

## Case Series



# Salmonellosis in Young Calves: A Perplexing Problem beyond Diarrhea

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## ABSTRACT

**Introduction:** Salmonellosis is a well-known infectious disease invading both adult and young cattle, commonly characterized by severe diarrhea and septicemia in calves as well as fever, dysentery, abortion, increased salivation, and decreased milk production in adults. Rapid outbreaks and heavy mortality rates have turned *Salmonella* spp. into a violent organism from farmers' and experts' perspectives. The objective of this article was to pragmatically underline different aspects of Salmonellosis infections in young calves with emphasis on novel clinical and post-mortem signs.

**Case report:** Two calves aged 75 days old were primarily diagnosed with respiratory disease, high body temperature ( $> 40^{\circ}\text{C}$ ), and hyperpnea in the Behrooz Dairy Farm, Tehran, Iran. Calves were treated with anti-inflammatory drugs and antibiotics (amikacin and penicillin) immediately, but they died at the next day. After that, the number of ill calves increased dramatically and 120 calves were discovered with the same signs, including persistent high body temperature, hyperpnea, and recumbency. Early diagnosis and proper treatment and nursing were key factors in reducing the recovery time and mortality rate.

**Conclusion:** In some salmonellosis cases, treatment could become complicated due to developing resistance to various antibiotics. Calves born in filthy calving pens and those with depressed immunity are susceptible to salmonellosis. Therefore, complying with sanitary practices as well as precise nutrition programs for pre-weaning and weaning calves could provide a preventive tool to reduce the risk of Salmonellosis outbreak.

## 1. Introduction

*Salmonella* spp. is classified as a group of Gram-negative anaerobic bacteria belonging to the family of Enterobacteriaceae<sup>1</sup>. *Salmonella* (*S.*) spp. causes illness in humans and animals, and lives mainly in the intestinal tract of the host<sup>1</sup>. Different types of *Salmonella* spp. have been identified. These include *S. typhimurium*, *S. dublin*, *S. newport*, *S. infantis*, *S. montevideo*, *S. anatum* and *S. muenster*. *Salmonella* spp. in cattle is one of the infectious and contagious pathogens that can infect animals at any age and cause infectious intestinal diseases, septicemia, and abortion<sup>1</sup>. Calves usually show signs of salmonellosis between 4 to 28 days after birth, which indicates that the infection is initiated in the first hours after birth. In

addition, older calves between 60 to 90 days of age can be infected with *salmonella* strains<sup>2</sup>. Symptoms of the disease in calves generally include fever, recumbency, appetite loss, and diarrhea that may contain mucus and blood<sup>3</sup>. Following inflammation, epithelial hemorrhage occurs and vascular permeability and hypersecretion are increased which can lead to maldigestion and malabsorption<sup>2</sup>. Existing undigested feed materials within the lumen of the intestine increase lumen osmolality and draw fluid towards the intestine lumen, resulting in dehydration and nutrient loss<sup>1-3</sup>. Due to the violence of the Salmonellosis outbreak and the risk of human infections, it is necessary to pay more attention to the factors causing the disease and to

the ways of its transmission in order to prevent the *salmonella* spp. spread<sup>3</sup>. The objective of this article was to pragmatically highlight different aspects of Salmonellosis infections in young calves with emphasis on novel clinical and post-mortem signs.

