

Pathological Studies on Mortality of Dairy Calves and the Associated Risk Factors

Sunil Malik¹, Shyama N. Prabhu^{1*}, Ajay Pratap Singh², Neeraj Kumar Gangwar¹, Ambika Arun², Rahul Singh Arya¹, Desh Deepak Singh¹

ABSTRACT

This study analyzed mortality causes in 27 calves (0-6 months). Most deaths occurred in neonates (0-3 months), primarily from pneumonia (various forms) and enteritis. Bacterial isolates included *E. coli*, *Salmonella* (enteritis), *Staphylococcus*, and *Klebsiella* (pneumonia). Parasites (*Coccidia*, *Toxocara*, *Theileria*, etc.) were also identified. Pneumonia and enteritis were identified as the predominant pathological conditions. Pneumonia was manifested in various forms, including bronchopneumonia, interstitial pneumonia, and granulomatous pneumonia. Various types of enteritis seen were catarrhal, necro-haemorrhagic, haemorrhagic, necrotic, and proliferative. Mortality correlated with delayed colostrum intake (>2 h), poor ventilation, and inadequate deworming, but not with birth weight, gender, or herd size. While bacterial and parasitic causes were confirmed, viral agents were not investigated. Larger studies including viral screening are needed for comprehensive understanding.

Key words: Calf mortality, Enteritis, Pneumonia, Risk factors.

Ind J Vet Sci and Biotech (2025): 10.48165/ijvsbt.21.5.14

INTRODUCTION

India possesses one of the largest livestock populations globally, with dairy production being a cornerstone of its agricultural economy, making it the world's leading milk producer. The early survival and health of calves are pivotal to the sustainability and profitability of cattle farming, as high mortality rates directly compromise herd expansion, productivity, and economic returns (Winder *et al.*, 2016). Calf mortality, particularly within the initial weeks to months of life, remains a significant challenge for farmers and veterinarians worldwide, driven by multifactorial causes involving environmental, nutritional, infectious, and genetic factors (Uetake, 2013). Addressing these determinants is critical for implementing effective interventions to enhance calf welfare and reduce economic losses. Neonatal calf diarrhea (NCD) and bovine respiratory disease (BRD) are the leading infectious causes of mortality, with pathogens such as *Escherichia coli*, Rotavirus, Coronavirus, *Cryptosporidium* spp., *Pasteurella multocida*, *Mannheimia haemolytica*, and *Mycoplasma bovis* frequently implicated (Kochewad *et al.*, 2013). The susceptibility of calves to these infections is exacerbated by their immature immune systems, which rely heavily on passive immunity acquired through timely and adequate colostrum intake. Failure in colostrum transfer significantly heightens disease vulnerability and mortality risk (Godden *et al.*, 2019).

Accurate diagnosis of calf mortality remains challenging due to multiple interacting risk factors. The economic impact is severe, reducing farm profits and hindering livestock sector growth, particularly in developing countries where limited veterinary services and poor management practices sustain high

¹Department of Veterinary Pathology, College of Veterinary Science & Animal Husbandry, DUVASU, Mathura-281001, UP, India

²Department of Microbiology, College of Veterinary Science & Animal Husbandry, DUVASU, Mathura-281001, UP, India

Corresponding Author: Dr. Shyama N. Prabhu, Assistant Professor, Department of Pathology, College of Veterinary Science & Animal Husbandry, DUVASU, Mathura Mathura-281001, UP, India. e-mail: kris_shyama@yahoo.co.in

How to cite this article: Malik, S., Prabhu, S. N., Singh, A. P., Gangwar, N. K., Arun, A., Arya, R. S., & Singh, D. D. (2025). Pathological Studies on Mortality of Dairy Calves and the Associated Risk Factors. *Ind J Vet Sci and Biotech*, 21(5), 69-75.

Source of support: Nil

Conflict of interest: None

Submitted 29/06/2025 **Accepted** 28/07/2025 **Published** 10/09/2025

mortality rates. Since calf mortality reflects overall herd health and farm management quality, understanding its leading causes - especially gastrointestinal and respiratory diseases - is vital for developing effective control strategies. Bacterial infections contribute significantly to deaths while increasing treatment costs and productivity losses. This study specifically investigates bacterial pathogens in calf diarrhea and respiratory diseases, along with key management and environmental risk factors. The findings will guide targeted interventions to reduce mortality, improve herd health, and promote sustainable dairy farming.

MATERIALS AND METHODS

The study was conducted from December 2023 to November 2024 on 27 calf carcasses (22 cattle and 5 buffalo calves) aged 0-6 months, divided into two age groups: Group 1 (0-3

months; n=22) and Group 2 (4-6 months; n=05). Samples were collected from the University Livestock Farm Complex and Veterinary Clinical Complex of DUVASU, Mathura (India), along with nearby private gaushalas. Detailed records were maintained for each case, including breed, age, gender, identification number, dam parity, herd size, housing type, birth weight, colostrum intake timing, deworming status, and clinical history. Complete necropsy examinations were performed with evaluation of gross pathological changes in all major organs, including alterations in size, shape, color, consistency, and presence of any pathological lesions. Wherever required appropriate samples, such as impression smears, blood smears, sterile swabs were collected aseptically for further microbiological studies. Tissue specimens (preserved in 10% neutral buffered formalin) were collected for routine histopathological studies.

