Public Health England

Protecting and improving the nation's health

Human Animal Infections and Risk Surveillance (HAIRS) group

Qualitative assessment of the risk that West Nile virus presents to the UK human health population

Updated December 2020

Contents

About the Human Animal Infections and Risk Surveillance group

This document was prepared by Public Health England (PHE) on behalf of the joint Human Animal Infections and Risk Surveillance (HAIRS) group.

HAIRS is a multi-agency cross-government horizon scanning and risk assessment group, which acts as a forum to identify and discuss infections with potential for interspecies transfer (particularly zoonotic infections).

Members include representatives from PHE, Department for the Environment, Food and Rural Affairs (Defra), Department of Health and Social Care (DHSC), Animal and Plant Health Agency, Food Standards Agency, Public Health Wales, Welsh Government, Public Health Scotland, Scottish Government, Public Health Agency of Northern Ireland and the Department of Agriculture, Environment and Rural Affairs for Northern Ireland.

Information on the risk assessment processes used by the HAIRS group can be found at www.gov.uk/government/publications/hairs-risk-assessment-process

Risk assessment version control

Date of this assessment: December 2020

Version: 3.0

Reason for the assessment/update: Continued outbreaks in Europe, including first detection of West Nile virus in a bird and *Culex* mosquitoes in the Netherlands in August/September 2020, and subsequently a human case in October 2020, as well as the expansion of *Culex modestus* in southern England.

Completed by: HAIRS Secretariat and members

Date of previous risk assessment: November 2017

Date of initial risk assessment: July 2006

Risk assessment summary

Overview: West Nile virus (WNV) infections have long been recognised in Europe where there is annual surveillance for human and equine disease. There is no evidence that WNV is present in the UK and very few travel related cases have been reported to date. Populations of competent mosquitoes (*Culex modestus*), that may act as bridge vectors have, however, been detected in areas of Essex and Kent.

Assessment of the risk of infection in the UK is:

- probability - Very low for the general population, Low for those living, working or visiting area with human biting mosquito vectors
- impact - Low/Moderate

Level of confidence in assessment of the risk: High

Action(s) and/or recommendations are:

- continue to monitor vector and host populations
- continue surveillance for autochthonous human and animal infections
- raise awareness amongst medical and veterinary professionals and encourage testing of humans, equidae and wild bird species in relevant areas of the UK with known vector populations
- raise awareness of the WNV plan and the Wetland Mosquito Survey Handbook with local and national government, authorities and resilience fora

Step 1: Assessment of the probability of infection in the UK human population

This section of the assessment examines the likelihood of an infectious threat causing infection in the UK human population. Where a new agent is identified there may be insufficient information to carry out a risk assessment and this should be clearly documented. Please read in conjunction with the Probability Algorithm following the boxes shaded green in Annex A. Where the evidence may be insufficient to give a definitive answer to a question the alternative is also considered with the most likely outcome shown in solid colour and the alternative outcome in hatched colour. The text alternative to the probability algorithm can also be found in Annex B.

Is this a recognised human disease?

