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# ZOONOTIC BACTERIAL INFECTIONS: EPIDEMIOLOGY, KEY PATHOGENS, AND CONTROL IN A ONE HEALTH FRAMEWORK

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**Abstract:** Bacterial zoonoses—diseases that are naturally transmitted between vertebrate animals and humans—remain a major yet under-recognized contributor to global disease burden. They account for a substantial fraction of emerging and re-emerging infections and are closely linked to environmental change, expanding and intensifying animal production systems, globalization of trade and travel, and antimicrobial use across human and animal sectors. Important zoonotic bacteria include Salmonella spp, Campylobacter spp., Shiga toxin–producing Escherichia coli (STEC), Brucella spp, Leptospira, Yersinia pestis, Coxiella burnetii, Bacillus anthracis, and others. This review outlines the concept and burden of zoonotic bacterial infections; presents a comparative table of approximate incidence and prevalence worldwide, in South Asia, and in Central Asia; summarizes epidemiology and clinical features of key pathogens; discusses antimicrobial resistance (AMR) in a One Health context; and highlights priorities for surveillance, prevention, and control, particularly in low- and middle-income countries (LMICs).

**Keywords:** Zoonotic, Bacterial, Infections, Epidemiology, Pathogens, Control

## Introduction and Definitions

Zoonoses are infections and diseases that are naturally transmissible between vertebrate animals and humans.[1] Bacterial zoonoses represent a diverse set of pathogens with different animal reservoirs, routes of transmission, clinical syndromes, and geographic patterns. Their emergence and persistence are driven by multiple, interconnected forces[2]. Rapid population growth and urban expansion, intensification of livestock production and closer wildlife–livestock–human interfaces, Land-use changes such as deforestation and agricultural encroachment, Global trade and movement of animals and animal products, International travel and migration, Climate variability, flooding, and other extreme weather events, Widespread antimicrobial use in human medicine, veterinary practice, and agriculture. The burden of zoonotic bacterial infections falls disproportionately on rural and marginalized populations, who often live in close contact with animals, are highly exposed to contaminated environments, and have limited access to diagnostics and effective treatment.[2–4]

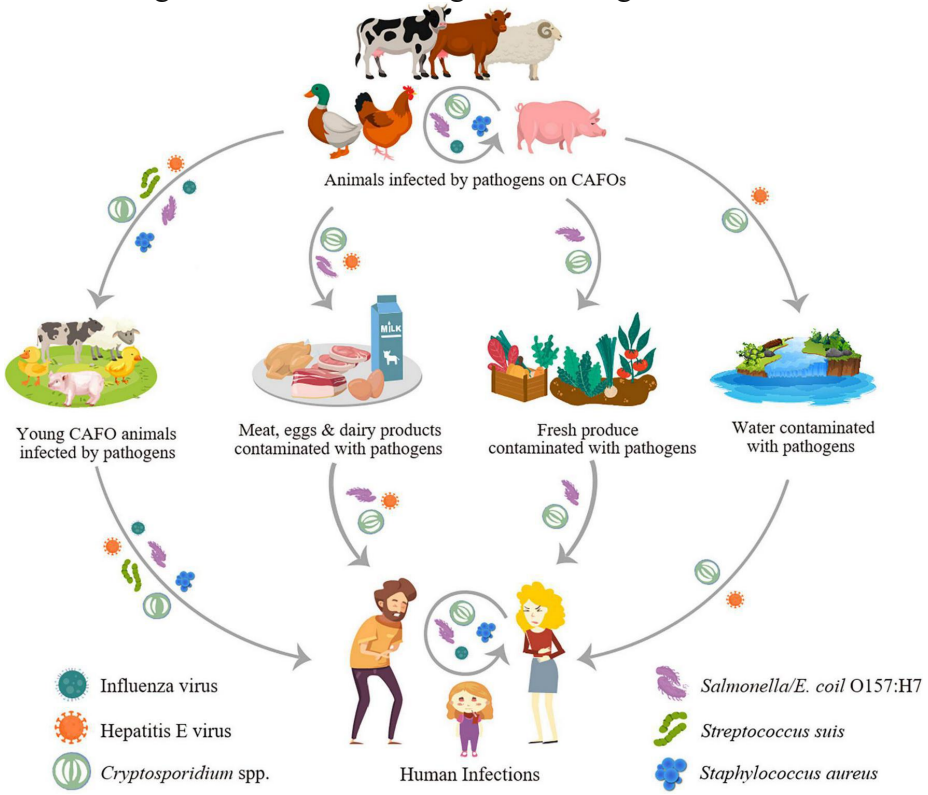
**Table 1. Approximate burden of selected zoonotic bacterial infections worldwide, in South Asia, and in Central Asia**

