Animal & Plant Health Agency

# Canine Brucellosis:
## Summary information sheet for veterinary staff

## Contents


Summary ..... 2

1. Introduction ..... 3
2. Legal position ..... 4
3. Frequency of occurrence in Great Britain ..... 5
4. Clinical signs of canine brucellosis in dogs ..... 6
5. Transmission of infection between dogs ..... 6
6. Management of infected dogs ..... 7
7. Considerations before importing a dog or breeding from an imported dog ..... 9
8. Testing dogs for canine brucellosis ..... 10
9. How brucellosis spreads from dogs to people and risks to human health ..... 13
10. Symptoms of brucellosis in people ..... 14
11. Actions for people who have been exposed to *Brucella canis* ..... 14
12. Preventing transmission of *Brucella canis* from an infected dog in a veterinary setting ..... 14
13. Other animals at risk of infection with *Brucella canis* ..... 15


**This information is for veterinary staff. For information for members of the public, including owners of imported dogs and dog breeders, please see "Brucella canis: information for the public and dog owners". Vets are requested to ensure that owners of *Brucella canis* positive dogs are directed to this link for information.**

## Summary

**Introduction:** The bacterium *Brucella canis* (*B. canis*) is the most common cause of canine brucellosis in Great Britain (GB). Until 2020, very few cases were identified in dogs in GB. Since 2020, there has been a large increase in cases in dogs driven by an increase in the number of dogs imported in GB, especially imports from Eastern Europe.

**Legal position:** *B. canis* in dogs is a reportable disease under the 2021 amendments to the Zoonoses Order and positive test results must be reported to the Animal & Plant Health Agency (APHA). Occupational exposures to *B. canis* (including in veterinary settings) are subject to the requirements of the Control of Substances Hazardous to Health Regulations 2002 (COSHH) and accidents involving *B. canis* are subject to the Reporting of Injuries, Diseases, and Dangerous Occurrences Regulations 2013 (RIDDOR). Testing dogs for *B. canis* before importation to GB is strongly recommended but is not a legal requirement. Where there is a public health risk, legal options are available to the government to enforce proportionate measures. Outside of this all actions are voluntary.

**Frequency of occurrence in Great Britain:** There is no systematic surveillance for *B. canis* in GB, meaning that the true prevalence in dogs in GB is unknown. Cases appear to have been rising substantially since 2020.

**Clinical signs of canine brucellosis in dogs:** Dogs may have no signs or may have clinical signs. These are commonly reproductive including abortion and infertility. Puppies born to an infected female dog are more likely to be weak and to die soon after birth. Signs in infected dogs may also be non-specific and include lethargy, premature ageing, lameness, and generalised lymph node enlargement. Dogs without signs that are infected can still be infectious.

**Transmission of infection between dogs:** The most important route of transmission between dogs is the reproductive route and reproductive tissues and fluids from infected dogs contain high numbers of *B. canis* bacteria (including birth and abortion products, milk, seminal fluid, and oestrus blood). Transmission can also occur through exposure to other materials and fluids, such as urine, non-oestrus blood, faeces, saliva, and nasal secretions. Please report incidents where there is likely to be infection of multiple dogs.

**Management of infected dogs:** Unless legal powers have been granted (see above) all management options are voluntary. Euthanasia is the only way to completely eliminate all future risk of disease transmission from the dog. It is noted that this is potentially a very upsetting measure and owners may wish to consider treatment and take other ways of managing risk to animals and humans. Treatment is not recommended due to the poor likelihood of success and involves several weeks of antibiotic therapy (dual antibiotic therapy is the best option if this is pursued). Neutering reduces transmission risk but has not been proven to eliminate risk. Veterinary staff should be aware that neutering an infected dog has a risk of exposure to *B. canis* for those carrying out the procedure and appropriate precautions should be taken. There may be a risk to staff health from other treatments and procedures.

**Considerations before importing a dog or breeding from an imported dog:** Measures such as pre-import testing of dogs and owners being confident that male and female dogs are not infected before breeding would help reduce the number of infected dogs in GB. Dogs who are infected with *B. canis* or where there is any suspicion of this should not be bred from.

**Testing dogs for canine brucellosis:** Validated testing methods for *B. canis* in dogs include culture and serology. PCR tests are available but have not been validated. Serological testing is recommended in most cases and for pre-import testing. Samples can be submitted to the UK National Brucella Reference Laboratory, APHA Weybridge for testing, following appropriate procedures. Testing at this laboratory is done using two test types in parallel, giving a high sensitivity and specificity. Serology results must be interpreted in the context of the presence or absence of risk factors for infection with *B. canis*. Further information on testing can be found in this section and in the "Frequently asked *Brucella canis* testing questions" document (accessible here).

**How brucellosis spreads from dogs to people and risks to human health:** Humans can be infected with *B. canis*, though human cases have only been rarely reported internationally. Information on the human health risks can be found in a risk assessment by the Human Animal Infections and Risk Surveillance Group (HAIRS). Contact with reproductive materials and fluids from a dog infected with *B. canis* is associated with a higher risk of transmission. People who are immunosuppressed and young children may be at higher risk of clinically apparent and severe illness after infection with *B. canis*. There is very limited evidence available to understand the risk to people who are pregnant. Human to human transmission of *B. canis* has not been reported but is theoretically possible.

