Determination of lying behavior patterns in healthy beef cattle by use of wireless accelerometers

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Objective—To describe daily, hourly, and animal-to-animal effects on lying behavior in steers.

Animals—25 crossbred beef steers.

Procedures—Wireless accelerometers were used to record behavioral data for cattle housed in a drylot cattle research facility during two 20-day periods (winter 2007 [n = 10 steers] and spring 2008 [15]). Behavioral data were categorized into lying, standing, and walking behaviors for each time point recorded. Logistic regression models were used to determine potential associations between the percentage of time spent lying and several factors, including time (hour) of day, day of trial, and steer.

Results—Lying behavior was significantly associated with hour of day, and a distinct circadian rhythm was identified. Steers spent >55% of the time between 8:00 AM and 4:00 AM lying and were most active (<30% lying behavior) during feeding periods (6:00 AM to 7:00 AM and 4:00 PM to 5:00 PM). Model-adjusted mean percentage of time spent lying was significantly associated with study day and was between 45% and 55% on most (27/40 [67.5%]) days. Lying behavior varied significantly among steers, and mean ± SD percentage of time spent lying ranged from 28.9 ± 6.1% to 66.1 ± 6.6%.

Conclusions and Clinical Relevance—Cattle had distinct circadian rhythm patterns for lying behavior, and percentage of time spent lying varied by day and among steers. Researchers need to account for factors that affect lying patterns of cattle (ie, time of day, day of trial, and individual animal) when performing research with behavioral outcomes. (Am J Vet Res 2011;72:467–473)

Quantifying the normal behavior patterns of cattle can provide researchers and animal health-care providers with baseline activity information that is useful for determining the effects of various environmental and procedural stimuli on behavior. In addition, the development of a baseline for behavior patterns of cattle may allow for the evaluation of disease effects on various activities (eg, feeding, drinking, lying, and standing behaviors). Commercial production settings as well as research settings for production, health, and welfare research routinely house cattle in large groups, which make it difficult to monitor behavior of individual cattle.

Current subjective scoring systems have limited ability for use in behavioral analyses,1–3 and more technologically advanced and objective methods have been suggested for their potential use in identifying signs of clinical illness or abnormal behavior in cattle. Investigators have reported that infrared thermography may be capable of detecting cattle with respiratory tract disease, whereas others have reported4 the use of temperature monitoring devices that were implanted in steers for the early detection of diseases (such as respiratory tract disease) known to cause elevations in body temperature. In another study5 in dairy cattle, investigators found that information recorded by pedometers could be used to predict ovulation and therefore improve fertilization rates. There have been other studies6–8 conducted to investigate the use of behaviors such as feeding and drinking as indicators of animal health, and they have revealed a distinct relationship between those behaviors and unfavorable outcomes with respect to animal health. Cattle behavior (activity), such as standing, lying, feeding, and drinking, may be useful for identifying animals at risk for disease. However, investigators must first be able to define and monitor normal behavior patterns for individual cattle to be able to successfully delineate behavior associated with disease.

Accelerometers are small and noninvasive devices that are used to objectively monitor animal behavior, and their use is not likely to have an influence on natural behavior patterns. Accelerometers use continuous and individual-animal sampling methods to generate data sets of unique behaviors that would be difficult to acquire through the use of other monitoring schemes. Quantification of cattle activity by use of accelerometers has been reported9 to be extremely accurate for describing normal lying and standing behaviors (99.2% and 98%, respectively) that can prove to be difficult to
assess with conventional methods. Investigators in previous studies have implemented accelerometer-based activity monitoring systems in several animal species, including cattle,10 dogs,11 cats,12 and horses,13 and demonstrated the usefulness of these systems as a behavioral monitoring tool. Accelerometer-type automatic activity monitoring systems have been validated and used to describe behaviors of dairy cattle14 and have been used to describe behavior in dairy calves.15

Because behavior has been used to analyze the health and well-being of cattle, there is a need for an objective analysis of natural, undisturbed behavior. By more effectively defining typical behavior patterns of cattle, instances of conditions (eg, infectious diseases) in cattle that require an intervention can be more precisely and efficiently identified. The purpose of the study reported here was to describe the effects that impact typical behavior patterns in cattle, which specifically includes percentage of time spent lying throughout the day, day-to-day variation, and calf-to-calf variation. Our hypotheses were that cattle have both circadian rhythms and daily patterns for behavior and individual calves have varied amounts of activity.

