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INCIDENCE OF RESPIRATORY DISEASES IN POST-WEANED HEIFERS ON A DAIRY FARM

Mihaela-Felicia SITARU[1*], Dragoș BÎRȚOIU[2], Manuella MILITARU[1]

[1]University of Agronomic Sciences and Veterinary Medicine of Bucharest, Faculty of Veterinary Medicine, 105 Splaiul Independentei, 5th District, 050097, Bucharest, Romania
[2]Vets for Cows SRL, District 5, Bucharest, Romania

*Corresponding author email: mihaelasitaru9514@gmail.com

Abstract

Bovine respiratory disease (BRD) is a leading cause of morbidity and mortality in cattle worldwide, significantly affecting both beef and dairy production systems. This article explores the epidemiology, risk factors, and management strategies linked to BRD. It emphasises the multifactorial nature of the disease, with key contributions from infectious agents like Mannheimia haemolytica, Pasteurella multocida, and viral pathogens, including infectious bovine rhinotracheitis (IBR). Environmental and management factors such as poor ventilation, high animal density, and stress during transport or weaning further increase the disease's incidence and complicate prevention efforts. The study shows that calves aged 2 to 4 months are most vulnerable, particularly during the post-weaning phase when immune defence is weakened, making them more susceptible to infection. Early detection through clinical observation and advanced diagnostic tools is essential, alongside preventive measures like vaccination, proper colostrum management, and stress reduction. The article highlights the significant economic impact of BRD, including slower growth, reduced productivity and higher veterinary costs, and advocates for integrated approaches that combine management, diagnostics, and vaccination to control the disease effectively and reduce long-term losses.

Key words: *Bovine Respiratory Disease, morbidity, mortality, economic impact.*

INTRODUCTION

Bovine respiratory disease (BRD) is a leading cause of illness and death in cattle worldwide, posing significant challenges to both beef and dairy production systems. Characterised by its multifactorial nature, BRD is influenced by an intricate interplay of infectious agents, environmental conditions, and management practices. Pathogens such as *Mannheimia haemolytica*, *Pasteurella multocida*, and the infectious bovine rhinotracheitis (IBR) virus are commonly implicated, often acting synergistically to exacerbate disease severity (Griffin et al., 2010; Fulton, 2009).

Environmental and management factors - such as overcrowding, inadequate ventilation, and stress from transport or weaning - further heighten susceptibility, particularly in calves aged 2 to 4 months during their vulnerable post-weaning phase (Taylor et al., 2010).

Early diagnosis, coupled with preventive strategies like vaccination, colostrum management, and stress reduction, has been emphasised as key to mitigating the disease's impact (Cusack et al., 2003; Chirase & Greene, 2001).

The economic repercussions of BRD are substantial, including reduced growth rates, diminished productivity, and increased veterinary expenditures, making it a priority for producers and veterinarians alike (Duff & Galyean, 2007).

The prevalence of BRD varies by farm; results from Bach (2011) also showed that 4 or more clinical BRD events before weaning doubled the odds that a calf would leave the herd before completing her first lactation. Lung consolidation (because of an inflammatory process) may also increase the risk of preweaning mortality and decrease the likelihood of pregnancy and first-lactation milk production (Buczinski et al., 2014; Buczinski et al., 2018; Dunn et al., 2018). Moreover, the upper respiratory resident bacterial population is known to play a crucial role in respiratory health (Caswell, 2014); however, the characterisation of its role in the pathogenesis of BRD, due to perturbations of the microbiota, is not well understood (McMullen et al., 2019). Early diagnosis is essential for control of BRD, as late identification leads to a greater risk of treatment failure, chronic disease, and a higher number of calves weaning with "dirty lungs" (i.e., lung consolidation; Ollivett, 2016). Clinical scoring systems facilitate recognition of calves with clinical BRD; however, these systems are insensitive to detecting calves with subclinical disease and do not reliably correlate with lung lesions identified at necropsy (Love et al., 2014; Maier et al., 2019; Berman et al., 2021).