**Symptoms of brucellosis in people:** Signs and symptoms in humans are often mild and include fever, loss of appetite, weight loss, sweating, headaches, fatigue, and back or joint pain. Serious illness and complications from *B. canis* have been reported.

**Actions for people who have been exposed to *Brucella canis*:** Signs and symptoms may occur within one week of exposure and up to six months later. People who may have been exposed to *B. canis* should be aware of the signs and symptoms and seek medical attention if these develop. They should inform the clinician that they have been exposed to *B. canis* specifically. Veterinary staff who have had a high-risk exposure in the last six months should contact their local health protection team. Vets are requested to ensure that owners of *B. canis* positive dogs are directed to "Brucella canis: information for the public and dog owners" for information.

**Preventing transmission of *Brucella canis* from an infected dog to people in a veterinary setting:** Where there is a risk of exposure to *B. canis*, veterinary practices must carry out a local risk assessment and ensure that appropriate control measures are in place. Waste that may be contaminated with *B. canis* should be disposed of as infectious waste.

**Other animals at risk of infection with *Brucella canis*:** Infection and disease from *B. canis* in animals other than dogs is exceptionally rare.

## 1. Introduction

This document is aimed at veterinary staff and represents disease specific information relating to infection of dogs with *Brucella canis* (*B. canis*) in Great Britain (GB) (England, Scotland, Wales) and associated issues. It is not an official statement of government policy. This document may be revised in future as more information about *B. canis* in GB becomes available, so please check the Animal & Plant Health Agency (APHA) Vet Gateway regularly to ensure you have the most up to date version.

*B. canis* is the most common *Brucella* species found in dogs although other *Brucella* species can also cause infection. In countries from which most imported dogs into GB originate, any *Brucella* infection in dogs is predominantly due to *B. canis*. As there are no other species of *Brucella* present in GB terrestrial animals, *B. canis* is the most likely cause of a dog in the GB having brucellosis, whether imported or born in GB. *B. canis* can also infect humans and cause disease.

Although a member of the *Brucella* genus, there are some important distinctions between *B. canis* and other classical *Brucella* species (i.e. in this context - *B. abortus*, *B. melitensis* and *B. suis* ["*B. ab/mel/suis*"]). These three *Brucella* species may infect livestock and humans and account for the vast majority of human infections globally (*B. mel* > *B. ab* > *B. suis*). GB is free from these bacteria and the diseases they cause and has strong systems in place to maintain this freedom, for example livestock surveillance, international trade testing, and a strong legal framework to underpin this. There are also well recognised and internationally established testing processes in place, for example through the World Organisation for Animal Health (WOAH), with respect to *B. ab/mel/suis* owing to the significance of the threat they present to the livestock

industry and human health. The incidence of *B. canis* has no impact on the Officially Brucellosis Free status of the UK as this relates only to the presence of *B. ab/mel/suis* in livestock.

The situation with respect to *B. canis* is quite different. It does not cause disease in livestock and although it can and does infect humans, compared to the incidence of human disease due to infection with *B. ab/mel/suis*, the number of identified cases of human infection and disease due to *B. canis* is many orders of magnitude lower (although there are significant knowledge and capability gaps in this area). At present, there are no universally recognised and internationally established testing processes in place for *B. canis*, no chapter in the WOAH manual, and it is not a listed disease under EU Animal Health Law. Furthermore, *B. canis* also has a different bacterial cell surface structure compared to that of *B. ab/mel/suis* and consequently the serodiagnostic methods used to test for infection with *B. canis* are very different from those used to test for infection with *B. ab/mel/suis*.

Relative to the disease caused by *B. ab/mel/suis* (in both animals and humans) there are many knowledge and capability gaps with respect to infection and disease caused by *B. canis*. Some of these are listed in the Human Animal Infection Risk Surveillance group (HAIRS) Risk Assessment (link). This is at least partly because *B. canis* is believed to have less impact on human health and economics and there has therefore been less money available to support research and development activities.

Prior to 2020 *B. canis* infection in dogs was an exceptionally rare occurrence in Great Britain (GB) (with only 3 cases identified previously, all from imported dogs). A huge increase in the number of dogs imported into GB in recent years (HAIRS risk assessment: Brucella canis) especially from Eastern Europe, has led to a large increase in the number of identified cases (Zoonoses and Veterinary Public Health: disease surveillance reports). As of July 2023 in GB, there have been two laboratory-confirmed cases of human brucellosis caused by *B. canis*.

The risk to human health has recently been reviewed by HAIRS and a Risk Assessment has been published (HAIRS risk assessment: Brucella canis).

The number of reported incidents of *B. canis* infections in dogs are reported on a Quarterly basis in the publicly available APHA Zoonoses and Veterinary Public Health: disease surveillance reports.

## 2. Legal position

The primary legislation that covers brucellosis in dogs is the Animal Health Act 1981 (**https://www.legislation.gov.uk/ukpga/1981/22/contents**), with the secondary legislation being the Zoonoses Order 1989, amended to cover dogs in 2021.