**Materials and Methods**

**Cattle and husbandry**—The study involved cattle at drylot beef cattle research facility (ie, feedlot) and was completed during 2 periods (trials) between November 20 and December 9, 2007, (winter 2007) and April 15 and May 4, 2008 (spring 2008). Cattle were procured from a local livestock market by an order buyer under the stipulation that purchased cattle consist of beef steers weighing between 181.4 and 226.8 kg. The study was approved by the Animal Care and Use Committee at Kansas State University.

On arrival in the feedlot, steers were administered vaccinations and an ear tag was applied for identification. In addition, a commercially manufactured accelerometer b was attached to the lateral aspect of the right hind limb just proximal to the metatarsophalangeal joint of each steer, which was in accordance with methods described elsewhere.9 Steers were not allowed an acclimation period because of their simultaneous use in another study that required the accelerometers be applied immediately on arrival; however, for the information provided in the study reported here, the first 24 hours of recorded data were removed from the analysis to simulate a brief acclimation period as well as to account for altered behavior because of the application of the accelerometer to each steer’s hind limb. The winter 2007 study period consisted of 10 steers (mean body weight, 190.1 kg). The spring 2008 study period consisted of 15 steers (mean body weight, 191.2 kg).

Steers were fed during twice-daily feeding periods (6:00 AM to 7:00 AM and 4:00 PM to 5:00 PM). Initially, prairie hay was offered to the steers on arrival to aid in the acclimation of the steers to the primary diet that consisted of a pelleted beef growing ration, which included wheat middlings, cracked corn, corn gluten feed, extender pellets, cottonseed hulls, and dried distillers grain. However, steers were weaned from the hay as the study progressed. Steers had unlimited access to an automatic waterer, which had the ability to provide water for up to 100 cattle, during both study periods.

**Housing and weather conditions**—The drylot beef research facility near Manhattan, Kan, consisted of 2 drylot pens with a capacity of 38 and 59 cattle, respectively. The smaller pen (dimension, 62.7 X 33.9 m) was used during both study periods. Pen capacities were calculated to determine minimum stocking densities for a pen with these dimensions by use of the higher bound weight range provided in an agricultural animal care and use guide.16 Except for the feeding area where adjustable steel cables were strung, a 1.5-m-high steel pipe fence comprised the perimeter of the pen. In addition, the research facility was relatively void of any human interactions except during the twice-daily feeding periods. Data for environmental conditions were retrieved from the records of a local airport weather station located 13.1 km southwest of the feedlot.

**Steer health monitoring**—During twice-daily feeding periods, health of each steer was evaluated by a veterinarian who was licensed to practice veterinary medicine by the state of Kansas. The veterinarian devoted a minimum of 30 min/feeding to fully evaluate the health of each calf via visual inspection and assignment of a subjective clinical illness score (1 = clinically normal, 2 = slightly ill, 3 = moderately ill, and 4 = severely ill). Steers were designated for further evaluation of a suspected illness subsequent to each feeding on the basis of the assignment of a score > 1; if a steer had a rectal temperature > 40°C at the time of this examination, it was treated in accordance with typical health protocols for the feedlot.

Improper application of the mounting apparatus to the hind limb had the potential to negatively impact the health and well-being of a steer, such as the formation of skin lesions and impairment of blood flow to the distal portion of the hind limb. To avoid health and well-being issues caused by an improperly applied apparatus, calves also were visually examined by the veterinarian during feeding to ensure proper orientation of the apparatus and unimpaired mobility of each calf.

**Accelerometers**—The same continuous sampling accelerometer-based monitoring system was used during both study periods. Accelerometers consisted of a triaxial, capacitance-type, ± 10-g integrated circuit and recorded data at 100 Hz. Data were summarized for variables on the basis of user-defined reporting intervals (epochs). The accelerometers recorded 3 variables, including mean acceleration in each of 3 axes (x-, y-, and z-axis, respectively), vector magnitude mean, and vector magnitude maximum. Values for axis mean and vector magnitude mean were calculated by the sum of the inputs (eg, 100 samples/s) divided by the different reporting intervals (3- or 5-second epochs). Vector magnitude maximum was the single highest combined axis acceleration per reporting interval.

