Glanders

Farcy,
Malleus,
Droes

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Importance

Glanders is a serious bacterial disease that primarily affects horses, mules and donkeys. Some animals die acutely within a few weeks. Others become chronically infected and can transmit the causative agent, *Burkholderia mallei*, for years before succumbing. Occasionally, glanders affects other mammals in contact with equids, including carnivores that eat meat from infected animals, and humans. While clinical cases in people are uncommon, they can be painful and life threatening, with a case fatality rate that approaches 95% in untreated patients with some forms of the disease.

Glanders was a worldwide problem in equids for several centuries, before being eradicated from most countries by the mid-1900s. This disease is now uncommon and reported from limited geographic areas; however, imported cases are seen sporadically in glanders-free regions, and the disease has recurred in some areas where it had been eliminated. *B. mallei* is also considered to be a potential bioterrorist threat: it has been tested against humans and equids as a biological weapon, and was used against military horses in past wars.

Etiology

Glanders results from infection by *Burkholderia* (formerly *Pseudomonas) mallei*, a Gram negative rod in the *B. pseudomallei* complex of the family Burkholderiaceae. This bacterium is closely related to, and appears to have evolved from, the agent of melioidosis, *Burkholderia pseudomallei*. The *B. pseudomallei* complex also contains several environmental *Burkholderia* species (*B. thailandensis*, *B. humptydooensis*, *B. oklahomensis*) of limited or no clinical significance that can be confused with *B. mallei*.

Species Affected

Horses, mules and donkeys are the primary hosts for *B. mallei*. There does not seem to be any information about whether zebras are also susceptible. Small ruminants, camels, dogs, cats, ferrets, hamsters, guinea pigs, some wild rodents (e.g., voles) and nonhuman primates have been infected experimentally, while pigs, cattle, rabbits and laboratory rats were resistant. Laboratory mice do not become ill unless the dose of organisms is high. In addition to equids, naturally-acquired clinical cases have been documented occasionally in dromedary camels and various felids including domestic cats, tigers, lions and leopards, with deaths also reported in dogs, bears, wolves, jackals and hyenas that ate glanderous meat. Some sources mention infections in small ruminants in contact with equids; however, the information about these incidents is vague and contains no details. Limited evidence suggests that goats might be more susceptible than sheep. Birds appear to be highly resistant to *B. mallei*, though few studies have been done.

Zoonotic potential

B. mallei can affect humans.

Geographic Distribution

The geographic distribution of glanders can be difficult to determine precisely, as cross-reactions to *B. pseudomallei* and other soil-dwelling *Burkholderia* can interfere with serological surveys, and glanders in equids can resemble melioidosis, which is relatively widespread. *B. mallei* is generally thought to be endemic in some parts of the Middle East, Asia, Africa and Central and South America. It has been eradicated from Western Europe, Canada, the U.S., Australia, Japan and some other countries, and was never established in New Zealand. There are, however, some relatively recent reports of glanders reemergence in countries where it had been eradicated (e.g., Brazil) or was previously limited to small foci of infection (e.g., India). A stray/ abandoned donkey found near the Mexican border in the U.S. tested positive for glanders in 2015, but there is no evidence that any other equids in this area became infected.

Transmission

Glanders is mainly transmitted by contact with infected horses, mules and donkeys, most often via respiratory secretions and exudates from skin lesions. Subclinically

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infected animals can also shed *B. mallei*, either intermittently or constantly. The organism can enter the body through skin abrasions and mucous membranes, or via inhalation. Equids often seem to become infected when they ingest *B. mallei* in contaminated food or water, and carnivores when they eat contaminated meat. There are reports of venereal transmission from stallions to mares and vertical transmission from the dam.

B. mallei is readily spread on fomites including harnesses, grooming tools, and food and water troughs. Some authors have speculated that flies might also act as mechanical vectors. This organism is inactivated by heat, drying and sunlight, but its survival is prolonged in wet or humid environments. It was reported to persist for up to 6 weeks in some infected stables, and one early report suggested that it might remain viable in room temperature water for up to 100 days. Under most conditions, however, *B. mallei* is not thought likely to survive in the environment for more than 2 weeks.

People can be infected by contact with sick animals, contaminated fomites, tissues or bacterial cultures. The organism is thought to enter the body through wounds and abrasions in the skin, as well as by ingestion or inhalation. Transmission through unbroken skin has been reported, but not proven (minor breaks in the skin could also explain these cases). Most laboratory-acquired infections have occurred during routine handling and processing of cultures or samples, rather than after injuries or accidents. Rare cases of person-to-person transmission have been reported in family members who nursed sick individuals. Two cases were thought to have been sexually transmitted.

Disinfection

B. mallei is reported to be susceptible to many common disinfectants including 1% sodium hypochlorite, 70% ethanol, 2% glutaraldehyde, iodine, some quaternary ammonium compounds, glycolic acid, benzalkonium chloride, mercuric chloride in alcohol and potassium permanganate. It can also be destroyed by heating to 55°C (131°F) for 10 minutes, or by exposure to UV radiation.

Infections in Animals

Incubation Period

While many cases in equids become apparent in about 2-6 weeks, infections can also remain subclinical for varying periods, resulting in an incubation period that ranges from a few days to many months. Experimentally infected equids can develop a fever in 1-2 days and other clinical signs after 3 days. There is limited information about other species, but some cats became ill 8-14 days after eating infected meat.

Clinical Signs

Horses, donkeys and mules

The first sign of glanders is usually an elevated temperature, though this is likely to be missed in many animals. One old description of large outbreaks among mules also reported that, several days before the onset of other clinical signs, many mules developed a prodromal syndrome of severe head and neck stiffness, possibly due to myositis, and often coinciding with a rise in body temperature. This syndrome was noted to be a good predictor of which animals would soon develop overt glanders. A second prodromal indicator, seen in a much smaller number of mules, was foreleg lameness of unclear origin, most evident when trotting.

