Epidemiology of Brucellosis

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Learning objectives

By the end of the lecture, students should be able to:

1. Define brucellosis and explain why it is an important zoonosis.
2. Identify the principal *Brucella* species, their preferred animal hosts, reservoirs, and sources of human infection.
3. Describe the epidemiological triad, chain of infection, modes of transmission, incubation period, and high-risk groups.
4. Explain the global and Iraqi distribution of brucellosis and interpret its person–place–time pattern.
5. Recognize the clinical and laboratory features required for case detection and surveillance.
6. Outline the investigation of a suspected case or outbreak.
7. Propose prevention and control measures using primary, secondary, and tertiary prevention.
8. Counsel patients and communities about safe dairy consumption and occupational protection.

Definition and importance

Brucellosis is a systemic bacterial zoonosis caused by brucellosis-causing species of the genus *Brucella*. It primarily circulates in animals and is transmitted to humans through infected animals, their tissues or body fluids, contaminated food—especially unpasteurized milk and fresh cheese—or inhalation of infectious aerosols.

The disease is also known as **undulant fever**, **Malta fever**, or **Mediterranean fever**. "Undulant fever" describes a classical fluctuating fever pattern, but absence of this pattern does not exclude the disease.

Brucellosis matters to Community Medicine because it:

- Is among the most widespread zoonoses and remains endemic in many low- and middle-income settings.
- Produces prolonged illness, disability, work loss, diagnostic delay, and relapse when inadequately treated.
- Causes abortion, infertility, breeding failure, and reduced milk production in livestock, creating losses for households and the agricultural economy.
- Cannot be sustainably controlled in humans without controlling infection in animal reservoirs.

A 2023 evidence-based global analysis estimated approximately 1.6–2.1 million human cases annually depending on the statistical model, substantially exceeding the older commonly quoted estimate of 500,000 cases. The wide uncertainty reflects underdiagnosis, incomplete reporting, uneven laboratory access, and weak surveillance in many endemic areas.

The causative agent

Brucella organisms are small, Gram-negative, non-spore-forming coccobacilli. They are facultative intracellular pathogens; survival within host phagocytic cells contributes to systemic dissemination, persistence, focal disease, relapse risk, and the need for combination antimicrobial therapy of adequate duration.

Important species and hosts

Species	Preferred animal host or reservoir	Epidemiological importance to humans
B. melitensis	Goats, sheep, and camels	Most prevalent cause of human brucellosis worldwide; usually the most virulent major species for humans.
B. abortus	Cattle	Associated with cattle exposure, raw dairy products, reproductive tissues, and accidental exposure to live vaccine strains.
B. suis	Domestic pigs	Important in pig handlers, abattoir workers, and hunters.
B. canis	Dogs	Uncommon human infection; exposure may occur among breeders, veterinarians, and laboratory staff.

Reservoir and source

Reservoirs

The principal reservoirs are infected domestic and wild animals. Cattle, sheep, goats, camels, pigs, dogs, can be involved depending on species and geographic setting.

Sources of human infection

High concentrations of organisms may be present in:

- Blood and tissues from infected animals (Placenta, aborted fetus)
- Raw milk and products prepared from it, especially fresh or soft cheese.
- Aerosols generated during animal handling, slaughter, laboratory procedures, or environmental cleaning.
- Live attenuated veterinary vaccines after accidental needlestick or mucosal exposure.

Chain of infection

		Point for interruption
Infectious agent	Brucellosis-causing *Brucella* species	Laboratory detection; effective treatment of human cases does not eliminate the animal reservoir
Reservoir	Infected livestock, dogs, wildlife	Animal vaccination, testing, movement control
Portal of exit	Milk, placenta, fetus, uterine secretions, blood, tissues	Safe milking, isolation of aborting animals and safe disposal of reproductive waste
Mode of transmission	Ingestion, direct inoculation or mucosal contact, inhalation	Pasteurization, food regulation, PPE, ventilation.
Portal of entry	Gastrointestinal tract, conjunctiva or other mucosa, respiratory tract, broken skin	Gloves, eye/face protection, respiratory protection when indicated, wound covering, hand hygiene
Susceptible host	Exposed consumer, worker, household member, hunter, veterinarian, or laboratorian	Education, occupational health systems, exposure assessment, post-exposure management

Modes of transmission

Foodborne transmission

Consumption of unpasteurized milk or dairy products is the most common route in the general population in many endemic settings.