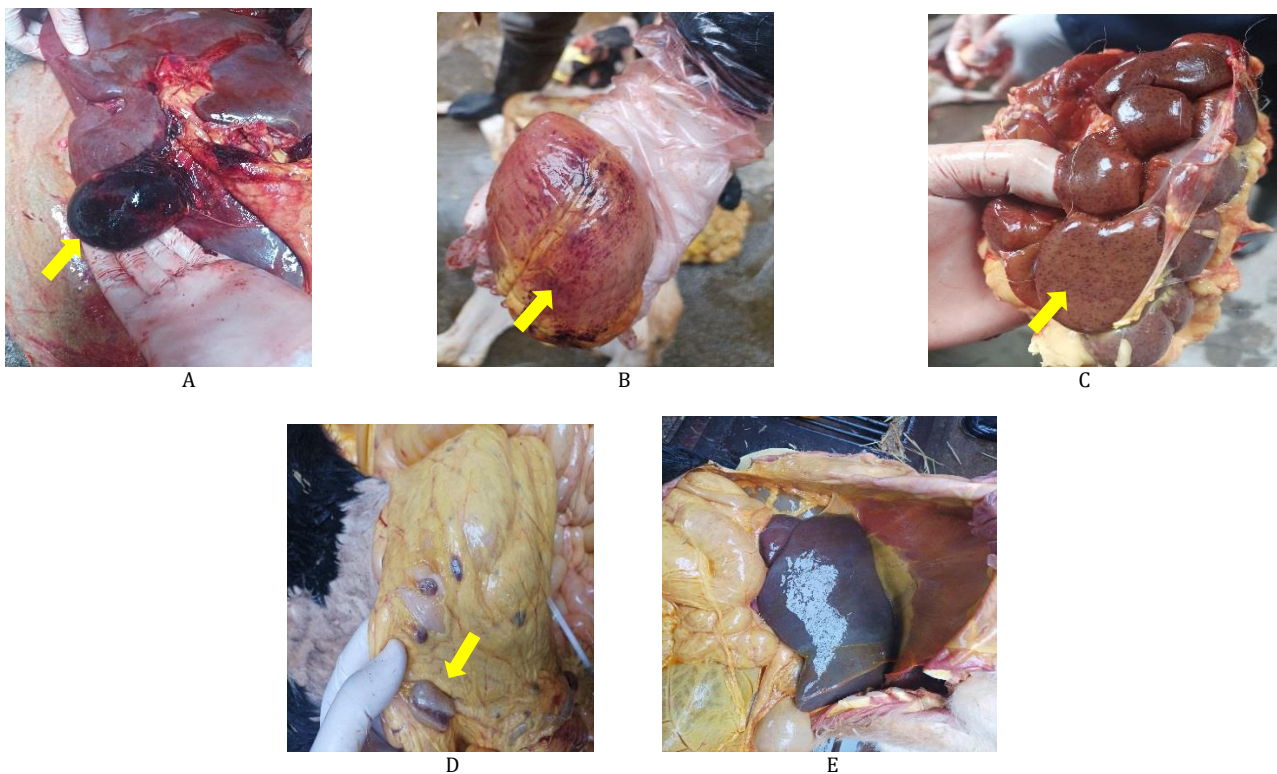
## 2. Case report

In the current study, two calves aged 75 days old were primarily diagnosed with respiratory disease with high body temperature ( $> 40^{\circ}\text{C}$ ) and hyperpnea. Calves were treated by anti-inflammatory drugs and antibiotics immediately (amikacin 500, 2 cc/40 kg of calf body weight; penicillin IV, 50000 unit/kg of calf body weight)<sup>2</sup>, but they died on the next day. After that, there was an increase in the number of ill calves and 120 calves were discovered with the same signs including persistent high body temperature, hyperpnea, and recumbency. The rapid outbreak, resistance to the common antibiotics treatment, and high mortality rate were among the characteristics of salmonellosis. However, some complexities existed in diagnosing the exact cause of infection according to the clinical signs it might be because the disease pathology was different among the infected calves. In some cases, calves died within a few hours after the initial diagnosis whereas in other cases, the treated calves died after 7 to 10 days following the first diagnosis. In the second group (those with extended periods of disease progress), severe anemia was identified. Mucosal membranes were markedly pale and turned to be yellowish as the diseases progressed. The

signs were similar to those of theileriosis<sup>4</sup>.

It is important to highlight that none of the infected calves had diarrhea. Necropsy findings were slightly different between the two categories (rapid onset versus extended period of disease progress). In on-farm necropsy, liver enlargement, gallbladder ulcers, and petechiae on the abomasum, heart, and kidneys were similarly observed post-mortem in different calves (Figure 1). The samples were taken from the liver, lung, gallbladder, and small intestine and sent to a veterinary laboratory (Mabna Lab., Karaj, Iran) for microbial culture and *Theileria* spp. identification. The peripheral blood sample (2 cc) was taken from the ear of infected calves and sent to the same laboratory (Mabna Lab., Karaj, Iran) for blood parameters analyses. *S. Dublin* was separated from all samples. *Theileria* spp. was not seen in blood samples. The hematological survey revealed significant reductions in white and red blood cell counts (3700 white blood cells/ $\mu\text{l}$  and  $1.01 \times 10^6$  red blood cells/ $\mu\text{l}$ ) and the normal range was 4.6-16.4 white blood cells/ $\mu\text{l}$  and  $6.8-14.6 \times 10^6$  red blood cells/ $\mu\text{l}$  for white and red blood cells, respectively.