In equids, glanders often affects the nasal cavity, lungs and/or skin. This has resulted in the traditional categorization of the disease into nasal, pulmonary and cutaneous forms, though clinical cases often involve various combinations of these sites. When the nasal tract is affected, deep ulcers and nodules develop within the nasal passages, resulting in a thick, sticky, yellowish, mucopurulent discharge. This discharge can be copious, may be unilateral or bilateral, and may contain flecks of blood or become blood-tinged. Nasal ulcers sometimes coalesce over wide areas, and nasal perforation is possible. Healed ulcers become stellate scars, which may be found concurrently with nodules and ulcers. The regional (mandibular) lymph nodes are also enlarged bilaterally or unilaterally, and may occasionally suppurate and drain. Nasal infections can spread to involve the lower respiratory tract.

Pulmonary involvement occurs in most animals, often in combination with other sites, and is characterized by the development of nodules and abscesses in the lungs, or bronchopneumonia in some cases. Some pulmonary lesions remain clinically inapparent; others result in mild to severe respiratory signs (e.g., coughing, dyspnea), with fever or febrile episodes and progressive debilitation. If the upper respiratory tract was not involved initially, it may become infected via discharges from pulmonary abscesses.

In the cutaneous form (known as ‘farcy’) multiple nodules develop in the skin, along the course of the lymphatics. While they may appear anywhere, in chronically infected animals these nodules are reported to be most common on the inner thighs, limbs and abdomen. They often rupture and ulcerate, discharging a thick, oily, yellow exudate that has been described as honey-like. Glanders ulcers on the skin heal very slowly, often continuing to discharge fluid, though dry ulcers may also be seen. The regional lymphatics and lymph nodes become chronically enlarged, and the lymphatics are often filled with a purulent exudate. Some animals with cutaneous involvement also have swelling of the joints or painful edema of the legs, and intact males may develop glanderous orchitis. Animals with cutaneous glanders can remain in good condition for a time, but they eventually become debilitated and die.

Glanders in equids can be an acute, chronic or latent disease, depending on the animal’s resistance to *B. mallei*. Chronic cases predominate in horses, while donkeys most often develop acute glanders. Acute cases are also common in mules, though they can have either form. Acute glanders is usually characterized mainly by nasal and respiratory involvement, often with a high fever, decreased appetite,

weight loss, depression, swelling of the nostrils, bouts of coughing and progressive dyspnea. An initial watery nasal discharge, often unilateral at first, can develop into the classic signs of the nasal form. Some donkeys have also had nodules and thickening of the lymphatic vessels in the neck. Ocular lesions, which may be accompanied by a purulent discharge, can be seen occasionally, and neurological signs were reported in some experimentally infected horses, possibly as the result of secondary bacterial (*Streptococcus zooepidemicus*) infection of the brain from a compromised blood-brain barrier. Most animals with acute glanders die within a few days to a few weeks, typically from septicemia and respiratory failure.

Chronic glanders develops insidiously and lasts for months to years, with periodic episodes of exacerbation and slowly progressive debilitation. Although the initial nonspecific signs (e.g., intermittent low fever and slightly labored breathing) may be mild and easily overlooked, progression of the lesions eventually results in listlessness, generalized weakness and wasting, with an intermittent cough. Some animals become lame, with swelling of the joints in the hindquarters, or develop epistaxis, hematuria, polyuria, diarrhea or orchitis. Signs of nasal glanders or skin involvement may also be seen, and stressors can result in acute bronchopneumonia. Extension of lesions to the brain has been reported in at least one case. Chronic glanders is eventually fatal in most animals, although a few may recover clinically while remaining carriers. Animals that recover from glanders can relapse.

In latent cases, lesions may occur sporadically in the lungs and other internal organs. The clinical signs are usually minimal, and most often consist only of intermittent low fever, nasal discharge and/or occasional labored breathing. Latent glanders is most common in resistant hosts such as horses.

Other species

The clinical signs in naturally infected dromedary camels were similar to those in equids, and included fever, lethargy, emaciation, and nodules and ulcers in the nasal passages, accompanied by severe mucopurulent discharge. In cats that ate infected meat, nodules and ulcers were found in the nasal passages and on the conjunctivae, as well as deeper in the respiratory tract. They also developed a purulent, yellowish nasal discharge that sometimes became bloody, swelling of the lymph nodes and dyspnea, and usually died in 1-2 weeks. Similar respiratory and nasal signs, a well as nonspecific signs of illness (e.g., anorexia, depression) were reported in large felids during outbreaks at zoos. Some zoo felids vomited, had skin ulcers or developed swelling of the face and head.

Post-Mortem Lesions

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Some animals with glanders have extensive involvement of the skin, respiratory tract and other organs; in others, the distribution of lesions is more limited. Equids with subclinical infections may also have occasional lesions in internal organs including the lungs. Glanders lesions can include nodules, granulomas, stellate scars and/or ulcers, which can occur concurrently. The nodules are firm, round and up to about 1 cm in diameter, with a caseous or calcified center, and are typically surrounded by areas of inflammation. In the lungs and other internal organs, nodules may occasionally be diffuse and miliary.

The upper respiratory tract is involved in many cases, with varying numbers of ulcers, nodules and/or stellate scars in the nasal passages, larynx and other tissues. Mildly affected animals sometimes have only a few lesions in the posterior portion of the nasal cavity, while the anterior is hyperemic and catarrhal. Swollen lymphatics, with chains of nodules and ulcerated nodules, can be found in the skin of some animals, while the lymph nodes may be enlarged, congested and/or fibrotic, and may contain abscesses. Internally, lesions are most likely to be found in the lungs, with nodules often visible beneath the pleura. Some animals may have evidence of bronchopneumonia. Glanders lesions can also occur sometimes in other visceral organs, particularly the liver and spleen, and occasionally at other sites such as the bones, muscles or testes. They are rare in the gastrointestinal tract, except in experimentally infected animals administered large doses of *B. mallei*.

