PEER REVIEWED

Lung Auscultation and Rectal Temperature as a Predictor of Lung Lesions and Bovine Respiratory Disease Treatment Outcome in Feedyard Cattle

Keith DeDonder[1], *DVM, MS;* **Daniel U. Thomson**[2*], *PhD, DVM;* **Guy H. Loneragan**[3], *BVSc, PhD;* **Tom Noffsinger**[4], *DVM;* **Wade Taylor**[5], *DVM;* **Michael D. Apley**[2], *DVM, PhD*
[1]*Banner Creek Animal Hospital, PA, Holton, KS 66436*
[2]*Department of Clinical Sciences, Kansas State University, Manhattan, KS 66506*
[3]*Department of Agricultural Sciences, West Texas A&M University, Canyon, TX 79016*
[4]*Benkelman, NE 69021*
[5]*Oakley Veterinary Services, Oakley, KS 67748*
**Corresponding author: Dr. Dan Thomson, 1800 Denison Ave., Manhattan, KS 66506, dthomson@vet.ksu.edu*

Abstract

Studies were conducted to examine the use of lung auscultation to predict bovine respiratory disease (BRD) case outcome in feeder cattle. In the first study, lung sounds were obtained and lung auscultation scores (LAS) were assigned by trained personnel. Antemortem physical examination and LAS were correlated with lung pathology and lung lesion scores at harvest. A field study was then conducted to determine LAS and case outcome in 4,341 feeder cattle treated for BRD. Lung auscultation score (P<0.01) and rectal temperature (P<0.01) were predictive of cattle with increased risk for BRD retreatment and mortality. The model-adjusted probability of a calf with a LAS of 2 requiring retreatment was 13%, whereas the probability of retreatment for cattle assigned a LAS of 9 was 63%. An increase in rectal temperature from 100.0 to 108.0°F (37.8 to 42.2°C) was correlated with a 266% increase in likelihood for retreatment for BRD. Risk of death from BRD increased nearly 2,200%, from 1.7% to 39%, as LAS increased from a score of 2 to 9. Risk of death due to BRD increased 196% as rectal temperature proceeded from 100.0 to 108.0°F. These studies demonstrate that lung auscultation score and rectal temperature could be useful to better predict BRD case outcomes in feeder cattle, and to facilitate targeted management decisions.

Key words: bovine respiratory disease, auscultation, rectal temperature, clinical diagnosis, beef cattle

Résumé

Des études ont été menées afin d'examiner l'utilisation de l'auscultation des poumons pour prédire le résultat des cas de maladie respiratoire chez les bovins de boucherie en parc d'engraissement. Dans la première étude, les bruits pulmonaires ont été obtenus et les scores d'auscultation des poumons ont été générés par du personnel entraîné. L'examen avant la mort et les scores d'auscultation étaient corrélés avec la pathologie pulmonaire et les scores de lésion pulmonaire à l'abattage. Une étude sur le terrain a été menée par la suite pour déterminer les scores d'auscultation et le résultat des cas chez 4341 bovins traités pour des maladies respiratoires. Le score d'auscultation pulmonaire (P < 0.01) et la température rectale (P < 0.01) prédisaient une augmentation du risque de retraitement pour maladie respiratoire et du risque de mortalité. Un veau avec un score d'auscultation de 2 avait une probabilité ajustée prédite par le modèle de 13% de nécessiter un nouveau traitement alors que cette même probabilité était de 63% chez les veaux avec un score de 9. Une hausse de température de 100.0 à 108.0°F (37.8 à 42.2°C) s'accompagnait d'un accroissement de 266% des chances de retraitement pour maladie respiratoire. Le risque de mortalité associé aux maladies respiratoires augmentait de 2200%, soit de 1.7% à 39%, lorsque le score d'auscultation augmentait de 2 à 9. Le risque de mortalité causée par les maladies respiratoires augmentait de 196% lorsque la température rectale augmentait de 100.0 à 108.0°F. Ces études démontrent que le score d'auscultation et la température rectale peuvent être utiles afin de mieux prédire le résultat des cas de maladie respiratoire chez les bovins de boucherie en parc d'engraissement et de faciliter la prise de décision au niveau de la régie.

