Paratuberculosis
Summary

Introduction

1. This document summarizes the analysis conducted by a DISCONTOOLS expert group on Paratuberculosis (ParaTB). Their review encompassed current knowledge of the disease, existing control tools, gaps in their effectiveness, and research priorities for developing improved solutions. Full details can be accessed at t http://www.discontools.eu/ by selecting "Disease Database," choosing the relevant disease, and highlighting key variables of interest. Also, the full gap analyses for Paratuberculosis can be found here

Disease profile

2. Paratuberculosis (Johne's disease) is caused by *Mycobacterium avium* subsp. *paratuberculosis* (MAP). It predominantly affects adult cattle, sheep, goats, and deer, with species-adapted strains that can still infect multiple hosts to varying degrees. The disease manifests differently across species and can follow highly variable courses. Paratuberculosis is an untreatable intestinal condition in ruminants, characterized by progressive wasting and, in severe cases, diarrhea. MAP also affects camelids, wildlife—including deer and rabbits—and animals in zoological collections. The full spectrum of potential carriers, whether symptomatic or asymptomatic, has yet to be fully identified.

3. In cattle, infection occurs in three stages:

Early susceptibility – Calves are highly vulnerable, typically ingesting MAP within the first month of life. Some may begin excreting the bacteria shortly after infection.

Latent phase – An extended, asymptomatic period follows, during which infected animals intermittently shed low levels of MAP but remain clinically healthy. These silent carriers may play a key role in disease transmission.

Clinical disease – Eventually, infected cattle exhibit persistent diarrhea, weight loss, and, in many cases, a gradual decline in milk production. In sheep and goats, weight loss is often the sole clinical symptom.

Risk

4. Paratuberculosis is globally prevalent, though underreporting and inconsistent study designs make regional comparisons unreliable. Most studies fail to accurately estimate both herd-level and individual animal prevalence. Paratuberculosis has been recognised as a widespread problem throughout the world.

5. Meta-analyses suggest a specific but unproven association between MAP and Crohn's disease in humans. While antimycobacterial antibiotics have induced remission in pediatric Crohn's cases, a definitive causal relationship remains unverified. Transmission from cattle to humans has never been demonstrated. Nonetheless, proactive efforts to control Johne's disease would bolster consumer confidence should a stronger link to Crohn's disease emerge.

6. MAP is primarily transmitted through fecal contamination of food, water, and the environment, but can also be shed in milk and colostrum or passed in utero. Its slow progression complicates detection, with poor hygiene and management accelerating herd-wide infections. Most outbreaks stem from the introduction of infected animals into a herd.

Diagnostics

7. There are commercial kits available for ELISAs to detect antibody, interferon-gamma kits to detect cellular immune response and culture and PCR kits to detect the organism and bacterial DNA. Tests based on presence of MAP in faeces may be false-positive regarding infection because they may just detect transient passive digestive carriers. Tests can be divided in early-stage diagnostics (detecting pro-inflammatory immune responses, e.g. interferon-gamma assays), late-stage diagnostics (detecting anti-inflammatory immune responses, e.g. IgG1 ELISA) and herd-level diagnostics (based on environmental sampling or bulk-tank milk analysis).
8. No existing test reliably detects latent infections, and all can produce false positives in field conditions due to MAP's chronic nature.
9. Quantitative and digital PCR offer promising advancements for MAP detection, while emerging techniques—such as metabolomic profiling, microRNA identification, and fecal microbiota analysis—may further refine diagnostics.

Vaccines

10. killed vaccine is widely used in Australian sheep herds, significantly reducing MAP prevalence, shedding, and mortality. However, it does not prevent infection and is unsuitable for full eradication. No effective vaccine exists for cattle, hindering control efforts. Current vaccines help mitigate clinical symptoms and occasionally reduce shedding, but they fail to prevent infection. Challenges include interference with tuberculosis diagnostics and severe injection-site reactions. Developing a ParaTB vaccine that prevents both infection and shedding while maintaining compatibility with TB testing remains a critical need for the livestock industry.

Pharmaceuticals

11. MAP treatment remains impractical for production animals due to cost and efficacy limitations. While bacterial probiotics and mycobacteriophage research show potential, further validation is required before practical application.

Knowledge

12. Major gaps persist in understanding protective immune responses. The assumption that cell-mediated immunity is solely protective while antibodies are not, requires reevaluation. Antibody responses should be studied in greater depth across host tissues beyond blood.
13. The fact that macrophages predominate, and neutrophils ares scarce in intestinal lesions albeit IL-8 levels are high is intriguing. Further research on the role of neutrophils and other important cells of the immune system is needed.
14. Additionally, the full spectrum of MAP carriers—both symptomatic and asymptomatic—remains undetermined, especially among pasture-managed animals. Research into fecal-oral transmission rates under varying stocking densities and age groups is needed.
15. Genetic studies on resistance and susceptibility offer promise for improving disease management. Identifying genetic factors contributing to resistance, along with selection markers for highly susceptible animals, is an approach gaining traction in some countries.

Conclusion

16. Despite decades of control efforts, Johne's disease continues to impose significant losses on the livestock industry, largely due to critical knowledge gaps.
17. Developing more effective diagnostic and screening tools, particularly for early infections, should be prioritized. Cost-effective immunodiagnostics capable of distinguishing between "non-infected," "exposed," "MAP-infected," and "infectious" animals are essential.
18. Improved vaccines that prevent MAP shedding, offer robust protection for young animals, and do not interfere with tuberculosis testing are urgently needed.