

Brucellosis and Antibiotic Resistance: An Overlooked Public Health Challenge in India

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INTRODUCTION

India possesses one of the largest livestock populations in the world, with millions of households relying on cattle, sheep and goats for their livelihood, nutrition and economic stability. Livestock production plays a critical role in food security and rural development. However, alongside these benefits exists a persistent but often overlooked zoonotic disease—brucellosis. This bacterial infection affects both animals and humans and continues to pose a significant challenge to public health, livestock productivity and rural livelihoods.

Although brucellosis rarely receives widespread public attention, its global burden remains substantial. More than 500,000 human cases are estimated to occur annually worldwide, making it one of the most important neglected zoonotic diseases (Pappas et al., 2006). In countries such as India, where close contact between humans and livestock is common, the risk of disease transmission remains particularly high.

UNDERSTANDING BRUCELLOSIS

Brucellosis is caused by bacteria belonging to the genus *Brucella*. Among the different species, *Brucella melitensis*, *Brucella abortus* and *Brucella suis* are the most important pathogens responsible for human infections. *B. melitensis*, primarily associated with sheep and goats, is regarded as the most virulent species affecting humans (Corbel, 2006; Xavier et al., 2010).

Human infection generally occurs through:

- Consumption of unpasteurized milk or dairy products
- Direct contact with infected animals or aborted materials
- Inhalation of contaminated aerosols in farms, laboratories or slaughterhouses

Because of these transmission routes, brucellosis is considered an occupational disease, particularly affecting veterinarians, dairy workers, shepherds, farmers and abattoir workers (Pappas et al., 2005).

BRUCELLOSIS IN INDIA

Brucellosis was first reported in India in 1942 and the disease is now considered endemic in many parts of the country (Upadhyay et al., 2019). The widespread presence of livestock, coupled with traditional farming practices and limited awareness about zoonotic diseases, contributes to its persistence.

Serological studies indicate a considerable prevalence of brucellosis in livestock populations. Bovine brucellosis has been reported with a seroprevalence of approximately 13.5% in cattle, reflecting the widespread nature of the infection in India (Mitra et al., 2018).

Small ruminants also play a significant role in disease transmission. A nationwide survey reported apparent and true prevalence rates of 7.45% and 3.79% respectively in sheep and goats, with several Indian states showing prevalence greater than 5% (Shome et al., 2021).

Human infections are frequently detected among individuals with occupational exposure to livestock. Studies have reported seroprevalence rates of around 8.5% among dairy workers, highlighting the occupational risk associated with the disease (Hemashettar & Patil, 1991; Pandit & Pandit, 2013).

Despite these findings, brucellosis remains underdiagnosed and underreported, largely due to limited diagnostic facilities, low awareness and nonspecific clinical symptoms.

CLINICAL IMPACT IN ANIMALS AND HUMANS

In livestock, brucellosis mainly affects the reproductive system. Infected animals commonly exhibit:

- Abortions during late pregnancy
- Retained placenta
- Infertility in males and females
- Reduced milk production

These reproductive losses can significantly affect farmer income and livestock productivity.

In humans, the disease typically presents as undulant fever, characterized by intermittent fever, fatigue, night sweats, joint pain and weight loss. In some cases, complications may involve

osteoarticular, cardiovascular or genitourinary systems (Corbel, 2006).

Because these symptoms resemble those of other febrile illnesses such as malaria, typhoid or tuberculosis, brucellosis is often misdiagnosed or overlooked in clinical settings.

ANTIBIOTIC TREATMENT AND THE EMERGING THREAT OF RESISTANCE

Treatment of human brucellosis generally requires prolonged antibiotic therapy. The World Health Organization recommends combination therapy, typically doxycycline with either rifampicin or streptomycin (Corbel, 2006). Other antibiotics such as gentamicin, ciprofloxacin and trimethoprim-sulfamethoxazole are also used in certain treatment regimens.

However, recent studies indicate that antimicrobial resistance (AMR) may be emerging in *Brucella* species. Resistance to commonly used antibiotics such as rifampicin and co-trimoxazole has been reported in several studies (Trott et al., 2018; Doimari et al., 2019).

This issue is particularly concerning because rifampicin is also a key drug used in the treatment of tuberculosis, raising concerns about cross-resistance and treatment failure.

Furthermore, treatment failures and relapse of infection have been documented in some cases, emphasizing the need for improved surveillance and rational antibiotic use (Yousefi-Nooraie et al., 2012).

GENOMICS AND FUTURE DIRECTIONS IN BRUCELLOSIS RESEARCH

Recent advances in modern genetic technologies, particularly whole genome sequencing (WGS), are helping scientists better understand how disease-causing bacteria evolve and develop resistance to antibiotics.

By studying the complete genetic blueprint of *Brucella melitensis*, researchers can identify small changes in the bacterial DNA that may influence how the organism responds to antibiotics. These changes can act as genetic markers, helping scientists predict resistance patterns and understand how the pathogen spreads.

Interestingly, studies have shown that the genome of *Brucella* species is highly stable and conserved, with more than 90% genetic similarity between different species (Michaux et al., 1993; Rajendran, 2021). This makes genomic analysis particularly useful for detecting subtle genetic variations that may influence virulence or drug resistance.

Such genomic tools are increasingly important for tracking the evolution of pathogens, improving diagnostic methods, and strengthening disease surveillance systems, ultimately helping public health authorities respond more effectively to emerging threats.

THE NEED FOR A ONE HEALTH APPROACH

Brucellosis highlights the close interconnection between human health, animal health and environmental factors. Addressing this disease requires an integrated One Health approach, which promotes collaboration between veterinary, medical and environmental sectors.

Important strategies include:

- Strengthening livestock vaccination and surveillance programs
- Improving farm biosecurity and hygiene practices
- Promoting public awareness regarding consumption of pasteurized milk
- Ensuring responsible antibiotic use in both human and veterinary medicine

India has already initiated national programs aimed at controlling brucellosis in livestock. However, strengthening surveillance systems and integrating human and animal health monitoring remain essential for effective disease control.

CONCLUSION

Brucellosis remains one of the most important yet neglected zoonotic diseases affecting livestock and humans worldwide. In a country like India, where livestock farming is deeply integrated into rural livelihoods, controlling brucellosis is essential not only for animal health but also for public health and food safety.

With the growing concern of antimicrobial resistance, continued research,

improved surveillance systems and greater public awareness will be critical to reducing the burden of brucellosis and safeguarding both human health and livestock productivity.

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