Introduction

Bovine respiratory disease (BRD) is the most common and costly disease of feeder cattle, and significant expense is incurred to prevent and treat the disease.

Loneragan estimated initial treatment costs alone in calendar year 1999 were $45.7 million.[7] Total economic losses were estimated to approach $692 million in a survey from 2005 conducted by the National Agricultural Statistics Service, a division of the United States Department of Agriculture (USDA).[11]

Death loss associated with BRD in feeder cattle has been well documented. Vogel and Parrott reported mortality data from 59 feedyards (38,593,575 head of cattle) in seven midwestern states from January 1990 through May 1993.[12] Deaths due to BRD represented 44.1% of total deaths in these feedyards, while digestive disorders and "other" causes accounted for 25.9 and 28.6% of deaths, respectively, over the three-and-a-half-year period.[12] Another report was provided by the USDA National Animal Health Monitoring System, in which data were collected from 21,753,082 head of cattle placed on feed from 1994 to 1999 (121 feedyards in 12 states).[8] Analysis of these data showed that mortality due to all causes tended to increase (P=0.09) from 10.3 deaths per 1,000 head of cattle in 1994 to 14.2 deaths per 1,000 head of cattle in 1999. Respiratory mortality rates increased from 5.4 deaths per 1,000 head in 1994 to 8.7 per 1,000 head in 1999.[8]

Performance of cattle is also adversely affected by BRD. Gardner *et al* reported that steers without pneumonia lesions in the lungs at harvest had improved average daily gain (ADG) relative to cattle that had lung lesions (3.48 vs 3.09 lb [1.58 vs 1.41 kg]/day, P<0.01).[5] Similarly, Bryant *et al* showed that lung lesions present at harvest were associated with a decrease in ADG (0.057 lb or 0.026 kg/day) in single source calves, and up to a 0.65 lb (0.30 kg)/day decrease in ADG in commingled calves, compared to cattle in their respective groups without lung lesions.[2] More recently, researchers in South Africa found that ADG of feeder cattle with lung lesions at harvest was 0.051 lb (0.023 kg)/day less than cattle without lung lesions.[10] Additionally, the presence of lesions at harvest was associated with an additional 5.5 days to finish cattle.

Disease detection starts with the pen riders in North American feedyards. Pen riders check cattle at least once each day for signs of any illness. Clinical signs used to identify cattle possibly ill with BRD include respiratory rate, respiratory character, rumen fill, observed anorexia, nasal discharge, ocular discharge, and depression.[1] Chute-side feedyard diagnostics consist of examining for clinical signs and taking the rectal temperature. Decisions on therapeutic regimens are often outlined in a treatment protocol designed by the consulting veterinarian, and are generally based on a rectal temperature greater than some arbitrary cutoff, for example, ≥103.5°F (≥39.7°C).[3]

Rectal temperature can vary because of such factors as environmental temperature, relative humidity, heat of fermentation, exercise, excitement, and anxiety. These changes in rectal temperature result from physiologic rather than pathologic changes.[4] Vogel *et al* reported that for each unit (F) increase in maximum ambient temperature (ambient temperature range from 82.0 to 105.0°F [27.8 to 40.6°C), rectal temperature in all cattle pulled increased 0.07°F (P<0.01).[13] In the same study, they found no association between the rectal temperature in cattle pulled and treated for BRD and the risk of retreatment or mortality.[13]

Using elevated rectal temperature as the sole diagnostic tool beyond clinical signs is essentially treating on the basis of depression with undifferentiated fever, which could result in unnecessary antimicrobial use.[1] Additional diagnostic tools, such as a stethoscope, may aid in decision making; however, the literature is largely devoid of reports evaluating the use of a stethoscope as a diagnostic aid to better identify and manage BRD or to predict BRD-case outcome in feeder cattle. Therefore, the objectives of this paper were to 1) validate a thoracic auscultation scoring system by correlating ante-mortem lung sounds with postmortem lung lesions, and 2) to evaluate chute-side diagnostic tools to predict case outcome in the feeder cattle treated for BRD in a field setting.

