Paratuberculosis in Cattle

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KEYWORDS

• Johne disease • *Mycobacterium avium* ssp *paratuberculosis* • Ruminants • Herd • Pathogenesis • Diagnosis • Control • Vaccination

KEY POINTS

- Paratuberculosis, or Johne disease, is caused by *Mycobacterium avium* ssp *paratuberculosis* (MAP), which has a long incubation period leading to delayed fecal shedding and a delayed humoral response in infected animals.
- Although the classic signs of Johne disease in cattle include diarrhea and weight loss, most infected cattle are in the subclinical phase of the disease and appear healthy; however, they have decreased milk production and reduced fertility when compared with uninfected herd mates.
- Subclinically, infected cattle can shed large amounts of MAP in their feces, contaminating the environment and infecting the replacement stock.
- Control of the disease relies on preventing infection of the susceptible animals in the herd, testing and culling the infected animals, and increasing resistance to MAP.

INTRODUCTION

Paratuberculosis is a chronic, granulomatous infection of the intestinal tract of cattle and other domestic and wild ruminants caused by *Mycobacterium avium* ssp *paratuberculosis* (MAP). The organism is an acid-fast, gram-positive, facultative intracellular pathogen that requires iron for growth and has the ability the survive within macrophages.[1] The organism is extremely resistant and, in ideal conditions, can survive for up to a year in the environment.[2] MAP has also been shown to survive pasteurization.[3,4] Because of MAP's long incubation period (between 2 and 7 years), most infected cattle (around 95%) are considered to be in the subclinical stages of the disease, with less than 5% of infected cattle displaying clinical signs of illness.[5] The term *Johne disease* typically refers to the clinical syndrome of diarrhea and weight loss that results from advanced MAP infection.

PREVALENCE OF PARATUBERCULOSIS IN CATTLE

Paratuberculosis is widely distributed throughout the world in many ruminant species. Many studies have been conducted in the United States as well as in other countries to

Disclosure Statement: The author has nothing to disclose.
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Vet Clin Food Anim ■ (2017) ■–■
https://doi.org/10.1016/j.cvfa.2017.10.011 **vetfood.theclinics.com**

estimate MAP prevalence in cattle. Fecal cultures and antibody-detection methods have been the most common diagnostic methods used for determination of prevalence.[6] Estimates of MAP prevalence are complicated by several factors, including the low sensitivity of the diagnostic tests available for subclinical animals, and that cattle in the clinical phase of the disease are usually culled before a final diagnosis of MAP infection is made. In the United States, at least 68% of dairy herds have MAP-infected cattle, with a much lower prevalence (less than 10%) among beef herds.[7,8] The most recent estimates of within-herd prevalence among a sample of 106 US dairy herds were reported to range from 0% to 27.3%, with a mean of 5.5%.[9] High within-herd prevalence is usually associated with higher MAP fecal shedding among positive animals, MAP fecal shedding at a younger age, shorter incubation period, and higher numbers of animals in the clinical phase of the disease.[6] It has also been proposed that the number of advanced clinical cases found in a herd can be used as a proxy for the determination of within-herd prevalence, in that for every cow with advanced Johne disease, it is likely that 15 to 25 others in the herd are infected.[10]

TRANSMISSION OF PARATUBERCULOSIS IN CATTLE

Routes of Transmission

Most new infections occur via the fecal-oral route, although other routes are possible. Calves born to seropositive dams were shown to be 6.6 times more likely to be seropositive compared with calves born to seronegative dams.[11] A meta-analysis estimated that 9% of fetuses born from subclinically infected dams and 39% born from clinically affected dams were infected in utero.[12] These findings indicate that the likelihood of fetal infection depends on the severity of the dam's infection. As the infection status of the dam represents a major risk factor for the newborn calf, it is not advised to keep a clinical cow within the herd in the hopes of obtaining the calf before culling, as the cow will continue to shed MAP organisms into the environment while the calf has a good chance to be infected.

MAP has been isolated from uterine flush fluids of infected cattle, and MAP organisms have been shown to adhere to embryos in vitro.[13] Therefore, an embryo obtained from an infected cow could result in an infected fetus; however, oocytes and embryos processed according to current embryo transfer recommendations are unlikely to result in infected calves.[14] Semen from infected bulls can be infected with MAP, even subclinically infected bulls.[15] However, semen from bulls kept in commercial bull studs is considered to have a very low risk of transmission, as these animals are rigorously tested for MAP. Herd sires (dairy and beef) should, therefore, be tested annually to ensure their negative status.

Most infections with MAP occur in the early neonatal period and are often associated with the calf sucking the manure-contaminated teat and udder when ingesting colostrum.[16] Multiple-use maternity pens can serve as focal points to spread the infection to the neonates. MAP may be passed through the colostrum and milk of cattle in the later stages of infection.[17,18] It has been demonstrated that colostrum from known infected cows is a much greater risk to spread MAP to calves compared with colostrum from known negative dams.[19] The practice of feeding pooled colostrum or waste milk may help spreading the infection from infected adults to many calves in the herd and should be discouraged. It is also important to note that MAP can survive pasteurization temperatures, therefore, colostrum and milk from known infected cows should not be used.[20]

Because beef calves nurse their dams from birth to several months of age, there may be more opportunity for transmission via MAP-positive colostrum and milk as