Similar lesions have been reported in other species.

Diagnostic Tests

In animals with glanders, large numbers of bacteria can sometimes be found by microscopic examination of smears from fresh lesions. Organisms may be more difficult to find in older lesions, and are usually absent from ulcers. *B. mallei* is a Gram negative, straight or slightly curved rod; bacteria from clinical samples and young cultures appear as rods, while those from older cultures can be pleomorphic. In tissue sections, this organism may have a beaded appearance. *B. mallei* can also be stained with Giemsa, methylene blue or Wright stain, with some authors reporting that it stains best with Giemsa and that Gram staining may be weak or irregular.

A definitive diagnosis can be made by culturing *B. mallei* from affected sites, such as lesions or respiratory secretions. It is uncommonly recovered from ulcers or blood, and Brazilian researchers have reported that culture is more likely to be successful from unruptured skin nodules than nasal exudates. Bacteriological diagnosis can sometimes be difficult when the animal is in the early stages of the disease or subclinically infected. *B. mallei* can grow on ordinary culture media (though not well on MacConkey agar), but its slow growth and the potential for overgrowth by other bacteria can make isolation difficult. It grows best on media enriched with glycerol, and detailed guidelines for its culture have been published by the World Organization for Animal Health (WOAH, formerly OIE) and other sources. One selective medium for *B. mallei* (BM agar) has been developed, and certain isolates may grow on selective agar for *B. pseudomallei* or other species of *Burkholderia*. If necessary, it may be recovered by inoculation into guinea pigs.

Colonies of *B. mallei* are usually identified with biochemical tests, but PCR assays and sequencing are also used, and matrix-assisted laser desorption–ionization time-of-flight mass spectrometry (MALDI-TOF-MS) is reported to identify this organism at least to the genus level in most cases. The absence of motility is important in distinguishing *B. mallei* from other members of the *Pseudomonas* group, including its close relative *Burkholderia pseudomallei*. It is sometimes misidentified as other bacteria by automated bacterial identification systems. Genetic techniques available in specialized laboratories (e.g., PCR-restriction fragment length polymorphism, pulse-field gel electrophoresis, 16S rRNA sequencing) can distinguish *B. mallei* from *B. pseudomallei*, and specialized genetic techniques, such as variable number of tandem repeat analysis (MLVA) or single nucleotide polymorphisms (SNP), can be used to identify specific isolates in outbreak investigations. Due to the risks of human infection, isolates suspected to be *B. mallei* are usually sent to a reference laboratory for identification.

Where PCR tests are available, *B. mallei* may also be identified directly in clinical samples. Some of these assays can only identify it as a member of the *B. pseudomallei* complex, while others are reported to be capable of distinguishing it from *B. pseudomallei* and other *Burkholderia*. Loop mediated isothermal assays and recombinase polymerase amplification-lateral flow assays have also been published. Genetic variants of *Burkholderia* species might occasionally complicate the interpretation of genetic tests. There do not appear to be any validated antigen detection assays for *B. mallei* in common use, but some tests (e.g., latex agglutination, immunofluorescence) have been described.

A hypersensitivity reaction called the mallein test was employed in many glanders eradication programs in the past, and is still used to detect infected equids in some countries. In the three versions of this test, a protein fraction of *B. mallei* is either injected into the eyelid (intradermo-palpebral test), administered in eyedrops, or injected subcutaneously at a site other than the eye. The intradermo-palpebral test is considered to be the most reliable and sensitive version. Reactors in this test develop swelling of the eyelids, which may be accompanied by purulent ocular discharge and an elevated body temperature, after 1-2 days. Horses usually respond strongly, with marked eyelid swelling, while some mules may have only a slight reaction, such as slight palpebral edema of the lower eyelid. Conjunctivitis occurs after administration in eyedrops, and a firm, painful swelling with raised edges is seen within 24 hours after subcutaneous (non-ocular) injection.

Mallein testing can cause transient false positives in subsequent serological tests, and such reactivity could become permanent if the animal is mallein tested repeatedly. It can give inconclusive results in acute glanders or in the late stages of chronic disease, and may be negative before the onset of clinical signs. Cross-reactivity has been reported, and some groups (e.g., WOAH) discourage its use for animal welfare reasons.

Serological tests can be used in diagnosis, surveillance or import testing of equids, but cannot distinguish whether the animal has antibodies to *B. mallei* or *B. pseudomallei*. Currently available glanders tests, depending on the location, include complement fixation, ELISAs, a rose bengal plate agglutination test (which is limited to a few countries) and immunoblotting. Other tests, such a microsphere-based immunoassay, have also been developed and might be in use in individual laboratories. Immunoblotting is generally employed as a confirmatory test for other assays. Complement fixation was also used to help diagnose glanders in some camels and large zoo cats, and an ELISA test was positive in an infected camel. Cross-reactivity can be an issue in serological tests, and false negatives also occur, especially in chronically infected, debilitated, pregnant or old animals.

Treatment

Glanders treatment is only allowed in few endemic regions; in most areas, infected animals are euthanized due to the concern that they might infect other animals or people, or that they might become subclinical carriers. Designing effective treatments for glanders is complicated by the inherent resistance of *B. mallei* to some common antibiotics, differences in antibiotic susceptibility patterns between *B. mallei* isolates, and the inability of some drugs to penetrate into the host cells where this organism replicates. Protocols that may be able to eliminate this organism have been published, but not fully evaluated. Some require treatment for several months with multiple drugs.

Control

Disease reporting

Veterinarians who encounter or suspect glanders should follow their national and/or local guidelines for disease reporting. In the U.S., state or federal veterinary authorities should be informed immediately.

Prevention

During outbreaks in glanders-free areas, animals that test positive are usually euthanized, and the premises are quarantined, cleaned and disinfected. Carcasses, contaminated bedding and food should be destroyed (e.g., burned or buried), and equipment and other fomites disinfected. Import testing, usually by serology, reduces the risk of introducing an infected animal.