Outcome: Yes

Quality of evidence: Good

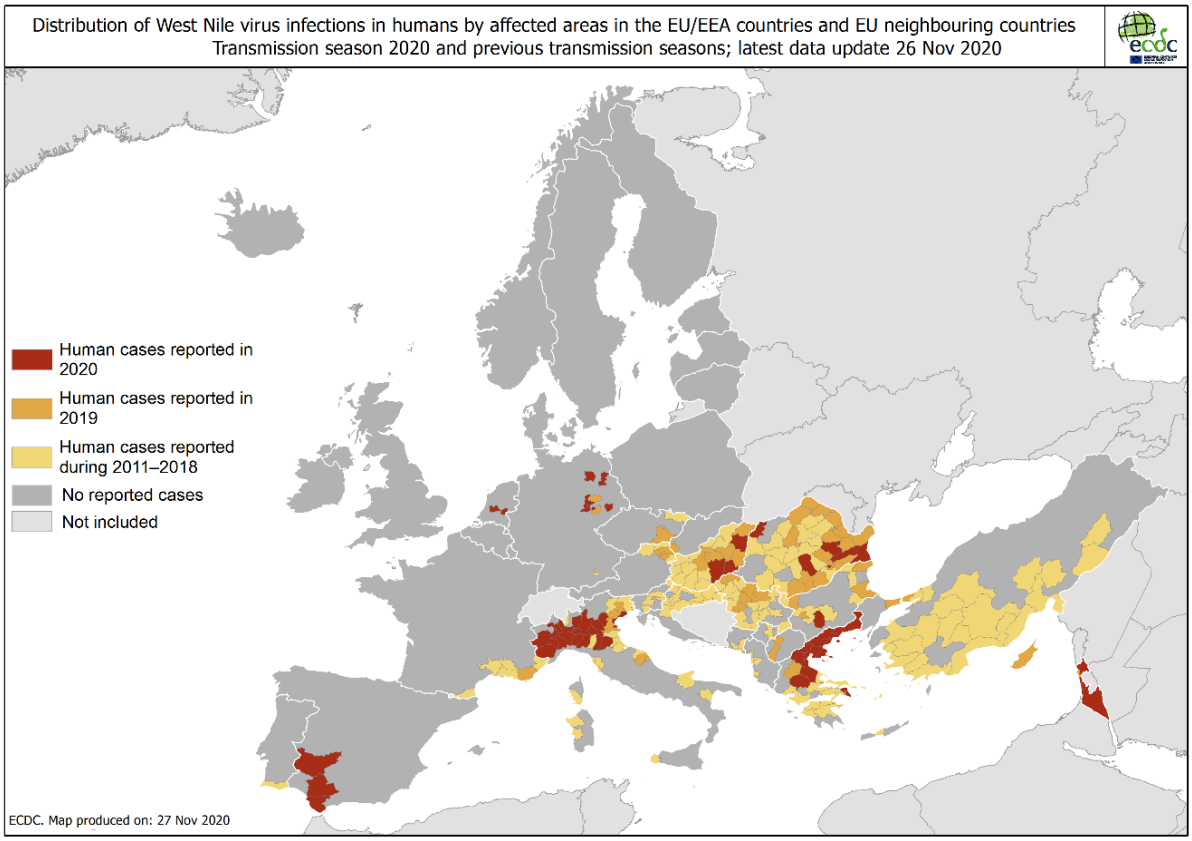
West Nile virus (WNV) is a viral infection of birds transmitted by mosquitoes, although horses and humans can also be infected but are dead-end hosts and not involved in the transmission cycle of WNV. The virus was first isolated in 1937 from a woman with fever in the West Nile district of Uganda and it was later recognised as a cause of meningo-encephalitis (1). WNV strains are characterised into several lineages, of which lineage 1 is globally widespread. Lineage 2 strains, endemic in southern Africa, appeared in Europe for the first time in Hungary in 2004. Over subsequent years, lineage 2 viruses have been found in eastern Austria, Greece, Italy and several countries in eastern Europe (2-4).

In 1999, WNV (lineage 1) was introduced into the eastern US, where human cases were preceded by large numbers of bird deaths (5). The virus spread westwards causing increasing numbers of human cases and deaths, peaking in 2003 with 9,862 cases and 264 deaths. Case reports and deaths have since reduced, but with substantial fluctuations year on year. Since 2015, and including preliminary data for 2019, numbers appear to have stabilised to an average of 2,005 cases (range 958-2,647) and 123 deaths (range 54-167) per year (6, 7).

Europe has experienced sporadic cases and outbreaks of WNV in humans and horses since the 1960's (1). After the first large outbreak in Romania in 1996, WNV was recognised as a public health concern in Europe. Since 2004 lineage 2 viruses have predominated. WNV infection is considered endemo-epidemic in parts of Europe, affecting countries in southern, eastern and western Europe (as described in Figure 1)

and is considered a re-emerging public health challenge in the Europe, with annual seasonal outbreaks during the summer months and early autumn (main transmission season between April and November). WNV infection in animals is reportable to the OIE (8), and human cases are notifiable to ECDC (9). Monitoring of cases in Europe continues annually throughout the transmission season (10).

Figure 1. Geographical distribution of West Nile virus human cases reported to ECDC since 2011 to 26 November 2020