Ultrasonography (US) has become an essential diagnostic tool for evaluating pulmonary abnormalities in calves with respiratory disease, providing a non-invasive, real-time assessment of lung pathology. Unlike traditional auscultation, which may be subjective, lung ultrasonography (LUS) offers a more objective and sensitive method to detect early and subclinical pulmonary lesions. Lung ultrasonography (US) is a non-invasive diagnostic tool that is highly accurate in identifying lung consolidation (Rabeling et al., 1998; Maier et al., 2019). Integrating clinical respiratory scoring (CRS) and US can improve detection of BRD by capturing subclinical cases that may be missed by physical examination alone (Maier et al., 2019; Cramer and Ollivett, 2019).

The purpose of this study is to assess the impact of bovine respiratory disease (BRD) on the health of dairy cows in a large-scale farm by using clinical examination, ultrasound, and necropsy. Microbiological evaluation was done for subjects with suspicion of bacterial infections at necropsy. It was retrospectively analysed data from 2023 and 2024 from a Romanian dairy farm with approximately 4,500 cattle.

MATERIALS AND METHODS

Farm and herd health management

The farm operates an intensive rearing system, with detailed records maintained for each animal, including primary data such as identification, health status, production parameters, and reproduction records. This dairy milks 1,100 Holsteins and has an average of 13,000 kg of milk/305 milking days. Environmental indicators, such as temperature, humidity, ventilation efficiency, and air quality, are also monitored regularly, focusing more on adult cows.

This study was conducted on 2710 calves. In this farm, sexed semen is predominantly used, leading to a greater number of female calves; this study is made on females. Case selection was based on everyone who has a respiratory clinical sign. All the calves included in the evaluation are kept outdoors in individual pens (Figure 1).

In 2023, out of a total of 1335 births, 1195 were female calves, accounting for 89.5% of the total. In 2024, from 1375 births, 1250 were females, 90.9% of the total.

The dataset was compiled from monthly farm records, encompassing critical metrics related to births, deaths, and respiratory health outcomes.

The primary data points included:

- reproductive metrics - total births, categorised into male and female calves;
- mortality data - total deaths, disaggregated by gender (e.g., female and male deaths) and age groups (0-20 days, 20-60 days, and > 60 days).

All data were recorded as part of routine farm management practices, with records maintained by trained personnel.

During gestation, all dams received vaccination against *E. coli*, rotavirus, and coronavirus to safeguard against neonatal diarrhoea. Newborn calves were fed about 4 litres of colostrum within their first 6 hours of life and were then placed in individual stalls lined with straw bedding.

At birth, calves are fed exclusively colostrum, verified by a refractometer to have a Brix value of at least 22. In our study, no female calf exhibited a serum protein level below 5. On the second day of life, along with blood sample collection to assess colostrum effectiveness, the calves were administered a dose of iron as a preventive measure.

Between January 2023 and January 2024, the vaccination protocol for calves was carefully designed to ensure comprehensive protection against respiratory and clostridial diseases:

- Intranasal vaccine (7-10 days of age): calves were administered an intranasal vaccine targeting Bovine Respiratory Syncytial Virus (BRSV) and Parainfluenza-3 Virus (PI3);
- Subcutaneous respiratory vaccine (14-21 days of age): a subcutaneous vaccine was given to target BRSV, PI3, and *Mannheimia haemolytica*

serotypes A1 and A6. A booster dose was administered approximately 28 days later to strengthen and prolong immunity;
- Clostridial vaccine (14-21 days of age): during the same period (ideally between 14-21 days), calves received a vaccine against *Clostridium perfringens*. A booster dose was provided about 4 weeks after the initial vaccination to ensure robust and lasting protection.