In endemic areas, good biosecurity (e.g., cleaning and disinfecting fomites that enter farms, not sharing equipment equids may contact) and keeping susceptible animals away from other equids can help prevent glanders. Avoiding communal feeding and watering areas is also thought to be helpful, as glanders is more common where animals congregate and it can be acquired by ingestion. Common water troughs should be kept as clean as possible, with frequent changes of fresh water. Good management and

nutrition may increase animals' resistance to infection. Routine testing and euthanasia of infected animals can eradicate glanders or reduce its incidence. Meat from equids that might be infected should not be fed to other animals or used for human consumption. Vaccines are not available.

Morbidity and Mortality

Glanders can spread widely when large numbers of animals are in close contact. A high percentage of infections may be subclinical or latent, especially in horses, and clinical cases are reported to be more common in animals that are undernourished or otherwise in poor condition. While acute glanders is usually fatal within a short period, animals with the chronic form can sometimes survive for years. Mortality rates are thought to be high, but estimates are difficult to make because infected animals are usually euthanized to prevent them from spreading the disease.

Cases of glanders are reported infrequently in animals other than equids. Among carnivores, felids appear to be particularly susceptible, with cases and outbreaks reported in both domesticated cats and captive large felids.

Infections in Humans

Incubation Period

The incubation period for acute glanders is reported to be 1-14 days in people, with most cases of localized disease becoming apparent within several days. Chronic cases can take months to appear.

Clinical Signs

Forms of glanders that have been described in humans include acute localized infections of the skin or mucous membranes, pulmonary involvement, disseminated disease, septicemia and chronic cases. Some people have a biphasic illness, separated by remissions lasting a few days to several weeks. Glanders nodules with no associated symptoms have been reported occasionally as an incidental finding at necropsy.

Localized infections are characterized by nodules, abscesses and/or ulcers in the mucous membranes, skin and/or subcutaneous tissues at the site of inoculation. In the skin, the initial lesion sometimes appears as a blister that gradually develops into an ulcer. There may also be lymphangitis with numerous foci of suppuration, and lesions on mucous membranes can be accompanied by a mucopurulent, sometimes blood–tinged, discharge. The nose and/or face may swell if the nasal passages are affected, and tissue destruction is possible. Localized lesions are sometimes accompanied by nonspecific signs of illness including fever (which may be low grade and fluctuating), sweats, malaise, headache and swelling of the regional lymph nodes, which may contain abscesses. Mucosal or skin infections may disseminate to other tissues and organs, both locally and at more distant sites.

Pulmonary involvement is characterized by abscesses, pleural effusion and/or pneumonia. It can develop acutely after inhaling *B. mallei*, but organisms can also reach the lungs by regional or hematogenous spread from other sites. The symptoms usually include fever and other nonspecific signs of illness (e.g., chills, sweats, headache, myalgia), together with coughing and chest pain, which may progress to dyspnea. In some cases, respiratory signs may be accompanied by lymphangitis, nasal involvement, gastrointestinal signs and/or skin abscesses. Skin lesions can develop up to several months after inhalation of the organism.

Disseminated infections often result in lesions in the spleen and liver, as well as the lungs, but any tissue including the muscles and bones can be affected. The clinical signs in disseminated cases may be nonspecific (e.g., nausea, dizziness, night sweats, myalgia, headache, weight loss) or include symptoms specific to the sites involved (e.g., osteomyelitis, myositis). There are also reports of gastrointestinal signs, including episodes of melena or vomiting with blood, or a papular or pustular rash, in conjunction with other symptoms. Untreated pulmonary illnesses or disseminated *B. mallei* infections often develop into septicemia. The symptoms in these patients can include granulomatous or necrotizing lesions, as well as signs common to patients with sepsis, and often progresses rapidly to multi-organ failure and death.

Chronic glanders is characterized by abscesses, nodules and ulcers at a variety of sites, such as the subcutaneous tissues, muscles, bones, respiratory tract and various internal organs, with periodic recrudescence. Meningitis has also been reported. The symptoms of chronic glanders are typically milder than in acute cases, and often include weight loss, lymphadenopathy and lymphangitis. This form of the disease has been documented to last up to 25 years.

Diagnostic Tests

Glanders can be diagnosed by culturing *B. mallei* from lesions and affected tissues, as in animals. In humans, the organism has also been found occasionally in the sputum, blood or urine, though the number of bacteria in these specimens is usually low and blood cultures are often negative. PCR assays and antigen detection tests may be able to detect *B. mallei* directly in clinical specimens; however, these are not routine tests in human diagnostic laboratories.

Serology might be helpful if tests are available, but there can be unexplained high background titers in some normal sera, and seroconversion tends to occur late. At least one human ELISA test for glanders has been developed (at the U.S. Army Medical Research Institute). Serological tests for human melioidosis have also been used in some clinical cases, to take advantage of the cross-reactivity between *B. mallei* and *B. pseudomallei*. It should be kept in mind that some healthy people in endemic regions have antibodies to the latter agent. The mallein test is not used in humans.

Radiography is not specific for glanders, but may reveal bilateral bronchopneumonia, miliary nodules, segmental or

lobar infiltrates, and cavitating lesions that can resemble tuberculosis. Similar lesions may be detected in other organs and tissues.

Treatment

Glanders is treated with antibiotics. The optimal protocol is still uncertain, but some treatment recommendations are available, and a number of clinical cases have been treated successfully. Long-term treatment and/or multiple drugs may be necessary in some cases. Abscesses may need to be drained.

Prevention

Precautions, including appropriate personal protective equipment (PPE), should be taken when handling cultures, infected animals and contaminated fomites. Particular care is needed in the laboratory, where some countries, including the U.S., stipulate that *B. mallei* must be handled with biosafety level 3 practices. Postexposure prophylaxis with antibiotics might be employed after some types of exposures. The only vaccine known to have been produced, to date, is a killed glanders vaccine for use in people at high risk of exposure, which was available at one time in Russia.