Materials and Methods

Pilot Study

Cattle (n=36) sold for salvage harvest from feedyards were used to validate a lung auscultation scoring system to diagnose lung lesions. Twenty-seven head of cattle were delivered to a small backgrounding feedyard in Booker, Texas, and nine head were presented to the Kansas State University Veterinary Diagnostic Laboratory (KSU VDL). Ante-mortem evaluation consisted of general physical examinations, including rectal temperature and thoracic auscultation. Lung sounds were scored at the time of examination using a 1 to 10 scoring system (Table 1) utilizing an electronic stethoscope.[a]

Table 1. Antemortem auscultation scoring system.

Lung score	Auscultation findings
1 – 2	Normal lung sounds
3 – 4	Mild adventitious lung sounds (crackles/rales)
5 – 6	Moderate adventitious lung sounds (crackles/rales)
7 – 9	Severe adventitious lung sounds (crackles/rales)
10	Diffuse, severe adventitious lung sounds (crackles/rales)

Regular stethoscopes are commonly utilized in the field for pulmonary auscultation; however, an electronic stethoscope was utilized in this study to amplify lung sounds. Lung score groups were based on level of severity of the adventitious lung sounds. These groupings and case definition (i.e., 1 and 2 equal normal lung sounds; Table 1) were established by veterinarians that had used this technology extensively in the field (Tom Noffsinger and Wade Taylor, personal communication). Most lung sounds generated by feeder cattle with BRD are crackles or rales.[9] Thus, the difference in severity in the scoring system is based on the loudness and intensity of crackles/rales when auscultating lungs of cattle. Lungs were scored systematically with auscultations performed in the area of the cranioventral lung fields, and just dorsal to the approximate location of the carina on both the left and right sides of the thorax. Lung sounds were scored for both the left and right sides of each calf.

Calves in the study were ear-tagged with a unique number to ensure proper identification at the packing plant. After physical examination, including pulmonary auscultation and scoring, cattle were transported to a nearby abattoir for harvest. Several checkpoints were established within the packing plant to ensure the lung lesion scores (LLS) were matched with the correct animal. At harvest, lungs were evaluated and scored using a scoring system modified from that previously developed by other research groups[2,6] (Table 2). Lung lesion scores were determined for both left and right lung lobes.

Nine chronically ill cattle from a backgrounding yard in Centralia, KS, were presented to the KSU VDL for diagnostic evaluation. All cattle were physically examined and lung auscultation scores (LAS) were assigned as described earlier. All calves were humanely euthanized, and a complete necropsy was performed. Lung lesion scoring was performed using the same system as the other group of cattle in the study.

Separate LAS were recorded for the left and right sides of each animal, and a collective LLS was recorded for the left and right lung, respectively. Because initial data analysis indicated that there were no LAS or LLS differences between the left or right side of the animal, the mean LAS and LLS values for the left and right sides of the cattle were used in the analysis of the pilot study. Statistical analysis was performed with LAS as the dependent variable to determine the extent of correlation with LLS utilizing linear regression (SAS).[b]

Field Study

A retrospective cohort study was conducted using data obtained from three commercial feedyards located in Kansas, Nebraska, and Washington. Cattle were enrolled in the study if they showed clinical signs of BRD in the home pen, including depression, inattentive to stimuli, lack of rumen fill, nasal and/or ocular discharge, and coughing. Cattle were taken to the feedlot hospital where animal identification, LAS,[c] rectal temperature,[d] and treatment regimen were recorded at the time of treatment for BRD. Elevated rectal temperature or elevated LAS were not necessary for enrollment in the study, only the presence of clinical signs of BRD, which was standard practice when treating cattle for BRD at the cooperating feedyards. A total of 4,341 cases met the requirements for inclusion in the study (KS, N = 287; NE, N = 404; WA, N = 3,650).

After enrollment in the study, animal treatment outcomes were observed and entered into the animal health computer system. Outcome data collected for this study included retreatment for BRD and/or death. All animals that died were necropsied by trained personnel.

Observers at each feedyard were trained by the same veterinarian to collect and record LAS, but there were different observers at each feedyard. Mixed-model logistic regression was used, and to account for potential clustering of outcome within specific feedyards, feedyard was forced into the models as a random variable.