All infected calves were treated with Gram-negative sensitive anti-microbial drugs (amikacin 500, 2 cc/40 kg of calf body weight; penicillin IV, 50000 unit/kg of calf body weight)<sup>2</sup> and simultaneously received an aggressive supportive fluid therapy using vitamins, and minerals to alleviate anemia and facilitate recovery. However, 18 calves died despite the aggressive treatment. From these findings, it could be suggested that farmers could immensely suffer from Salmonellosis outbreaks if the



**Figure 1.** The internal organs of a Holstein calf aged 75 days old in Tehran, Iran, December 2022. A. Gallbladder bleeding, B. Petechiae on heart, C. Petechiae on kidney, D. Enlarged lymph nodes. E. Enlarged liver

disease is not diagnosed and well-treated in the early stages.

### 3. Discussion

*Salmonella typhimurium* and *S. Dublin* are two prevalent strains infecting calves in different stages of life. Similar to other bacterial infections such as *Escherichia coli*, the interaction between host immunity and virulence of the bacteria determines the calf's susceptibility to the infection. Ingesting the infective agent is the primary route of Salmonellosis transmission in farm animals<sup>5</sup>. Contaminated feed and water, and upper respiratory tract secretions of infected animals are common sources of infection in Salmonellosis cases. In addition, infected calves are considered another source of infection because most of the infected calves (> 80%) shed the bacteria even following the recovery<sup>6</sup>. After ingestion of materials contaminated with *salmonella* spp., intestine is colonized by *salmonella* spp. which is mediated via intestinal M-cells (specialized cells of the mucosal immune system)<sup>6</sup>. In addition, enterocytes and tonsillar lymphoid tissue are other routes for invading *salmonella* spp.<sup>7,8</sup>. Then, *Salmonella* spp. enters mononuclear phagocytes disseminating in the whole body through blood stream<sup>2</sup>. It is believed that multiplying in the lymphoid tissues is the main way of *salmonella* spp. invasion<sup>2</sup>. In calves, *S. typhimurium* invades the intestine causing enteric disease that is able to move across the intestinal epithelium and transfer to other body organs<sup>2</sup>. In septic cases, bacteria have been isolated from the spleen, lung, and liver of calves without causing lesions in the intestine<sup>9</sup>.

Early diagnosis of salmonellosis according to clinical and post-mortem signs are key factors in controlling Salmonellosis outbreaks at the herd level. Treatment of salmonellosis is a tedious and time-consuming practice with inevitably high mortality rates. Therefore, prevention is the best safe strategy against *Salmonella* spp. Peri-weaning calves could develop salmonellosis if the intestines' condition is suitable for *salmonella* spp. overgrowth<sup>10</sup>. Providing a balanced diet with appropriate levels of protein, vitamins, and minerals with reduced environmental stresses and contaminations are the factors that can decrease the risk of *salmonella* infections<sup>9,11</sup>. Any disturbance in the microbial population of the intestine may increase the risk of bacterial infection by providing an opportunity for bacteria to attach to the epithelial surface<sup>1</sup>. Since the microbial population of calves undergoes dramatic change during the transition from the pre- to the post-weaning period, stress, poor nutrition, and contaminated environments predispose calves to severe bacterial invasions<sup>11</sup>.

Maternity pen hygiene, maternal nutrition in late gestation, colostrum feeding (preferably with high levels of globulins), housing, farm sanitary protocols, stress management, and bedding conditions are among the factors affecting the calves' susceptibility to various infectious diseases<sup>11-13</sup>. As such, a collection of

management practices should be adopted to decrease the risk of infectious diseases, such as salmonellosis in commercial dairy herds.

### 4. Conclusion

Salmonellosis is one of the most dangerous diseases infecting young calves of different ages. With a number of calves with persistent fever at the same time, *salmonella* spp. could be a major suspect. Calves infected by *salmonella* spp. do not respond to ordinary treatment protocols easily. Thus, supportive aggressive treatments are necessary to keep calves alive. Providing a hygienic maternity pen alongside feeding high-quality colostrum is still the golden benchmark to reduce the risk of infection in neonatal calves. In addition, feeding a balanced starter, exercising step-down weaning methods, regular sanitary protocols as well as reducing stress in the calf environment are the key factors that reduce the incidence of bacterial diseases in peri-weaning calves. Future studies could investigate possible inter-breed differences in the pathology and practical farm management of salmonellosis.

### Declarations

#### Competing interest

None.

#### Authors' Contribution

Akbar Nikkhah led the project, conceptualized the idea, strategized the topic development, and did the ultimate writing and editing. Masoud Alimirzaei contributed to making clinical observations and writing the initial draft. Hossein Kazemi helped with the literature review and initial draft preparation. The final manuscript was checked and approved by all authors.

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#### Availability of data and materials

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#### Ethical considerations

The authors have made necessary ethical considerations (plagiarism, consent to publish, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancy).

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