Evaluation of behavioral changes in cattle using three-dimensional accelerometers during experimental infection with bovine viral diarrhea virus

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Introduction

Bovine respiratory disease (BRD) is a leading cause of morbidity and death in cattle. Timely recognition of sickness before development of irreparable damage to the lungs, which results in substantial economic loss, continues to be difficult. Bovine viral diarrhea virus (BVDV) contributes to the development of BRD. Currently, detection of BRD relies upon subjective assessment of cattle, which is reported to have a low diagnostic sensitivity and specificity because ill cattle alter behavior in the presence of human observers. Efforts to identify BRD and predict its occurrence have used clinicopathologic measures of inflammation, including alterations in inflammatory cells and acute phase proteins, such as haptoglobin. These diagnostics are invasive, expensive, and subject to variability dependent upon the stage of the disease. The need for remote, objective measurement of behavior in ill cattle prompted the development of several technologies capable of real-time collection of various physiologic variables. The objective of this study was to evaluate the behavior of cattle that were experimentally inoculated with a low-virulent strain of BVDV and presumably subclinically infected by the use of 3-D accelerometers. Behavior responses were evaluated in conjunction with traditional markers of inflammation.

Materials and Methods

Twenty BVDV seronegative beef calves that weighed approximately 550 lb (250 kg) were randomly assigned to either a BVDV (n=10) or control (n=10) group. Each group was housed in a separate biosecure pasture. Each calf was fitted with an accelerometer and pedometer to continuously monitor behavior including time spent lying, standing, and walking throughout the 28-day trial. Baseline behavior data were collected for 7 days prior to viral challenge. Calves in the BVDV group were intranasally inoculated with BVDV on day 0. Physical examinations, differential blood cell counts, and serum biochemical analyses were performed on all calves on days -7, 0, 7, 14, and 21. Haptoglobin concentrations were determined on days 0 and 7. Clinical illness scores (CIS; 1=normal to 5=moribund) were assigned by observation from a distance once daily, and behavioral data were retrieved every 7 days to minimize the impact of human observation on calf behavior. Clinical laboratory data were analyzed using mixed-model procedures as implemented in SAS® PROC GLIMMIX. Accelerometer data were converted to proportions and analyzed using a random-effects logistic regression approach in SAS®.

Results

During the 7 days prior to BVDV inoculation, all calves in the BVDV group were clinically normal, whereas 2 calves in the control group had a CIS of 2 (1 on day –3 and the other on day –2). Mild clinical illness (CIS=2) was observed in 4 of 10 BVDV calves on days 8 through 12, and in 1, 3, and 2 BVDV calves on days 14, 17, and 23, respectively. For the control group, a CIS=2 was assigned to 2 calves on day 15 and to 1 calf on day 16. For the calves in the BVDV group, the mean rectal temperature was significantly (P=0.002) higher on days 7 and 28, the total mean WBC and neutrophil counts were significantly ($P \leq 0.035$) lower on days 7 and 14, and the mean lymphocyte count was significantly (P=0.012) lower on day 7, compared with those for calves in the control group. Haptoglobin, fibrinogen, and serum iron concentrations did not differ significantly between the 2 groups following virus inoculation. Numerically, BVDV calves spent more time lying than did the control calves throughout the study. On days 8, 9, and 10, the BVDV calves spent significantly more time lying than did the control calves. Compared with calves in the control group, calves in the BVDV group spent significantly ($P \leq 0.045$) more time walking prior to BVDV inoculation and after day 10; however, the amount of time spent walking did not differ significantly between the 2 groups on days 0 through 9, which indicated that walk-

ing behavior in the BVDV group was reduced during BVDV infection.

Significance

In this study, evaluation of subjective clinical illness scores was not effective for the differentiation of BVDV calves from control calves. However, behavioral changes as determined by evaluation of data obtained from 3-D accelerometers were detected for calves in the BVDV group during the first 9 days after inoculation, suggesting that this method was more sensitive than the CIS for detecting calves with subclinical BVDV infection.