Eight different treatment regimens were utilized by the three feedyards, and therapeutic decisions were made based on clinical findings, rectal temperature, and LAS. As a result, it was assumed that there could be a treatment effect on case outcome affecting retreatment and mortality rates. The antimicrobial regimen selected was highly co-linear with feedyard; therefore, antimicrobial regimen was assumed to be at least partially

Table 2. Postmortem lung lesion scoring system.[2]

Lesion score	Postmortem findings
0	Normal lung / no lesions
1	Total affected area or volume involving less than one cranioventral lobe (<5% lung volume) and/or adhesions (fibrin tags)
2	Adhesions affecting more than one cranioventral lobe (>5% lung volume) and/or missing piece of lung due to adhesions
3	Missing lung >15% of total lung area (>three cranioventral lobes) and/or active tracheobronchial lymph nodes

controlled by including feedyard as a random variable in the statistical model.

Predicted values (retreatment and death) were obtained with 95% confidence levels using a model based on either LAS or rectal temperature. Only animals with LAS of 2 to 9 were included in the risk analysis. In the field study, calves that exhibited a LAS of 1 were considered normal and received no treatment for BRD. Nearly 94% (105/112) of calves with an initial LAS of 1 were subsequently re-pulled and treated for BRD. This was classified as a first treatment for BRD, and not a retreatment.

Results

Pilot Study

Two calves were removed from the study. One escaped the chute before lung sounds could be captured. There was excessive background noise when the second calf was caught in the chute which precluded adequate scoring of lung sounds.

Only 44% of the 34 remaining cattle in the pilot study had lung lesions at postmortem examination. Twenty cattle had LAS of 1 and LLS of 0, and therefore were likely marketed early for reasons other than chronic respiratory disease as no pulmonary pathology was grossly or clinically evident. Eleven head of cattle received a LLS of 3, reflecting severe lung pathology, and were likely marketed early due to chronic respiratory disease. The number of calves scored in each LAS and LLS are given in Table 3. Most calves had LAS of 1 or 7, and subsequently received LLS of 0 or 3.

Results of linear regression revealed a strong positive correlation (R^2 = 0.89; P<0.0001) between antemortem LAS and postmortem LLS (Figure 1). These data indicate that lung auscultation is predictive of lung lesions associated with BRD.

Field Study

A total of 4,341 cattle in the field trial met the inclusion criteria described earlier and were treated for BRD. The distribution of calves within each LAS are shown in Figure 2. Ninety-six percent of cattle had a LAS ranging from 2 to 6 at the time of first treatment for BRD (Figure 2). Retreatment rate was defined as the percentage of cattle that did not respond to the first treatment for BRD, and were subsequently treated a second time. Case fatality rates due to BRD were determined by dividing the number of cattle treated for BRD that died by the total number of cattle treated for BRD. Since only animals pulled for sickness were utilized in this study, the case fatality rate and BRD death loss rates within LAS category were considered synonymous.

Retreatment and case fatality rates for cattle categorized in each LAS are shown in Table 4. Lung auscultation scores (Figure 3) were significantly (P<0.0001) correlated with retreatment and case fatality rates (Figure 4; P<0.0001) in calves diagnosed and treated for BRD. The model-adjusted probability of a calf with a LAS of 2 at first treatment for BRD being retreated was 13%, while the retreatment rate for cattle assigned a LAS of 9 was 63%. This increase in retreatment risk associated with increasing LAS score is shown in Figure 3. The model-adjusted probability of death following treatment for BRD increased from 1.7 to 39% as LAS score increased from 2 to 9 (Figure 4; P<0.0001).

Table 3. Antemortem lung auscultation and postmortem lung lesion scores for 34 head of cattle culled from commercial feeding operations.