Since February 2024, the vaccination protocol has been updated, discontinuing the use of intranasal vaccination in favour of a subcutaneous vaccine. This new vaccine is administered starting on the 10th day of life and targets the same respiratory pathogens - Bovine Respiratory Syncytial Virus (BRSV) and Parainfluenza-3 Virus (PI3). The subcutaneous administration provides systemic protection, and a booster dose is given at 21 days of age to ensure robust and long-lasting immunity.

This revised protocol is implemented alongside the existing clostridial vaccination schedule. The clostridial vaccine, targeting *Clostridium perfringens* and related pathogens, is also administered during the 14-21-day window, with a booster approximately 4 weeks later.

Weaning and post-weaning management

Calves underwent a structured weaning and post-weaning protocol designed to minimise stress, ensure a smooth dietary transition, and optimise immunity development.

The management practices were as follows:

1. Weaning phase (60-65 days of age): the process included gradually reducing milk feedings over several days to minimise digestive and behavioural stress. During this phase, calves were introduced to dry feed, allowing them to adjust to a solid diet before complete weaning.
2. Post-weaning transition/grouping (66-80 days of age): after weaning, calves were moved into groups of three animals. Dry feed was the sole dietary component during this period, with rations formulated to meet the nutritional needs of growing calves. Feed intake was monitored daily to ensure proper adaptation. Calves were closely observed for signs of stress, such as reduced feed intake, weight loss, or respiratory symptoms, which could indicate disease or difficulty adapting to the new diet.
3. Integration into larger groups (81-100 days of age): calves were transitioned into larger groups of 30 animals to promote socialisation and prepare them for group housing in later production phases. Environmental conditions, such as ventilation, bedding quality, and stocking density, were optimised to reduce stress and the risk of respiratory infections during this period. Calves were regularly checked for signs of illness, with particular attention to respiratory symptoms, given the increased risk associated with larger group housing.
4. Vaccination Protocol: initial Herpesvirus Vaccination (100-120 days of age): All calves received their first dose of the vaccine for bovine herpesvirus. Booster Dose (130-150 days of age): A booster dose was administered one month after the initial vaccination to ensure robust and long-lasting immunity. Vaccination records were meticulously maintained to ensure compliance with the schedule.
5. Supportive care: additional measures, such as providing adequate bedding, access to clean water, and consistent handling practices, were implemented to reduce stress during weaning and group transitions. During the transition periods, calves received nutritional supplements, including vitamins and trace minerals, to support their immune system and overall health. This systematic approach aimed to reduce the risk of disease outbreaks, including respiratory infections, during critical growth periods. The combination of gradual dietary changes, group housing strategies, and timely vaccination ensured that calves developed strong immunity and adapted well to their production environment.

Clinical and paraclinical evaluations

Animals were sourced from a dairy farm and case selection was based on everyone who has a respiratory subclinical or clinical sign.

The subjects (2445 female calves) were monitored daily, and veterinary consultation was conducted whenever clinical signs of illness were observed. The clinical manifestations of respiratory disease in calves include coughing, nasal discharge, pyrexia, tachypnoea, dyspnoea, lethargy, and reduced feed intake. The calf’s body temperature was measured using a digital rectal thermometer, followed by pulmonary auscultation to assess respiratory sounds. Subsequently, thoracic ultrasonography was performed to evaluate lung health and detect potential lesions associated with respiratory disease. According to Feitoza et al. (2025), "TUS provides superior accuracy in detecting both subclinical and advanced respiratory conditions, particularly in high-risk populations".