Although person-to-person transmission is rare, human glanders patients should be isolated. Infection control precautions should be taken, and barrier precautions with PPE used as appropriate for the specific conditions and procedures.

Morbidity and Mortality

Glanders is a sporadic, and currently uncommon, disease that usually occurs in people who work with clinical samples or have frequent, close contact with infected horses or their tissues. *B. mallei* can be highly infectious in some laboratory settings, particularly when it is aerosolized, with morbidity rates up to 46% reported after exposure to aerosolized bacteria. However, transmission from horses to humans outside the laboratory seems to be inefficient. Even when morbidity rates in horses are 5-30%, zoonotic disease is reported to be uncommon, and human epidemics have never been seen. A few recent surveys found no serological evidence of infection in people who handled equids with glanders, though the level of validation for these tests is not clear. Nevertheless, it remains possible that some subclinical infections or mild illnesses are missed. Old autopsy studies conducted in endemic areas sometimes found glanders-associated nodules as an incidental finding in people who had contact with horses.

Untreated, disseminated acute glanders is usually fatal, with a mortality rate of 95% or more in septicemia and 90-95% in the pulmonary form. Even with treatment, up to 40-50% of these patients were reported to die in the past. The estimated case fatality rate for localized disease is 20% when treated, while untreated cases often progress to other forms. Chronic glanders can be difficult to treat, with a case fatality rate reported to be as high as 50%. However, it should be noted that these estimates were based on historical cases (and possibly extrapolated from melioidosis in some instances), and mortality appears to be significantly lower with modern supportive care and effective antibiotics.

Internet Resources

American Association of Equine Practitioners. Glanders Guidelines

FAO. Manual on Meat Inspection for Developing Countries

Public Health Agency of Canada. Pathogen Safety Data Sheets

The Merck Manual (Professional)

The Merck Veterinary Manual

United States Animal Health Association. Foreign Animal Diseases

Van Zandt et al. Glanders: An Overview of Infections in Humans

World Organization for Animal Health (WOAH)

WOAH Manual of Diagnostic Tests and Vaccines for Terrestrial Animals; WOAH Terrestrial Animal Health Code

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References

Abreu DC, Gomes AS, Tessler DK, Chiebao DP, Fava CD, Romaldini AHCN, Araujo MC, Pompei J, Marques GF, Harakava R, Pituco EM, Nassar AFC. Systematic monitoring of glanders-infected horses by complement fixation test, bacterial isolation, and PCR. Vet Anim Sci. 2020;10:100147.

Animal Health Australia. The National Animal Health Information System [NAHIS]. Glanders [online]. NAHIS; 2001 Oct. Available at: http://www.brs.gov.au/usr–bin/aphb/ahsq?dislist=alpha.* Accessed 4 Oct 2002.

Bauernfeind A, Roller C, Meyer D, Jungwirth R, Schneider I. Molecular procedure for rapid detection of *Burkholderia mallei* and *Burkholderia pseudomallei*. J Clin Microbiol. 1998;36: 2737-41.

Biberstein EL, Holzworth J. In: Holzworth J, editor. Diseases of the cat. Philadelphia: WB Saunders; 1987. Bacterial diseases: Glanders; p. 296.

Bossi P, Tegnell A, Baka A, Van Loock F, Hendriks J, Werner A, Maidhof H, Gouvras G; Task Force on Biological and Chemical Agent Threats, Public Health Directorate, European Commission, Luxembourg. Bichat guidelines for the clinical management of glanders and melioidosis and bioterrorism-related glanders and melioidosis. Euro Surveill. 2004;9:E17-8.

Brangsch H, Singha H, Laroucau K, Elschner M. Sequence-based detection and typing procedures for *Burkholderia mallei*: assessment and prospects. Front Vet Sci. 2022;9:1056996.

Calfee MW, Wendling M. Inactivation of vegetative bacterial threat agents on environmental surfaces. Sci Total Environ. 2013;443:387-96.

Centers for Disease Control and Prevention [CDC]. Glanders. CDC; 2011 Jan. Available at: http://www.cdc.gov/glanders.* Accessed 26 Feb 2015.

Centers for Disease Control and Prevention [CDC]. Glanders (*Burkholderia mallei*) technical information. CDC; 2005 Oct. Available at: http://www.cdc.gov/ncidod/dbmd/diseaseinfo/glanders_t.htm.* Accessed 26 Aug 2007.

Centers for Disease Control and Prevention. Laboratory-acquired human glanders--Maryland, May 2000. Morb Mortal Wkly Rep. 2000;49:532-5.

Cetin FT, Gundeslioglu OO, Bakanoglu E, Ummuhan C, Alabaz D, Gumus H, Kibar F, Kundakci B. Patient presenting with abscess unresponsive to treatment and progressive to osteomyelitis: a rare cause *Burkholderia mallei*. Sisli Etfal Hastan Tip Bul. 2024;58(2):258-61.

Cossu CA, Bhoora RV, Cassini R, van Heerden H. The significance of viral, bacterial and protozoan infections in zebra:a systematic review and meta-analysis of prevalence. Hystrix, It J Mamm. 2022;33(1):17-33.

Derbyshire JB. The eradication of glanders in Canada. Can Vet J. 2002;43:722-6.

Duval BD, Elrod MG, Gee JE, Chantratita N, Tandhavanant S, Limmathurotsakul D, Hoffmaster AR. Evaluation of a latex agglutination assay for the identification of *Burkholderia pseudomallei* and *Burkholderia mallei*. Am J Trop Med Hyg. 2014;90(6):1043-6.

Edler C, Derschum H, Köhler M, Neubauer H, Frickmann H, Hagen RM. Comparison of Mast *Burkholderia cepacia*, Ashdown + gentamicin, and *Burkholderia pseudomallei* selective agar for the selective growth of *Burkholderia* spp. Eur J Microbiol Immunol (Bp). 2017;7(1):15-36.