	Postmortem lung lesion score							
	Left lung field				Right lung field			
Ante-mortem lung auscultation score	0	1	2	3	0	1	2	3
1	19	1	0	0	16	2	0	0
2	0	0	0	0	1	0	0	0
3	1	0	0	0	2	0	1	0
4	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	1	0
6	0	0	0	0	0	0	0	1
7	0	0	1	8	0	0	0	6
8	0	0	0	3	0	0	0	2
9	0	0	1	0	0	1	0	1
10	0	0	0	0	0	0	0	0

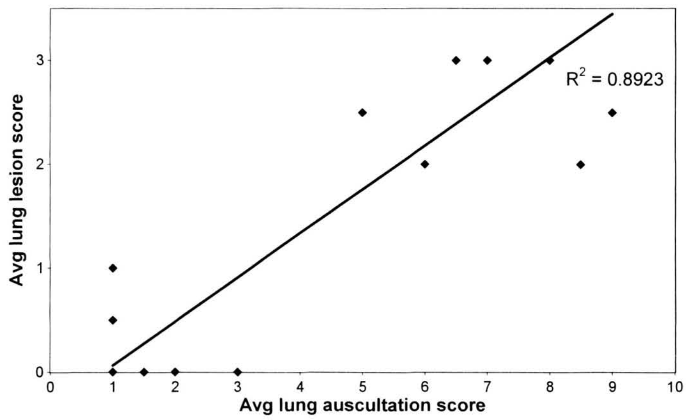

Figure 1. Scatter plot of average ante-mortem lung auscultation score and postmortem lung lesion score from 34 cattle culled from commercial feeding operations ($P<0.0001$).

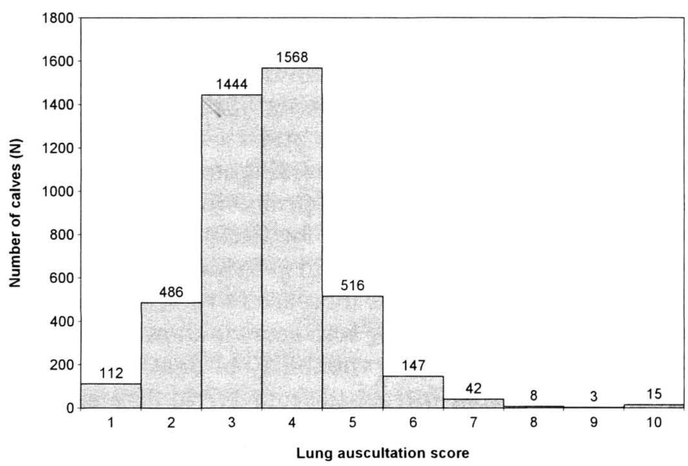

Figure 2. Distribution of calves by lung auscultation score determined at time of first treatment for bovine respiratory disease in three commercial feedyards.

Rectal temperatures ranged from 100.0 to 108.0°F (37.8 to 42.2°C). Summary statistics of the number of calves, retreatment rate, and case fatality rate within each rectal temperature range from the three feedyards are in Table 5. Cattle that had a rectal temperature ≤104.0°F (40°C; 26% of cattle enrolled) had a retreatment rate of 28.2% and a case fatality rate of 2.5% (data not shown). Seventy-four percent of cattle enrolled in the study had a rectal temperature >104.0°F when first treated for BRD. Cattle with an elevated rectal temperature (>104°F) had a retreatment rate of 40.6% and a case fatality rate of 5.1% (data not shown). Rectal temperature was also predictive of retreatment ($P<0.0001$) and case fatality rates ($P<0.0001$) in calves treated for BRD. An increase in rectal temperature from 100.0 to 108.0°F correlated with increased probability of retreatment (Figure 5) and death due to BRD (Figure 6).

Detailed necropsy results were not retrievable at the end of the study. As a result, mortality outcomes reflect crude rather than specific case fatality rates.

Discussion

In this study, increased LAS in cattle was correlated with higher LLS found during postmortem examination. The results also demonstrate that LAS is a good predictor of retreatment rates and case fatality rates in various populations of feeder cattle treated for BRD; elevated LAS at the time cattle were first treated for BRD was associated with increased risk of retreatment or death due to BRD. In addition, rectal temperature was also predictive of retreatment and case fatality rates in cattle suffering from BRD.