The 2021 amendments to the Zoonoses Order made it a legal duty to report positive test results relating to the detection or diagnosis of *B. canis* in dogs to the competent government authority (along with the provision of specified statutory information). However, canine brucellosis in dogs due to infection with *B. canis* is not notifiable (note, canine brucellosis due to infection with *B. ab/mel/suis* is a notifiable disease). For a notifiable disease in animals a suspicion of infection must be notified to the relevant authorities by the animal's keeper or vet, whereas for a reportable disease only a positive test result must be reported. As a result, the legal position with respect to *B. canis* is different to that for *B. ab/mel/suis*. Legal powers do exist – under the Zoonoses Order – that enable government bodies to take (or enforce) actions when there is a proportionate public health risk. Outside of this, all actions with respect to the management of dogs with *B. canis* infection are voluntary. However, this does not prevent the option of individuals taking civil action, for

example owners taking action against those distributing dogs that are infected. Testing dogs prior to importation into the UK is strongly recommended but at the moment is not a legal requirement.

*B. canis* is categorised by the Advisory Committee on Dangerous Pathogens (ACDP) as a Hazard Group 3 pathogen which has ramifications with respect to control of occupational exposure (under the Control of Substances Hazardous to Health Regulations 2002 (COSHH)) and reporting of occupational infection and exposure to the Health and Safety Executive via RIDDOR (Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 2013).

## 3. Frequency of occurrence in Great Britain

Canine cases of *B. canis* appear to be rising in number in GB due to increasing numbers of imported dogs, some of which are infected. Because of mixing and breeding, the first identified cases of within-GB transmission of this disease have now occurred.

The prevalence of canine brucellosis (and infection of dogs with *B. canis*) in GB is unknown and, as there is no systematic surveillance, it is not possible to generate a reliable estimate. Testing for *B. canis* in GB is voluntary and comprises a combination of testing done for pre-export purposes (for example to New Zealand and Australia), for diagnostic purposes (for example if dogs have clinical signs consistent with brucellosis, especially if there are also other risk factors), for screening purposes (some veterinary centres may have a policy on this for imported dogs), and for contact tracing relating to a confirmed case. The results from this testing do not allow for an estimate of prevalence of infection in GB or within dogs being imported into GB. Reliable estimates for prevalence in other countries, including those countries from where significant numbers of dogs have been imported, are also unavailable due to an absence of surveillance and testing. This lack of information globally is partly due to lack of resources directed into this question and difficulties with respect to the tests themselves; for example, imperfect sensitivity and specificity and a lack of international standardisation and harmonisation (for more information refer to subsequent text on testing).

The number of cases of *B. canis* infections in GB dogs is reported quarterly by APHA (with an additional annual report). From 2020 to 2022 (inclusive) there have been 100 incidents with 262 dogs tested as part of these and 143 dogs positive. In the first quarter of 2023 there were 22 incidents with 103 dogs tested, 43 being positive. All cases had been associated with imported dogs, although within-GB transmission has occurred. In the second quarter of 2023 there were 50 incidents with 54 positive dogs identified. Prior to 2020 only 3 cases in dogs, confirmed by isolation of *B. canis* by culture, had been identified in GB (all imported from Eastern Europe).

The APHA considers an incident to be a single independent epidemiological event. Each event may involve one or more dogs. For example, many cases are just one dog (imported rescue dog) while another case may involve a breeder with a number of dogs where more than one dog is infected. Most of these cases have been determined based on positive serology and epidemiological evidence but without isolation of *B. canis*. Completely unequivocal confirmation of infection can only be achieved by isolation, by bacterial culture, of *B. canis* from a sample from the animal in question. Unfortunately, bacterial culture, especially from blood (the most accessible sample), has poor diagnostic sensitivity (estimated to be less than 50%). Dependence on isolation of *B. canis* by culture to identify cases would result in a high number of false negative results and leave infected animals as unidentified, uncounted, and presenting ongoing risk to human and animal health. *Brucella* culture is therefore not routinely applied as it is not appropriate as a confirmatory assay, nor is it appropriate as a routine screening assay due to its low sensitivity. Culture is also more labour intensive and costly than other forms of testing (especially as the classification of *B. canis* as an ACDP Hazard Group 3

pathogen requires culture within a high-containment (CL3) laboratory). Since the start of 2020, to the end of March 2023 there were 18 dogs in GB from which *B. canis* has been isolated by culture.

## 4. Clinical signs of canine brucellosis in dogs

In female dogs, brucellosis usuallycauses abortion between the 45th and 59th day of the first pregnancy following infection. Subsequent pregnancies are more likely to reach full term, although pups may be weak and more likely to die shortly after birth. Other puppies in the same litter may appear healthy but develop brucellosis later in life. Other common reproductive issues include failure to conceive in an otherwise healthy dog, infertile males with abnormal semen quality, and enlarged and painful testicles and epididymis that may subsequently decrease in size in chronic infection. Non-specific symptoms for both sexes include: lethargy (decrease in activity, appearing depressed), loss of libido, premature ageing, lameness (particularly back pain), and generalised lymph node enlargement. However, in many cases the disease may show no clinical signs. Dogs with no clinical signs can still be infectious and therefore a vehicle of disease transmission. Outwardly healthy but infected dogs are also at high risk of going on to suffer clinical disease later in their life. Further information about clinical signs can be found in the BSAVA Scientific Information Document for *Brucella canis*.

