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Diagnostic utility of ultrasonographic and clinical assessment of bovine respiratory disease in feedlot calves

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ABSTRACT

Bovine Respiratory Disease (BRD) is the main cause of death in feedlot cattle, leading to considerable economic losses. This work assessed the clinical and ultrasonographic features of BRD-affected calves. Forty calves (3-9 months old) were selected, including 22 BRD-affected and 18 clinically healthy calves (control group). The calves were examined for clinical signs such as fever, dyspnea, nasal discharge, coughing, and weight loss. Lung auscultation revealed abnormal sounds, including wheezing, crackles, and moist rales in BRD-affected calves. Ultrasonographic examination was performed using a handheld ultrasound device, revealing hypoechoic zones, pleural thickening, and areas of consolidation in the lungs of BRD-affected calves. These results support the use of clinical lung scoring combined with lung ultrasonography for diagnosing and classifying calves based on the severity of lung lesions. Transportation and commingling of calves were identified as key predisposing factors for BRD, as stress and exposure to multiple pathogens increased disease susceptibility. This work highlights the value of combining clinical and ultrasonographic approaches for the early diagnosis of BRD.

1. INTRODUCTION

Bovine Respiratory Disease (BRD) is recognized as one of the most critical health issues affecting calves (Abdisa and Minda, 2016), leading to substantial financial losses in the feedlot cattle industry (Snowder et al., 2007). BRD impacts cattle across all production stages, accounting for about 75% morbidity and 50-70% mortality in feedlots (Edwards, 2010). These mortality and morbidity rates vary depending on the feedlot management protocols and the involved etiological agents (Griffin et al., 2010). Globally, the economic burden of BRD on the beef industry is estimated to exceed $4 billion annually, factoring in treatment costs, disease prevention, and losses due to reduced productivity caused by the morbidity and mortality of affected calves (Hodgson et al., 2010).

BRD in calves is associated with cough, sneezing, mucoid to mucopurulent nasal discharge, congested nasal mucous membrane, elevated pulse and respiratory rates, fever, and depression. (Yehia, 2000; El-Sebaieet al., 2002)

Diagnosis of BRD typically relies on clinical signs and elevated rectal temperatures, but accurately diagnosing the disease in the field remains challenging (Buczinski et al., 2014). Current methods of BRD detection are often subjective, lacking the ability to identify the disease in its early stages, which can result in unnecessary antimicrobial use (Apley, 2006). Various markers were applied at the early stages of BRD diagnosis to mitigate the adverse economic effect to guide treatment based on predicted outcomes (Montgomery et al., 2009).

Clinical scoring approaches for bovine respiratory disease are not new, since at least three scoring systems were described for diagnosing BRD. Thomas et al. (1977) developed the first published score as a research instrument to objectively identify the severity of BRD in calves infected with BRSV or BVDV. More recently, McGuirk (2008) devised a score system based on 5 symptoms to recognize calves that should be treated for BRD. Another technique, identified as DART (Depression, Appetite, Respiration, and Temperature), was created to select beef cattle for BRD therapy (Panciera and Confer, 2010).

Diagnostic techniques such as lung auscultation and ultrasonography are employed to enhance the accuracy of diagnostics (Duff and Galyean, 2007). Among the available diagnostic tools, lung auscultation stands out for its affordability and speed, making it a practical option for chute-side assessments (Buczinski et al., 2014). However, lung auscultation is a subjective method, requiring experienced individuals with strong acoustic skills to differentiate normal from abnormal lung sounds accurately (Duff and Galyean, 2007). To overcome these limitations, a computer-aided lung auscultation system, Whisper® technology, has been authorized for use in cattle (Mang et al., 2015). This system has shown promise in enhancing the accuracy of BRD diagnosis, although its effectiveness must be rigorously evaluated in case-control studies. The use of a scoring system could significantly reduce false-positive diagnoses, leading to a reduction in feedlot mortality (Noffsinger et al., 2014; Mang et al., 2015).

Lung ultrasonography is a non-invasive demonstrative and diagnostic device that has many applications in bovine medicine (Khalphallah et al., 2016), including the respiratory infections in cattle (Reinhold et al., 2002).