Pulmonary ultrasonography was performed on 308 live animals using a specific ultrasound machine and probe, a 7.5 MHz linear transducer. Thoracic ultrasound examinations were conducted throughout the weaning period. Examinations were conducted bilaterally across defined thoracic zones following established protocols. Findings such as comet-tail artefacts, pleural irregularities, consolidations, and pleural effusions were recorded and classified according to severity. In ultrasonography, bovine respiratory disease (BRD) severity is classified based on lung lesions. In the mild stage, stage 1, minimal changes are seen, with slight consolidation or fluid that does not significantly impact lung function. In the moderate stage, stage 2, more consolidation and pleural effusion are present, with visible tissue changes. The severe stage, stage 3, shows significant lung damage with extensive consolidation and pleural effusion. In the advanced stage, stage 4, fibrosis or scarring may occur, along with abscesses or cavities. These findings were later correlated with post-mortem lesions to assess diagnostic accuracy.

Pathological evaluation

Necropsies were performed on 22 animals following standard procedures, with special attention to the respiratory system. Lungs, trachea, bronchi, and associated lymph nodes were collected and examined for pathological changes. Macroscopic examination of the lungs was conducted to assess the presence of lesions such as consolidation, pleuritis, abscess formation, and fibrin deposition. Lesions were scored based on distribution, severity, and type using a standardised grading system.

Microbiological evaluation

Samples were collected from 19 animals. Lung tissue and tracheal swabs were cultured on selective and non-selective media (e.g., blood agar, MacConkey agar) and incubated under aerobic and anaerobic conditions. Colony morphology, Gram staining, and biochemical tests were used for bacterial identification. These analyses were performed in an authorised laboratory.

RESULTS AND DISCUSSIONS

Clinical exam findings

In 2023, out of a total of 1195 females, 274 (22.9%) exhibited respiratory signs. When categorised by age, 28 (2.3%) affected females were between 0 and 20 days old, 30 (2.5%) were between 20 and 60 days old, and the majority, 216 (18.1%), were older than 60 days.

In 2024, in contrast, out of 1250 females, only 99 (7.9%) showed respiratory signs. The age distribution of affected females was as follows: 1 (0.08%) in the 0-20-day group, 6 (0.48%) in the 20-60-day group, and 92 (7.4%) in the over 60-day group.

Over the course of 2023 and 2024, a total of 308 cases of calves presenting with pulmonary pathology were documented beyond 60 days of age. The affected calves exhibited a range of clinical signs characteristic of respiratory disease, including nasal discharge in 54 cases (17.53%), coughing in 44 (14.29%), laboured breathing in 16 cases (5.19%), fever in 72 cases (23.38%), lethargy in 6 cases (1.95%), poor appetite in 18 cases (5.84%), ocular discharge in 45 cases (14.61%), abnormal lung sounds in 36 cases (11.69%), and weight loss in 86 cases (27.92%). These symptoms varied in severity, with some calves displaying mild nasal discharge and intermittent coughing, while others exhibited more pronounced respiratory distress and systemic illness. Fever was present in 72 cases (above 39.5°C), indicating an active inflammatory response. Lethargy and reduced feed intake were particularly notable in severely affected calves, contributing to weight loss and overall poor body condition. Calves that showed lethargy were most often hypothermic, even in the summer months, and when the temperature dropped below 38°C, all bodily functions progressively deteriorated, ultimately leading to death.

In auscultation, abnormal lung sounds, such as wheezing and crackles, were detected, suggesting lower respiratory tract involvement, possibly due to bronchopneumonia or interstitial pneumonia.

Laboured breathing and abnormal lung sounds suggest lower airway involvement, potentially due to pulmonary oedema, bronchoconstriction, or mucus accumulation. The presence of nasal and ocular discharge indicates excessive mucus production, which is a typical response to viral.
The progression to weight loss and poor body condition (Figure 6) highlights the metabolic toll of chronic inflammation and reduced nutrient absorption. In this study, we observed in 42.6% of cases a weight loss, comparing the body size of calves of the same age and from the same group.