Data recorded by the accelerometers were downloaded weekly or semiweekly for the 5- or 3-second epochs, respectively, because of 1-Mb memory storage limitations of the accelerometers. For the downloading of data, calves were restrained in a squeeze chute and both the mounting apparatus and accelerometer
were removed from the limb. The accelerometer was removed from the apparatus and connected to a laptop via a universal serial bus cable, and the data were downloaded from the accelerometer to the computer. Then, the accelerometer was replaced within the mounting apparatus and reattached to the limb of the calf. In the winter 2007 portion of the study, 3- and 5-second epochs were used, but published information has indicated no difference between these epochs. Therefore, only 5-second epochs were used for the spring 2008 portion of the study.

Data inclusion criteria—The objective of the study was to quantify natural uninterrupted behaviors of cattle; therefore, periods of disturbances (eg, when cattle were subjected to human interaction) were removed from the final data set used for statistical analyses. Time was recorded at the beginning of the human-cattle interaction, and the entire hour or hours that included the interaction were removed from the data set. Examples of these interactions included time periods when cattle were processed for downloading of data from the accelerometers as well as when a specific calf was removed from the pen for evaluation of a suspected illness. If an illness was diagnosed in a steer and subsequently treated, accelerometer data were removed from that time point through the end of the trial for that calf as well as for the 24-hour period prior to the initiation of treatment for that calf. Accelerometer data recorded during the feeding periods were included in the analyses to enable us to evaluate behavior during these periods; feeding periods were not defined as disturbance periods because humans did not enter the pen or interact with the steers.

Data processing—Commercial data mining software was used to transform data into a uniform structure for comparison and analysis. A validated classification tree system categorized individual calf behavior for each data point (epoch) as walking, standing, or lying; this system used combinations of data for variables recorded by the accelerometer to estimate the posture and activity of a calf at a given point in time. Lying caused distinct changes in the x- and y-axes, compared with changes during standing, on the basis of the positional change of the accelerometer relative to the pull of gravity. Movement associated with walking typically resulted in increased vector magnitude mean and vector magnitude maximum. Categorized behavioral data points (1 for each epoch) were aggregated by hour to create proportions in which the count of each individual behavior classified was the numerator and the total possible count of all behaviors per hour was the denominator.

Statistical analysis—Analyses were performed by use of models similar to those described elsewhere for this type of data. Associations between model-adjusted percentage of time spent lying for each calf and fixed effects of trial replicate (ie, winter 2007 or spring 2008), day within trial replicate, hour within day, and calf within trial were analyzed by use of generalized linear logistic regression models in a commercial software program. Percentage of time spent lying per call-hour was modeled as a binomial events per trials response by use of the logit link function, where the number of epochs classified as lying behavior was the event and the number of recorded epochs within the hour was the number of trials. Effects were modeled as categorical variables with day of trial modeled within trial replicate and hour modeled within day of trial replicate. In addition, steer identification within trial was included as a fixed effect to account for repeated measures on calves over time and to facilitate description of differences among steers. A restricted maximum likelihood estimation method was used, and type 3 likelihood ratio statistics were used to test for associations of effects. A conservative α of P < 0.001 was selected to account for multiple pairwise comparisons in each model. The SDs for the model-adjusted percentage of time spent lying were calculated by use of model estimates of SE and number of observations (ie, call-hours) for each calf.

Results

Well-being and weather conditions—No instances of decreased well-being of the calves because of accelerometer placement were observed during either study period. During the winter 2007 study period, ambient temperature ranged from −8° to 13°C (mean, 0°C) and precipitation consisted primarily of light rain and light snow. During the spring 2008 study period, ambient temperature ranged from 7° to 22°C (mean, 13°C) and precipitation consisted primarily of light rain with an overall accumulation of 19 cm of precipitation.

Excluded data—Each 20-day trial consisted of data that were void of all partially recorded hours, periods of disturbances, and calves determined to be ill. The winter 2007 study period initially had the potential for the inclusion of 4,800 call-hours for analysis; however, 288 hours of data from 2 steers were removed from the analysis because of illness. The spring 2008 study period initially had the potential for the inclusion of 7,200 call-hours for analysis; however, this study period resulted in more data loss than for the winter study period because of incorrect battery placement in the accelerometers that resulted in power interruption. Therefore, for the spring 2008 study period, 792 hours of data from 6 calves were removed because of device-operator malfunctions and an additional 240 hours from 1 steer was removed because of illness. Data removed because of device-operator malfunctions had a mean of 132 hours (range, 48 to 192 hours). Of the total 12,000 hours of continuous call-hour data initially available for analysis, 9,999 hours of continuous call-hour data were available for analysis on the 25 calves, with a mean of 399.96 call-hours (range, 190 to 480 call-hours). The winter 2007 (n = 10 steers) and spring 2008 (15) study periods provided 4,387 and 5,612 continuous call-hours of data, respectively, for analysis.