For parasitological analysis, intestinal contents were examined using direct smear microscopy and fecal flotation to detect parasites and eggs. Haematological evaluation was performed by preparing direct smears from jugular vein blood collected immediately before post-mortem, which were subsequently stained with Giemsa stain for identification of haemoparasites. Bacterial isolation and identification were systematically conducted from suspected tissue samples using standard microbiological procedures.

RESULTS AND DISCUSSION

Gross and Histopathology Findings

Out of the 27 carcasses examined, respiratory lesions were observed in 17 cases. Common respiratory findings included pulmonary congestion, pulmonary edema, and pneumonia (Fig. 1). There were nine cases of pneumonia presenting as bronchopneumonia (6/9), interstitial (2/9), or granulomatous types (1/9) (Fig. 2). Pulmonary congestion was observed in seven cases, while pulmonary edema was noted in one case. Histologically, bronchopneumonia was characterized by eosinophilic edema fluid in the alveolar and bronchiolar lumina, along with inflammatory cell infiltration. Interstitial pneumonia exhibited thickened alveolar walls infiltrated with neutrophils and red blood cells. Granulomatous pneumonia presented with multifocal granulomas in the lung parenchyma, consisting of caseous necrotic centers surrounded by epithelioid cells, macrophages, lymphocytes, and giant cells, with peripheral fibrous tissue. Pneumonia has been identified as one of the leading causes of death in young dairy calves (Mansour *et al.* 2014). Of the different types of pneumonia in calves, *viz.*, suppurative bronchopneumonia, fibrinous bronchopneumonia, interstitial pneumonia, granulomatous pneumonia and embolic pneumonia (Pancieria and Confer, 2010), the most common type is bronchopneumonia in the domestic animals (Lopez and Martinson, 2017).

Additionally, enteritis was a notable gross lesion, identified in 17 cases. The affected intestines exhibited thin

walls, gas distension, and congested serosal layers. Gross examination revealed different forms of enteritis, including catarrhal, haemorrhagic, and diphtheritic types (Fig. 3). The catarrhal and necro-haemorrhagic types were seen in six cases each (6/17), haemorrhagic enteritis in three (3/17), and necrotic and proliferative enteritis in one case (1/17). The proliferative form showed crypt hyperplasia and mucosal neutrophil infiltration (Fig. 4).

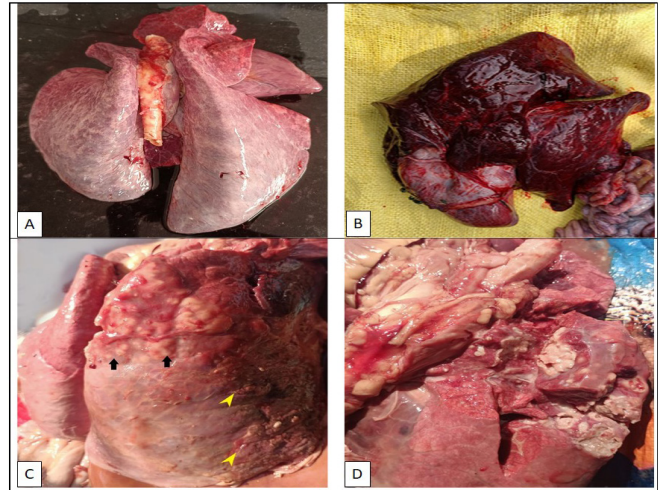


Fig. 1: Pathological findings in calf lungs: (A) Non-collapsible, edematous lungs with rounded margins; (B) Diffuse congestion and consolidation in a 2-month-old female calf; (C) Focal caseous necrosis (arrow) and pleuritis (arrowheads) in a 2-month-old male calf; (D) Transverse section showing multifocal granulomas with caseous necrosis.

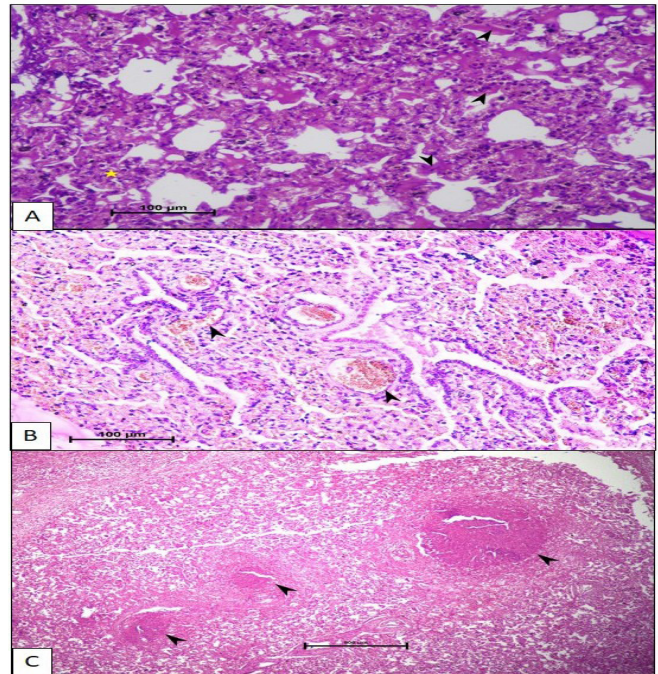


Fig. 2: Histopathological lung findings: (A) Interstitial pneumonia with thickened alveolar septa (★) and hyaline membranes (arrowheads); (B) Vascular congestion (arrowheads), hemorrhage, and neutrophilic infiltration (H&E, ×200); (C) Granulomas with central caseous necrosis (arrowheads), surrounded by macrophages, epithelioid cells, and fibrous tissue (H&E, ×40).