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Furthermore, ultrasonography of the lung enabled rapid grouping of the affected animal according to the degree of pneumonic lesion (Jung and Bostedt., 2004). Compared with other diagnostic methods, such as radiography, ultrasonography has been found to be more sensitive to describe and assess respiratory diseases in cattle (Reef et al., 1991). This work is designed to assess the clinical and ultrasonographic features of BRD-affected calves.

2. MATERIALS AND METHODS

Animals and sample collection

This work was performed on a farm situated in Qaliobia Governorate. A total of 40 calves, aged 3 to 9 months, were selected for the study. Calves had been recently transported to the farm from sale barns within a week before the beginning of the study. The calves were categorized based on clinical examination into two groups: clinically healthy calves (Control, n=18) and calves exhibiting signs of respiratory disease (BRD-affected calves, n=22). Calves suspected of having BRD were visually assessed for clinical signs such as discharge from the nose and eye, pulmonary distress, coughing, and inappetence. Rectal temperature was estimated; if two or more of these signs were present, the. WI The BRD clinical scoring system (table 1) was used for the assessment of calves suspected of having BRD (McGuirk, 2008); calves with a score of 5 (table 1) or above were considered morbid and included in the research. Calves were exposed to a thorough examination that included pulse and respiratory rate, body temperature, and thoracic auscultation (Radostits et al., 2000).
Physical examinations, including thoracic auscultation and ultrasonographic assessment, were conducted to confirm the presence of disease.

Ultrasonographic Examination

Ultrasonographic evaluations were performed using a Dramanski ultrasonographic scanner equipped with linear transducers (4, 5, 7, 8, and 9 MHz) and a sector transducer (2, 3.5, 5, 6.5, and 8 MHz). Each calf's thorax was systematically scanned using the sector transducer, which was positioned parallel to the ribs and moved between the 7th and 11th intercostal spaces (Buczinski et al., 2014). The scanning procedure was done with an 8.5 MHz linear probe directly applied to the thoracic region after spraying 70% isopropyl alcohol on the examination area to improve image clarity. To accommodate future field use, the area of interest was not clipped (Buczinski et al., 2013). Images were displayed on a portable device screen. Thoracic sonograms were assessed for the appearance of the pleurae, pulmonary tissue, and other criteria such as the presence of comet-tail artifacts, fluid in the pleural space, pleural fluid accumulation, and lung consolidation (Babkine and Blond, 2009).

Table (1). McGuirk's summary of the bovine respiratory disease (BRD) grading system developed by researchers at Wisconsin University, Clinical symptoms scoring as "0" are regarded clinically normal.

Score Parameter	0	1	2	3
Rectal temperature(°C)	37.7–38.2	38.3–38.8	38.9–39.3	≥39.4
Cough	None	single cough	repeated coughs or infrequent spontaneous cough	Repeated spontaneous coughs
Nasal discharge	Normal serous discharge	Small unilateral cloudy discharge	Bilateral cloudy or excessive mucus discharge	Copious bilateral mucopurulent discharge
Eye score	Normal	Small ocular discharge	Moderate bilateral discharge	Heavy ocular discharge
Ear score	Normal	Ear flick or head shake	Slight unilateral droop	Head tilt or bilateral droop

-A Calf with a score of 5 or higher was categorized as a BRD-afflicted calf.Notes. Each calf received a total WI score by summing the discharge from the nose, rectal temperature, cough scores, and the bigger of the two scores from discharge from the eye and head/ear carriage (Love et al., 2014)

Statistical analysis

Statistical analysis was performed using IBM SPSS Statistics version 20 (IBM Armonk, NY, USA). The data was statistically analyzed using independent sample t-test was performed to compare healthy with diseased animal as previously described by Bailey (2008). Values were represented as means ± standard error (SE). All differences were considered statistically significantly when $P<0.05$.

3. RESULTS

The calves affected by BRD exhibited signs of acute respiratory disease. These calves were diagnosed as BRD cases based on the criteria outlined in Table 2. The most commonly observed and earliest clinical symptoms included fever, varying levels of depression, shallow and rapid breathing, anorexia, and nasal discharge (Figure 1a). Additional signs included coughing, weight loss (Figure 1b), dyspnea with mouth breathing (Figure 1c), and conjunctival mucous membrane congestion with discharge from the eye (Figure 1d). Lung auscultation in BRD-affected calves exhibited a variety of aberrant sounds, such as loud wheezing, crackling, and wet rales. Frictional and increased vesicular breath noises were observed. Compared to the control group, BRD-affected calves showed substantial increases in temperature of the body, respiration, and pulse rate. (Table 3).