Walking, standing, and lying behaviors—Lying and standing represented the majority (97.1% [lying, 47.8%; standing, 49.2%]) of the behaviors classified during the trials; the remainder (2.9%) of the time was classified as walking. Percentage of time spent lying was significantly associated with trial replicate, day within trial replicate, hour within day, and call. Percentage of
time spent lying was significantly greater during the spring 2008 trial (48.9%) than during the winter 2007 trial (47.6%). Calves spent between 45% and 55% of the day as lying behavior during 67.5% (27/40 days) of all trial days. A frequency distribution was used to display the percentage of days steers had lying behavior by model-adjusted percentage of time spent lying (Figure 1).

Circadian rhythm—Hourly percentage of lying behavior ranged from 22.7% to 76.4%, and analysis of the pattern revealed a distinct circadian rhythm (Figure 2). During nighttime hours (8:00 PM to 4:00 AM), calves spent most (>55%) of these hours lying, compared with the least amount of hours spent lying (<30%) during feeding periods. Most hours differed significantly for the model-adjusted percentage of time spent lying; however, hours that did not differ significantly from another hour included 12:00 AM and 10:00 PM, 1:00 AM and 9:00 PM, 3:00 AM and 8:00 PM, 5:00 AM and 12:00 PM, 3:00 PM and 1:00 PM, 6:00 AM and 7:00 AM, 9:00 AM and 10:00 AM, and 11:00 AM and 6:00 PM. The model-adjusted mean ± SD percentage of time spent lying* for 25 beef steers in a drylot beef cattle research facility (ie, feedlot) was determined by use of a logistic regression model, which also included significant effects of trial (replicate), day within trial, hour within day, and steer.

Table 1—Model-adjusted mean ± SD percentage of time spent lying* for 25 beef steers in a drylot beef cattle research facility (ie, feedlot).

<table>
<thead>
<tr>
<th>Steer</th>
<th>Trial*</th>
<th>Percentage of time spent lying†</th>
<th>Calf-hours‡</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Winter 2007</td>
<td>28.9 ± 6.1*</td>
<td>478</td>
</tr>
<tr>
<td>2</td>
<td>Winter 2007</td>
<td>32.3 ± 6.7*</td>
<td>433</td>
</tr>
<tr>
<td>3</td>
<td>Spring 2008</td>
<td>34.7 ± 6.5*</td>
<td>441</td>
</tr>
<tr>
<td>4</td>
<td>Spring 2008</td>
<td>38.4 ± 6.8*</td>
<td>249</td>
</tr>
<tr>
<td>5</td>
<td>Spring 2008</td>
<td>41.9 ± 6.9*</td>
<td>324</td>
</tr>
<tr>
<td>6</td>
<td>Winter 2007</td>
<td>44.7 ± 6.9</td>
<td>478</td>
</tr>
<tr>
<td>7</td>
<td>Winter 2007</td>
<td>44.9 ± 6.9</td>
<td>480</td>
</tr>
<tr>
<td>8</td>
<td>Winter 2007</td>
<td>45.0 ± 6.9</td>
<td>445</td>
</tr>
<tr>
<td>9</td>
<td>Spring 2008</td>
<td>45.0 ± 6.8</td>
<td>480</td>
</tr>
<tr>
<td>10</td>
<td>Spring 2008</td>
<td>45.2 ± 6.9</td>
<td>408</td>
</tr>
<tr>
<td>11</td>
<td>Spring 2008</td>
<td>46.3 ± 7.0*</td>
<td>190</td>
</tr>
<tr>
<td>12</td>
<td>Winter 2007</td>
<td>48.2 ± 8.9*</td>
<td>478</td>
</tr>
<tr>
<td>13</td>
<td>Spring 2008</td>
<td>48.2 ± 8.9*</td>
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</tr>
<tr>
<td>14</td>
<td>Spring 2008</td>
<td>50.6 ± 6.9*</td>
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</tr>
<tr>
<td>15</td>
<td>Spring 2008</td>
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<td>323</td>
</tr>
<tr>
<td>16</td>
<td>Spring 2008</td>
<td>51.6 ± 6.9*</td>
<td>446</td>
</tr>
<tr>
<td>17</td>
<td>Spring 2008</td>
<td>51.8 ± 6.9*</td>
<td>480</td>
</tr>
<tr>
<td>18</td>
<td>Winter 2007</td>
<td>53.8 ± 6.9</td>
<td>440</td>
</tr>
<tr>
<td>19</td>
<td>Winter 2007</td>
<td>54.4 ± 8.9*</td>
<td>475</td>
</tr>
<tr>
<td>20</td>
<td>Spring 2008</td>
<td>54.8 ± 7.0*</td>
<td>224</td>
</tr>
<tr>
<td>21</td>
<td>Spring 2008</td>
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<tr>
<td>22</td>
<td>Spring 2008</td>
<td>58.3 ± 8.8*</td>
<td>480</td>
</tr>
<tr>
<td>23</td>
<td>Winter 2007</td>
<td>58.2 ± 6.9*</td>
<td>317</td>
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<tr>
<td>24</td>
<td>Spring 2008</td>
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</tr>
<tr>
<td>25</td>
<td>Winter 2007</td>
<td>66.1 ± 8.8*</td>
<td>317</td>
</tr>
</tbody>
</table>

