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The sickness response at and before clinical diagnosis of spontaneous bovine respiratory disease

Rachel L. Toaff-Rosenstein, Cassandra B. Tucker*

Center for Animal Welfare, Department of Animal Science, University of California-Davis, 1 Shields Ave, Davis, CA, 95616, United States

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ABSTRACT

Bovine respiratory disease (**BRD**) is often diagnosed in feedlots after observing behavioral changes such as anorexia, with fever confirmatory. However, this method has poor diagnostic accuracy compared to postmortem lung lesions. Little is known about how these or other sickness responses such as low grooming present in early, spontaneous BRD, especially during feedlot acclimation. To inform improved detection, we studied 3 aspects of the BRD sickness response at and before diagnosis and the effect of acclimation on behavior in beef heifers. We hypothesized that heifers with BRD would have fever and spend less time feeding and grooming compared to controls, and that both behaviors would increase with acclimation. Beef heifers were randomized to replicate and pen, balanced for body weight (total n = 80), and monitored for 12 d, starting 2 d after shipping. Rectal temperature was measured with a logger, while feeding time and brush use were video-recorded. Clinical signs were recorded daily: heifers remaining healthy over the entire 12 d were Controls (n = 46); those meeting set criteria were classified as BRD (n = 21). Health effects were analyzed for all 3 dependent variables on the day of diagnosis (d 0), and for fever and feeding, the 2 days before (d −1 and −2), using analogous days for Controls. Acclimation effects were tested separately using all available behavioral data. BRD heifers had a fever on d 0 and −2 (≥0.4 °C higher than Control, $P < 0.01$) but not on d −1 ($P = 0.10$). After excluding 4 outliers (all Controls; never seen at the feed bunk), BRD heifers had lower feeding time on d 0 (19% less than Control, $P = 0.04$), but not on d −1 or −2 ($P \geq 0.32$); or at all when outliers were included ($P \geq 0.32$). BRD had no effect on brush use (29.6 ± 6.6 vs. 19.8 ± 4.4 min/18.5 h; $P = 0.22$). While feeding behavior was stable over time ($P = 0.28$), the effect of outliers suggests that acclimation may also affect anorexia-based diagnosis of individual heifers. Brush use results also reflect the effect of acclimation to a novel device, evidenced by generally increased grooming later compared to earlier days ($P < 0.01$). Fever, occurring first, and anorexia may be useful in early BRD diagnosis. However, in recently-arrived cattle, effects of acclimation should be considered when monitoring behavior for sickness detection.

1. Introduction

Bovine respiratory disease (**BRD**) is the top cause of morbidity and mortality in U.S. feedlots (Hilton, 2014). Incidence peaks in the weeks following shipment to feedlots (Snowder et al., 2006), with stressors (e.g. weaning, shipping) promoting immunosuppression and secondary morbidity (Taylor et al., 2010; Mosier, 2014). Visual observation of clinical signs, including depression, anorexia, and lethargy as well as respiratory-specific clinical signs such as tachypnea, coughing, and nasal discharge, is used as the primary form of detection. Fever is used as confirmation only in suspect animals (Duff and Galyean, 2007). However, the diagnostic accuracy of visual observation is poor (Wittum et al., 1996; Thompson et al., 2006; Schneider et al., 2009; White and Renter, 2009) and a key issue for the industry (Wolfger et al., 2015b).

The infection-initiated sickness response, including fever, anorexia, and low grooming (Hart, 1988), is increasingly studied. However, knowledge gaps remain in implementation for improved BRD diagnosis. For example, much of the work to-date characterizing the BRD sickness response has relied on challenge models (e.g. White et al., 2012; Toaff-Rosenstein et al., 2016b), which, while beneficial in certain regards, may inadequately mimic spontaneous disease (e.g. because of pathogen-specific effects; Gershwin et al., 2015). Absence of healthy controls (e.g. Timsit et al., 2011a) with which to compare diseased animals and confounding factors (e.g. varying susceptibility and immune response to infection secondary to stress; Hodgson et al., 2012) may also hinder study interpretation. Furthermore, many existing BRD studies use walk-by pen checks to determine clinical status, despite the known inaccuracy of this method (White and Renter, 2009). Automated

* Corresponding author.
E-mail address: cbtucker@ucdavis.edu (C.B. Tucker).