Undercooked infected meat is a possible route, although dairy products generally carry greater public-health importance. Thorough cooking reduces risk; freezing and drying should not be considered adequate decontamination.

Direct contact

Organisms enter through cuts or abrasions in the skin or through the conjunctival, nasal, or oral mucosa. High-risk events include assisting animal delivery, handling an aborted fetus or placenta, slaughtering and butchering and accidental injection with a veterinary vaccine.

Inhalation

Aerosol transmission occurs in laboratories, abattoirs where contaminated tissues or cultures are manipulated.

Person-to-person transmission

Person-to-person spread is **very rare**. Unusual transmission has been described in relation to pregnancy or breastfeeding, sexual contact, blood exposure, or transplantation.

Public-health interpretation: Routine isolation of an uncomplicated patient is generally not required to protect casual contacts. Investigation should instead search for a shared animal, food, occupational, or laboratory exposure.

Incubation

The incubation period is highly variable: WHO gives a range, usually two to four weeks, while CDC guidance recognizes a wider possible interval of about five days to six months.

Humans are usually epidemiological dead ends because ordinary person-to-person transmission is extremely uncommon.

Distribution: place

Brucellosis occurs globally but is unevenly distributed. High incidence is reported in parts of the Middle East, Mediterranean region, sub-Saharan Africa, Central and Southwest Asia, China, India and Mexico.

Low recorded incidence may represent successful control or may reflect limited detection. Reported case numbers depend on clinician awareness.

Iraq

Brucellosis is endemic and enzootic in Iraq. A national spatiotemporal analysis using Ministry of Health surveillance data recorded 51,508 human cases from 2007 through 2018; cases persisted throughout the study period and showed significant clustering in northern and northeastern Iraq.

The Iraqi study found more reported cases among females, particularly in the 15–45-year age group, and more cases during summer and spring.

Clinical epidemiology

Brucellosis may begin acutely or insidiously. Common manifestations include fever, sweats—often profuse and nocturnal—fatigue, malaise, headache, anorexia, weight loss, myalgia, arthralgia, and back pain.

Focal complications can involve:

- Osteoarticular system: peripheral arthritis, sacroiliitis, spondylitis, discitis, or osteomyelitis.
- Genitourinary system: orchitis or epididymitis.
- Nervous system: meningitis, encephalitis.
- Cardiovascular system: endocarditis.
- Reticuloendothelial system: hepatomegaly or splenomegaly.
- Localized abscesses or other organ involvement.

Untreated disease can become prolonged and disabling. Fatality is uncommon—CDC estimates no more than 2%—but serious focal disease, especially endocarditis or neuroborreliosis, requires urgent specialist management.

Differential diagnosis

The differential depends on setting and presentation and may include:

- Tuberculosis.
- Enteric fever.
- Malaria where relevant.

- Visceral leishmaniasis.
- Infective endocarditis.
- Viral infections.
- Lymphoma and other malignancies.
- Autoimmune or inflammatory disorders.
- Pyogenic spondylodiscitis or septic arthritis.

The key epidemiological lesson is that a nonspecific febrile syndrome becomes much more informative when combined with raw dairy intake, animal reproductive exposure, slaughtering, veterinary vaccination, hunting, travel, or laboratory work.

Diagnosis

Laboratory confirmation

Culture can confirm infection from blood, bone marrow, cerebrospinal fluid, joint fluid, abscess material, or other appropriate specimens. Because culture may expose laboratory workers, the laboratory must be warned when brucellosis is suspected.

Serological tests detect antibodies, but interpretation depends on assay, timing, local background exposure, vaccination history in animals, and clinical context.

Clinical criteria

Acute or insidious fever **and at least two** of the following: night sweats, arthralgia, headache, fatigue, anorexia, myalgia, weight loss, arthritis, spondylitis, meningitis/encephalitis or other neurological abnormality, discitis/osteomyelitis, abscess, or focal organ involvement such as endocarditis, orchitis/epididymitis, hepatomegaly, or splenomegaly.

Prevention and control

Primary prevention

Control in animals

Controlling animal infection is the most effective long-term protection for humans.

Key measures are:

- vaccination of cattle, sheep, and goats in endemic settings under veterinary programs.
- Testing and removal or managed segregation of infected animals where feasible.
- Surveillance of herds and investigation of animal abortions.
- Quarantine and testing of infected animals.
- Safe handling and disposal of aborted fetuses, placentas, and other tissues.