## 5. Transmission of infection between dogs

Canine brucellosis is primarily a reproductive disease, although non-reproductive routes of transmission are also possible. The most important routes of transmission of infection between dogs are those linked to reproduction, i.e.

- Through mating
- Contact with products of conception from an infected dog e.g. abortion material and birth products
- Vertical transmission (from mother to pup) within the uterus and/or from ingestion of infectious milk from the mother (all puppies will have been exposed and are at high risk of infection)
- Contact with infectious seminal fluid
- Contact with vaginal discharges, both oestrus fluids when a bitch is in heat/ season and those shed for several weeks following an abortion or apparently normal birth

Disease transmission via non-reproductive routes may also occur although this is a less important means of spread (i.e. less likely to occur):

- Contact with infectious urine (as infected dogs may excrete *B. canis* in the urine). Intact males are believed to present the highest risk, most likely due to the mixing of semen with urine. Neutered males are considered less likely to excrete infectious urine although this may still occur as *B. canis* may still reside in the prostate. Female dogs are considered less infectious, especially if neutered. Excretion in the urine is intermittent and the *B. canis* concentration variable
- Contact with non-oestrus blood, as this may contain *B. canis*
- To a far lesser extent faeces, saliva, or nasal secretions may be infectious although this is unusual and there is little evidence to demonstrate that such material would contain an infectious dose of *B. canis* and there has been no strong evidence that transmission has occurred via this pathway

- Contamination of the environment with infectious material may also lead to disease transmission. *B. canis* bacteria can survive in areas with high humidity and low temperatures with no sunlight for long periods of time. Therefore, dust, dirt, water, clothing, and other inanimate objects which have been contaminated with high-risk infectious fluids can pose a transmission risk for a prolonged period, possibly several months

The reproductive routes of dog-to-dog transmission (especially the first four bullet points above) are the most significant and present the highest risk of the spread of disease. Consequently, intact breeding dogs present the highest risk of dog-to-dog transmission (and also to humans as breeding such dogs will ultimately generate birth and abortion material that can contain very high numbers of *B. canis* bacteria). Intact but not breeding dogs do not present the same level of transmission risk, but excretion of fluids associated with reproduction will present a hazard. Intact dogs are also considered more susceptible to infection as they possess the reproductive tissue that *B. canis* has preference for. Neutered dogs are less of a threat as the reproductive means of transmission is closed off and they are also less likely to excrete *B. canis* in urine.

Dogs with clinical signs of disease may also be more infectious, although definitive evidence for this is limited. Dogs in transient contact with infected dogs, for non-breeding purposes, are unlikely to become infected on a single given occasion. However, multiple contacts or sustained contact increases the risk accordingly. Time spent in the environment where any of the above infectious material exists is also a risk, even without direct physical contact with an infected dog.

If it is likely that an infected dog has sire, dam, siblings or mates in the UK (for example it may have acquired infection at a breeder or it may have been imported with siblings) please report the relevant information to AHPA to help prevent further spread of disease. In England this can be done via the Defra Rural Services Helpline on 03000 200 301 (or email customeradvice.dutyvet@apha.gov.uk). In Wales, contact 0300 303 8268 (or email APHA.cymruwales@apha.gov.uk). In Scotland, contact your local Field Services Office.

## 6. Management of infected dogs

The management approach is ultimately up to owners (ideally in agreement with their vet) in all but the most extreme cases, where it might be considered that there is a substantial threat to public health (see Section 2. Legal position) and/or animal welfare. We understand the attachment that owners have for their dogs but we would also wish to prevent this disease from becoming endemic in GB as this would place many more dogs and people at risk.

- **Euthanasia:** it is very difficult to cure an infected dog, and if it is suffering from disease caused by *B. canis* then euthanasia may be the only way to stop it suffering. Once infected, the only way to completely eliminate any future risk of disease transmission to humans and other dogs is euthanasia, whether or not the dog is showing clinical signs. It is recognised that this is a severe and potentially very upsetting measure and that owners may not wish to make this choice and try to manage risks by other means. The risks will vary according to the specific nature of each case. The willingness (or not) to accept risk will vary between owners as will the judgement that people make when considering what action is proportionate for containing infection.
- **Treatment:** Treatment is not recommended as it has a poor success rate and can give a false sense of security. However, treatment is not illegal and some owners may wish to attempt treatment if clinical signs are present. However, treatment failure is common (even if it appears initially successful) and treatment is prolonged, expensive, and may have several serious side effects. It also

presents risks with respect to the potential development of antimicrobial resistance not only in *B. canis* but any other bacteria that the dog may be carrying. Long term treatment with antimicrobials could be subject to challenge over the quality of the prescribing vet's stewardship of antimicrobials. If owners choose to pursue treatment, it is important to note that it is expensive as it involves several weeks of therapy with antibiotics. Antibiotics in combination (often referred to as dual antibiotic therapy) provide the best option, but even this is often unsuccessful at eliminating the infection. It is impossible to prove that treatment has completely eliminated infection. Recurrence of disease is common, even after long term use of antibiotics, as the bacteria can hide in parts of the body (such as within cells of the reproductive tissue) that are hard for antibiotics to reach. Therefore, the dog may remain infected, be susceptible to recurrence of illness, and be an ongoing source of infection for other dogs and humans even if outwardly healthy. There is no universally acknowledged best treatment regimen. However, attached below are links to articles describing treatment options:

  - Canine Brucellosis: An Update - PubMed (nih.gov)
  - Brucella canis: An update on research and clinical management - PubMed (nih.gov)
  - Canine brucellosis management - PubMed (nih.gov)
  - Canine brucellosis - PubMed (nih.gov)
  - Use of enrofloxacin in the treatment of canine brucellosis in a dog kennel (clinical trial) - PubMed (nih.gov)
  - Antibody response over time correlated with treatment outcome in 30 dogs naturally infected with Brucella canis (2017-2022) - PubMed (nih.gov)
  - Canine brucellosis due to Brucella canis: description of the disease and control measures - PubMed (nih.gov)
  - Effect of a two-stage antibiotic treatment regimen on dogs naturally infected with Brucella canis – PubMed (nih.gov)
  - The effect of a two-stage antibiotic regimen on dogs infected with Brucella canis - PubMed (nih.gov)
  - Full article: The emergence of *Brucella canis* as a public health threat in Europe: what we know, and what we need to learn (tandfonline.com)

- **Neutering:** Neutering of the dog (male or female) will reduce transmission risk as it eliminates the reproductive route of transmission and some of the tissues that *B. canis* usually colonises. However, neutering alone has not been proven to fully eliminate the risk of transmitting infection to others because it does not remove all the bacteria from the body. If a vet decides to neuter an infected dog (or one where infection is suspected) they should be aware of the risks of human infection with *B. canis* that can arise from this procedure and take actions to mitigate this. Neutering could result in human exposure to material infectious with *B. canis* if not performed with due care and appropriate controls.
- **Antibiotic treatment and neutering:** Treatment with antibiotics against *B. canis* before neutering may reduce the transmission risk to the veterinary surgeon and team undertaking the surgery by reducing the bacterial load within the animal and target tissues, and minimises a potential infection flare up in the immediate post-surgery period. This combined approach (if antibiotic treatment is sustained) also offers the best chance of eliminating infection from the dog itself but there remains no guarantee.

- **Other treatments and procedures:** Other treatments such as taking blood or joint aspirates (to investigate lameness) or procedures such as collecting semen, undertaking a caesarean, or assisting whelping may also present a risk to humans. Where diagnostic samples collected are being sent for bacterial culture, laboratories should be made aware that brucellosis due to infection with *B. canis* is a potential diagnosis especially if methods used may propagate *B. canis*.

- **Repeat testing of infected dogs:** The value of repeat testing is dependent on several factors. For example, in the event a dog tests positive but is clinically well and therefore antibiotic treatment is not recommended this dog may be infected for life and repeat testing would not be required (unless the dog developed clinical signs in which case a rise in titre, i.e. increased antibody levels in the blood, may indicate this is due to emergence of *Brucella*). In the event a dog is infected and presenting with clinical signs and the owners decide against euthanasia, repeat serological testing after antibiotic treatment may be useful to ensure that antibody titre never rises (which would indicate re-emergence of *Brucella*). If an infected but outwardly healthy dog's serological result (titre) increases on subsequent testing, or it develops illness with clinical signs consistent with infection due to *B. canis,* its prognosis worsens and its management should be re-considered.

- **Managing movement/lifestyle of infected dogs:**
    - Infected dogs should not be used for breeding as the reproductive means of transmission are the most important (vertical, horizontal, infectious abortion/parturition material). Breeding infected dogs will result in events presenting high risk of exposure, i.e. abortion or birth.
    - Non-reproductive means of dog-dog transmission are less important than reproductive routes but can still occur. Infection can occur via ingestion, inhalation, contact with mucus membranes (such as the eyes), and also though broken skin (e.g. cuts and grazes). The most probable pathway for this is via the excretion of infectious urine and contact with this by other dogs. Intact male dogs are considered to present the highest risk of transmission to other dogs via this route. *B. canis* targets and infects the reproductive tissue in dogs so it is probable that they are also more at risk of infection that neutered dogs. The more frequent and longer the contact between dogs (enabling contact with potentially infectious excretions) the higher the risk of transmission. Transmission of disease to breeding dogs via non-reproductive means will likely trigger another cycle of disease transmission.
    - In many cases, the definitive infection status of the dog is not 100% certain and this is another component that feeds into decision making with respect to the dog's future.

## 7. Considerations before importing a dog or breeding from an imported dog

If importing a dog from abroad, especially a rescue dog or a dog that has or may have bred before, then testing the dog prior to import will help to avoid bringing infected animals into the country (see Section 8. Testing dogs for canine brucellosis). Infected dogs will be an infection risk to other dogs in GB, their owner's family, veterinarians and veterinary staff, and anyone else in contact with the dog (the relative risk being commensurate with the type of contact, as described elsewhere in this document).