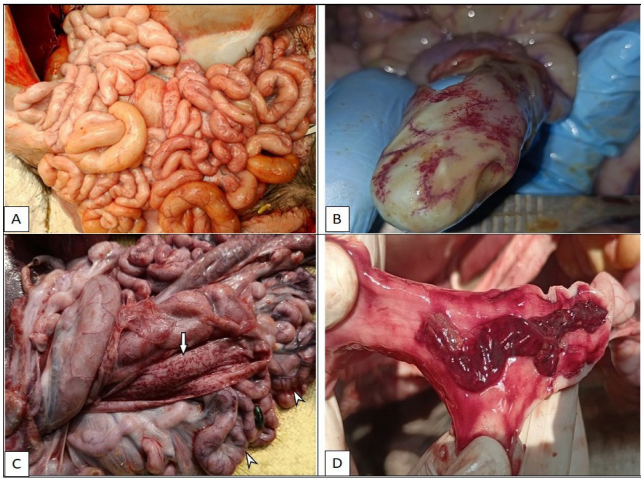


Fig. 3: (A) Markedly distended and congested intestines in a 6-month-old calf; (B) Mucosal haemorrhage with arboreal pattern; (C) Serosal congestion (arrowheads) and linear mucosal haemorrhages (arrow) in a 1-month-old female calf; (D) Intestinal lumen containing blood clots in a 20-day-old female calf.

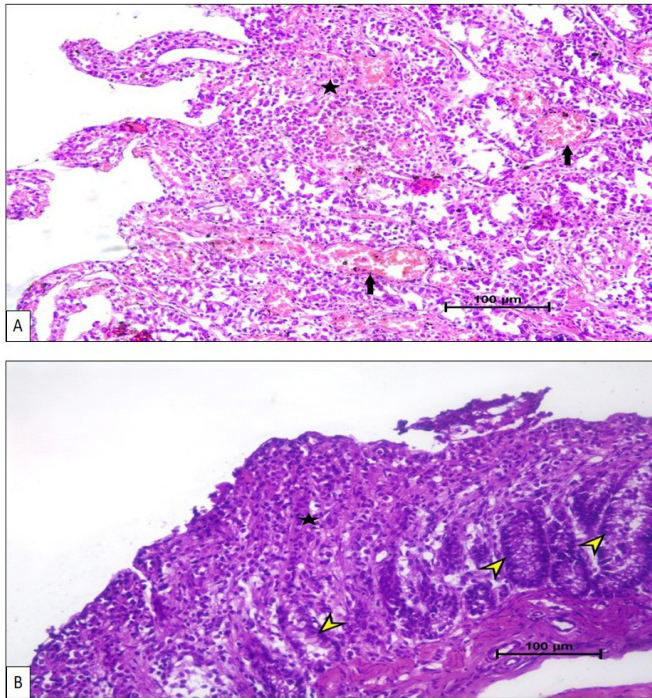


Fig. 4: Histopathological intestinal lesions: (A) Congested mucosa (arrows) with haemorrhages (★), villous shortening, epithelial necrosis, and diffuse inflammatory infiltration; (B) Catarrhal enteritis showing villous fusion (★), inflammatory infiltrates, and goblet cell hyperplasia (arrowheads) (H&E, ×200).

Diarrhea is another most common disease reported in calves up to three months old (Svensson *et al.*, 2003). Several infectious and non-infectious causes have been implicated in the calf diarrhea and associated enteritis (Cho and Yoon, 2014). The various pathological types of enteritis commonly encountered in the calves include catarrhal enteritis, fibrinonecrotic enteritis, haemorrhagic enteritis, necrotic enteritis etc (Morris *et al.*, 2011; Heller and Chigerwe, 2017).

Parasitological Findings

Table 1 summarizes the prevalence of various intestinal parasites across different age groups (0-6 months). *Eimeria* spp. was the most frequently detected parasite (47.06%), followed by *Toxocara* spp. (11.76%), *Trichuris* spp. (5.88%), and *Strongyloides* spp. (5.88%). Histopathological examination revealed coccidial oocysts within the enterocytes of intestinal villi, indicating coccidiosis. Additionally, *Trichuris* spp. worms were found deeply embedded in the colonic mucosa between crypts (Fig. 5). Blood smear examination showed piroplasms or the Koch blue bodies of *Theileria* spp. in four cases. Microscopic examination of a peripheral blood smear collected at post-mortem from a six-month-old female calf revealed the presence of trypanosomes (Fig. 6).

