

# A case of septicemia in a calf: why calves' management is so important at the farm



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## SUMMARY

A 21 days old female Holstein Friesian calf was referred by a free practitioner veterinarian for the worsening of clinical signs despite the therapy. The calf belonged to a farm with poor calves' management. At admission time, the calf presented severe depression, dehydration, lack of suckling reflex, positive Systemic Inflammatory Response Syndrome score and signs of septic shock (e.g. tachycardia, tachypnea, hypothermia, pale mucous membranes, cold extremities). Increase lung sounds and watery diarrhea were detected. Laboratory analysis showed signs of septicemia. Ultrasonography of the thorax showed diffuse comet tails on both sides and areas of adherence between the lung and the hearth. The calf was treated with enrofloxacin (5 mg/kg, SC, q24h) and flunixin meglumine (1 mg/kg, IV, q24h). Fluid therapy was also started. The calf was euthanized 12 hours after the admission. A diagnosis of neonatal septicemia has been confirmed by necropsy.

The major critical points of this farm were the absence of colostrum and passive transfer of immunity management and the high prevalence of diarrhea (almost 92%) in pre-weaning calves. Both these concerning might predisposed calves to neonatal septicemia. The cleaning, steaming and disinfection of calf housing and calving pens was largely improved. More calf pens were added in order to decrease the animals density and a regular disinfection of utensils and an adequate and clean straw bedding was introduced in the daily management. The colostrum was checked with a Brix refractometry and the 21% has been considered the break point for high-quality (>50 g of IgG/L) maternal colostrum. The farmer was also advised to administer 4 L of colostrum 6 to 8 hours after birth. Every calf was checked for the immunity passive transfer by the evaluation of refractometric serum total protein. The incidence rate of diarrhea in pre-weaning calves decreased to 78% and no more cases of sepsis have been reported since 6 months. Improving the general calves' management at the farm would be essential for the prevention of septicemia in calves and related economical losses.

## KEY WORDS

Calf, septicemia, colostrum.

A 21 days old female Holstein Friesian calf was presented to the Veterinary Teaching Hospital "M. Modenato" (VTH), University of Pisa, for depression, anorexia and increased lungs sound. The calf belonged to a dairy farm in which there was no supervision on animals from 18.00 to 04.00. The owner found the calf already birth, thus there were no history about calving. The vitality of the calf was normal and she was immediately brought in a dedicated single pen where she received 2 liters (L) of her own dam colostrum. Other 2 L of colostrum were given 10 hours after the first administration. The colostrum was not checked for Immunoglobulin G (IgG) content, thus the total amount of IgG received by the calf was unknown. The calf received 2L of colostrum twice a day (q12h) until the 3rd day of life. Then she received 3L q12h of whole milk. Ten days later the calf developed diarrhea, managed at the farm with an oral electrolyte solution composed by sodium chloride (2.34 g), potassium chloride (1.12 g), sodium bicarbonate (6.72 g), citric acid anhydrous (3.84 g), lactose monohydrate (32.44 g), glycine (2.25 g). At 15 days old the calf became depressed, with poor suckling reflex and lot of time spent recumbent, she showed fever and respiratory distress. The veterinarian of the farm made a di-

agnosis of respiratory infection and the calf was treated with procaine benzylpenicillin (30.000 IU/kg, IM, q24h) for 7 days. Due to the worsening of calf's conditions the owner decided to refer the case to the VTH one week later.

At admission time the calf was recumbent and severely depressed. The calf presented poor general condition with 36.8 kg of body weight (weight at birth 43.9 kg) and 2.0/5 of BCS, lack of suckling reflex, purulent nasal discharge and profuse watery diarrhea. A complete physical examination was performed at admission time and the calf was also scored according to a Systemic Inflammatory Response Syndrome (SIRS) scale<sup>1</sup>. Blood samples for CBC, biochemical and blood gas analysis and proteins electrophoresis were collected from the jugular vein. A sample for blood culture was also collected aseptically from the same site and a commercial culture system (OXOID SIGNAL Blood Culture System, Oxoid) was used. Feces were immediately tested with a rapid ELISA test (Test Strips for detection of Rota, Corona, *E. coli* F5 and *C. parvum* in bovine feces, Biox Diagnostics, Belgium) and analyzed for gastrointestinal parasites. An ultrasonography evaluation of the thorax and the abdomen was performed with a 5 MHz convex probe (Mylab30TM, ESAOTE, Italy). The thorax was scan from the 10th intercostal space (ICS) cranial to the 1st ICS for the right lung and from the 10th ICS cranial to the 2nd ICS for the left lung. The left, right and ventral abdomen were scan, with special

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attention to umbilicus remains, liver parenchyma, caudal vena cava, portal vein, gallbladder, intestine, abomasum and reticulum, kidneys and urinary bladder.