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monitoring systems, intended to detect sickness response changes in affected animals, have the potential to improve the accuracy and timeliness of BRD diagnosis in feedlot populations (Jackson et al., 2016; White et al., 2016). Ideally, proof-of-concept and validation of these systems would occur in commercial settings involving cattle with naturally-occurring disease, and whose health status has been verified using a gold standard test such as post-mortem examination (Wolfger et al., 2015b), which is not often the case. Instead, studies often use visual observations to classify health status and day of BRD onset (e.g. Moya et al., 2015; Wolfger et al., 2015a; White et al., 2016), despite this diagnostic method's inaccuracy.

In addition, some aspects of the BRD sickness response have received little attention. All forms of grooming, whether involving rubbing on objects or self-licking, are expected to decrease in sick animals, as resources are redirected from behaviors that are not essential in the short-term towards the energetically-expensive immune response (Hart, 1988; Dantzer, 2004). An automated grooming brush is readily used by healthy cattle maintained in confined environments (i.e. those without other suitable objects such as trees which might otherwise be used to access hard-to-reach body parts; Kohari et al., 2007) for self-care (Georg and Totschek, 2001; DeVries et al., 2007; Georg et al., 2007). Indeed, as expected, use of an automated grooming brush decreases in dairy cows with metritis (Mandel et al., 2017), and preliminary work in a BRD model shows that it also has potential to help differentiate between healthy and sick beef steers (Toaff-Rosenstein et al., 2016b). Further inquiry is required in order to determine whether grooming behavior can be used to reliably detect individuals with BRD in a feedlot setting. Furthermore, in recently-arrived, stressed cattle, the process of acclimation may explain some of the observed behavioral changes, independent of health status (Wechsler and Lea, 2007). Acclimation as a factor underlying the behavioral changes observed in feedlots during the weeks following arrival is important to consider, particularly when some of these behaviors (e.g. feeding) are also of interest for sickness monitoring.

We described fever and feeding at and 2 d before, and grooming at diagnosis in beef heifers with spontaneous BRD after arrival at the feedlot, using daily, detailed clinical examinations to determine health status. Our objective was to better understand the potential of measuring brush use in early BRD detection, relative to fever and time spent feeding, which have been more thoroughly characterized than grooming and whose utility in BRD detection is already known. Furthermore, a post-hoc decision was made to describe the effect of acclimation on these behaviors, given that BRD often occurs in recently-shipped cattle that have yet to fully adjust to their new environment. We hypothesized that all 3 measures of the BRD sickness response would occur at and before diagnosis and that feeding and grooming would increase as cattle acclimated.

2. Materials and methods

2.1. Animals and pre-trial procedures

Data collection was completed between June and August 2014. Eighty crossbred beef heifers between the ages of 7.5 and 12 mo (average body weight: 257 kg, range 157–353 kg), originating from the UC Davis cow-calf herd, were enrolled in the trial. Heifers were managed per standard herd health protocol, including receiving a selenium bolus, vaccination for clostridial diseases, *Histophilus somni*, Infectious Bovine Rhinotracheitis, Bovine Virus Diarrhea types 1 and 2, Parainfluenza-3 virus, Bovine Respiratory Syncytial Virus, and *Moraxella bovis*, deworming, and topical treatment for ectoparasites approximately 1 mo before weaning. After weaning, heifers were maintained as a single group on pasture and accustomed to eating from a feed bunk for at least 1 mo (until the day of shipment to the trial site), given a second selenium bolus, a *Moraxella bovis* booster, re-treated for topical ectoparasites, and a fly-repellant ear tag attached.