*The 2 study periods were between November 20 and December 9, 2007 (winter 2007) and between April 15 and May 4, 2008 (spring 2008). †Values for mean percentage of time spent lying were calculated as adjusted means by use of a logistic regression model, which also included significant effects of trial (replicate), day within trial, hour within day, and steer. ‡Steer-hours represent the number of hours recorded by an accelerometer‡ that were used for analysis. **Values with differ superscript letters differ significantly (P < 0.001).

Figure 3—Frequency distribution for the percentage of steers that spent various amounts of time lying during the winter 2007 and spring 2008 study periods. Values were determined on the basis of the model-adjusted mean percentage of time spent lying. The winter 2007 and spring 2008 study periods were between November 20 and December 9, 2007, and April 15 and May 4, 2008, respectively. See Figure 1 for remainder of key.
Discussion

The study reported here was unique because lying behavior patterns for individual calves and calf-to-calf variation in the percentage of time spent lying have not been adequately described. Furthermore, these results could influence the design of future health and welfare research projects in which animal behavior is evaluated as an outcome. The continuous recording of data by accelerometers in the study reported here provided an objective description of typical behaviors of cattle located in a feedlot environment. Other investigators have evaluated video surveillance techniques to monitor behavior of cattle located in a feedlot setting,

although those investigators were successful in determining group behavior, video surveillance was less capable of identifying an individual calf’s behavior within a pen. Our procedure for classifying accelerometer data by use of a decision-tree analysis system has been determined to be an accurate and objective method, compared with classification by use of a standard real-time video, which is considered the criterion-reference standard. By implementing a remote accelerometer monitoring system, we were able to describe differences in activity among calves and to also identify differences in circadian rhythm patterns and activity among the days of the study. These novel data may be pivotal for the evaluation of future studies that use behavior as a variable to assess the health and well-being of cattle.

Accelerometer data for the present study were recorded continuously with minimal interruption; this allowed these devices to record natural activity patterns without human interaction, with the exception of twice-daily feeding periods. Therefore, the effects identified as impacting the percentage of time spent lying should be applicable to common, group-housed cattle management systems. Lying behavior was selected as the analysis variable in the present study because calves were standing or walking when they were not lying; in addition, walking comprised only a negligible portion (2.9%) of the total amount of time. Therefore, lying was reflective of the overall behaviors of each calf for the selected period.

Our finding that most (16 [64%]) calves spent between 40% and 55% of the day lying agrees with the findings of another study, in which investigators monitored randomly selected steers within pens and found that mean percentage of time spent lying was 49.8%. In that study, the monitoring method used had limited ability to quantify multiple steers within each pen because this was accomplished via direct human observation, compared with the method in the present study that was able to objectively monitor all calves remotely within the pen at the same time and yielded a more thorough representation of lying behavior. We attempted to eliminate instances of artifact behavior by removing known human contact times from the analyses; however, we realize that cattle located in typical production settings are subject to periods when behaviors; hence, feeding influenced the increase in percentage of time spent lying prior and subsequent to feeding.