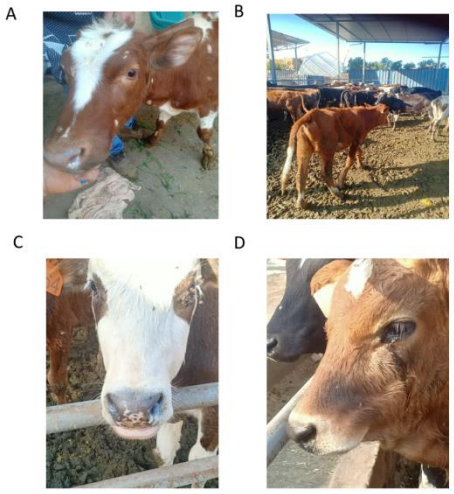

Figure 1. Clinical signs observed in BRD-affected calves

Table 2. Clinical criteria for diagnosing BRD in calves.

Score	No of Animals	Case definition	Severity
0	18 (45%)	Normal temperature, no cough, without nasal or ocular discharge and erected ear	Normal
4	10 (25%)	Temperature 38.3-38.8 caused a single cough, a tiny unilateral hazy discharge, minimal discharge from eye, and shaking of the ear flick or head.	Preclinical
8	8 (20%)	Temperature 38.9-39.3, caused frequent coughing or occasional spontaneous cough, Bilateral mucous discharge is hazy or profuse. Moderate bilateral nasal discharge and some unilateral droop.	Moderate respiratory signs
12	4 (10%)	fever ≥39.4, coughing, bilateral mucopurulent discharge, excessive eye discharge, and head tilt/droop.	Severe respiratory signs

Table outlines the clinical signs and scoring system used to categorize calves as BRD-affected, including parameters such as nasal discharge, respiratory effort, cough, body temperature, depression, and feed intake. Calves with a score of 5 or higher were diagnosed with BRD according to McGuirk (2008) clinical scoring system.

Table (3): Physical examination of apparently healthy and BRD affected calves.

Parameters	Control	BRD
Temperature (c°)	38.65±0.22 [a]	40.82±0.15[b]
Pulse rate (beat /min)	90.1±1.25 [a]	148.25±1.66 [b]
Respiration rate (breath/min)	30.6±1.41 [a]	55.88±1.78 [b]

Data represented as Mean ± SE. Superscript letters: Mean significance difference between groups on P<0.05.

Ultrasonographic examination:

Ultrasonographic examination of the thoracic region in calves from the control group demonstrated that normal lung tissue was not discernible due to the high air content, which impairs ultrasound transmission. However, comet-tail artifacts, characterized by echogenic bands that appeared parallel to the lung surface, were identified (Figure 2). In contrast, ultrasonography of calves affected by Bovine Respiratory Disease (BRD) revealed pleural effusion (Figure 3) along with lung consolidation. The consolidated lung areas were depicted as heterogeneous, hyperechoic regions (Figures 4 and 5), indicating a significant pathological change in lung parenchyma.

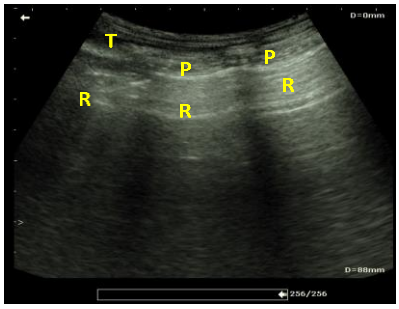

Figure 2: Ultrasonography of calf chest with normal lung.
Comet-tail reverberation artifacts (R) pulmonary pleura (P) the thoracic wall (TW).