EFSA Panel on Animal Health and Welfare (AHAW); Nielsen SS, Alvarez J, Bicout DJ, Calistri P, Canali E, et al. Assessment of the control measures of the category A diseases of Animal Health Law: *Burkholderia mallei* (glanders). EFSA J. 2022;20(1):e07069.

Elschner MC, Laroucau K, Singha H, Tripathi BN, Saqib M, Gardner I, Saini S, Kumar S, El-Adawy H, Melzer F, Khan I, Malik P, Sauter-Louis C, Neubauer H. Evaluation of the comparative accuracy of the complement fixation test, Western blot and five enzyme-linked immunosorbent assays for serodiagnosis of glanders. PLoS One. 2019;14(4):e0214963.

Elschner MC, Melzer F, Singha H, Muhammad S, Gardner I, Neubauer H. Validation of a commercial glanders ELISA as an alternative to the CFT in international trade of equidae. Front Vet Sci. 2021;8:628389.

Elschner MC, Neubauer H, Sprague LD. The resurrection of glanders in a new epidemiological scenario: a beneficiary of "global change." Curr Clin Micro Rpt. 2017;4:54-60.

Elschner MC, Scholz HC, Melzer F, Saqib M, Marten P, Rassbach A, Dietzsch M, Schmoock G, de Assis Santana VL, de Souza MM, Wernery R, Wernery U, Neubauer H. Use of a Western blot technique for the serodiagnosis of glanders. BMC Vet Res. 2011;7:4.

Estes DM, Dow SW, Schweizer HP, Torres AG. Present and future therapeutic strategies for melioidosis and glanders. Expert Rev Anti Infect Ther. 2010;8(3):325-38.

Feodorova VA, Sayapina LV, Corbel MJ, Motin VL. Russian vaccines against especially dangerous bacterial pathogens. Emerg Microbes Infect. 2014;3(12):e86.

Fonseca Júnior AA, Pinto CA, Alencar CAS, Bueno BL, Dos Reis JKP, de Carvalho Filho MB. Validation of three qPCR for the detection of *Burkholderia mallei* in equine tissue samples. Arch Microbiol. 2021;203(7):3965-71.

Fritz DL, Vogel P, Brown DR, Deshazer D, Waag DM. Mouse model of sublethal and lethal intraperitoneal glanders (*Burkholderia mallei*). Vet Pathol. 2000;37:626-36.

Fritz DL, Vogel P, Brown DR, Waag DM. The hamster model of intraperitoneal *Burkholderia mallei* (glanders). Vet Pathol. 1999;36:276-91.

Garner G, Saville P, Fediaevsky A. Manual for the recognition of exotic diseases of livestock: A reference guide for animal health staff [online]. Food and Agriculture Organization of the United Nations [FAO]; 2003. Glanders. Available at: http://www.spc.int/rahs/Manual/Equine/GLANDERSE.HTM.* Accessed 27 Aug 2007.

Gilad J, Schwartz D, Amsalem Y. Clinical features and laboratory diagnosis of infection with the potential bioterrorism agents *Burkholderia mallei* and *Burkholderia pseudomallei*. Int J Biomed Sci. 2007;3(3):144-52.

Gilbert RO. Glanders. In: Foreign animal diseases. Richmond, VA: United States Animal Health Association; 2008. p. 281-6.

Gulati RL, GautamOP. Glanders in mules. Indian Vet J. 1962;39:588-93.

He G, Zeng Y, He Q, Liu T, Li N, Lin H, Zeng M, Li Y, Peng M, Cheng J, Liu W, Yao W. A case report of *Burkholderia mallei* infection leading to pneumonia. Comb Chem High Throughput Screen. 2023;26(1):241-5.

Herenda D, Chambers PG, Ettriqui A, Seneviratna P, da Silva TJP. Manual on meat inspection for developing countries [online]. FAO animal production and health paper 119. Publishing and Multimedia Service, Information Division, FAO; 1994 (reprinted 2000). Glanders. Available at: http://www.fao.org/docrep/003/t0756e/T0756E07.htm#ch6.2.3. Accessed 27 Aug 2007.

Janesomboon S, Muangsombut V, Srinon V, Meethai C, Tharinjaroen CS, Amornchai P, Withatanung P, Chantratita N, Mayo M, Wuthiekanun V, Currie BJ, Stevens JM, Korbsrisate S. Detection and differentiation of *Burkholderia* species with pathogenic potential in environmental soil samples. PLoS One. 2021;16(1):e0245175.

Janse I, Hamidjaja RA, Hendriks AC, van Rotterdam BJ. Multiplex qPCR for reliable detection and differentiation of *Burkholderia mallei* and *Burkholderia pseudomallei*. BMC Infect Dis. 2013;13:86.

Karimi A, Mosavari N. Development of Rose Bengal test against mallein test for rapid diagnosis of equine glanders. Trop Anim Health Prod. 2019;51(7):1969-74.

Khaki P, Mosavari N, Khajeh NS, Emam M, Ahouran M, Hashemi S, Taheri MM, Jahanpeyma D, Nikkhah S. Glanders outbreak at Tehran Zoo, Iran. Iran J Microbiol. 2012;4(1):3-7.

Khan I, Wieler LH, Melzer F, Elschner MC, Muhammad G, Ali S, Sprague LD, Neubauer H, Saqib M. Glanders in animals: a review on epidemiology, clinical presentation, diagnosis and countermeasures. Transbound Emerg Dis. 2013;60(3):204-21.

Kinoshita Y, Cloutier AK, Rozak DA, Khan MSR, Niwa H, Uchida-Fujii E, Katayama Y, Tuanyok A. A novel selective medium for the isolation of *Burkholderia mallei* from equine specimens. BMC Vet Res. 2019;15(1):133.