Vaccination is often central in high-prevalence endemic areas; as prevalence falls, surveillance, testing, traceability, and removal of infected animals become increasingly important.

Food safety.

- Avoid raw milk and products of uncertain pasteurization.
- Thoroughly cook meat.

Boiling milk (100C) for 20 _30 min where pasteurization is unavailable can reduce risk

Occupational protection

Workers should use gloves, protective clothing, eye or face protection, and respiratory protection when aerosol risk warrants it. Cuts should be covered, hands washed after animal contact, and contaminated clothing or equipment safely cleaned.

Particular caution is required during animal births, abortions, slaughtering, and vaccination. Needlestick or mucosal exposure to a live veterinary vaccine should be reported immediately for occupational-health assessment.

Laboratory biosafety

Suspected cultures and high-risk specimens should be handled in a certified biological safety cabinet with appropriate PPE.

Secondary prevention

Secondary prevention aims at early detection and prompt effective treatment:

- Maintain a high index of suspicion for prolonged fever in endemic areas.
- Take a structured exposure history.
- Use appropriate combination antimicrobial therapy for adequate duration.

There is no widely used licensed human vaccine

Tertiary prevention

Tertiary measures reduce complications and disability:

- Assess for focal disease when symptoms or examination indicate osteoarticular, neurological, cardiac, hepatic, spleen
- ic, or genitourinary involvement.
- Ensure adherence and follow-up for relapse or persistent symptoms.
- Refer complicated disease, pregnancy, young children, immunocompromised patients, and suspected endocarditis or neurobrucellosis for specialist care.
- Support rehabilitation when chronic pain, fatigue, or functional limitation persists.

Treatment overview

WHO lists doxycycline 100 mg twice daily for 45 days plus streptomycin 1 g daily for 15 days as one option; an alternative is doxycycline 100 mg twice daily plus rifampicin 600–900 mg daily for 45 days. Treatment is generally combined because monotherapy and inadequate duration increase the risk of failure or relapse.

clinical scenario

A 32-year-old woman from a sheep-rearing household presents with three weeks of intermittent fever, drenching night sweats, fatigue, back pain, and weight loss. She regularly prepares fresh cheese from unpasteurized sheep milk and assisted a ewe during an abortion one month earlier. This scenario immediately suggests the two major exposure pathways of human brucellosis: ingestion of contaminated unpasteurized dairy products and direct contact with infected reproductive tissues or secretions.

Questions

1. **What is the most likely diagnosis?**
   Human brucellosis is strongly suspected, but laboratory evidence is needed.

2. **Which exposures are highest priority?**
   Direct contact with abortion products and consumption of unpasteurized sheep-milk cheese.

3. **Which organism is epidemiologically most likely?**
   B. melitensis, because sheep and goats are its principal hosts and it is the most prevalent cause of human brucellosis worldwide.

4. **What immediate actions are needed?**
   Obtain appropriate specimens, alert the laboratory, notify public health according to local rules, begin treatment once evaluated and confirmed or when clinically indicated, identify all persons who consumed the same cheese and inform veterinary and food-safety partners.

5. **Should family members be isolated from the patient?**
   No routine isolation is required for casual household contact because person-to-person transmission is extremely rare. Family members should be assessed for the shared food or animal exposure.

6. **What upstream intervention has the greatest long-term effect?**
   Investigation and control of infection in the source flock, combined with safe milk processing and education.

Take-home messages

1. Brucellosis is a systemic bacterial zoonosis maintained mainly in animal reservoirs.
2. *B. melitensis* from sheep, goats, and camels is the leading cause of human disease worldwide.
3. The two central human exposure pathways are unpasteurized dairy consumption and contact with infected animals or reproductive tissues.
4. Incubation is usually two to four weeks but may range from days to months; take a broad exposure history.
5. Symptoms are nonspecific, so diagnosis requires epidemiological suspicion plus laboratory testing.
6. Human-to-human transmission is extremely rare; investigate shared sources rather than isolating casual contacts.
7. Iraq has documented endemic disease with historical clustering in northern and northeastern regions and more cases in spring and summer.
8. Pasteurization, occupational protection, animal vaccination, testing, movement control, and safe disposal of abortion products form the prevention package.

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