Ultrasonographic progression of lung consolidation after experimental infection with *Mannheimia haemolytica* in Holstein bull calves

T. L. Ollivett, *DVM, DACVIM (Large Animal)*; **J. Hewson**, *DVM, PhD, DACVIM (Large Animal)*;
R. Shubotz, *DVM*; **J. Caswell**, *DVM, PhD, DACVP*
Ontario Veterinary College, University of Guelph, Guelph, Ontario, Canada N1G 2W1

Introduction

Bronchopneumonia (BP) is a disease process that reduces the well-being and economic potential of dairy replacement animals and is a world-wide issue. Clinical signs are variable and frequently inapparent or non-specific, which often results in misclassification of affected animals. Misclassification causes the inappropriate use of antimicrobials and reduces labor efficiency for the operation. At the research level, proper classification is instrumental in achieving an unbiased investigation of the individual animal or whole herd. Thoracic ultrasonography (US), which detects consolidated lung tissue, is a potentially fast and reliable method for diagnosing BP. Studies conducted to determine how quickly lung consolidation develops following bacterial infection by use of antemortem methods, such as thoracic US, are lacking. Results of studies that used postmortem methods suggest that inflammatory infiltrates develop in the lower airways within 2 to 3 hours after infection. Ultrasonography might detect exudate-filled airways equally soon after infection. The purpose of this study was to describe the progression of lung consolidation as determined by US after experimental infection of dairy calves with *Mannheimia haemolytica.*

Materials and Methods

Four-month-old Holstein bull calves were randomly assigned to either an infected (25 mL of 10^9 cfu/mL of *M. haemolytica* at log phase; n = 6) or control (25 mL of sterile saline [0.9% NaCl] solution; 5) group. At baseline (0 hour), each calf was assessed for the presence of lethargy, fever, nasal and ocular discharge, cough, and droopy ears. A portable 6.2-MHz (depth, 9 cm) linear rectal transducer was used to evaluate both hemithoraxes from the first to tenth intercostal spaces. Calves were then sedated and experimentally inoculated with the assigned treatment by means of endoscopic delivery into the distal trachea. For each calf, clinical and thoracic US examinations were performed at 2, 6, 12, 24, 48, 72, 96, and 120 hours after inoculation. Calves were then euthanized and postmortem examinations (PM) were performed.

Results

Prior to challenge inoculation, thoracic US findings were within reference limits for 4 of 5 and 6 of 6 calves in the control and infected groups, respectively. At 2 hours after inoculation, new lung consolidation was detected in 1 of 5 control and 5 of 6 infected calves (P=0.08). Median time to severe lung consolidation (consolidated area > 1.2 x 0.39 inch [> 3 cm x 1 cm]) was 6 hours (interquartile range [IQR], 6 to12 hours) and time to maximum lesion within an intercostal space was 24 hours (IQR, 12 to 48 hours). The median maximum size of lesion was 7.1 inches (18 cm) (IQR, 4.7 to 7.1 inches [12 to 18 cm]). Consolidation persisted in all calves in the infected group and was present at assessment 120 hours after inoculation. Lung consolidation that was present in 1 calf in the control group at 2 hours after inoculation had resolved by 120 hours after inoculation. Respiratory scores changed over time, but were normal in 5 of 6 calves in the infected group at the assessment 120 hours after inoculation, whereas the respiratory scores remained normal for all calves in the control group throughout the observation period. Moderate agreement existed between US and PM diagnosis of lung consolidation (Kappa, 0.6; 95% confidence interval, 0.4 to 1.0).

Significance

Results suggested that lung consolidation developed soon after infection with *M. haemolytica*, progressed rapidly, and could be diagnosed antemortem by use of thoracic US. Additionally, ultrasonographic lesions developed prior to and persisted longer than clinical signs associated with BP. Compared with clinical signs, thoracic US was a superior method for the proper classification of calves with bronchopneumonia on dairy farms.