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Modeling of Mycobacterium Avium Subsp. Paratuberculosis Dynamics in a Dairy Herd: An Individual Based Approach

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Abstract

In the dairy industry, Johne's disease (JD), caused by *Mycobacterium avium subsp. paratuberculosis* (MAP) is one of the major investigated diseases. To date, researchers have suggested some control strategies for JD, such as test-and-cull based herd management, isolated calf rearing management, and vaccinations. Due to the slow progressing nature of MAP, tests with low diagnostic test sensitivity and specificity, and economic limitations, implementing these strategies has not resulted in elimination of MAP from farms. To date, no study has integrated detailed dairy herd dynamics with different MAP transmission routes. We have developed an individual-based dairy herd model by incorporating basic herd dynamics in a closed herd environment where no new animals have been bought from outside. The model considered three age groups of animals: calves, heifers and adults. It includes sequential life events of a dairy animal and such key dynamic processes of the dairy herd as lactation cycle, calving, voluntary waiting period, insemination, pregnancy, dry-off period and calf and heifer rearing. After initially validating that the model reproduced typical herd dynamics, it was extended by incorporating MAP infection dynamics, where each individual adult animal belonged to one of four infection compartments: susceptible, latent, low shedding and high shedding. The model includes two disease transmission routes: horizontal transmission (i.e., fecal-oral) and vertical transmission (i.e., in utero infection). The results confirm that this model can simulate a realistic dairy herd and that inclusion of the above-mentioned