Koirala P, Maharjan M, Manandhar S, Pandey KR, Deshayes T, Wang G, Valvano MA, Laroucau K. First glanders cases detected in Nepal underscore the need for surveillance and border controls. BMC Vet Res. 2022;18(1):132.

Kortepeter M, Christopher G, Cieslak T, Culpepper R, Darling R, Pavlin J, Rowe J, McKee K, Eitzen E, editors. Medical management of biological casualties handbook [online]. 4th ed. United States Department of Defense; 2001. Glanders and melioidosis. Available at: http://www.vnh.org/BIOCASU/8.html.* Accessed 14 Nov 2002.

Laroucau K, Aaziz R, Vorimore F, Varghese K, Deshayes T, Bertin C, Delannoy S, Sami AM, Al Batel M, El Shorbagy M, Almutawaa KAW, Alanezi SJ, Alazemi YSN, Guernier-Cambert V, Wernery U. A genetic variant of *Burkholderia mallei* detected in Kuwait: Consequences for the PCR diagnosis of glanders. Transbound Emerg Dis. 2021;68(2):960-3.

Laroucau K, Saqib M, Martin B, Deshayes T, Bertin C, Wernery U, Joseph S, Singha H, Tripathi BN, Beck C. Development of a microsphere-based immunoassay for the serological detection of glanders in equids. Acta Trop. 2020;207:105463.

Lee MA, Wang D, Yap EH. Detection and differentiation of *Burkholderia pseudomallei*, *Burkholderia mallei* and *Burkholderia thailandensis* by multiplex PCR. FEMS Immunol Med Microbiol. 2005;43:413-7.

Lopez J, Copps J, Wilhelmsen C, Moore R, Kubay J, St-Jacques M, Halayko S, Kranendonk C, Toback S, DeShazer D, Fritz DL, Tom M, Woods DE. Characterization of experimental equine glanders. Microbes Infect. 2003;5:1125-31.

Lowe CW, Satterfield BA, Nelson DB, Thiriot JD, Heder MJ, March JK, Drake DS, Lew CS, Bunnell AJ, Moore ES, O'Neill KL, Robison RA. A quadruplex real-time PCR assay for the rapid detection and differentiation of the most relevant members of the *B. pseudomallei* complex: *B. mallei*, *B. pseudomallei*, and *B. thailandensis*. PLoS One. 2016;11(10):e0164006.

Lowe W. March JK, Bunnell AJ, O'Neill KL, Robison RA. PCR-based methodologies used to detect and differentiate the *Burkholderia pseudomallei* complex: *B. pseudomallei*, *B. mallei*, and *B. thailandensis*. Curr Issues Mol Biol. 2013;16(2):23-54.

Luz KG, Bezerra FRO, Sicolo MA, Silva AARS, Egito AA, et al. Clinical and molecular characterization of human *Burkholderia mallei* infection, Brazil. Emerg Infect Dis. 2024;30(11):2400-3.

Malik P, Singha H, Khurana SK, Kumar R, Kumar S, et al. Emergence and re-emergence of glanders in India: a description of outbreaks from 2006 to 2011.Vet Ital. 2012;48(2):167-78.

Monastyrskaya G, Fushan A, Abaev I, Kostina M, Filyukova O, Pecherskih E, Sverdlov E. Genome-wide identification and mapping of variable sequences in the genomes of *Burkholderia mallei* and *Burkholderia pseudomallei*. Res Microbiol. 2005;156:278-88.

Mota RA, Junior JWP. Current status of glanders in Brazil: recent advances and challenges. Braz J Microbiol. 2022;53(4):2273-85.

Nakase M, Thapa J, Batbaatar V, Khurtsbaatar O, Enkhtuul B, et al. A novel ready-to-use loop-mediated isothermal amplification (LAMP) method for detection of *Burkholderia mallei* and *B. pseudomallei*. BMC Microbiol. 2025;25(1):36.

Nasiri M, Zarrin A, RoshankarRudsari S, Khodadadi J. Glanders (*Burkholderia mallei* infection) in an Iranian man: A case report. IDCases. 2023;32:e01779.

Neubauer H, Sprague LD, Zacharia R, Tomaso H, Al Dahouk S, Wernery R, Wernery U, Scholz HC. Serodiagnosis of *Burkholderia mallei* infections in horses: state-of-the-art and perspectives. J Vet Med B Infect Dis Vet Public Health. 2005;52:201-5.

Pal V, Saxena A, Singh S, Goel AK, Kumar JS, Parida MM, Rai GP. Development of a real-time loop-mediated isothermal amplification assay for detection of *Burkholderia mallei*. Transbound Emerg Dis. 2018;65(1):e32-9.

Promed Mail. Glanders –Brazil (South). Aug 15, 2004. Archive Number 20040815.2265. Available at: http://www.promedmail.org. Accessed 31 Aug. 2007.

Promed Mail. Glanders – equine (Brazil). May 29, 2000. Archive Number 20000529.0858. Available at: http://www.promedmail.org. Accessed 31 Aug. 2007.

Promed Mail. Glanders, equine - Russia (Chita). July 7, 2007. Archive Number 20070707.2167. Available at: http://www.promedmail.org. Accessed 31 Aug. 2007.

Promed Mail. Glanders, equine - United Arab Emirates: OIE. October 19, 2004. Archive Number 20041019.2836. Available at: http://www.promedmail.org. Accessed 31 Aug. 2007.

Public Health Agency of Canada (PHAC). *Burkholderia mallei*: Infectious substances Pathogen Safety Data Sheet. Centre for Biosecurity, PHAC; 2021 Sept. Available at: https://www.canada.ca/en/public-health/services/laboratory-biosafety-biosecurity/pathogen-safety-data-sheets-risk-assessment/burkholderia-mallei.html. Accessed 7 Aug 2025.

Redfearn MS, Palleroni NJ: Glanders and melioidosis. In: Hubbert WT, McCulloch WF, Schnurrenberger PR, editors. Diseases transmitted from animals to man. 6th ed. Springfield, IL: Charles C. Thomas; 1975. p. 110-28.