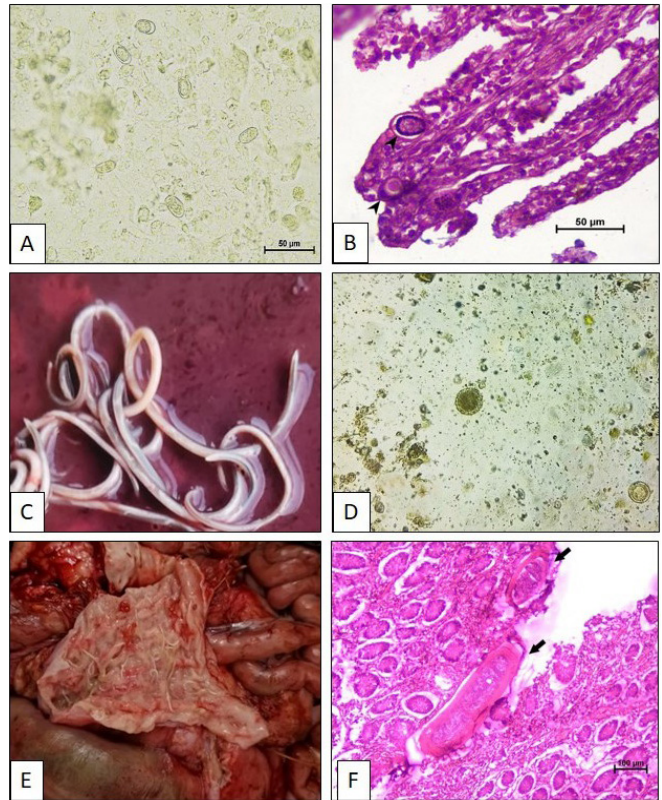


Fig. 5: (A). Intestinal scrapings showing numerous unsporulated oocysts, wet mount 400x. (B). Villous tips showing various stages of the coccidia (arrow heads) on higher magnification H&EX 400. (C). Adult *Toxocara vitulorum* seen in intestinal contents. (D). *Toxocara vitulorum* egg which is rounded with thick-rough wall, wet mount 400x. (E). Numerous whip worms, *Trichuris* spp. in the colon of a two month old female calf, (F). Histological section of colon showing *Trichuris* spp. (arrows) embedded deep in the intestinal mucosa between the crypts H&E X100.

Young animals, particularly those under one year of age, are highly susceptible to coccidial infections, with *Eimeria* spp. oocyst sporulation and transmission heavily influenced by environmental factors such as poor sanitation, humidity, organic matter accumulation, and temperature fluctuations (Lopez-Orsorio *et al.*, 2020). Studies report a 39.7% prevalence of *Eimeria* spp. in calves, alongside co-infections with *Strongyloides papillosus*, *Toxocara vitulorum*, and *Trichuris*

spp., emphasizing the significant parasitic burden in this age group (Olivares-Muñoz *et al.*, 2022; Wymann *et al.*, 2008). These findings highlight the critical need for improved management practices to reduce infection risks in young livestock.

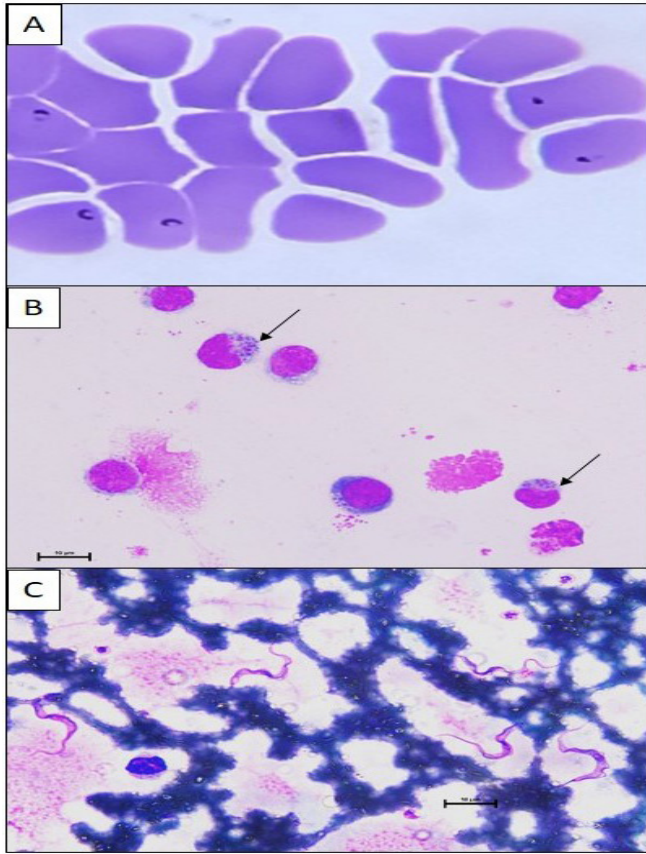


Fig. 6: (A). Piroplasms seen in the RBCs of blood smear prepared from a freshly dead calf with a history of fever. (B). Koch blue bodies in the blood smear in a freshly dead calf with the history of fever. (C). Blood smear showing numerous trypanosomes, Giemsa stain 1000X

Table 1: Prevalence of intestinal parasites in calves by age group (0-6 months)

| Parasites | Age group (months) | | Total n=17 | % |
|---------------------------|--------------------|-----|------------|-------|
| | 0-3 | 4-6 | | |
| <i>Eimeria</i> spp. | 7 | 1 | 8 | 47.06 |
| <i>Toxocara</i> spp. | 2 | 0 | 2 | 11.76 |
| <i>Trichuris</i> spp. | 1 | 0 | 1 | 5.88 |
| <i>Strongyloides</i> spp. | 1 | 0 | 1 | 5.88 |
| No parasitic eggs | 4 | 1 | 5 | 29.42 |