In the pilot study, 44% of cattle had pneumonia-associated lung lesions at harvest, which is consistent with other published reports.[2,5,10] These similarities in the proportion of cattle with postmortem lung lesions

Table 4. Number of calves, and model-adjusted probability of retreatment rates and case fatality rates, by lung auscultation score at the time of initial treatment.

Lung auscultation score	Number of calves (n)	Retreatment rate, %*	Case fatality rate, %**
2	486	25.3	1.0
3	1444	35.0	2.8
4	1568	39.9	4.2
5	516	45.3	8.1
6	147	40.1	14.3
7	42	35.7	26.2
8	8	37.5	25.0
9	3	66.7	33.3

* Retreatment rate = (calves pulled for second treatment/calves pulled for first treatment)*100
** Case fatality rate = (calves that died/calves pulled for first treatment)*100

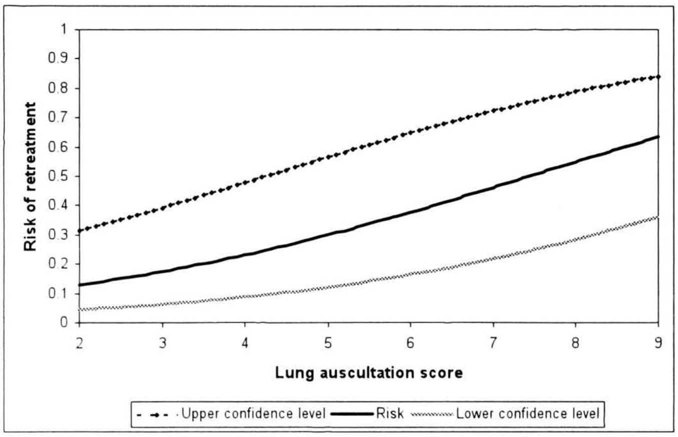

Figure 3. Predicted risk of retreatment for bovine respiratory disease by lung auscultation score modeled using logistical regression. The solid line is the model-adjusted risk (probability) of retreatment. The dashed line (upper conf. level) and gray line (lower confidence level) represent the 95% confidence intervals of the risk (P<0.0001).

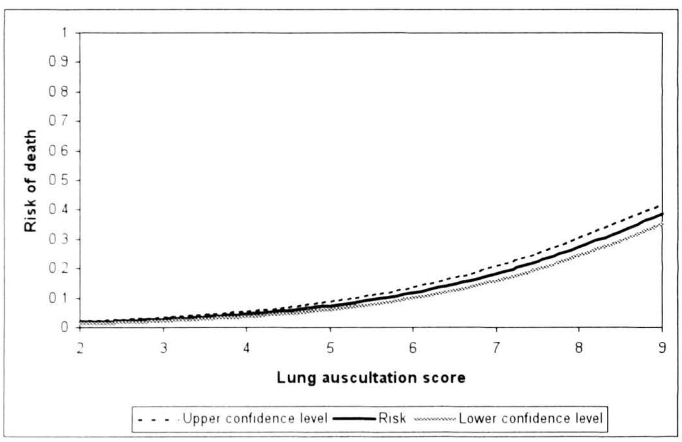

Figure 4. Predicted risk of a calf dying from bovine respiratory disease by lung auscultation score modeled using logistical regression. The solid line is the model-adjusted risk (probability) of death. The dashed line (upper conf. level) and gray line (lower confidence level) represent the 95% confidence intervals of the risk (P<0.0001).

were interesting. Cattle in this pilot study were sold for salvage because of poor performance or chronic illness, whereas other studies reported data from cattle shipped to a harvest facility at the end of the prescribed feeding period. Bryant *et al* found that 54% of all cattle from a commercial feedyard in Nebraska had lung lesions at harvest.[2] Other publications report similar results of 37% and 43%, respectively.[5,10] A study by Wittum *et al* found higher (72%) lung lesion rates in feeder cattle at the time of harvest.[14] All of the mentioned studies compared lung lesions at slaughter in cattle treated for BRD and cattle not treated for BRD. The incidence of lung lesions in these groups was similar. The data in the present pilot study only came from cattle sent to salvage slaughter, which might not be representative of the whole population compared to previously published papers. Lastly, in our field study, only cattle treated for BRD were utilized in the study.