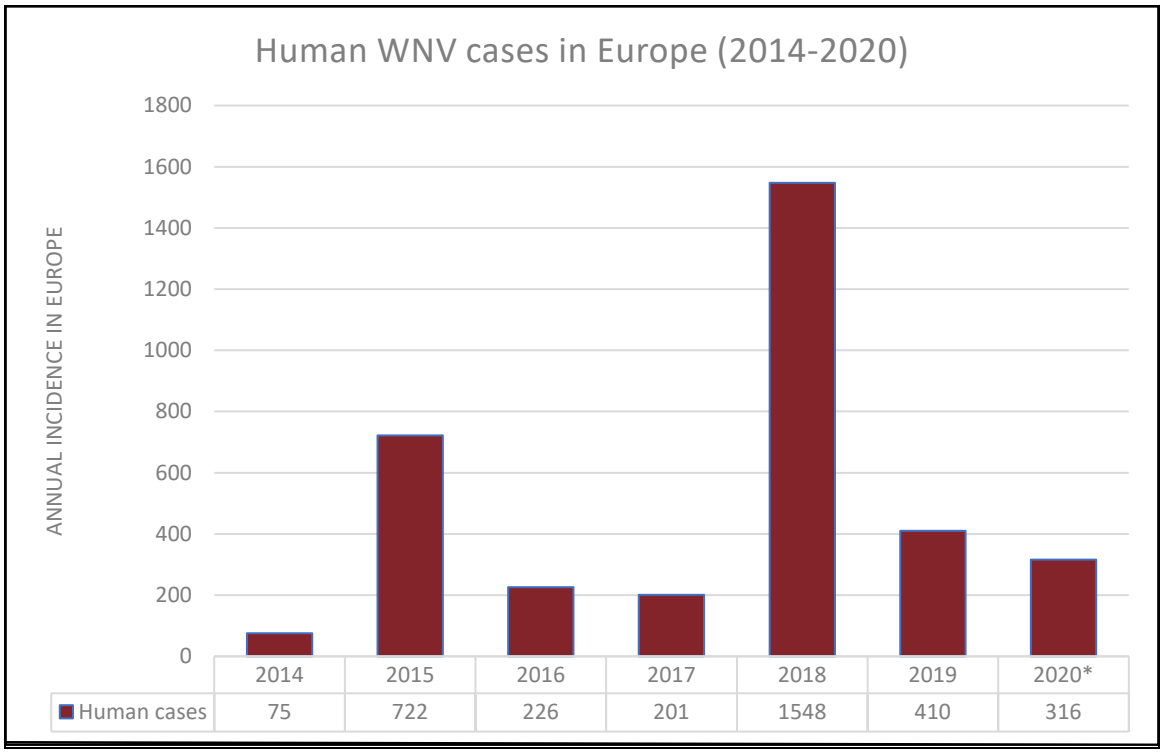


Further information can be found on ECDC's West Nile virus webpages

In recent years there has been a gradual expansion of the geographical range of human cases of WNV to more northern and western points in Europe as shown in Figure 1, where WVN infection cases peaked at 1,548 in 2018 (Figure 2). This is the largest number of WNV infection cases ever recorded in the continent, as it exceeds the cumulative number of all cases recorded in the previous 7 years as shown in the histograms below in figure 2. The notification rate for locally acquired WNV infections was almost 8 times higher in 2018 compared with 2017, and 4 times higher than reported in 2019. Almost all affected countries reported their highest annual incidence in 2018 and a longer than normal transmission season was observed (11). In 2019, both Germany and Slovakia reported their first autochthonous human WNV cases. The 2020 transmission season to November 2020 is notable for the large number of equid and human cases reported from south-west Spain and the first detection of locally acquired WNV infection in a bird, *Culex sp* mosquitoes and humans (7 cases to date) in the

Netherlands (12-15). As of 26 November 2020, 316 human cases have been reported so far in Europe in the 2020 transmission season.

Figure 1. Annual incidence of human cases of WNV in Europe between 2014 and 26 November 2020



Further information can be found on ECDC's West Nile virus webpages

Is this disease endemic in the UK?

Outcome: No

Quality of evidence: Good

Mosquito-borne diseases and transmission of mosquito-borne viral infections, in humans, are currently extremely rare events in the UK, unlike many parts of Europe and the USA. Between 2002 and 2012, enhanced surveillance for human cases of West Nile virus in the UK took place each year between 01 June and 31 October, the critical period for WNV transmission in Europe, and only travel-related cases were identified (16). As of December 2019, a total of 10 confirmed cases of WNV infection in humans had been recorded in UK residents, all acquired through travel: 3 to the USA, 2 to Canada, one each to Egypt, Hungary and South Africa, one to Eastern Europe and one to multiple destinations (17). No indigenous cases of WNV have been reported in the UK (17).

Are there routes of introduction into the UK?

Outcome: Yes

Quality of evidence: Good

Defra regularly perform qualitative assessments of the potential risk factors and likelihood for introduction of WNV into the United Kingdom (18). All routes (including the importation of infected animal germplasm; the legal trade of live poultry and captive birds; infected mosquitoes being blown across to the UK from infected countries; seasonal migrating birds from WNV endemic countries, movements of wild birds, in any month, crossing the English channel from affected European countries; mosquitoes imported via plants; or by means of transport vehicles) are currently deemed to present a very low risk of introduction to the UK (19, 20).