Ultrasonographic findings

In this study, ultrasonographic examination of the thorax revealed several characteristic pulmonary abnormalities, including:
B-lines (Lung Rockets): These hyperechoic, vertical artefacts extending from the pleural line indicate interstitial syndrome, commonly associated with pulmonary oedema, inflammation, or early pneumonia (Figures 2 and 4).
These B-lines appeared also in several scanned calves, which over time did not materialise into clinical signs of respiratory pathology. Also appeared in all pulmonary cases (100%).
Pleural Irregularities and Thickening: Disruptions in the normally smooth pleural interface suggest pleuritis or consolidation, in agreement with findings from previous studies on bovine respiratory disease (Timsit et al., 2020). In our research, it appeared in 10.07% (31 cases) of all 308 cases.
Lung Consolidation (Figure 3): Hypoechoic, non-aerated lung regions were detected in calves with severe respiratory symptoms, indicating bronchopneumonia. We found lung consolidation in 6.82% (21 cases).
Pleural effusion: some cases exhibited anechoic fluid accumulation within the pleural space, consistent with secondary pleuritis or fibrinous pneumonia. We diagnosed 22 (7.15%) cases with pleural effusion from all calves older than 60 days with respiratory disease.
The severity of lung ultrasonographic findings correlated positively with clinical symptoms such as laboured breathing, coughing, fever, and abnormal lung sounds on auscultation. Calves exhibiting severe dyspnoea and lethargy were more likely to have extensive lung consolidation and pleural thickening, suggesting a more advanced disease state (Figures 3 and 5).

Pathological findings

Post-mortem examination identified lung consolidation in 21 (95.45%) of cases, with pleuritis and abscess formation observed in 20 cases (90.9%).
Histopathology revealed neutrophilic infiltration, alveolar damage, and fibrin deposition, consistent with severe respiratory disease. Lesion severity was significantly associated with clinical signs, emphasising the importance of early detection.
In post-mortem findings we found:
Lungs: lobar pneumonia in 14 cases (63.64%) with firm, dark red areas with fibrinous exudates in cranio-ventral lobes, suggesting acute bacterial infection; bronchopneumonia we get it in 6 cases (27.28%); purulent exudate and inflammation around bronchi, likely caused by *Mannheimia haemolytica* or *Pasteurella multocida*; interstitial pneumonia 1 case (4.55%): diffuse congestion, oedema, and thickened septa;
Trachea and bronchi: tracheitis with mucosal congestion with mild catarrhal exudate; bronchitis with mucus accumulation and haemorrhagic exudates, indicative of secondary bacterial infection, presented in 6 cases (27.28%);
Pleura: pleuritis consisting of fibrinous exudate and mild adhesions, commonly secondary to bacterial pneumonia, presented in 7 cases (31.82%).

Comparative analysis of pulmonary ultrasonography with necropsy findings

Pulmonary ultrasonography revealed abnormalities in all of the animals with clinical signs of respiratory diseases, including lung rockets`, B lines (Figure 4), pleural effusions, and pulmonary consolidations (Figure 5).
These findings showed a high correlation with post-mortem lesions, with a sensitivity of (100%), and to calculate specificity, a control group of healthy calves confirmed lesion-free on post-mortem would be required.

Microbiological findings

Bacterial cultures identified *Mannheimia haemolytica* in 2 cases, *Pasteurella multocida* in

4 cases, and *Histophilus somni* in 4 cases. Not for all the cases could we identify the bacteria. The pathogenicity could not be determined for all specimens.

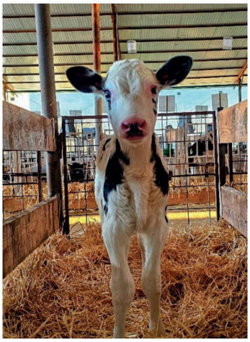

Figure 1. A young, healthy calf with his own pen

Figure 2. Post-mortem appearance of the lungs of a calf with ante-mortem lung ultrasound multiple B-lines (lung rockets), indicating alveolar-interstitial syndrome

