K-STATE Research and Extension

CATTLEMEN'S DAY 2017

Twenty-four Hour Holter Monitoring in Finishing Cattle Housed Outdoors

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Introduction

Ambulatory electrocardiogram monitoring, in the form of Holter monitoring, has been used in human and veterinary medicine for decades as an aid in the diagnosis and determination of appropriate therapy of heart rhythm disturbances. Within veterinary medicine, Holter monitors have been primarily used in companion animal species, yet little attention has been given to food animal species. Moreover, the heart rhythm in clinically normal cattle fed high concentrate diets and housed outdoors in confined dry-lot facilities has not been previously reported. In order to properly identify pathologic arrhythmias in cattle, the normal rhythm and arrhythmia prevalence in healthy cattle should be defined. Most prior reports of arrhythmia in cattle have been recordings of relatively shorter duration and in animals that were hospitalized or being handled for various reasons. Therefore, the objective of this study was to determine normal Holter monitor registrations including heart rate, rhythm, number of ventricular premature complexes, and atrial premature complexes in unrestrained finishing Angus steers.

Key words: cattle, electrocardiogram, Holter

Experimental Procedures

Twenty-seven (1,116 ± 12.1 lb) 15- to 17-month-old Angus steers were evaluated by clinical examination, complete blood count, and serum biochemical analysis. Cattle were determined to be disease-free based on normal physical examinations and blood count and serum chemistries. In addition, tissue histopathology was determined to be normal following euthanasia (27 days after Holter recordings). A lightweight Holter monitor was used in an outdoor environment. The steers were received from a commercial feeding facility in southwest Kansas. Steers were selected from a larger group based on weight uniformity and condition. Steers were adapted to a standard commercial finishing diet prior to shipment. Upon arrival, steers were weighed, identification recorded, placed in a pen with *ad libitum* access to grass hay/fresh water. Steers were reacclimated to the finish diet over 10 days. After 10 days, steers were placed into six dirt floor pens with feed bunks containing an individual animal feeding system. Steers were stratified by weight and randomly assigned to one of six pens. Pens were divided into two blocks of three pens. Study day was separated by 5 calendar days between the

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two blocks. Pens were approximately 59 × 11.8 ft and each contained five gated feed bunks and was equipped with water tanks. Approximately, 26.9 ft^2 of shade was provided per animal. Steers were individually fed twice daily. Blood samples for serum chemistry and complete blood count were collected on all study animals on days 11 and 16 for blocks 1 and 2, respectively. All samples were processed within 3 hours of sampling. Serum was submitted to the Kansas State University Veterinary Diagnostic Laboratory for analysis of serum chemistry panel. Complete blood counts were analyzed using a hematology analyzer. Sample frequency was 180 samples per second. Each registration had recorded three leads. Silver/silver chloride electrodes were applied to five vertically aligned locations just caudal to the forelimbs. The software identified individual heart beats as normal, abnormal, or artifact. Portions of the recording marked as artifact were excluded from the analysis. After evaluation, software output results were compiled into hourly intervals.

All data were analyzed using a generalized linear mixed model method accounting for repeated measures with steer as the repeated effect. The random effects included were block and pen. Degrees of freedom were calculated using the Kenward-Rogers method. The final model was inspected using QeQ plots and residual plots vs. predicted values.

Results and Discussion

Serum biochemistry analysis and complete blood count were within normal reference limits on all steers enrolled in the study. All steers accepted the Holter monitor and harness after a short adjustment period. The heart rate was calculated every hour with the mean heart rate of 66.8 to 16.4 beats per minute. Heart rates ranged from 20 to 102 beats per minute with a median and mode of 68 beats per minute. Mean heart rate throughout the day showed an increasing heart rate from 6:00 a.m. and peaking at 8:00 a.m., which was associated with feeding time. Heart rate decreased following feeding and remained somewhat stable until decreasing into the mid to low 60 beats per minute range after 8:00 p.m. This is similar to the pattern that has been previously reported in cattle, dogs, cats, horses, and humans.

Atrial premature complexes occurred in 23 out of 27 (85.2%) cattle, of which 100% of all events were singlets. Atrial premature complex occurrence ranged from 0 to 5 complexes per animal per hour. Median and mode were 0 atrial premature complex/hour. Ventricular premature complexes occurred in four (14.8%) steers. Rate of ventricular premature complex occurrence ranged from 0 to 3 complexes per animal per day. Median and mode were 0 ventricular premature complex/day. A total of 14 ventricular premature complexes were recorded during this study, of which nine occurred in a single steer. In addition to atrial premature complexes and ventricular premature complexes, simple second degree atrioventricular block was noted in 5 out of 27 (18.5%) cattle in this study (Figure 4). All second degree atrioventricular blocks were suggestive of hypervagotonia.

Implications

Based on the data from this study, atrial premature complexes are common, ventricular premature complexes are uncommon, and simple second degree atrioventricular block is a variable arrhythmia noted in clinically normal cattle. In addition, instances of

simple second degree atrioventricular block noted in the steers in this study were likely secondary to hypervagotonia. Cattle heart rhythms follow patterns similar to other species with slower rates during the evening and night hours, with higher rates in the morning and declining into the afternoon.

Table 1. Summary of laboratory data in normal steers

Analyte	Average	Range
Albumin, g/dL	3.6	2.9 - 3.9
Bicarbonate, mEq/L	25	17 - 28
Calcium, mg/dL	10.0	9.5 - 10.6
Chlorine, mEq/L	97	94 - 100
Creatinine, mg/dL	1.1	0.8 - 1.3
Globulin, g/dL	3.7	3.1 - 5.4
Glucose, mg/dL	43	17 - 66
Hematocrit, %	40.3	33.6 - 47.3
Lactate, mg/dL	4.3	1.8 - 9.6
Phosphorus, mg/dL	7.9	6.0 - 9.9
Potassium, mEq/L	5.7	4.7 - 7.7
Sodium, mEq/L	142	138 - 145
White blood count, K/uL	10.75	6.14 - 15.07
Neutrophils	3.17	0.48 - 6.16
Lymphocytes	5.38	2.62 - 9.86
Monocytes	1.65	0.78 - 3.42

Figure 1. Picture of Holter monitor apparatus applied to steer.