For WNV to be imported into the UK in viraemic migratory birds, the birds have to acquire virus prior to their arrival in the UK and remain viraemic long enough for them to be of concern when reaching the UK. When viraemic on arrival, they need to be in a location with active local mosquitoes for transmission to take place. The putative enzootic vector *Culex pipiens* overwinters as females, so there is a possibility of some biting in spring, but most *C. pipiens* activity occurs from July onwards, as does the adult activity of the putative bridge vector, *C. modestus.* Therefore, there would need to be viraemic birds in the UK during July and August for transmission by these mosquitoes to occur.

If the virus was endemic in UK birds, then transmission to humans would be expected. If there was a requirement for the virus to be re-introduced each year by migratory birds, then there is a likely disconnect between the arrival time of long-haul viraemic birds from Africa (March to May) and the activity of the UK enzootic and bridge vectors (July to September). Given the recent expansion of the WNV range in Europe, short-range migration of birds from affected countries in Europe, which can occur at any time of the year, may allow for the introduction of viraemic birds into the UK at peak vector activity times. However, there are potential limitations by weather on the extrinsic incubation of the virus, in contrast to southern Europe.

Any changes in mosquito seasonality, patterns of bird movements, the timing of viraemia and endemic WNV transmission in more of western Europe could affect the potential for incursion and local transmission in the UK.

Are effective control measures in place to mitigate against these routes of introduction?

Outcome: No

Quality of evidence: Good

The implementation of mitigation strategies to prevent the introduction of WNV by bird migration or mosquitoes is impractical. Proposed or currently applied measures to minimise the risk of WNV to the UK population concentrate on the early detection of infections in human or animal hosts and vectors, awareness of WNV, education in the methods to prevent mosquito exposure, and possibly vector control in the event of an outbreak.

The 2004 UK WNV contingency plan (21) sets out measures to raise awareness about potential infections; to enhance surveillance for the virus; to alert clinicians to the symptoms of West Nile fever; to communicate with veterinarians about the clinical signs of WNV in horses; and to control mosquito populations. It is acknowledged if indigenous competent vectors became widely established, an outbreak could be difficult to manage. A national contingency plan advising on local actions required on the detection of incursions of non-native invasive mosquito was published in 2020 (22).

Currently the primary strategy to minimise the risk of WNV to the UK population is surveillance. Monitoring and testing of potential cases of WNV in humans, horses, birds and mosquitoes is undertaken in the UK during the critical period for WNV transmission in Europe. No cases of bird, equine or human UK-acquired WNV have been detected thus far as of October 2020 (23-25).

To monitor the distributions of mosquito vector populations in the UK, PHE runs a passive mosquito surveillance scheme (mosquito@phe.gov.uk), with a dedicated database to record the incidences of mosquitoes nationally. PHE also runs a network of mosquito traps nationwide (26) with 20-30 locations across England each year.

Do environmental conditions in the UK support the natural reservoirs or vectors of disease?

Outcome: Yes

Quality of evidence: Good

A 2001-2 study looking for evidence of infection with WNV amongst both migratory and non-migratory birds suggested that virus was already present in resident (non-migratory)

birds in the UK (27). However, these serological findings were not supported by subsequent research and WNV was not isolated. There have been no detections of WNV through the annual testing of wild birds found dead in the UK (approximately 400 per year) by APHA (28). Avian hosts are however not likely to be a limiting factor for WNV transmission in the UK: birds ubiquitous in the UK, such as carrion crows (*Corvus corone*) (29) and house sparrows (*Passer domesticus*) (30), have been found to be susceptible and sufficiently viraemic to support transmission of WNV.

Of the 36 recorded species of mosquito in Britain, at least 9 species could potentially transmit WNV and 13 could act as bridge vectors as they bite both birds and humans (31). Should WNV be introduced to the UK, the most likely vectors would be mosquitoes belonging to genus *Culex*. Up until 2010, the most likely enzootic (transmission between birds) and bridge vectors (transmission from birds to humans) were the widely distributed *Culex pipiens* complex. Until recently, except for localised urban infestation of *Cx. pipiens molestus*, there appeared to be few situations in the UK where humans and livestock were exposed to sustained risks of exposure to mammal biting *Culex* and hence the primary WNV vectors (32).

However, an established population of *Cx. modestus* was discovered in the North Kent Marshes in 2010 (33). This was the first time this species, a recognised bridge vector for WNV, had been detected in the UK since 1944. In 2012, evidence of low numbers of *Cx. modestus* were found in the Cambridgeshire Fens (34). Since then PHE with academic colleagues have reported the presence of *Cx. modestus* across a number of wetland sites in North Kent (from Swanscombe to Canterbury) and in coastal Essex (from Rainham to Fingringhoe and Horsey) (35, 36). New and existing wetlands in this area may provide new habitats for *Cx. modestus* (37), and it appears that, in fact, it is expanding to new wetland sites, but so far there is no evidence of this mosquito in wetlands in Suffolk or Norfolk. PHE continue to monitor populations in these parts of England.

