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The efficacy of test-based culling for bovine tuberculosis control in US cattle herds: a modeling approach

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In 2009, the United States Department of Agriculture proposed a new policy for elimination of bovine tuberculosis (bTB) from cattle herds. This included whole-herd test-based culling, using the 2-stage series testing protocol (caudal fold test followed by comparative cervical test), with confirmatory culture and PCR at slaughter. We built a stochastic model of bTB spread within US cattle herds to determine the efficacy of this protocol. An SERI model (susceptible-latent-reactor-infectious) was implemented with slaughterhouse surveillance and pulsed whole-herd testing of herds detected in the slaughterhouse surveillance. The model was validated by comparison of simulated data to 10 real observed outbreaks on US dairy farms in which test-based culling was successful. The number of positive animals observed fell within the 95% prediction interval for all 10 herds. In a second validation simulation study, introduction of 1 latently infected animal to a herd of 276 adult animals showed that 27% of all simulated herds eliminated the infection without detection. For detected herds, median time to detection was 27 months, and test-based culling was sufficient to eliminate the infection within 3 whole-herd tests. Global sensitivity analysis indicated that the model outcome was most sensitive to the herd's culling rate, which is inversely related to the number of animals infected and which is higher in dairy herds than in beef herds. Scenario analysis showed that the number of animals culled was most sensitive to the number of negative whole-herd tests required to declare the herd bTB-free, while the length of quarantine was most sensitive to the interval between whole-herd tests. Overall, the model shows that the recommended test-based culling protocol should be efficacious for eliminating infection from herds.