| Infection / pathogen | Global burden (approximate) | South Asia (approximate pattern) | Central Asia (approximate pattern) |
|---|---|---|---|
| Non-typhoidal | ~93 million | High incidence of | Contributes to |

| | | | |
|---|---|---|---|
| | gastroenteritis cases and ~155,000 deaths annually; leading foodborne bacterial pathogen | foodborne diarrhoea; NTS important in community diarrhoea and some invasive disease, but robust incidence data lacking; burden highest in young children and immunocompromised | foodborne diarrhoea; sporadic outbreaks linked to eggs, poultry, and meat; routine surveillance incomplete, so true incidence likely underestimated |
| Invasive NTS (bacteraemia)[11] | Concentrated in sub-Saharan Africa; global incidence not well quantified but responsible for tens of thousands of deaths | Documented in India and neighbouring countries, mainly in malnourished or HIV-infected children; incidence lower than in Africa and poorly quantified regionally | Rarely measured; probably underdiagnosed in high-risk patients |
| *Campylobacter* | Among the most common bacterial enteric infections globally; tens to hundreds of millions of cases/year | Frequent cause of acute diarrhoea in community and travellers; underdetected due to limited culture capacity | Detected in outbreaks and travellers' diarrhoea; routine diagnostics limited; incidence likely under-reported |
| STEC (e.g. O157:H7) diarrhoea and HUS[13] | Hundreds of thousands of STEC infections/year; childhood HUS incidence ~2–3/100,000/year in high-surveillance settings | Sporadic cases and small outbreaks described; paediatric HUS likely under-recognized; overall incidence probably lower than in high-surveillance high-income countries | Very sparse data; STEC and HUS likely under-recognized and under-reported |
| Leptospirosis[8] | ~1 million cases and ~60,000 deaths annually worldwide; incidence in tropical/subtropical hotspots often >10–100/100,000/year | Recurrent outbreaks in India, Sri Lanka, Bangladesh, and Nepal; district-level incidence >10–20/100,000/year during epidemics; routine surveillance incomplete | Reported after floods or in agricultural communities; regional incidence poorly defined, but generally lower than in humid tropical settings |

| | | | |
|---|---|---|---|
| Plague | Several thousand suspected cases per decade; concentrated in Madagascar, DRC, Peru, and some Asian/American natural foci | Historically present but now extremely rare; most South Asian countries report few or no recent locally acquired cases | Natural foci persist in parts of Central Asia; current human incidence usually <1 case/million/year where reported |

HICs = high-income countries; LMICs = low- and middle-income countries. Values are approximate ranges based on available global and regional studies.




**Major Zoonotic Bacterial Pathogens**

1. **Non-typhoidal *Salmonella* (NTS)**

**Reservoirs and transmission**

NTS serovars (e.g. S. enteritidis, S. typhimurium) are widely carried by poultry, pigs, cattle, and other animals.[10] Human infection is mainly foodborne, via contaminated eggs, poultry, meat, and unpasteurized dairy, but may also follow direct contact with infected animals or contaminated environments.

**Epidemiology and resistance**

NTS is a leading cause of bacterial foodborne disease globally.[5] Multidrug resistance—including resistance to fluoroquinolones and third-generation cephalosporins—is increasingly reported from both human and animal sources.[10]

2. ***Campylobacter* spp.**

**Reservoirs and transmission**

*Campylobacter jejuni* and *C. coli* colonize poultry and other livestock. Humans usually acquire infection from undercooked poultry, unpasteurized milk, contaminated water, or via cross-contamination in kitchens.[12]

**Epidemiology and AMR**

*Campylobacter* ranks among the most common bacterial causes of gastroenteritis worldwide.[5],[12] Fluoroquinolone resistance is highly prevalent and linked to veterinary use; macrolide resistance is also emerging.[12]

3. **Shiga toxin–producing *Escherichia coli* (STEC)**

**Reservoirs and transmission**

Cattle and other ruminants are the main reservoirs. Transmission occurs via contaminated beef, unpasteurized milk or juice, fresh produce, or recreational/drinking water; secondary person-to-person spread is common in childcare settings and households.[13]