Microbiological Findings

The sterile swab samples collected from suspected lesions underwent pre-enrichment in buffered peptone broth, followed by sub-culturing on McConkey's agar to differentiate lactose-fermenting and non-lactose-fermenting colonies in the laboratory. Gram staining was performed to determine bacterial staining characteristics. Out of 17 animals exhibiting enteritis, seven bacterial isolates were recovered,

including *Escherichia coli* (n=4, 23.52%) and *Salmonella* spp. (n=3, 17.6%). The majority of affected animals were aged 0-3 months, with only one exception. These findings aligned with previous studies reporting a high prevalence of *E. coli* (75-80%) and a lower but notable presence of *Salmonella* spp. (5-18%) in diarrheic calves, with variations attributed to geographical location, farm management practices, and herd size (Hemashenpagam *et al.*, 2009; El-Seedy *et al.*, 2016).

A total of seven bacterial isolates were recovered from 17 dead calves showing the presence of lung lesions like pulmonary congestion, consolidation, pneumonia or granulomas (Fig. 7). These bacteria included *Staphylococcus* spp. (02/17, 11.76%), *Klebsiella* spp. (03/17, 17.65%) and *E. coli* (02/17, 11.76%). *Staphylococcus* spp. was isolated from two cases of hepatic abscess. Earlier studies have reported that the most predominant bacterial pathogens retrieved from lungs in pneumonic calves were *E. coli*, *P. vulgaris*, *S. aureus* and *Klebsiella pneumoniae* (Mohsen and Dapgh, 2007; Algammal *et al.*, 2020).

The present study identified bacterial and parasitic pathogens as primary etiological agents responsible for the observed pathological alterations in calf mortality cases. While these findings provide significant insights, the potential contribution of viral pathogens was not investigated and therefore cannot be excluded.

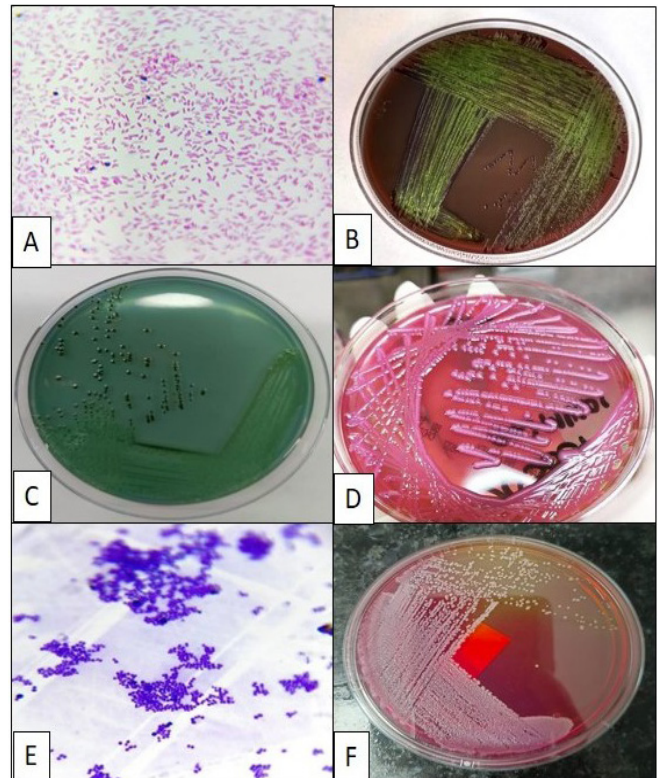


Fig. 7: (A). Pink colored rods of bacteria on Gram's staining. (B). Greenish metallic sheen of bacterial colonies on EMB agar. (C). Black colonies of Salmonella on Hektoen Enteric (HE) agar. (D). Large mucoid and red colonies of Klebsiella on Mc Conkey agar (E). Staphylococci seen as Gram positive cocci in bunches or clusters. (F). Yellow coloured colonies of Staphylococcus spp. on mannitol salt agar.



