This highlights the importance of initiatives focussing on infection prevention and control. Please note, these estimates of numbers are based on voluntary reporting in the human health sector.

Annex C - Glossary

Antimicrobial	An antimicrobial is a drug that selectively destroys or inhibits the growth of microorganisms. Sometimes referred to as an 'antimicrobial agent'. Examples include antibiotics (also known as antibacterials) antiviral and antifungal agents.
Antimicrobial resistance (AMR)	The ability of a microorganism to grow or survive in the presence of an antimicrobial at a concentration that is usually sufficient to inhibit or kill microorganisms of the same species and that exceeds concentrations achievable in the human / animal / patient.
Antimicrobial stewardship	The use of co-ordinated interventions to improve and measure the use of antimicrobials by promoting optimal drug regimen, dose, duration and route. The aim is for optimal clinical outcome and to limit selection of resistant strains. This is a key component of a multi-faceted approach to preventing antimicrobial resistance.
AmpC	AmpC β-lactamases are clinically important cephalosporinases encoded on the chromosomes of many of the Enterobacteriaceae and a few other organisms, where they mediate resistance to cephalothin, cefazolin, cefoxitin, most penicillins, and β-lactamase inhibitor-β-lactam combinations.
Broad-spectrum antibiotics	These are effective against a wide range of bacteria. For example, meropenem is a broad-spectrum antibacterial. Their use needs to be limited to resistant infections because they tend to increase the risk of resistance in other bacteria
Carbapenems	Carbapenems are broad-spectrum antibiotics, often used as the last line of treatment for hard to treat human infections caused by Gram-negative bacteria.
Carbapenemases	These are enzymes produced by bacteria which destroy carbapenems and other beta-lactam antibiotics.
Cephalosporins	Types of broad-spectrum antibiotics.
Cephalosporins – third-generation	Cephalosporins like cefotaxime and cefixime are particularly active against Gram-negative bacteria.
CQUIN	The CQUIN scheme is intended to deliver clinical quality improvements and drive transformational change. These will impact on reducing inequalities in access to services, the experiences of using them and the outcomes achieved.
Ciprofloxacin	Ciprofloxacin is an antibiotic belong to a group of drugs called fluoroquinolones. It is used to treat a number of bacterial infections including respiratory tract and urinary tract infections.
Critically Important Antimicrobials (CIAs)	Antibiotics identified by the World Health Organisation as critically important for human health and their use needs to be restricted, especially in the veterinary sector.
ESBL	Bacteria that produce enzymes called extended-spectrum beta-lactamases (ESBLs) are resistant to many penicillin and cephalosporin antibiotics and often to other types of antibiotic. The 2 main bacteria that produce ESBLs are Escherichia coli (E. coli) and Klebsiella species. The ESBLs that *E. coli* most often produce are called CTX-M enzymes. *E. coli* with ESBLs may cause urinary tract infections (UTIs) that can sometimes progress to more serious infections like blood poisoning, which can be life threatening. Resistance makes these infections more difficult to treat.
Gram-negative bacteria	Those bacteria that do not retain crystal violet dye in the Gram-staining procedure. They can cause many types of infection and include *E.* coli and *Pseudomonas aeruginosa*.
Gram-positive bacteria	These are bacteria that are stained dark blue or violet in the Gram-staining procedure. They include *Staphylococcus aureus* and *Clostridium difficile*.
Healthcare associated infections (HCAI)	Infections acquired via the provision of healthcare in either a hospital or community setting.

Multi-drug resistant	Resistant to multiple classes of antimicrobial.
Meticillin-resistant Staphylococcus aureus	MRSA – A strain of *Staphylococcus aureus* that is resistant to beta lactam antibiotics which include penicillins (eg 34ethicillin and oxacillin) and almost all cephalosporin antibiotics.
"One-Health" approach	Collaborative multi-disciplinary work at local, national, and global levels to attain optimal health for people, animals and the environment.
Pathogen	An infectious agent (bug or germ), a microorganism such as a virus, bacterium, or fungus that causes disease in its host.
Population Correction Unit	The Population Correction Unit (PCU) is a theoretical unit of measurement developed by the European Medicines Agency (EMA) in 2009 and adopted across Europe. It takes into account a country's animal population over a year, along with the estimated weight of each particular species at the time of treatment with antibiotics.
Prevalence	A snapshot at a particular point in time of the total number of cases, or proportion of resistant cases, in a given population.
Primary care	Services provided by GP practices, dental practices, community pharmacies and high street optometrists.
Quality Premium	The Quality Premium is intended to reward clinical commissioning groups (CCGs) for improvements in the quality of the services that they commission and for associated improvements in health outcomes and reducing inequalities
Quinolones	A family of antibiotics, includes broad-spectrum agents like ciprofloxacin.
Responsible prescribing	The use of antimicrobials in the most appropriate way for the treatment or prevention of infectious disease.
Secondary care	Covers acute healthcare, either elective care (planned specialist medical care or surgery, usually following referral) or emergency care.
Susceptibility testing	Testing to detect possible drug resistance in common pathogens and to assure susceptibility to drugs of choice for particular infections.