Before breeding any dog (whether by mating it or via artificial insemination), owners should be confident that neither the male nor female dog are infected. If there is doubt (for example they may have been imported from a country where canine brucellosis occurs or have previously mated with a dog from such a country or are a contact of a confirmed case) they should be tested for infection (see Section 8. Testing dogs for canine

brucellosis). Dogs should not be bred if they test positive for brucellosis. If the dog has only recently been imported, or only recently bred with an imported dog, then testing on more than one occasion may be necessary to determine whether it is infected. A negative test result from testing at least 3 months after potentially becoming infected should mean the negative test result can be relied on for an adult dog, but a young dog may not test positive after being infected until it is an adult (if at all). If there remains any suspicion that a dog may be infected, the dog should not be bred from.

## 8. Testing dogs for canine brucellosis

Test results must be considered alongside additional evidence, such as clinical signs, movement history and infection status of contact and related dogs (e.g. siblings, parents and dogs the individual has mated with or been in close contact with when giving birth or aborting) in order to determine the probable infection status of the dog in question. For serology it is crucial to use a test that is specific to *B. canis*, as tests that detect smooth *Brucella* species (e.g. *B. ab/mel/suis)* will not detect *B. canis* and will result in a false negative result if *B. canis* is present.

Important metrics to consider before and after testing:

- Diagnostic sensitivity (DSn [or sometimes DSe]): Percentage of known infected animals that test positive in the assay; infected animals that test negative are considered to have false-negative results
- Diagnostic specificity (DSp): Percentage of known uninfected animals that test negative in the assay; uninfected animals that test positive are considered to have false positive results
- Analytical sensitivity: the ability of an assay to detect a specific analyte within a matrix (sometimes expressed as the lowest limit of detection and often determined with spiked samples)
- Analytical specificity (or Exclusivity): the ability of the assay to detect an analyte that is unique to a targeted organism
- Positive Predictive Value (PPV): The probability that an animal that has tested positive is infected with the disease being tested for
- Negative Predictive Value (NPV): The probability that an animal that has tested negative is not infected with the disease being tested for

The Predictive Values are influenced by the true prevalence of the disease in the target population and are a function of this and the DSn and DSp values. For example, the PPV will be higher when the prevalence of the disease is higher and the PPV will be lower (there will be more false positive results) when the prevalence of the disease is lower.

For a useful guide for information about these values refer to the WOAH Manual of Diagnostic Tests and Vaccines for Terrestrial Animals, Chapter 1.1.6 (noting that brucellosis due to *B. canis* infection is itself not covered by WOAH, although the principles for the test metrics above still apply)

**Culture and PCR:** Some tests aim to detect *B. canis* directly (bacterial culture) or detect specific DNA from *B. canis* (PCR). However, blood samples from infected dogs may not always contain *B. canis* or its DNA, so a negative result from these tests is not a sufficient guarantee of absence of infection. Successful culture of *B. canis* is definitive evidence of infection and is 100% specific (i.e. there will be no false positive results).

Bacterial culture or PCR from suitable clinical material is diagnostically effective (e.g. materials from abortion or birth or a vaginal swab from an animal shortly after giving birth). The sensitivity of bacterial culture will vary according to the type of material cultured and the age/condition of that material, and therefore it is limited as a diagnostic tool as it is not sufficiently reliable to determine the infection status of an individual animal unless the result is positive (i.e. false negatives can occur). PCR has the potential for rapid results; however, there are no validated methods for this and therefore diagnostic sensitivity and diagnostic specificity data are not available. For this reason, APHA do not offer this method. It is available commercially from other providers; however, their methods are also unvalidated and the results therefore of limited value.

**Serological tests:** Indirect tests aim to detect antibodies in the blood that are specific to *B. canis* and are known as serological tests. Positive serology results provide evidence of a current or previous *B. canis* infection that the dog's immune system has responded to, even if *B. canis* is not directly detected. *B. canis* infection often persists for many years, potentially for the whole lifetime of a dog – even in the absence of clinical signs - therefore all positive results should be considered significant. However, detectable antibodies against *B. canis* are not produced by all dogs. This may be more common in puppies because their immune system may not have been sufficiently developed when they were first exposed to *B. canis*. The UK National Brucella Reference Laboratory at APHA Weybridge recommends serological testing in most cases in order to obtain results with the most reliable diagnostic sensitivity. This would also apply for any pre-import testing. Antibodies are typically produced within two weeks of infection, although it may take up to three months. Therefore, if there is suspicion of infection, a blood sample should be taken for serological testing three months after the dog in question was last in contact with an infected dog or infectious material. This may mean taking a repeat sample if the initial sample was taken shortly after the potential exposure, to provide the highest confidence that a negative result is a true indication of a dog's infection status.

Various *B. canis* serology tests are available commercially and the diagnostic sensitivity and specificity will vary depending on the test type and the manufacturer. It is recommended that samples are submitted for tests that detect both IgM antibodies (more abundant in early infection) and IgG antibodies (more abundant in late stage/chronic infection) to ensure detection from early to late stage/chronic infection. If testing was performed at a laboratory other than the UK National Brucella Reference Laboratory at APHA Weybridge it is recommended that samples are submitted to APHA Weybridge for confirmatory testing, although this is voluntary (for more information about testing at APHA please refer to APHA's "Frequently asked *Brucella canis* testing questions" document (accessible here). Information on the recommended test types and the sample submission procedure can be found below.