These findings highlight that *Cx. modestus* may be more widespread in the UK than previously realised, and in some locations, they are abundant. The WNV risk to humans and horses may be higher in these locations; however, further research on biting rates, host preference and dispersal, in addition to nationwide and targeted surveillance is ongoing (35, 38).

As both susceptible wild bird species and known bridge vectors are present in the UK, it remains an open question why WNV outbreaks have so far been limited to southern and central Europe. While various competence studies using *Cx. pipiens* mosquitoes from northern Europe resulted in lower transmission rates than studies performed with southern European mosquitoes, a direct comparison did not find any difference in competence (39, 40). However, temperature has been shown to increase vector competence of European mosquitoes for WNV (41-43), and it is believed that cooler

summer temperatures have so far limited the spread of WNV to northern European countries (39, 41). The risk of WNV outbreaks in the UK may thus increase with the increasingly warm summers.

There would need to be viraemic birds in the UK during July and August for transmission by native mosquitoes to occur but with endemic WNV areas in Northern and Western Europe the possibility of viraemic birds entering the UK in these months increases.

Will there be human exposure?

Outcome: Yes, in some areas

Quality of evidence: Good

WNV is maintained in a mosquito-bird-mosquito cycle. However, in favourable environmental conditions mosquitoes can proliferate and the risk of transmission to humans increases. The vast majority of infections are acquired through the bite of an infected mosquito. People can protect themselves by taking appropriate anti-mosquito measures (1).

Human exposure in the eastern US was linked to transmission by a hybrid form of *Cx. pipiens* which exhibited both bird and human biting tendencies. *Cx. pipiens pipiens* in the UK is believed to be predominantly bird biting and is unlikely to act as a bridge vector (32). *Cx. pipiens molestus* does bite humans, but evidence of bird biting is limited. Therefore, human exposure to the transmission of WNV by *Cx. pipiens* in the UK is likely to be different (much less) than has occurred in the US (32), even though vector competence for European variants of *Cx. pipiens* has been demonstrated (41).

Cx. modestus is a recognised bridge vector in Europe. However, as the human population is low in the marshes immediately adjacent to the Thames estuary and little is known about the dispersal ranges of *Cx. modestus* in the UK, it is difficult to quantify the significance of this vector to human exposures (33). However, PHE follow up all concerns about nuisance biting across England including the region where *Cx. modestus* occurs, to monitor which species are causing human biting. Some initial data is now available on host preference, confirming that *Cx. modestus* do seek blood meals from birds (including migratory) as well as humans (44-46).

Although human-biting *Culex* are likely to be the main vectors of WNV to humans in the UK, other mosquito species may play a role in transmission. For example, *Coquillettidia richiardii* bites both birds and humans and is implicated in WNV transmission elsewhere in Europe (32). Additionally, laboratory studies of vector competence of other British mosquitoes for WNV, such as *Aedes detritus*, have shown the potential for experimental

infection in the laboratory (47). However, there is no evidence to suggest they are significantly involved in transmission in the field.

Research into biting preferences (44-46, 48) and factors affecting the competence (39, 40) of relevant mosquito populations is ongoing.

Are humans highly susceptible?

Outcome: No

Quality of evidence: Good

Approximately 80% of humans infected have no symptoms at all and 20% have a mild influenza-like illness which generally lasts 3 to 6 days. A small proportion (less than 1%) can develop more severe disease such as, aseptic encephalitis, meningitis or meningo-encephalitis. Increasing age, particularly in those over 70 years, and immunosuppression are the greatest risk factors for the development of serious disease and death (1, 49).

Outcome of probability assessment

The probability of human infection with West Nile virus in the UK population:

General population - Very Low

Person living, working or visiting areas with human biting mosquito vectors - Low

Step 2: Assessment of the impact on human health

The scale of harm caused by the infectious threat in terms of morbidity and mortality: this depends on spread, severity, availability of interventions and context. Please read in conjunction with the Impact Algorithm following the boxes shaded green found in Annex C. Where the evidence may be insufficient to give a definitive answer to a question the alternative is also considered with the most likely outcome shown in solid colour and the alternative outcome in hatching. The text alternative to the impact algorithm can be found in Annex D.

Is there human-to-human spread of this pathogen?