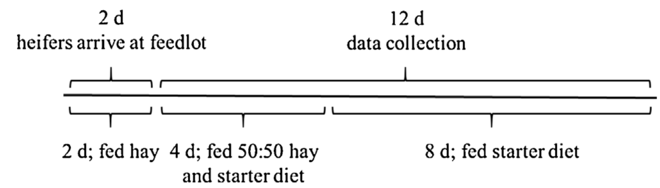

Fig. 1. Timeline for this experiment, where data collection commenced for 12 d (designated d 0 through 11), beginning 2 d after beef heifers arrived at a feedlot. Heifers were fed either hay (first 2 d), a combination of hay and a feedlot starter diet (next 4 d) and finally, exclusively, a starter diet.

Heifers were randomly assigned to 5 replicates (of 16 heifers each) and the 2 pens (8 heifers/pen). This randomization was balanced based on body weight. Two days before commencement of each replicate, designated heifers were shipped a distance of 84 km directly to UC Davis (Fig. 1).

Upon arrival, heifers were offered hay and water *ad libitum*. The following morning, heifers were individually restrained in a chute for approximately 30 min, in order to mark each with unique numerical identification (left and right withers and flank) using hair dye (Clairol Nice 'N Easy Borne Blonde, Procter and Gamble, Cincinnati, OH, USA) for the purpose of identifying them in video recordings, and treated with a topical insecticide (Cylence, Bayer Animal Health, Shawnee Mission, KS, USA). The distal portion of the tail switch was trimmed, leaving approximately 5 cm, to avoid entrapment of the tail in the mechanical brush (described below), per manufacturer recommendation. Data collection began on the second day (approximately 48 h) after arrival at UC Davis. Heifers were monitored for 12 d that followed, designated d 0 through 11. This timeframe was used to capture expected BRD peak incidence, typically during the first 1–2 wk after feedlot arrival (Snowder et al., 2006). For the purpose of analysis, a day was designated as beginning at 0700 h and ending at 0700 h the following day.

2.2. Housing and feeding

Heifers were kept in covered, concrete-floored pens (n = 8/pen, 2 pens/replicate) during the 12 d of data collection. Pens were enclosed, allowing for dim natural lighting and ventilation. The dimensions of the area containing the brush and feed bunks were 9.1 m × 7.3 m. The feed bunk was 5.4 m long and had 8 head gates. Water was provided *ad-libitum* from a self-filling trough. An automated grooming brush (Model # 91526202 Swinging Cow Brush, Delaval, Kansas City, MO, USA) was installed on one wall, 0.81 m above the floor measured from the bottom of the brush, according to manufacturer instructions. The lying area measured 9.1 m × 4.9 m, including a 4.9 m × 4.3 m bedded with an approximately 25 cm deep layer of straw.

During the first 4 days of data collection (d 0 through 3), heifers were fed a 50:50 mixture of chopped alfalfa (approximately 9 cm particle length) and starter diet, consisting of 47.5% flaked corn, 17.2% dried distiller's grains, 13.7% alfalfa hay, 11.7% oat hay, 7.1% molasses, and 1.3% fat and containing 87.5% DM, 13.3% CP, 27.7% NDF, and 75.8% TDN and providing 1.8 Mcal/kg NEm and 1.2 Mcal/kg NEg. For the remainder of the trial, heifers were fed the starter diet alone. The total amount fed per day was calculated as 4% of the total BW of heifers in the pen; with 40% offered at 0700 h and the remaining 60% at 1600 h, even distributed across all feed bunk segments. Any remaining feed was removed before the morning feeding. Melengestrol acetate (MGA 500 Premix, Zoetis, Florham Park, NJ, USA) was prepared according to manufacturer instructions and sprayed on top of feed at a rate of 4 mg/pen/d every morning to prevent estrus.

Air temperature was monitored on a continuous basis using a portable weather station (WS-16, NovaLynx Corp., Auburn, CA, USA) at the feedlot. The average daily temperature across all replicates was 23.5 °C (range 22.6–25.0), with a minimum of 11.4 °C and maximum of 41.6 °C.