Abnormalities at physical examination were: severe depression, lack of suckling reflex, dehydration score of 12%<sup>2</sup>, diarrhea (fluidity of diarrhea was described as a fecal score 4/4, meaning a "watery diarrhea" with liquid consistency and splatters), increase heart rate (HR) with 136 beats *per* minute (bpm), increase respiratory rate (RR) with 42 breaths *per* minute (bpm), decrease body temperature (BT)<sup>3</sup>, pale mucous membranes, cold extremities (ears, feet, tail), purulent bilateral nasal discharge, increased lung sounds both on the left and the right side, increased abdominal sounds especially in the right ventral abdomen. No abnormalities were found at the inspection and palpation of umbilicus and joints. The calf was not able to reach and maintain the standing position. Clinicopathological findings are reported in Tables 1 and 2<sup>4</sup>. Regenerative, microcytic and hypochromic anemia was present, confirmed by the presence of reticulocytes on the blood smear, probably due to chronic inflammation status. Those findings might also be correlated to a paraphysiologic "iron deficiency" status of calves up to 21

**Table 1** - Results concerning complete blood count (CBC) with differential and blood-gas analysis in a 21 days old Holstein Friesian calf with suspicious of sepsis<sup>4</sup>.

CBC parameters	Results	Reference values
RBC (10 <sup>6</sup> /L)	4.5	5.1-7.6
HCT	19.5%	22-33%
HGB	7.3 g/dL	8.5-12.2 g/dL
MCV	32.3 fL	38-50 fL
MCHC	37.4 g/dL	36-39 g/dL
RETIC (10 <sup>3</sup> /L)	6.0	0
WBC (10 <sup>3</sup> /L)	21.8	4.9-12
NEU (10 <sup>3</sup> /L)	9.9	1.8-6.3
BAND (10 <sup>3</sup> /L)	2.2	rare
LYM (10 <sup>3</sup> /L)	4.3	1.6-5.6
MONO (10 <sup>3</sup> /L)	0.5	0-0.8
EOS (10 <sup>3</sup> /L)	0.01	0-0.9
BASO (10 <sup>3</sup> /L)	0.01	0-0.3
BLOOD GAS	Results	Reference values
pH	7.274	7.31-7.53
pCO <sub>2</sub>	31 mmHg	35-44 mmHg
K <sup>+</sup>	1.0 mEq/L	3.9-5.8 mEq/L
Na <sup>+</sup>	142 mEq/L	132-152 mEq/L
Cl <sup>-</sup>	89 mEq/L	97-111 mEq/L
Glucose	36 mg/dL	45-75 mg/dL
Lactate	4.1 mmol/L	0.56-2.22 mmol/L
Bicarbonate	15.3 mmol/L	17-29 mmol/L
Anion gap	31.2 mEq/L	14-20 mEq/L

Legend: RBC - red blood cell; HCT - hematocrit; HGB - hemoglobin; MCV - mean cell volume; MCHC - mean cell hemoglobin concentration; RETIC - reticulocytes; WBC - white blood cell; NEU - neutrophils; BAND - band neutrophils; LYM - lymphocytes; MONO - monocytes; EOS - eosinophil; BASO - basophils.

days of life induced by almost exclusive milk feeding<sup>5</sup>. Leukocytes and neutrophils count were higher than normal range, also the band neutrophils count was increased, suggesting a severe inflammatory process, probably due to infectious causes. Blood gas analysis showed a pretty severe metabolic acidosis with compensatory response, hypokalemia and hypocloremia, probably consequence of diarrhea and sepsis. Beyond prolonged anorexia, hypoglycemia might be the result of severe sepsis. Sepsis is characterized by an initial transient hyperglycemic response, followed by marked hypoglycemia. The transient hyperglycemia is caused by the release of stress hormones and increased hepatic glycogenolysis and gluconeogenesis. The following severe drop of glycemia is due to increased peripheral glucose utilization, depletion of hepatic glycogen stores and inhibition of hepatic glucose production. Biochemical analysis showed high plasmatic urea, probably due to dehydration and hypovolemia secondary to septic shock, high gamma glutamyltransferase (GGT) that might be a remainder of colostrum GGT, high total and direct bilirubin concentrations, probably due to prolonged anorexia and increased creatine kinase plasmatic concentration in response to prolonged recumbency with inability to rise. Proteins electrophoresis showed low concentrations of total proteins, albumin and  $\gamma$ -globulins, suggesting a chronic and severe inflammatory status. Low plasmatic albumin concentration could also be due to chronic anorexia and malnutrition. Blood culture was negative but the sensitivity of this diagnostic test is generally low and the calf had already received antimicrobial drug at the admission time<sup>6</sup>. The fecal sample was positive for *Cryptosporidium parvum*. Fecal flotation was negative for gastrointestinal parasites. Ultrasonography of the thorax showed diffuse comet tails on both sides and alterations were more severe in the cranio-ventral portion of the lungs. In particu-

**Table 2** - Results concerning clinical chemistry and serum protein electrophoresis in a 21 days old Holstein Friesian calf with suspicious of sepsis<sup>4</sup>.