Outcome: No

Quality of evidence: Good

There is no direct person-to-person spread. WNV transmission through blood transfusions and organ transplants from infected donors has been reported, but these methods of transmission contribute small numbers of cases to the overall burden of the disease. It is also possible for WNV to be transmitted from mother to unborn child or through breast milk (1, 50), but such cases are rare.

Is there zoonotic or vector-borne spread of this pathogen?

Outcome: Yes

Quality of evidence: Good

WNV is maintained in an enzootic cycle between ornithophagic mosquitoes and birds. Bridge-vector mosquitoes (those that feed on both birds and mammals) can spread the virus to humans, horses and other incidental hosts. Rare cases of zoonotic transmission have been described during horse or bird autopsy (1, 23, 51). Mosquitoes are responsible for the vast majority of human transmissions.

For zoonoses or vector-borne diseases, is the animal host or vector present in the UK?

Outcome: Yes, in some areas

Quality of evidence: Good

The main host of WNV are birds and the vectors are mosquitoes, principally *Culex* species. Both hosts and vectors are present in the UK (19, 32)

Is the UK human population susceptible?

Outcome: Yes

Quality of evidence: Good

Yes. There is currently no vaccine licensed to protect humans. WNV infections acquired abroad have been recorded in a very limited number of individuals in the last 10 years.

Does it cause severe disease in humans?

Outcome: Yes

Quality of evidence: Good

The majority of people infected (80%) are asymptomatic and around 20% have a mild flu-like illness. Less than 1% of cases can develop more severe disease such as aseptic encephalitis, meningitis or meningo-encephalitis. The case fatality rate in patients with neuro-invasive illness is up to 17% (1). Both WNV lineages 1 and 2 are associated with clinical disease in humans (2, 3).

Would a significant number of people be affected?

Outcome: No

Quality of evidence: Good

Only those who are exposed to and bitten by infected mosquitoes. Although there is limited information on the incidence of mosquito biting in the UK, sustained human biting is currently considered to be a localised event (52).

Are effective interventions (preventative or therapeutic) available?

Outcome: Yes/No

Quality of evidence: Good

The risk of contracting WNV infection can be reduced by preventing exposure to mosquitoes (use of repellent, long sleeves, avoiding being outside at dusk and dawn when *Culex* mosquito vectors are most active). There is currently no human vaccine available and there is no specific antiviral therapy, only supportive care (1). If there is an outbreak of WNV infection at a time when mosquitoes are active, measures to control mosquito populations, by either targeting their breeding sites or, more rarely, killing adult mosquitoes, will be considered based on local and national risk assessments, and the West Nile virus control plan (21, 22). PHE, with partners from Greenwich University, recently published a handbook for wetlands managers on assessing suitability of wetlands for mosquitoes (53).