4. ***Brucella* spp.**

**Reservoirs and transmission**

Brucella melitensis (small ruminants), B. abortus (cattle), B. suis (pigs), and B. canis (dogs) constitute the main species infecting humans. People are infected through direct contact with infected animals or aborted materials, consumption of unpasteurized dairy, or occupational exposure in farming, veterinary, and slaughterhouse settings.[7]

**Epidemiology**

Endemic in the Mediterranean basin, Middle East, parts of Africa, and South Asia, brucellosis is substantially under-reported due to its non-specific presentation and limited diagnostic capacity in many endemic areas[14].

5. ***Leptospira* spp.**

**Reservoirs and transmission**

Pathogenic *Leptospira* are maintained in the kidneys of rodents, dogs, livestock, and wildlife. Human infection occurs via contact with urine-contaminated water or soil, particularly after heavy rainfall and flooding.[8]

***6.Yersinia pestis* (Plague)**

**Reservoirs and transmission**

Plague is maintained in wild rodent populations; transmission to humans occurs via infected flea bites or direct contact with infected animals or tissues. Pneumonic plague can spread person-to-person through respiratory droplets[9].

**Epidemiology**

Plague persists in enzootic foci in Madagascar, Democratic Republic of Congo, Peru, and several Asian and American regions, including some Central Asian natural foci[9].

**One Health Approach**

The One Health concept—recognizing the interdependence of human, animal, and environmental health—provides a unifying framework for tackling zoonotic bacterial infections and AMR[2].

Key One Health actions include:

• Integrated surveillance of zoonotic diseases and AMR in humans, domestic animals, wildlife, and food products.

• Veterinary public health measures: livestock vaccination (e.g. anthrax, brucellosis), improved husbandry and biosecurity, and control of stray animals and rodent populations.

• Food safety interventions: good agricultural and manufacturing practices, slaughterhouse and meat inspection standards, cold chain maintenance, and household food hygiene.

• Environmental management: water, sanitation, and hygiene (WASH) infrastructure, safe disposal of animal waste, and mitigation of flood-related exposures.

• Policy and governance: intersectoral coordination mechanisms, data-sharing platforms, and risk communication strategies.

**Prevention and Control**

1. **Animal-level measures;** Vaccination of livestock against anthrax, brucellosis, and other relevant pathogens[7]. Testing and removal or segregation of infected animals where feasible (e.g. in brucellosis control).Enhanced husbandry, housing, and nutrition to reduce infection pressures.

**2.Food safety;** Pasteurization of milk and dairy products.Hygienic slaughter and meat inspection.Temperature control and separation of raw and ready-to-eat foods to prevent cross-contamination.

**3. Environmental and WASH interventions;** Rodent control programmes to limit leptospirosis and plague risk.Improved drainage and sanitation to reduce exposure to contaminated standing water.

**4. Personal protective practices;** Use of protective clothing and gloves by farmers, veterinarians, abattoir and laboratory workers.Avoidance of raw milk, undercooked meat, and untreated surface water in endemic areas.

**Future Directions**

Priority areas for improving control of zoonotic bacterial infections include:

•Generating better burden estimates through well-designed epidemiological and serological studies in LMICs.

• Developing and scaling up rapid, affordable diagnostics suitable for frontline health facilities.

• Evaluating and implementing cost-effective animal vaccination and control strategies in different production systems.

•Building integrated AMR surveillance and modelling across human–animal–environment interfaces.

• Conducting operational research on how to implement and sustain one Health approaches in resource-limited settings.

**Conclusion**

Zoonotic bacterial infections are a major but often neglected component of the global infectious disease burden. Their occurrence is tightly linked to patterns of animal production, environmental change, and antimicrobial use, and their impact is greatest in disadvantaged populations. Pathogens such as Salmonella, Campylobacter, STEC, Brucella, Leptospira, Y. pestis, B. anthracis, and C. burnetii continue to cause endemic disease and outbreaks worldwide.Reducing this burden will require coherent One Health strategies that integrate surveillance, animal and food safety interventions, environmental management, and rational antimicrobial use. With sustained political commitment, investment, and cross-sectoral collaboration, substantial gains in prevention and control of zoonotic bacterial infections are achievable.

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