Rega PP. CBRNE – Glanders and melioidosis. eMedicine [online]; 2013. Available at: http://emedicine.medscape.com/article/830235-overview.* Accessed 7 Feb 2015.

Rhodes KA, Schweizer HP. Antibiotic resistance in *Burkholderia* species. Drug Resist Updat. 2016;28:82-90.

Santos Júnior ELD, Moura JCR, Protásio BKPF, Parente VAS, Veiga MHND. Clinical repercussions of glanders (*Burkholderia mallei* infection) in a Brazilian child: a case report. Rev Soc Bras Med Trop. 2020;53:e20200054.

Saqib M, Muhammad G, Naureen A, Hussain MH, Asi MN, Mansoor MK, Toufeer M, Khan I, Neubauer H, Sprague LD. Effectiveness of an antimicrobial treatment scheme in a confined glanders outbreak. BMC Vet Res. 2012;8:214.

Saxena A, Pal V, Tripathi NK, Goel AK. Development of a rapid and sensitive recombinase polymerase amplification-lateral flow assay for detection of *Burkholderia mallei*. Transbound Emerg Dis. 2019;66(2):1016-22.

Scoffone VC, Trespidi G, Barbieri G, Irudal S, Israyilova A, Buroni S. Methodological tools to study species of the genus *Burkholderia*. Appl Microbiol Biotechnol. 2021;105(24):9019-34.

Singha H, Shanmugasundaram K, Saini S, Tripathi BN. Serological survey of humans exposed to *Burkholderia mallei*-infected equids: a public health approach. Asia Pac J Public Health. 2020;32(5):274-7.

Srinivasan A, Kraus CN, DeShazer D, Becker PM, Dick JD, Spacek L, Bartlett JG, Byrne WR, Thomas DL. Glanders in a military research microbiologist. N Engl J Med. 2001;345:256-8.

Suniga PAP, Mantovani C, Dos Santos MG, do Egito AA, Verbisck NV, Dos Santos LR, Dávila AMR, Zimpel CK, Zerpa MCS, Chiebao DP, de Sá Guimarães AM, de Castro Nassar AF, de Araújo FR. Glanders diagnosis in an asymptomatic mare from Brazil: insights from serology, microbiological culture, mass spectrometry, and genome sequencing. Pathogens. 2023;12(10):1250.

Suniga PAP, Mantovani C, Santos MG, Rieger JSG, Gaspar EB, Dos Santos FL, Mota RA, Chaves KP, Egito AA, Filho JCO, Nassar AFC, Dos Santos LR, Araújo FR. Molecular detection of *Burkholderia mallei* in different geographic regions of Brazil. Braz J Microbiol. 2023;54(2):1275-85.

Thibault FM, Hernandez E, Vidal DR, Girardet M, Cavallo JD. Antibiotic susceptibility of 65 isolates of *Burkholderia pseudomallei* and *Burkholderia mallei* to 35 antimicrobial agents. J Antimicrob Chemother. 2004;54:1134-8.

Tikmehdash HT, Dehnad A, Mosavari N, Naghili Hokmabadi B, Mahmazi S. Isolation, serological and molecular methods in screening of *Burkholderia mallei* in East Azerbaijan province, Iran. Vet Res Forum. 2024;15(5):231-6.

Ulrich RL, Ulrich MP, Schell MA, Kim HS, DeShazer D. Development of a polymerase chain reaction assay for the specific identification of *Burkholderia mallei* and differentiation from *Burkholderia pseudomallei* and other closely related Burkholderiaceae. Diagn Microbiol Infect Dis. 2006;55:37-45.

Van Zandt KE, Greer MT, Gelhaus HC. Glanders: an overview of infection in humans. Orphanet J Rare Dis. 2013;8:131.

Verdegaal E. Glanders in horses and other equids. In: Kahn CM, Line S, Aiello SE, editors. The Merck veterinary manual [online]. 10th ed. Whitehouse Station, NJ: Merck and Co; 2025. Available at: https://www.merckvetmanual.com/generalized-conditions/glanders/glanders-in-horses-and-other-equids. Accessed 7 Aug 2025.

Waag DM, Chance TB, Trevino SR, Rossi FD, Fetterer DP, Amemiya K, Dankmeyer JL, Ingavale SS, Tobery SA, Zeng X, Kern SJ, Worsham PL, Cote CK, Welkos SL. Comparison of three non-human primate aerosol models for glanders, caused by *Burkholderia mallei*. Microb Pathog. 2021;155:104919.

Waag DM, DeShazer D. Glanders. New insights into an old disease. In: Lindler LE, Lebeda FJ, Korch GW, editors. Biological weapons defense: Infectious diseases and counterterrorism. Totowa, NJ: Humana Press Inc.; 2005. p. 209-38.

Wernery U, Wernery R, Joseph M, Al-Salloom F, Johnson B, Kinne J, Jose S, Jose S, Tappendorf B, Hornstra H, Scholz HC. Natural *Burkholderia mallei* infection in dromedary, Bahrain.Emerg Infect Dis. 2011;17(7):1277-9.

World Organization for Animal Health [WOAH] . Manual of diagnostic tests and vaccines for terrestrial animals [online]. Paris: OIE; 2018. Glanders and melioidosis. Available at: https://www.woah.org/en/what-we-do/standards/codes-and-manuals/. Accessed 29 Jul 2025:

World Organization for Animal Health [OIE] Handistatus II [database online]. OIE; 2004. Available at: http://www.oie.int/hs2/report.asp?lang=en.* Accessed 30 Aug 2007.

Zakharova I, Teteryatnikova N, Toporkov A, Viktorov D. Development of a multiplex PCR assay for the detection and differentiation of *Burkholderia pseudomallei*, *Burkholderia mallei*, *Burkholderia thailandensis*, and *Burkholderia cepacia* complex. Acta Trop. 2017;174:1-8.

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