There is little in the literature that describes relationships between diagnostic techniques and case outcomes. One study evaluated case outcomes following treatment for BRD relative to packed cell volume, plasma total protein, rectal temperature, maximum ambient temperature, body weight, and changes in body weight.[13] In that study, lower body weight relative to the estimated average pen weight (or changes in body weight) was associated with increased risk of cattle not surviving to harvest.[13] No other parameter measured was associated with case outcome.

In the present study, rectal temperature was predictive of retreatment and case fatality rates in cattle treated for BRD, which is in contrast with findings from another report.[13] In that study, rectal temperature of cattle treated for BRD was correlated with ambient temperature when cattle were treated. Ambient temperature was not recorded in our field study, but a study conducted in a central Kansas feedyard during June, July, and August did report record high ambient temperatures (some over 100.0°F).[13] It is likely that ambient temperature in the present study was more variable based on time of year as it was conducted from October through June in Washington, Nebraska, and Kansas.

Retreatment rates and case fatality rates differed between the three feedyards participating in this study. Retreatment rates ranged from 12.8 to 40.1%, and case fatality rates from 3.9 to 8.0%. The range of these data is somewhat surprising. Although there was no feedyard by LAS interaction, the feedyard in Washington had higher retreatment rates than the feedyards in Kansas and Nebraska. In contrast, the feedyards in Kansas and Nebraska had higher case fatality rates than the feedyard in Washington. The feedyard in Washington also enrolled more cases (3,650 head) in the study than the other two feedyards.

These differences illustrate the need for technology to objectively identify sick cattle, or the use of LAS matched with clinical signs to decrease the number of false positives brought to the chute for treatment. A feedyard with more aggressive pen riding and treatment programs for BRD could be expected to have a lower case fatality rate than a feedyard that treats fewer, more clinically ill cattle classified within the same health-risk category. In this type of scenario, the treatment regimen for BRD may not be more effective in feedyards

Table 5. Number of calves, and model-adjusted probability of retreatment rates and case fatality rates, by rectal temperature at the time of initial treatment.

Rectal temperature, °F	Number of calves, (n)	Retreatment, %*	Case fatality rate, %**
100.0-101.0	40	47.5	5.0
101.1-102.0	133	24.8	0.0
102.1-103.0	319	27.3	2.8
103.1-104.0	643	28.1	2.6
104.1-105.0	1120	33.3	3.1
105.1-106.0	1105	41.1	4.8
106.1-107.0	733	45.7	6.0
107.1-108.0	248	56.0	12.9

* Retreatment rate = (calves pulled for second treatment/calves pulled for first treatment)*100
** Case fatality rate = (calves that died/calves pulled for first treatment)*100

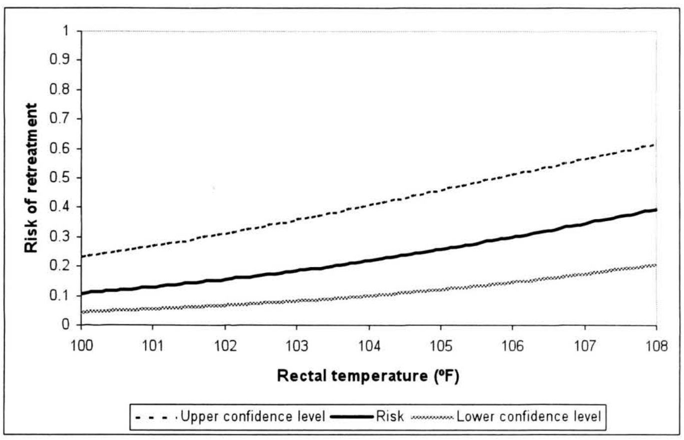

Figure 5. Predicted risk of retreatment for bovine respiratory disease by rectal temperature modeled using logistical regression. The solid line is the model-adjusted risk (probability) of retreatment. The dashed line (upper conf. level) and gray line (lower confidence level) represent the 95% confidence intervals of the risk (*P*<0.0001).