- **Screening or diagnostic serology:** APHA recommend that serum samples are submitted to APHA Weybridge for *B. canis* SAT (Serum Agglutination Test) and *B. canis* iELISA. By combining the SAT and iELISA in parallel (such that if either test is positive, then the sample is considered serologically positive) the protocol can detect both IgM and IgG antibody isotypes. If both tests are negative, then the sample is considered serologically negative. This approach gives an estimated diagnostic sensitivity (DSn) and specificity (DSp) of approximately 92% (95% Confidence Interval = 83.9% to 97.6%) and 99% (95% Confidence Interval = 96.0% to 99.7%) respectively. The two tests work well together as the SAT is more sensitive to IgM antibodies, which are more abundant during early stages of infection, and the iELISA detects IgG antibodies which are more abundant after the early stages of infection and during chronic infection. This gives good coverage for detection of disease from early to late/chronic stages of infection.

  For iELISA only DSp = 99.1%, 95% Confidence interval: 96.8% - 99.9%, DSn = 89.6%, 95% Confidence

interval: 80.8% - 94.6%. For SAT only DSp = 99.8%, 95% Confidence interval: 99.2% - 99.97%, DSn = 71.1%, 95% Confidence interval = 61.3% - 79.5%. The APHA aims to update the validation data for its tests when new material becomes available to make this possible. Therefore the exact DSp and DSn values may change over time. Those stated here are correct as of the date of publication (September 2023). To view the current values (and how these impact on PPV) please refer to the online "Frequently asked *Brucella canis* testing questions" document (accessible here).

When interpreting the serological results, consideration should be given the predictive probability value (see above). This is a function of the DSp and DSn of the test(s) and the prevalence of the disease in the population of which the test subject is a member. Although the prevalence is likely to be unknown, the presence of various risk factors for disease will have an impact on what the likely prevalence is. For example, the higher the prevalence, the more likely it is that a positive result is a true positive (and *vice versa*). Risk factors for disease include clinical signs of disease, coming from an area where disease is present or even endemic, coming from a population where breeding is uncontrolled (or even if controlled, where brucellosis testing is not undertaken), having contact with an infected dog (or infectious material from such a dog – particularly abortion/parturition material), mating with an infected dog (or a dog that may possess disease risk factors), and being born to an infected dog (may also be indicated by infected littermates). The PPV values for a range of hypothetical disease prevalence rates is shown in the "Frequently asked *Brucella canis* testing questions" document (accessible here).

APHA do not use diagnostic antigens derived from mucoid strains of *Brucella canis* or derived from *B. ovis*. Such antigens have inferior diagnostic properties, such as low specificity, and DSn and DSp values for tests using these antigens (and the description of bacteria that may cause cross reactions) are not translatable to the tests used by APHA. Many published reviews that cover *B. canis* diagnostics cite data and information that has been generated from these old and inferior tests and are therefore the specific findings are not applicable to the tests that APHA uses.

For dogs with low disease risk factors (other than positive serology) consideration may be given to repeating testing using another sample tested approximately one month after the initial sample. True positive results are more likely to remain positive (unless antibiotic treatment has occurred) and a negative result may indicate the first result was a false positive. However, such a negative result does not guarantee absence of infection and some caution and vigilance may still be advisable.

**Sample submission processes:**

- **Contact dogs (those identified for testing follow-up as part of an incident investigation if this is initiated):** Samples should be submitted to APHA Weybridge for *Brucella canis* serology as described above, and for *Brucella* culture. When submitting samples from contact dogs please ensure the incident reference number is recorded on the submission form. The reference number will be in format BC20**/**, e.g. BC2023/01.

- **Serology submission procedure:** The general submission form can be found using the following link APHA Weybridge: general testing form (LSW008). The test codes are as follows *Brucella canis* SAT (TC1032) and *Brucella canis* iELISA (TC0116), costs are as per APHA Scientific price list APHA Scientific Tests (vla.gov.uk). Samples for serology should be a non-heparinised blood sample (or other means of serum separation) and a minimum of 1 ml. These can be sent directly to the APHA as per sample submission form LSW008. The tests have a turn-around time of seven working days. All diagnostic samples should be packaged and dispatched in according with UN3372 packing

regulations. Failure to comply with this requirement may result in the sample being destroyed to avoid further infection risk.

- **Culture submission procedure:** As well as submitting serum for testing, 1ml of whole blood collected in a sodium citrate tube should be submitted for culture where this is appropriate, such as for a dog suffering clinical disease that has not recently been treated with antimicrobials. Culture of other material such as vaginal discharge post abortion or whelping, preputial discharge, joint fluid, birth products etc. is more useful for diagnostic purposes. Please note on the submission form that the whole blood (or other specific) sample is to be sent to the *Brucella* Reference Laboratory for culture. If you do send a sample for culture the results will take up to 14 days from receipt of the sample (for bloods samples, tissue [non-blood] samples may take longer) and the final interpretation of the lab data should wait until these results are back. All diagnostic samples should be packaged and dispatched in according with UN3372 packing regulations. Failure to comply with this requirement may result in the sample being destroyed to avoid further infection risk.