Outcome of impact assessment

The impact of West Nile virus on human health in the UK: Low/Moderate

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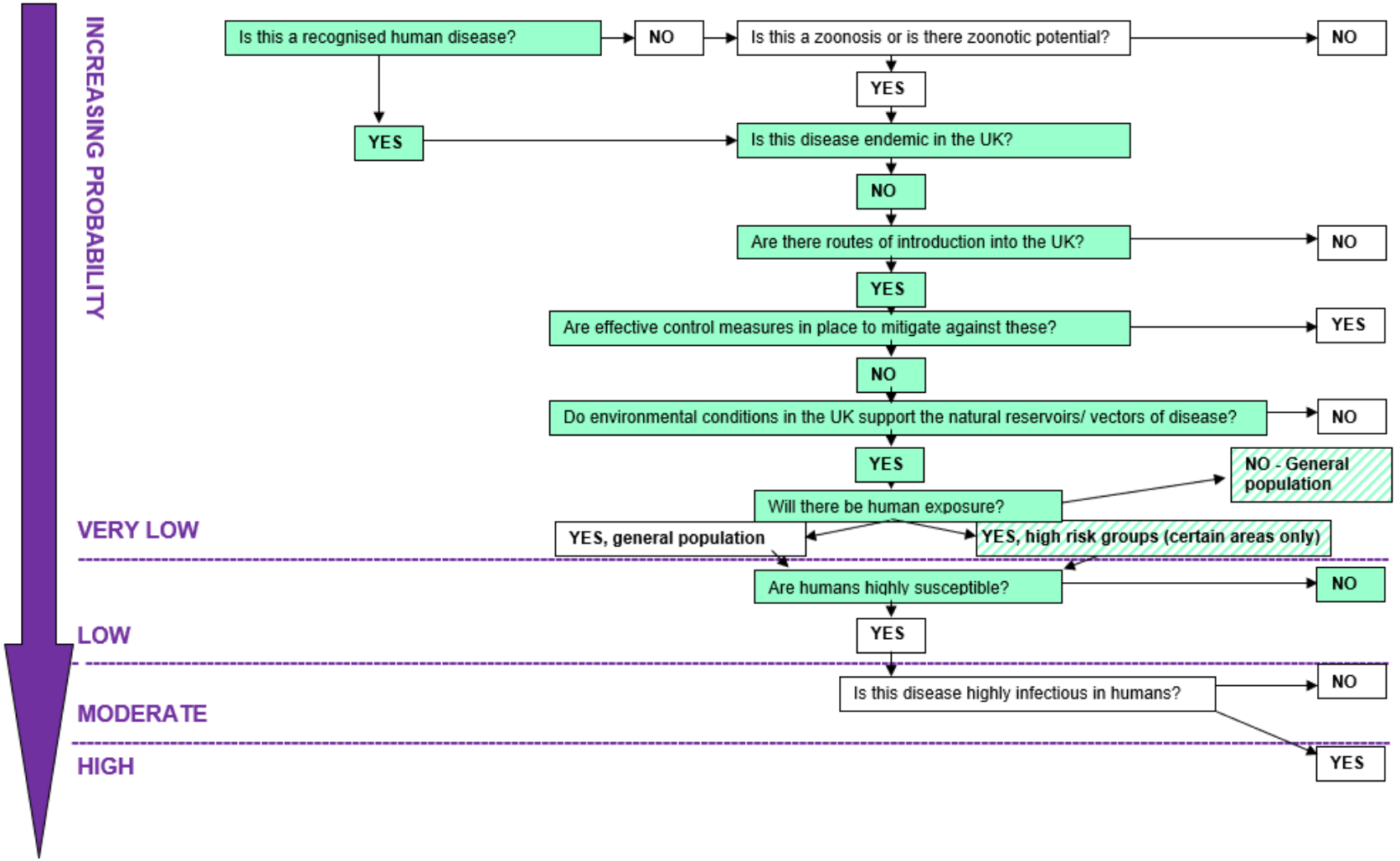
Annex A: Assessment of the probability of infection in the UK population algorithm



Annex B: Accessible text version of the assessment of the probability of infection in the UK population algorithm

Outcomes are specified by a ✓ beside the appropriate answer. Where the evidence may be insufficient to give a definitive answer to a question, the alternative is also considered with the most likely outcome shown with ✓✓ and/or the alternative outcome(s) with a ✓

Question 1: Is this a recognised human disease?

Yes: go to question 3 ✓
No: go to question 4

Question 2: Is this a zoonosis or is there zoonotic potential

Yes: go to question 3
No: probability of infection in UK population is very low

Question 3: Is this disease endemic in the UK?

Yes: go to question 7
No: go to question 4 ✓

Question 4: Are there routes of introduction into the UK?

Yes: go to question 5 ✓
No: probability of infection in UK population is very low

Question 5: Are effective control measures in place to mitigate against these?

Yes: probability of infection in UK population is very low
No: go to question 6 ✓

Question 6: Do environmental conditions in the UK support the natural reservoirs/vectors of disease?

Yes: go to question 7 ✓
No: probability of infection in UK population is very low