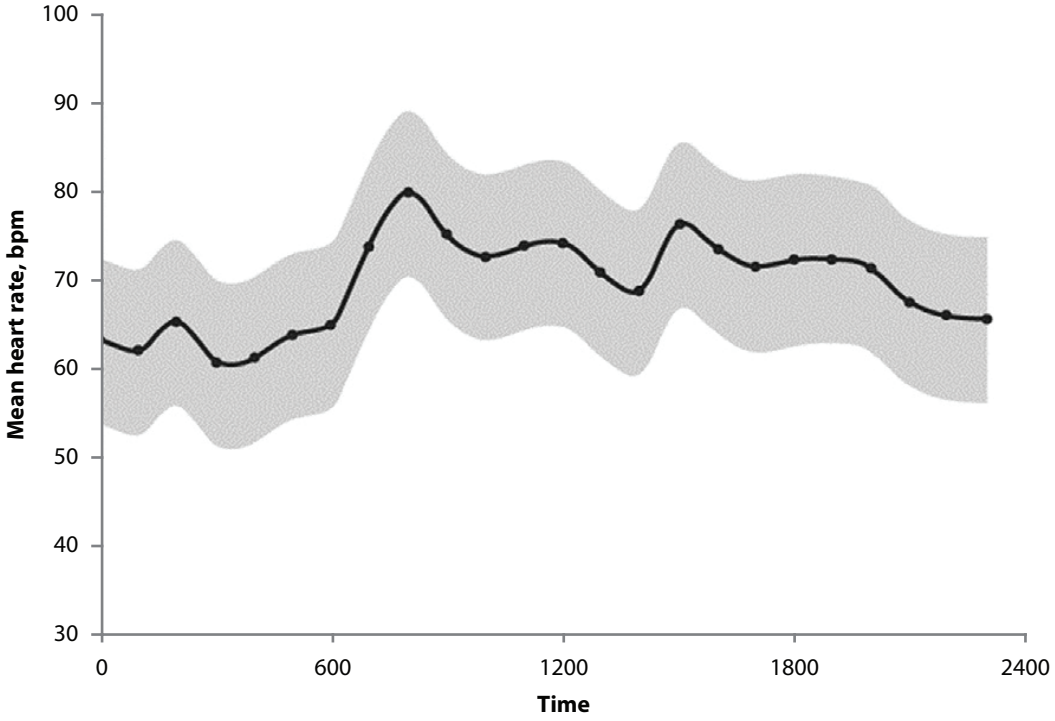

Figure 2. Mean heart rate and 95% confidence interval over 24 hours for finishing steers equipped with Holter monitor apparatus.

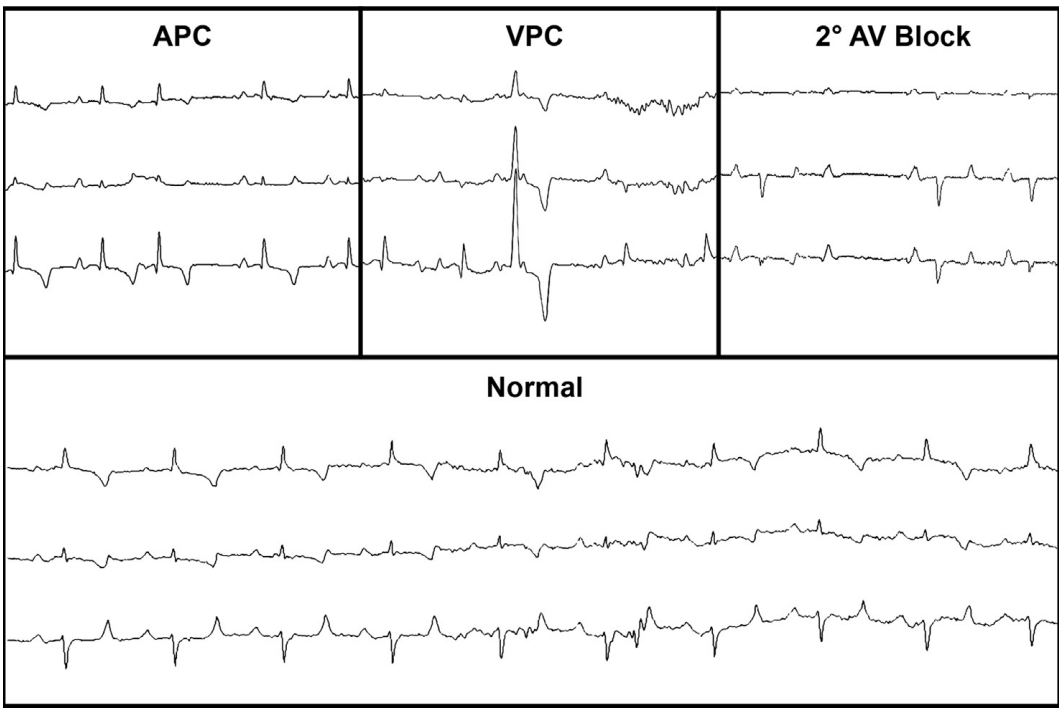

Figure 3. Representative atrial premature complex, ventricular premature complex, and low magnification Holter recordings in normal finishing steers.