Table 2: Animal details and various risk factors studied for calf mortality

| Age (month) | Sex | Breed | History | Herd size (nos.) | Birth wt (kg) | Colostrum ingestion (h) | Deworm-ing status | Housing | Respiratory problem | Gastro-intesti-nal problem |
|-------------|------|----------------|--------------------------------------|------------------|---------------|-------------------------|-------------------|-------------------|------------------------------|--------------------------------|
| 06 | F | Hariana | Diarrhoea | 15 | 30 | 1 | no | open, mud | Interstitial pneumonia | Necro-haemor-rhagic enteritis |
| 02 | F | Hariana | Diarrhoea | 60 | 30 | 2 | no | covered, concrete | Bronchopneumonia | Necro-haemor-rhagic enteritis |
| 03 | F | H.F. | Bloody diarrhoea | 50 | 25 | 1 | no | open, mud | -- | Necro-haemor-rhagic enteritis |
| 05 | Male | Murrah | Respiratory distress | 10 | 35 | 1 | no | covered, concrete | Bronchopneumonia | Catarrhal en-teritis |
| 03 | F | Hariana | Fever, diarrhoea | 100 | 30 | 1 | no | covered, concrete | -- | Catarrhal enteritis |
| 02 | F | Sahiwal | Fever | 50 | 25 | 1 | no | open, mud | -- | Catarrhal en-teritis & colitis |
| 04 | F | Hariana | High tick infestation | 50 | 25 | 4 | yes | covered, mud | Bronchopneumonia | -- |
| 06 | F | Hariana | Fever | 15 | 26 | 3 | yes | covered, concrete | Pulmonary edema | Proliferative enteritis |
| 16 days | F | Sahiwal | Fever | 20 | 32 | 2 | no | covered, mud | Interstitial pneumonia | Necrotic en-teritis |
| 02 days | F | Sahiwal | Resp. distress, recur-rent diarrhoea | 50 | 30 | 2 | no | covered, mud | bronchopneumonia | -- |
| 2.5 | Male | Hariana | Greenish diarrhoea | 10 | 35 | 2 | no | covered, concrete | Pulmonary congestion | -- |
| 2.5 | Male | Sahiwal | Muscle tremors | 50 | 25 | 4 | yes | open, mud | Pulmonary congestion | -- |
| 02 | Male | Hariana | Recurrent diarrhoea | 50 | 30 | 1 | no | open, concrete | -- | Necro-haemor-rhagic enteritis |
| 01 | F | Hariana | Respiratory distress | 50 | 30 | 1 | no | covered, mud | Pulmonary congestion | -- |
| 10 days | Male | H.F. | Fever, Respiratory distress | 50 | 25 | 4 | no | open, mud | Pulmonary congestion & edema | Necro-haemor-rhagic enteritis |
| 03 | Male | Sahiwal | Fever | 50 | 35 | 2 | no | open, mud | -- | Necrohaemor-rhagic enteritis |
| 03 | Male | Sahiwal | Fever | 50 | 32 | 1 | no | open, concrete | -- | Catarrhal en-teritis |
| 05 | Male | Sahiwal | Respiratory distress | 25 | 30 | 2 | no | covered, concrete | BronchoPneumonia | -- |
| 02 | Male | Murrah | Diarrhoea, fever | 50 | 30 | 2 | no | concrete, covered | Granulomatous pneu-monia | -- |
| 02 | Male | Indige-nous ND | Respiratory distress | 50 | 35 | 3 | yes | covered, mud | Pulmonary congestion | -- |
| 02 | Male | Hariana | Respiratory distress | 30 | 25 | 4 | yes | covered, mud | Pulmonary congestion | -- |
| 02 | F | Indige-nous ND | Diarrhoea | 20 | 26 | 4 | yes | open, concrete | -- | Haemorrhagic Enteritis |
| 1.5 | F | Murrah | Mud colour faeces | 20 | 33 | 3 | no | covered, concrete | -- | Catarrhal En-teritis |
| 2.5 | F | Crossbred | Diarrhoea, Resp. distress | 35 | 27 | 5 | yes | covered, concrete | -- | Catarrhal en-teritis |
| 1.5 | F | Murrah | Fever, nasal dis-charge | 50 | 26 | 2 | no | open, concrete | BronchoPneumonia | Haemorrhagic enteritis |
| 20 days | F | Murrah | Dysentery | 2 | 24 | 3 | no | open, mud | -- | Haemorrhagic enteritis |
| 10 days | Male | Sahiwal | Hypothermia | 20 | 18 | 2 | no | open, concrete | Pulmonary congestion | -- |

Risk Factors

The various risk factors studied are given in Table 2. These variables were critically analyzed to determine their potential correlation with mortality rates, providing valuable epidemiological data for developing targeted intervention strategies.

The epidemiological analysis revealed that the majority of affected animals (81.48%) belonged to the 0-3 month age group, with peak mortality occurring during the neonatal period (first week of life). These findings aligned with established literature demonstrating heightened vulnerability during early postnatal development (Windeyer *et al.*, 2014), when immature immune function and transitional physiology predispose calves to increased disease susceptibility. Regarding breed distribution, mortality cases were predominantly observed in Harijana (40.9%), Sahiwal (36.4%), and HF crossbred (13.6%) cattle, along with nondescript varieties (9.1%). All five cases of buffalo calves involved Murrah-breed. This breed-specific trend aligned with Uttar Pradesh's livestock demographics, where Harijana and Sahiwal are the most common cattle breeds (Singh *et al.*, 2020).

Analysis of birth weight parameters revealed that the majority of animals studied fell within the normal physiological range. The relationship between birth weight and health outcomes remains a subject of scientific debate. While some studies demonstrate that deviations from mean birth weight, particularly low birth weight, correlate with increased susceptibility to digestive disorders and higher pre-weaning mortality (Urie *et al.*, 2018), other investigations have reported minimal association between birth weight and disease incidence (Glover *et al.*, 2019). These contradictory findings suggest that birth weight alone may not serve as a reliable prognostic indicator, and its clinical significance likely depends on interactions with other management and environmental factors.