Question 7: Will there be human exposure

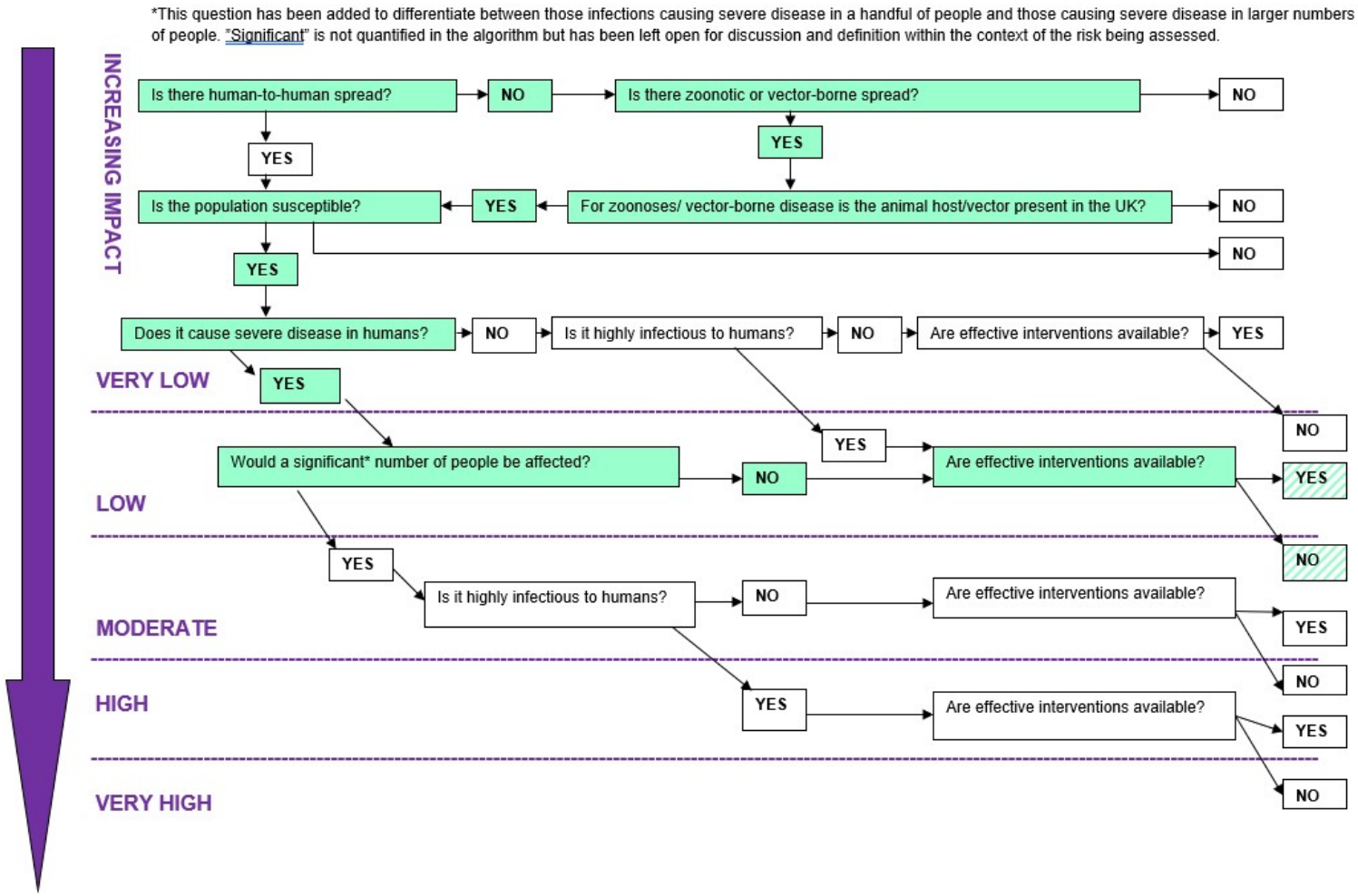
Yes: General population or high-risk groups: Go to question 8 ✓

No: probability of infection in UK population is very low✓

Question 8: Are humans highly susceptible?

Yes: go to question 9
No: probability of infection in UK population is low ✓

Annex C: Assessment of the impact on human health algorithm



Annex D: Accessible text version of the assessment of the impact on human health algorithm

Outcomes are specified by a ✓ beside the appropriate answer. Where the evidence may be insufficient to give a definitive answer to a question, the alternative is also considered with the most likely outcome shown with ✓✓ and/or the alternative outcome(s) with a ✓

Question 1: Is there human-to-human spread?

Yes: go to question 4
No: go to question 2 ✓

Question 2: Is there zoonotic or vector borne spread?

Yes: go to question 3 ✓
No: impact on human health in the UK is very low

Question 3: Is the animal host or reservoir present in the UK?

Yes: go to question 4 ✓
No: impact on human health in the UK is very low

Question 4: Is the population susceptible?

Yes: go to question 5 ✓
No: impact on human health in the UK is very low

Question 5: Does it cause severe human disease?

Yes: go to question 8 ✓
No: go to question 6

Question 6: Is it highly infectious to humans?

Yes: go to question 9
No: go to question 7

Question 7: Are effective interventions available?

Yes: impact on human health in the UK is very low
No: impact on human health in the UK is low

Question 8: Would a significant number of people be affected?

Yes: go to question 10
No: go to question 9 ✓

Question 9: Are effective interventions available?

Yes: impact on human health in the UK is low ✓
No: impact on human health in the UK is moderate ✓

About Public Health England

Public Health England exists to protect and improve the nation's health and wellbeing, and reduce health inequalities. We do this through world-leading science, research, knowledge and intelligence, advocacy, partnerships and the delivery of specialist public health services. We are an executive agency of the Department of Health and Social Care, and a distinct delivery organisation with operational autonomy. We provide government, local government, the NHS, Parliament, industry and the public with evidence-based professional, scientific and delivery expertise and support.

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