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Evaluating the cost implications of a radio frequency identification feeding system for early detection of bovine respiratory disease in feedlot cattle

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ABSTRACT

New technologies to identify diseased feedlot cattle in early stages of illness have been developed to reduce costs and welfare impacts associated with bovine respiratory disease (BRD). However, the economic value of early BRD detection has never been assessed. The objective was to simulate cost differences between two BRD detection methods during the first 61 d on feed (DOF) applied in moderate- to large-sized feedlots using an automated recording system (ARS) for feeding behavior and the current industry standard, pen-checking (visual appraisal confirmed by rectal temperature). Economic impact was assessed with a cost analysis in a simple decision model. Scenarios for Canadian and US feedlots with high- and low-risk cattle were modeled, and uncertainty was estimated using extensive sensitivity analyses. Input costs and probabilities were mainly extracted from publicly accessible market observations and a large-scale US feedlot study. In the baseline scenario, we modeled high-risk cattle with a treatment rate of 20% within the first 61 DOF in a feedlot of >8000 cattle in Canada. Early BRD detection was estimated to result in a relative risk of 0.60 in retreatment and 0.66 in mortality compared to pen-checking (based on previously published estimates). The additional cost of monitoring health with ARS in Canadian dollar (CAD) was 13.68 per steer. Scenario analysis for similar sized US feedlots and low-risk cattle with a treatment rate of 8% were included to account for variability in costs and probabilities in various cattle populations. Considering the cost of monitoring, all relevant treatment costs and sale price, ARS was more costly than visual appraisal during the first 61 DOF by CAD 9.61 and CAD 9.69 per steer in Canada and the US, respectively. This cost difference increased in low-risk cattle in Canada to CAD 12.45. Early BRD detection with ARS became less expensive if the costs for the system decreased to less than CAD 4.06/steer, or if the underlying true BRD incidence (not treatment rate) within the first 61 DOF exceeded 47%. The model was robust to variability in the remaining input variables. Some of the assumptions in the baseline analyses were conservative and may have

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underestimated the real value of early BRD detection. Systems such as ARS may reduce treatment costs in some scenarios, but the investment costs are currently too high to be cost-effective when used solely for BRD detection compared to pen-checking.

1. Introduction

Despite various control efforts, bovine respiratory disease (BRD) continues to have tremendous impacts on economics and animal welfare in the feedlot industry (USDA, 2013a). A feedlot with a 14.4% BRD treatment rate per feeding period was estimated to lose approximately USD 14,000 per 1000 incoming cattle, not including feed costs before the death of calves, labor and associated handling costs (Snowder et al., 2006). However, not all incoming cattle are at the same risk for developing BRD; feedlot personnel (pen-checkers) classify cohorts into risk categories to choose an arrival protocol that includes or excludes antimicrobial metaphylaxis (USDA, 2013b). Once cattle are affected by BRD, they show clinical signs late in the disease process (Timsit et al., 2011), and sensitivity and specificity of visual appraisal (pen-checking) confirmed with rectal temperature are low (White and Renter, 2009). Consequently, many cattle are treated unnecessarily, although performance is reduced due to missed cases and late treatment of BRD. In contrast, early detection of BRD results in higher treatment efficacy (Ferran et al., 2011) and lower mortality (Janzen et al., 1984).

One method of early BRD detection is monitoring feeding time and intake. A study that used feeding behavior to predict BRD reported identification of sick cattle on average 4 d prior to pen-checker identification (Quimby et al., 2001). However, the economic value of early BRD detection has never been assessed. Therefore, the objective of this study was to assess the economic value (in Canadian dollars – CAD) of early BRD detection using automated recording systems (ARS) in comparison to pen-checking during the first 61 d on feed (DOF). We hypothesized that ARS would be the economically preferred strategy of BRD detection during the first 61 DOF.

2. Methods

This economic modeling study was conducted following Canadian guidelines for economic evaluation of health technologies (CADTH, 2006). The study extracted data from existing literature and databases; therefore, no animal care approval was required.

The economic impact of early BRD detection with ARS in comparison to pen-checking was assessed using a deterministic model based on costs and revenues of finishing cattle in high-risk (treatment rate during feeding period 20%, baseline scenario) and low-risk (treatment rate during feeding period 8%) cohorts. General management practices were identical, but disease detection (decision nodes) during the first 61 DOF was based on either the traditional method of pen-checking, or ARS detecting feeding behavior changes 4 d prior to pen-checker identification (Quimby et al., 2001). After 61 DOF, disease detection was done with pen-checkers in both decision nodes. The economic impact was calculated as the difference in net-benefit (slaughter revenues minus expenditures; Cernicchiaro et al., 2013) between pen-checking and ARS expressed in CAD per calf at the end of the feeding period. The simulation was performed from the perspective of a mid-size to large North American feedlot operation with a one-time capacity of >8000 head (to account for the size of the investment).

2.1. BRD detection methods

Two disease detection methods were compared during the first 61 DOF, the high-risk period for BRD (Babcock et al., 2010):

(1) Pen-checking was based on health evaluations done twice daily during the high-risk period. Feedlot personnel identified sick cattle according to their appearance in the feedlot pen (visual appraisal), with a follow-up chute assessment and treatment. Sensitivity and specificity of clinical illness scoring has been estimated at 82% (range: 55–96%) and 95% (range: 81–97%), respectively, in calves with 5% of the lung affected (Amrine et al., 2013).
(2) Individual feeding behavior monitoring identified sick cattle based on changes in feeding behavior. When a steer was present at an individual feeding node, ARS (Growsafe Ltd., Airdrie, AB, Canada) scanned its unique radio-frequency ear tag in 1-s intervals, enabling calculation of feeding time. Concurrently, an embedded scale measured feed disappearance. Detailed description and validation of the system has been published (Schwartzkopf-Genswein et al., 2011). Differences in feeding time led to detection of cattle approximately 4 d before clinical signs of sickness appeared (Quimby et al., 2001). Early detection of BRD resulted in better response rate to treatment (Ferran et al., 2011) and lower mortality (Janzen et al., 1984). To the best of our knowledge, sensitivity and specificity estimates for ARS have until now only been calculated on the basis of pen-checking, which is an imperfect test (Quimby et al., 2001; Silasi, 2007).

2.2. Estimating true incidence

Due to low sensitivity and specificity, using pen-checking to determine the true disease status will not provide a good estimate of the BRD incidence in post-weaned calves. The most likely true incidence of BRD was therefore calculated using Bayesian approaches in WinBUGS 1.4.3