The study found no significant sex predilection in calf mortality, with both male and female calves being similarly affected. Existing literature presents conflicting evidence regarding sex-related susceptibility patterns. While some studies report no association between sex and mortality rates (Khan and Khan, 1996), others demonstrate higher mortality in male calves during both the perinatal and neonatal periods (Mee *et al.*, 2008). However, to draw more definitive conclusions regarding sex-related mortality patterns, future studies incorporating larger sample sizes across diverse geographical regions and breeds would be valuable. Most of the animals were from the herd of size 20-100 animals. Calf mortality has been found to be positively correlated with the herd size in many previous studies (Gulliksen *et al.*, 2009).

Of the 17 enteritis cases observed, eight calves were housed on mud flooring while nine were maintained on concrete flooring, revealing no significant association ($p > 0.05$) between floor type and diarrheal incidence. However, analysis of respiratory lesions showed that 11 of 17

affected calves were housed under closed roofing systems compared to six in open housing, suggesting increased respiratory disease risk in confined environments ($p < 0.05$). These findings aligned with existing literature. Outdoor housing may compromise welfare during extreme weather conditions. Comparative studies indicate indoor group housing associated with higher respiratory disease incidence, but lower diarrheal cases relative to outdoor systems (Earley *et al.*, 2004). Particularly in closed sheds, inadequate ventilation has been strongly correlated with respiratory pathologies (Woolums *et al.*, 2009). Current literature shows mixed evidence on optimal housing systems, indicating management may matter more than structure. Our findings highlight that hygiene and farm management are crucial for disease prevention, regardless of housing type.

While previous studies indicate an inverse relationship between dam parity and calf mortality (Van John, 2012), our findings showed no significant association ($p > 0.05$), with most mortalities occurring in calves from multiparous dams. Optimal colostrum intake within the first 2 h postpartum is critical for passive immunity transfer (McGuirk and Peek, 2014). Our data revealed suboptimal practices, with only 29.6% (8/27) of calves receiving timely colostrum administration, potentially contributing to increased disease susceptibility in the study population.

The study identified inadequate parasite control measures, with 74.1% (20/27) of calves lacking proper deworming. While pastured calves require early anthelmintic intervention due to environmental exposure (Kimeli *et al.*, 2020), optimal deworming protocols for zero-grazed systems remain to be established. This finding highlights the need for evidence-based parasite management strategies tailored to different production systems.

CONCLUSION

The study identified key risk factors for calf mortality: young age (0-3 months), delayed colostrum intake (>2 h), poor ventilation in closed housing, and inadequate deworming. Bacterial pathogens (*E. coli*, *Salmonella* spp., *Klebsiella* spp., *Staphylococcus* spp.) were major causes of respiratory and enteric diseases. However, the potential role of viral agents in calf mortality remains unexplored in this investigation, representing an important knowledge gap that warrants dedicated virological studies in future research. No significant links were found between mortality and gender, dam parity, birth weight, breed, or herd size, though larger studies are needed. To reduce mortality, focus on timely colostrum feeding, proper ventilation, deworming, hygiene, and pathogen surveillance (bacterial and viral) is needed.

ACKNOWLEDGEMENT

The authors are highly thankful for the indispensable assistance and support provided by the Vice Chancellor, DUVASU, Mathura.