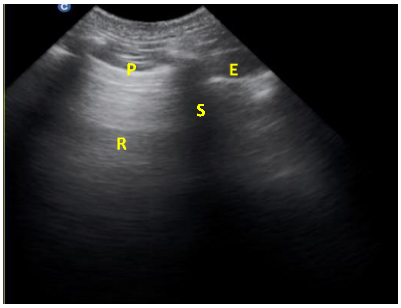

Figure3. Ultrasonography of calf chest with pleural effusion.
The pleural surface (P) appeared thick hyperechoic band. The pleural effusion (E) hypoechoic fluid represents pleural effusion. (R) Represent reverberation comet-tail artifacts

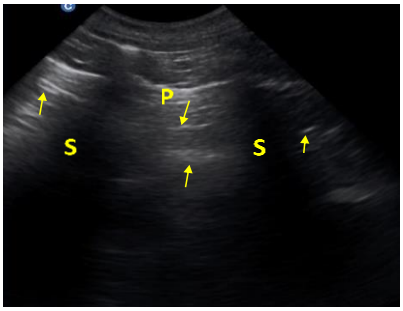

Figure4. Ultrasonography of calf chest with lung consolidation:
Consolidated lung tissue (yellow arrow) represented by a heterogeneous hyperechoic area. (p) Represent pleural surface appeared thick hyperechoic band. (S) represent rib shadow appeared anechoic

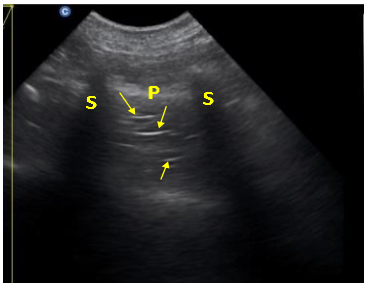

Figure 5. Ultrasonography of calf chest with lung consolidation.
Consolidated lung tissue (yellow arrow) represented by a heterogeneous hyperechoic area. (p)represent pleural surface appeared thick hyperechoic band. (S) represent rib shadow appeared anechoic.

4. DISCUSSION

The primary signs observed in BRD-affected calves include shallow, rapid breathing, which was likely caused by hypoxia, and, in some cases, dyspnea, which can be attributed to severe bronchiolitis and pneumonia that disrupt normal gas exchange. Nasal discharge was also commonly observed, potentially resulting from rhinitis. In response to hypoxia, heart rates were elevated in BRD-affected calves. Additionally, some calves exhibited painful coughing, depression, and a reduction in appetite. Lung auscultation revealed various abnormal sounds in the BRD-affected calves, such as loud wheezing, crackles, and moist rales, which are likely caused by inflammatory exudates. Frictional and exaggerated vesicular sounds were also heard. These clinical observations align with findings from previous studies by Ismael et al. (2017), Metwally et al. (2017), and Kumar et al. (2018).

In the present study, claves were transported before enrollment. The stress of transportation, introduction to a new environment, and mixing with other cattle contributed to their susceptibility to BRD, as these are recognized as important risk factors (Griffin et al., 2010; Zeineldin et al., 2019). Commingling of calves at sale barns further increases the risk of BRD, as these environments expose cattle to a wider range of pathogens and stressors compared to cattle purchased directly from farms or ranches (Amat, 2019).

Without a reference test, it is difficult to reliably categorize calves as BRD-positive or -negative. Identifying cases and controls without a gold standard is a typical difficulty in epidemiologic research. Case definitions based on numerous criteria are widely used and regarded as satisfactory as long as the standards are proper for the aims of the study (Coggon et al., 2005).

BRD scoring systems are most useful as diagnostic tools when estimations of the sensitivity and specificity of tests are available (Dohoo et al., 2010).

In healthy animals, ultrasonography of the lungs and pleura provides valuable reference information for the evaluation of thoracic diseases (Scott, 2013). In normal lungs, the presence of air prevents ultrasound waves from penetrating deeply into the lung parenchyma, resulting in a uniformly hyperechoic line on the ultrasound (Jung and Bostedt, 2004).

The use of handheld ultrasonography for diagnosing BRD takes approximately two minutes while the calf is restrained in a chute, adding significant value to veterinary

examinations in routine practice. Our ultrasonographic examination of BRD-affected calves, conducted one month after their arrival, revealed hypoechoic zones on the lung surface, along with thickened and distorted pleural lines, as well as pleural effusion. In some cases, hyperechoic circumscribed areas with anechoic centers were observed, indicative of lung parenchyma inflammation. Additionally, some calves showed evidence of lung consolidation. These findings are consistent with those reported by Buczinski et al. (2014) in calves with pneumonia.

5. CONCLUSIONS

In conclusion, this work highlights the value of combining clinical and ultrasonographic methods for the early diagnosis of BRD and suggests that lung scoring systems may enhance early diagnostic accuracy in feedlot settings.

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