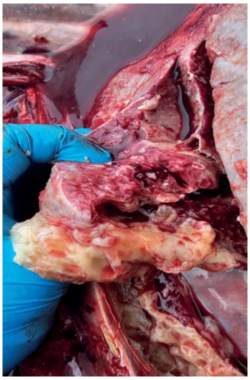

Figure 3. Following the post-mortem examination, this finding is consistent with lung consolidation

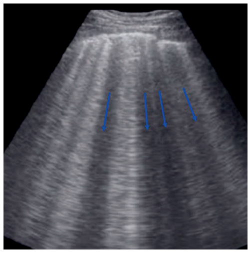

Figure 4. Ultrasonographic exam with B-lines (lung rockets) found in the early stages of pneumonia

Figure 5. Following the necropsy examination, fluid was identified in the thoracic cavity, along with fibrin and pleuritis in the calf

Figure 6. Two calves of the same age group exhibited notable differences in growth. The left calf has a documented history of respiratory diseases, while the right calf has no such medical records

Our findings align closely with prior research on BRD and other respiratory infections in calves. Nasal discharge and coughing are among the earliest clinical indicators of respiratory disease, often progressing to abnormal lung sounds and weight loss if left untreated. Similarly, Lisuzzo et al. (2024) emphasised that fever and respiratory distress correlate strongly with bacterial pneumonia, particularly in cases involving *Mannheimia haemolytica* or *Pasteurella multocida*.

However, some discrepancies exist between our findings and previous reports. While Wilson et al. (2017) found that severe weight loss was uncommon in BRD cases managed with early antibiotic intervention, our study observed significant weight loss in some calves, likely due to delayed treatment initiation and reduced feed intake. This suggests that early detection and prompt therapeutic intervention play a crucial role in mitigating disease severity and economic impact.

According to Bowen et al. (2021), calves with a history of respiratory disease before weaning exhibit significantly lower weaning weights and reduced lifetime productivity, emphasising the need for early intervention and preventive measures.

Environmental monitoring helps correlate conditions that increase the risk of respiratory diseases in calves. Studies have shown that housing calves outdoors, particularly in individual hutches with proper shelter, is associated with a decreased risk of respiratory diseases compared to indoor group housing.

Outdoor housing provides better ventilation and reduces exposure to airborne pathogens, which are common risk factors for respiratory issues in calves. Like on this farm, all the calves are housed outdoors. This study highlights the significant role of pulmonary ultrasonography as a valuable diagnostic tool in detecting and monitoring respiratory disease in cattle. The correlation between ultrasonographic findings and post-mortem examinations confirms its reliability in assessing lung pathology. The identification of bacterial and possible viral pathogens reinforces the necessity of targeted antimicrobial and preventive strategies. Implementing ultrasonography in routine veterinary practice can enhance disease management, reduce treatment failures, and improve animal welfare.

CONCLUSIONS

The clinical signs observed, including nasal discharge, coughing, fever, and weight loss, align with previous studies on BRD, underlining the importance of early detection, proper vaccination, and improved management strategies to mitigate disease impact.

Ultrasonographic examination of the lungs proved to be a valuable, non-invasive diagnostic tool for detecting pulmonary pathology in calves with respiratory disease. Findings such as B-lines, pleural irregularities, lung consolidation, and pleural effusion provided objective evidence of disease severity, complementing clinical assessment.

Following an integrated analysis of the results from clinical exam, ultrasound, necropsy, and microbiology, measures were implemented to adjust the vaccination protocol, leading to a reduction in the incidence of bovine respiratory disease (BRD). A notable decrease in respiratory disease prevalence from 2023 to 2024, dropping from 22.9% to 7.9%. The reduction was observed across all age groups, with the most significant decline occurring in females older than 60 days (from 18.1% in 2023 to 7.4% in 2024). This downward trend suggests a potential improvement in health management or environmental conditions influencing respiratory disease incidence due to changes in the vaccination protocol.

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