REFERENCES

- Algammal, A.M., El-Kholy, A.W., Riad, E.M., Mohamed, H.E., Elhaig, M.M., Yousef, S.A.A., Hozzein, W.N., & Ghobashy, M.O. (2020). Genes encoding the virulence and the antimicrobial resistance in enterotoxigenic and shiga-toxigenic *E. coli* isolated from diarrheic calves. *Toxins*, 12(6), 383.
- Cho, Y.I., & Yoon, K.J. (2014). An overview of calf diarrhea: Infectious etiology, diagnosis and intervention. *Journal of Veterinary Science*, 15(1), 1-17.
- Earley, B., Murray, M., Farrell, J.A., & Nolan, M. (2004). Rearing calves outdoors with and without calf jackets compared with indoor housing on calf health and live-weight performance. *Irish Journal of Agricultural and Food Research*, 43(1), 59-67.
- El-Seedy, F.R., Abed, A.H., Yanni, H.A., & Abd El-Rahman, S.A.A. (2016). Prevalence of *Salmonella* and *E. coli* in neonatal diarrheic calves. *Beni-Suef University Journal of Basic and Applied Sciences*, 5(1), 45-51.
- Glover, I.D., Barrett, D.C., & Reyher, K.K. (2019). Little association between birth weight and health of preweaned dairy calves. *Veterinary Record*, 184(15), 477-477.
- Godden, S.M., Lombard, J.E., & Woolums, A.R. (2019). Colostrum management for dairy calves. *Veterinary Clinics: Food Animal Practice*, 35(3), 535-556.
- Gulliksen, S.M., Lie, K.I., Løken, T., & Østerås, O. (2009). Calf mortality in Norwegian dairy herds. *Journal of Dairy Science*, 92(6), 2782-2795.
- Heller, M.C., & Chigerwe, M. (2017). Diagnosis and treatment of infectious enteritis in neonatal and juvenile ruminants. *The Veterinary Clinics of North America. Food Animal Practice*, 34(1), 101.
- Hemashenpagam, N., Kiruthiga, B., Selvaraj, T., & Panneerselvam, A. (2009). Isolation, identification and characterization of bacterial pathogens causing calf diarrhea with special reference to *Escherichia coli*. *International Journal of Microbiology*, 7(2), 1-4.
- Khan, A., & Khan, M.Z. (1996). Neonatal calf mortality in Pakistan. I: Prevalence and factors influencing mortality in buffalo and cow neonates. *Buffalo Journal*, 12, 219-229.
- Kimeli, P., VanLeeuwen, J., Gitau, G.K., Heider, L.C., McKenna, S.L., & Greenwood, S.J. (2020). Management factors associated with time-to-onset and fecal egg/oocyst counts of gastrointestinal parasites in heifer calves on Kenyan smallholder farms. *Veterinary Parasitology*, 283, 109174.
- Kochewad, S.A., Singh, J.P., Patil, V.M., Kumar, V., & Bhokre, S.M. (2013). Calf mortality. *Indian Farming*, 62(10), 23-26.
- Lopez, A., & Martinson, S.A. (2017). Respiratory system, mediastinum, and pleurae. In: *Pathologic Basis of Veterinary Disease*. Zachary, J.F., McGavin, M.D. (Eds), 6th edn., Elsevier Health Sciences, pp. 517.
- Lopez-Osorio, S., Villar, D., Failing, K., Taubert, A., Hermosilla, C., & Chaparro-Gutierrez, J.J. (2020). Epidemiological survey and risk factor analysis on *Eimeria* infections in calves and young cattle up to 1 year old in Colombia. *Parasitology Research*, 119, 255-266.
- Mansour, A.E., Abdelgadir, A.E., & El Zubeir, I.E. (2014). Major causes and risk factors associated with calf mortality in dairy farms in Khartoum State, Sudan. *Journal of Veterinary Medicine and Animal Health*, 6(5), 145-153.
- McGuirk, S.M., & Collins, M. (2004). Managing the production, storage, and delivery of colostrum. *Veterinary Clinics: Food Animal Practice*, 20(3), 593-603.
- Mee, J.F., Berry, D.P., & Cromie, A.R. (2008). Prevalence of, and risk factors associated with, perinatal calf mortality in pasture-based Holstein-Friesian cows. *Animal*, 2(4), 613-620.
- Mohsen, D., & Dapgh, A. (2007). Characterization of *Klebsiella* species recovered from pneumoenteric buffalo calves. *Veterinary Medical Journal (Giza)*, 55(3), 951-965.
- Morris, W.E., Venzano, A.J., Elizondo, A., Vilte, D.A., Mercado, E.C., Fernandez-Miyakawa, M.E. (2011). Necrotic enteritis in young calves. *Journal of Veterinary Diagnostic Investigation*, 23(2), 254-259.
- Olivares-Muñoz, A., Alonso-Díaz, M.A., Romero-Salas, D., Cruz-Romero, A., Barrientos-Morales, M., & Pinos-Rodríguez, J.M. (2022). Prevalence and risk factors of coccidiosis in calves from Veracruz, México. *Revista Brasileira de Parasitologia Veterinaria*, 31(3), e005622.
- Pancieria, R.J., & Confer, A.W. (2010). Pathogenesis and pathology of bovine pneumonia. *The Veterinary Clinics of North America. Food Animal Practice*, 26(2), 191.
- Singh, R.K., Sharma, A.K., Singh, Y.P., & Tripathi, S.C. (2020). Dairy sector development in sugarcane based cropping system of Uttar Pradesh (UP): Challenges and opportunities. *Journal of Community Mobilization and Sustainable Development*, 15(1), 17-31.
- Svensson, C., Lundborg, K., Emanuelson, U., & Olsson, S.O. (2003). Morbidity in Swedish dairy calves from birth to 90 days of age and individual calf-level risk factors for infectious diseases. *Preventive Veterinary Medicine*, 58(3-4), 179-197.
- Uetake, K. (2013). Newborn calf welfare: A review focusing on mortality rates. *Animal Science Journal*, 84(2), 101-105.
- Urie, N.J., Lombard, J.E., Shivley, C.B., Kopral, C.A., Adams, A.E., Earleywine, T.J., Olson, J.D., & Garry, F.B. (2018). Preweaned heifer management on US dairy operations: Part V. Factors associated with morbidity and mortality in preweaned dairy heifer calves. *Journal of Dairy Science*, 101(10), 9229-9244.
- Van John (2012). Factors contributing to calf mortality in veterinary pathology. *Journal of Veterinary Medicine*, 45(3), 203-215.
- Winder, C.B., Kelton, D.F., & Duffield, T.F. (2016). Mortality risk factors for calves entering a multi-location white veal farm in Ontario, Canada. *Journal of Dairy Science*, 99(12), 10174-10181.
- Windeyer, M.C., Leslie, K.E., Godden, S.M., Hodgins, D.C., Lissemore, K.D., & LeBlanc, S.J. (2014). Factors associated with morbidity, mortality, and growth of dairy heifer calves up to 3 months of age. *Preventive Veterinary Medicine*, 113(2), 231-240.
- Woolums, A.R., Ames, T.R., & Baker, J.C. (2009). The bronchopneumonias (respiratory disease complex of cattle, sheep, and goats). *Large Animal Internal Medicine*, 4, 602-643.
- Wymann, M.N., Traore, K., Bonfoh, B., Tembely, S., Tembely, S., & Zinsstag, J. (2008). Gastrointestinal parasite egg excretion in young calves in periurban livestock production in Mali. *Research in Veterinary Science*, 84(2), 225-231.