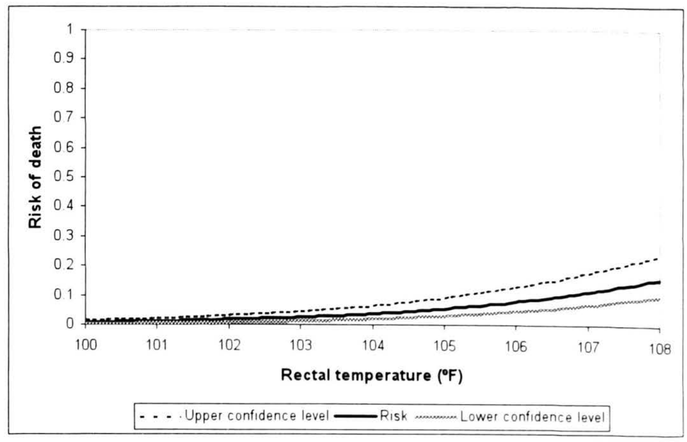

Figure 6. Predicted risk of a calf dying from bovine respiratory disease by rectal temperature modeled using logistical regression. The solid line is the model-adjusted risk (probability) of death. The dashed line (upper conf. level) and gray line (lower confidence level) represent the 95% confidence intervals of the risk (*P*<0.0001).

with lower case fatality rates compared to those with higher case fatality rates. Feedyards with higher case fatality rates may be treating fewer false-positive BRD cases than feedyards that ride and treat more aggressively for BRD.

Evaluator bias at the time of LAS could have affected the outcome of the field study. Clinical signs, such as depression, nasal discharge, and gauntness seen in cattle in the home pen or hospital chute, could clearly bias the evaluator's interpretation and scoring when conducting pulmonary auscultation. Therapeutic regimen could also be a confounding variable, as eight different treatment regimens were used. In addition, 84% of the cases were from one feedyard, which could introduce a feedyard effect not completely controlled in the analysis, even though it was forced into the model. No comparison has been made to examine the variation in LAS between individual observers in a field setting. This information could be useful when comparing this technology within and across feedyards. Lastly, there were few cattle that had LAS values of 8 or 9. This could indicate the need for re-evaluating the LAS system. It is also possible that few cattle reach an 8 or 9 LAS at the time of their first BRD treatment. Further evaluation of cattle at multiple retreatment times would be warranted.

Although lung auscultation has been utilized in medicine for many years, scoring systems are very subjective and vary between people interpreting the sounds. As technology advances, electronic scoring systems will be developed to more accurately score these sounds but until that time this type of research will be difficult to replicate exactly. This is due to the subjectivity of the lung sound interpretations and the room for different interpretations in lung score definitions in Table 1. However, we believe this is another tool for practitioners and feedyard personnel to utilize in diagnosing BRD chute-side.

Further research utilizing the stethoscope to assign different BRD treatments based on severity of LAS is warranted. Newer antimicrobial products used for treatment of BRD are costly compared to earlier options, and government and society are demanding more judicious use of antimicrobials in food producing animals. A controlled study evaluating case outcomes in cattle treated with different antimicrobial therapies within different LAS and rectal temperature ranges could provide information to improve case outcomes or decrease treatment costs in cattle suffering from BRD.

A weakness of the present study was that detailed necropsy results were not retrievable at conclusion of the project. In follow-up studies, case fatality rates based on necropsy examination should be determined for each LAS and rectal temperature range. Future studies should also measure performance and subsequent carcass characteristics in cattle within different LAS score and temperature ranges. These data could be used by producers to change marketing strategies of cattle to maximize economic return.

Conclusions

Lung auscultation scoring and determining rectal temperature requires minimal capital input and can be performed chute-side. These data indicate that these tools can be used by trained technicians to predict case outcomes for BRD. Results of this study may serve veterinarians and managers as they design treatment protocols better aimed at animals with a higher risk of treatment failure or death from BRD.

Endnotes

[a]3M Littman Electronic Stethoscope Model 4100, St. Paul, MN

[b]Statistical Analysis Software, Version 9.1.3, SAS Institute Inc., Cary, NC

[c]GLA Agricultural Electronics, San Luis Obispo, CA

[d]Standard (non-electronic) stethoscopes were used to determine LAS in the field study.

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