Our findings are consistent with those in another study, in which investigators reported that behavior of feedlot steers varies from hour to hour, and this variation should be accounted for in research in which calf activity is a variable of interest. Percentage of time spent lying in the present study potentially could be used to categorize call activity into various activity categories. Periods of darkness (8:00 PM to 4:00 AM) represent a period of low activity, as indicated by an increase in the model-adjusted percentage of time spent lying (>55%), whereas late morning to afternoon hours (8:00 AM to 3:00 PM, respectively) had moderate amounts of activity, with lying behavior representing between 30% and 55% of total activity during that period. Periods of high activity corresponded with the morning and evening feeding periods (6:00 AM to 7:00 AM and 4:00 PM to 5:00 PM, respectively); the model-adjusted percentage of time spent lying was the least (<30%) for those hours. Variation in the percentage of time spent lying during periods throughout the day can influence the manner by which herd personnel evaluate behavior of individual calves. It may be more beneficial for animal health providers and researchers to assess individual calves during periods of high and low activity (ie, avoiding interaction with calves during periods of typical call-to-call variation) to decrease noise in the data and thus more successfully identify cattle that deviate from typical behaviors of the group during a particular period.

Feeding behavior has been actively evaluated as an indicator of animal well-being, and analysis of our results indicated that calves spent the lowest proportion of time lying during the hours associated with feeding. Malaise toward feeding is often a subjective measure used by animal health personnel to identify illness in several species, including dogs, horses, and cattle. In other studies, investigators were able to demonstrate that feeding and watering behavior was related to the overall health of feedlot cattle. As discussed previously, we found lying behavior was the lowest during feed-
ing periods; however, if a calf had signs of depression or illness, it may have displayed increased lying behavior during feeding. Because we eliminated data from ill calves, we were unable to evaluate the ability to analyze data recorded by accelerometers for the identification of behavior changes caused by illness during feeding periods. We recommend further investigation into the use of accelerometer monitoring systems for identifying behavioral changes of cattle caused by illness.

Individual calf behaviors in the 2 study periods reported here had the tendency to be highly repeatable within individual calves over hours and days, which was indicated by the SD for mean percentage of time spent lying. Repeatability of the findings of the present study is similar to that in another study in which lying, standing, and locomotion activities of dairy cows were found to be highly repeatable within individual cattle. Behavior repeatability within an individual calf promotes the use of an animal as its own control subject, rather than the use of group measurements that compare behavioral changes before and after a stimulus; in addition, studies in castrated calves revealed that accelerometers could be successfully used for behavior repeatability. We also were able to determine that within a group of cattle, individual calves had variations in degrees of lying behavior. In the study reported here, calves had differing amounts of activity, and perhaps this indicates a need to reexamine the criteria used to evaluate individual calves for signs of illness. These values for model-adjusted mean percentage of time spent lying were compared to detect variation in behavior when cattle are housed in a group setting. Furthermore, this behavioral variation indicates that monitoring of cattle on an individual basis, rather than on a pen-level basis, may lead to more efficient study designs for studies conducted to identify behavioral changes.

Results from this study should be interpreted cautiously because data were generated from 25 calves included in 2 separate trials. Numerous factors, including facilities, access to other cattle, interactions with people, and weather events, could have influenced the percentage of time spent lying. Although the results of the present study cannot be used to predict the exact percentage of time that a calf will spend lying, results of this study indicated that this behavior differed on the basis of time of day, day of the trial, and calf evaluated.

In the study reported here, we found that accelerometers could be successfully used to collect data on use in analyzing the classification of behavior of cattle in a feedlot environment and provided valuable data on continuous activity of individual cattle for an extended period. We were able to detect day-to-day variation in activity as well as the pattern of variation across hours within a day. Our results revealed that behavioral patterns of individual cattle were repeatable and that there are differences in activity among cattle. These findings advocate the use of each calf as its own control animal for future treatment and intervention studies. This study indicated that accelerometers can be used successfully as part of a monitoring system and have the capability of providing data for overall behaviors of cattle for use in comparing treatments among individual cattle as well as among groups of cattle. Because all data assessed were from healthy cattle, additional studies are necessary to investigate the effects of various stimuli (eg, disease and stressors) on natural behavior patterns.

References


