# Effect of Experimental Infection with *Pasteurella haemolytica* on Pulmonary Function in Feedlot Calves

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## Abstract

**The purpose of this study was to evaluate the effect of experimentally-induced pneumonia due to *Pasteurella haemolytica* on pulmonary function in feedlot calves.**

**Fifteen healthy 6-8 month old Hereford-cross calves (250-400kg) were studied. Baseline measurements included rectal temperature (RT), arterial blood gasses (ABG) and pulmonary function testing (PFT) which included measures of respiratory frequency, tidal volume, minute volume, dynamic compliance ($C_{Dyn}$), lung resistance ($R_L$), maximum change in transpulmonary pressure ($\Delta P_{Pl}$), and work of breathing per minute. Arterial blood gas samples were collected via an indwelling catheter in the femoral artery.**

**Following baseline measurements calves were sedated and, *P. haemolytica* type A1 was delivered to the lung by means of an intratracheal catheter. Measures of RT, ABG and PFT were repeated at 18, 19, 20, 21, 22, 24, 30, and 42 hours following infection. Calves were then euthanized and gross post mortem scoring and histologic evaluation was performed on the lungs.**

**Intratracheal inoculation with *P. haemolytica* resulted in significant reductions in $PaO_2$, and $PaCO_2$ and tidal volume as well a significantly increased respiratory rate and RT. The changes in $PaO_2$ and RT persisted throughout the subsequent measurement periods, $PaCO_2$ remained significantly depressed until 42 hours, respiratory rate remained elevated until the 22 hour measurement period and tidal volume returned to baseline at 19 hours post inoculation. Alterations in lung mechanics as evaluated by $C_{Dyn}$, $R_L$, $\Delta P_{Pl}$ and work of breathing were not prominent. The actual number of organisms administered had no correlation with any parameter during the monitoring period, nor did it correlate with post mortem score. Post mortem examination revealed the presence of acute lobar bronchopneumonia in all 15 calves. Post mortem score correlated strongly to $PaO_2$ at 42 hours ($r = -0.81$, $p \leq 0.01$).**

**We conclude that experimental infection of feedlot calves with *P. haemolytica* in the method described produced a marked bronchopneumonia, the severity of which was not associated with the actual number of organisms inoculated. The infection technique described had profound effects on RT and gas exchange while measures of pulmonary mechanics were affected to a lesser degree. This suggests that acute pulmonary infection with *P. haemolytica* does not cause significant bronchoconstriction. Consequently, we speculate that treatment modalities for this disease which are directed at relieving bronchoconstriction and improving lung mechanics may be of less importance than those that target airway and alveolar inflammation.**

Protocols for the experimental induction of *Pasteurella haemolytica* pneumonia in beef calves are well documented.[1] Little, however, is known of the effects of this procedure on pulmonary function in these animals. The effect of pneumonia on arterial blood gas and pulmonary function measurements has been documented in calves of feedlot age following natural infection with respiratory pathogens[2] and in newborn[3] and two-week old calves[4] following experimental infection with *P. haemolytica*. This is the first study to document the effects of experimental *P. haemolytica* infection on the pulmonary function of feedlot age calves.

Fifteen healthy 6-8 month old Hereford-cross calves (250-400kg) were studied. All animals had undergone a full physical examination and were monitored daily for 2 weeks prior to the study in order to determine that they were free of respiratory disease. Baseline measurements included rectal temperature (RT), arterial blood gasses (ABG) and pulmonary function testing (PFT). Arterial blood gas samples were collected via an indwelling catheter in the femoral artery. Pulmonary function testing was performed by restraining the calves in a headgate and fitting a flexible plastic face mask over the muzzle. The facemask was connected to a heated Fleisch #4 pneumotachograph which was used to measure air flow, with volume derived by the electronic integration of the flow signal. Transpulmonary pressure was measured as the difference between pressure at the airway opening (facemask) and pressure in a latex esophageal balloon (10 cm long, with 3 ml air injected, attached to a 2 m polyethylene catheter), inserted to mid-thorax, to estimate pleural pressure. A total of 5-10 breaths from each recording segment, chosen on the basis of loop closure and uniformity, were averaged and the values recorded. Pulmonary function parameters included: respiratory frequency, tidal volume, minute

volume, dynamic compliance ($C_{Dyn}$), lung resistance ($R_L$), maximum change in transpulmonary pressure ($\Delta P_{P1}$), and work of breathing per minute.