For further information about APHA tests (serology and culture), please refer to APHA's "Frequently asked *Brucella canis* testing questions" document (accessible here).

## 9. How brucellosis spreads from dogs to people and risks to human health

*B. canis* can infect humans, although human cases have only been rarely reported internationally.

The Human Animal Infection and Risk Surveillance Group (HAIRS) have recently published a Risk Assessment to consider the risk that *B. canis* presents to the UK human population (HAIRS risk assessment: Brucella canis). This document contains additional information about the human health risks and the evidence gaps.

*B. canis* can be transmitted if infectious aerosols (airborne droplets containing *B. canis*) are generated and are inhaled, which can occur during specific veterinary and laboratory procedures involving an infected dog. It can also be transmitted if infectious materials come into contact with a person's mucous membranes (e.g. eyes, mouth) or an area of broken/damaged skin.

Contact with birthing fluids, abortion products, afterbirths or vaginal discharges from an infected dog that has recently given birth or aborted is associated with higher risk of transmission, as this material contains very high concentrations of *B. canis*.

*B. canis* bacteria can also be present in canine urine, blood (oestrus blood is likely to be higher risk than non-oestrus blood), and milk, although typically in lower concentration than in reproductive fluids. *B. canis* is present in even lower concentrations in faeces, nasal secretions and saliva. The risk of transmission from these materials is therefore much lower.

The risk of transmission to humans from an exposure can be influenced by both the type of material from the dog and the type of contact.

Human to human transmission of *B. canis* has not been reported although it is theoretically possible through exposures such as blood transfusion; in practice this is likely to be extremely rare.

It is thought that people who are immunosuppressed and young children may be at higher risk of clinically apparent and severe illness after infection with *B. canis*.

There is very limited evidence available to understand the risk to people who are pregnant; evidence from human brucellosis more generally is that there are more adverse outcomes compared to healthy pregnant individuals, but much less than in animals who are infected. Given that *B. canis* appears to have lower virulence in humans, the risk is likely to be lower than from other species of *Brucella*. Treatment of brucellosis is more difficult in pregnancy.

## 10. Symptoms of brucellosis in people

Symptoms are often mild and non-specific. The most common signs and symptoms of human infection include a continued, intermittent, or irregular fever sometimes accompanied by loss of appetite, weight loss, sweating, headaches, fatigue, back and/or joint pain. If not treated the disease may become chronic and more serious symptoms can arise. Severe complications from *B. canis* infection, including endocarditis and septicaemia, have been described (rarely) in case reports in the scientific literature.

## 11. Actions for people who have been exposed to *Brucella canis*

People who may have been exposed to *B. canis* should be made aware of the signs and symptoms of brucellosis. If a person who has been exposed develops signs or symptoms of brucellosis they should consult their GP and alert them of their possible exposure to a dog with *B. canis* specifically (as serological tests for infection with other *Brucella* species will not detect antibodies for *B. canis*). This should be done promptly and particularly for young children and people who are pregnant or immunosuppressed. Signs of illness can occur within one week but up to six months after exposure. On average, signs and symptoms will begin within two to four weeks following infection. If brucellosis is diagnosed the treatment is dual antibiotic therapy for a period of several weeks.

Precautionary (prophylactic) antibiotic treatment is only recommended if there has been a high-risk exposure within the preceding 72 hours.

Vets are requested to ensure that owners of *B. canis* positive dogs are directed to "Brucella canis: information for the public and dog owners" for information.

## 12. Preventing transmission of *Brucella canis* from an infected dog in a veterinary setting

There is no vaccine available to protect against canine brucellosis.

Information in this section should be read in conjunction with Section 2 Legal position, Section 6 Management of infected dogs, and Section 9 How brucellosis spreads from dogs to people.

In line with health and safety legislation for the workplace, veterinary practices must ensure that where there is a risk of human exposure to *B. canis*, a local risk assessment is done and appropriate control measures are put in place to control exposure (as would be expected for any biological hazardous agent).

Waste that may be contaminated with *B. canis* should be disposed of as infectious waste. As for other infectious waste, this means disposal in an orange infectious clinical waste bag coded 18 02 02* from the veterinary practice. Bags must be collected by a registered waste carrier and taken to a permitted site.

Separation of infectious and non-infectious waste is a legal requirement in England and Wales and is considered best practice in Scotland.

## 13. Other animals at risk of infection with *Brucella canis*

*B. canis* seems well adapted to causing disease in canines (i.e. dogs and other similar species such as foxes and wolves) and is not very effective at causing disease in other species. Apart from in people, disease in other animals is exceptionally rare. Cats have been reported to produce antibodies to *B. canis* but no disease in cats due to *B. canis* has been reported. Other GB-living species, for example horses, pigs, cows, sheep, goats, and birds appear resistant to infection. Testing of non-canine animals is not recommended. The exception to this might be testing of other mammalian carnivores if there has been significant high exposure, for example contact with birth or abortion products.