Following baseline measurements, a 12 hour brain/heart infusion broth of *P. haemolytica* type A1 was centrifuged (4000g, 15 min) and resuspended in sterile PBS to an optical density of 1.0 at 525 nm. The calves were sedated with xylazine (0.2 mg/kg IM) and the suspension (25 ml), followed by sterile phosphate-buffered saline (25 ml), was delivered to the lung by means of an intratrecheal catheter. The intratracheal catheterization procedure consisted of clipping and surgically preparing the skin over the lower cervical trachea followed by local anesthesia with 2% lidocaine. A 14-guage needle was then passed into the tracheal lumen. Through the needle, sterile polypropylene tubing (70 cm in length) was passed caudad to a distance of 60 cm or until a cough reflex was elicited. The bacterial suspension and PBS were then administered through the tubing. Actual number of organisms per inoculum was determined by standard culture techniques.

Measures of RT, ABG and PFT were repeated at 18, 19, 20, 21, 22, 24, 30 and 42 hours following infection. Calves were then euthanized and gross post mortem scoring and histologic evaluation was performed on the lungs.

Data was entered into a spreadsheet before statistical analysis. The effect of *P. haemolytica* infection on RT, respiratory frequency, tidal volume, minute volume, $C_{Dyn}$, $R_L$, $\Delta P_{P1}$, work of breathing, $PaO_2$, $PaCO_2$ and pH was analyzed by repeated measures analysis of variance with the Tukey's test for means comparison. The correlation between RT, ABG and PFT parameters at 18 hours and inoculum dosage was determined by Pearson's correlation. The same test was used to evaluate the correlation between RT, ABG and PFT parameters at 42 hours and post mortem score. The level of significance was set at $p \leq 0.05$ for all analyses.

Intratracheal inoculation with *P. haemolytica* resulted in significant reductions in $PaO_2$, $PaCO_2$ and tidal volume as well a significantly increased respiratory rate and RT. The changes in $PaO_2$ and RT persisted throughout the subsequent measurement periods, $PaCO_2$ remained significantly depressed until 42 hours, respiratory rate remained elevated until the 22 hour measurement period and tidal volume returned to baseline at 19 hours post inoculation. Alterations in lung mechanics as evaluated by $C_{Dyn}$, $R_L$, $\Delta P_{P1}$ and work of breathing were not prominent. The actual number of organisms administered had no correlation with any parameter during the monitoring period, nor did it correlate with post mortem score. Post mortem examination revealed the presence of acute lobar bronchopneumonia in all 15 calves. Affected lung lobes were diffusely reddened, consolidated, and congested. Large amounts of fibrin overlay affected areas and a fibrin peel was often adherent to the parietal pleura. Histologic examination of the lesions revealed extensive fibrin deposition and massive neutrophilic infiltration. The neutrophils displayed variable degrees of toxicity and lysis and rod-shaped bacteria were frequently observed. Post mortem score correlated strongly to $PaO_2$ at 42 hours ($r = -0.81$, $p \leq 0.01$).

From this study we conclude that experimental infection of feedlot calves with *P. haemolytica* in the method described produced a marked bronchopneumonia the severity of which was not associated with the actual number of organisms inoculated. The technique described had profound effects on RT and gas exchange while measures of pulmonary mechanics were affected to a lesser degree. Consequently, we speculate that treatment modalities for this disease which are directed at relieving bronchoconstriction and improving lung mechanics may be of less importance than those that target airway and alveolar inflammation.

## References

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