Clinical chemistry parameters	Results	Reference values
Urea	69 mg/dL	20-30 mg/dL
Creatinine	1.5 mg/dL	1-2 mg/dL
Total bilirubin	4.3 mg/dL	0.01-0.5 mg/dL
Direct bilirubin	1.4 mg/dL	0.04-0.44 mg/dL
GGT	221 IU/L	15-39 IU/L
AST	91 IU/L	78-132 IU/L
CK	602 IU/L	44-211 IU/L
Serum protein electrophoresis	Results	Reference values
Total protein	4.9 g/dL	6.7-7.5 g/dL
Albumin	2.2 g/dL	3.0-3.55 g/dL
Alpha	0.8 g/dL	0.75-0.88 g/dL
Beta	1 g/dL	0.8-1.1 g/dL
Gamma	0.8 g/dL	1.7-2.2 g/dL
A/G ratio	0.91	0.84-0.94

Legend: GGT - gamma glutamyltransferase; AST - aspartate aminotransferase; CK - creatine kinase. A/G ratio - albumin/globulin ratio.

lar, close to the hearth, a hyperechoic area of about 2 cm were found: the aspect of this area suggested the presence of fibrin and adherence between the lung and the hearth. Moreover, very close to this site, there were areas of lung consolidation and a structure that looked like an abscess. The structure presented a non-heterogeneous echogenicity of the content with a hyperechoic capsule. There was no particles movement inside the structure. Concerning the abdomen, abnormalities found were a slightly thickening of the small intestinal wall and a mild increase in small intestine motility. There were no alterations of the liver, peritoneum, prestomachs and stomach, urinary bladder and umbilicus.

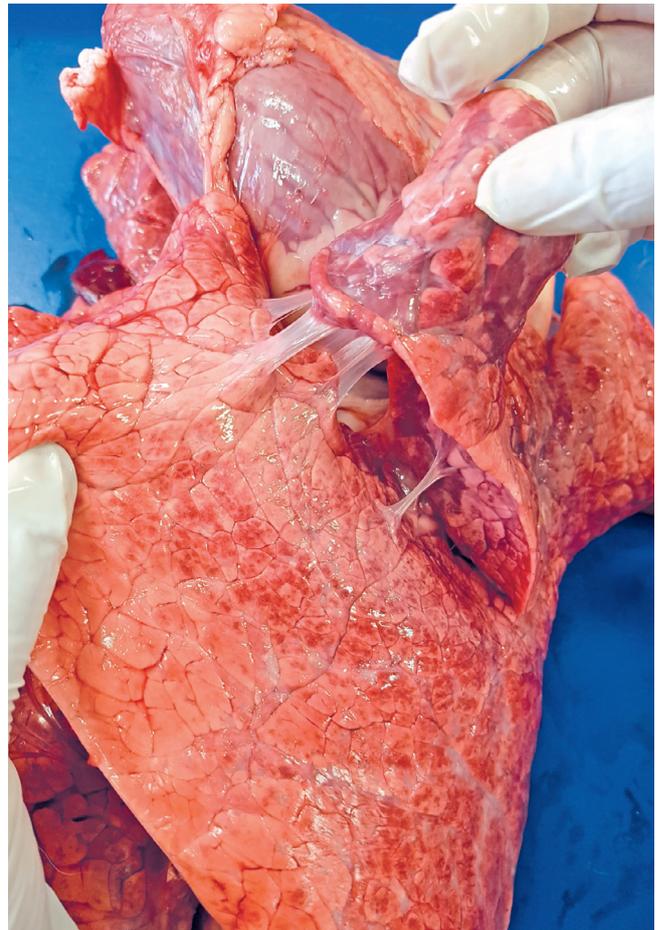
According to the literature, a SIRS score is considered positive if 2 out of 4 criteria are met by a subject, thus the calf was considered affected by SIRS because she reached a score of 4/4<sup>1</sup>. Moreover, the list of diagnosis included sepsis, diffuse pneumonia with abscess formation, diarrhea, regenerative anemia, metabolic acidosis, hypoproteinemia and cryptosporidiosis. The most likely etiopathogenetic hypothesis was an underlying failure of passive transfer (FPT) that predisposed the calf first to diarrhea, then to respiratory tract infection and bacterial diffusion in the bloodstream.

The calf was treated with enrofloxacin (5 mg/kg, SC, q24h) and flunixin meglumine (1 mg/kg, IV, q24h). Fluid therapy was started with 5 L of 0.9% NaCl solution at flow rate of 40 mL/kg/h with 750 mmol of NaHCO<sub>3</sub><sup>-7</sup>. Dextrose (5%) was combined to improve the severe hypoglycemia. The calf was euthanized during the night for severe worsening of general status compatible with septic shock. In particular, the calf showed deep decreasing in mentation status, worsening of pulse quality, cold extremities, prolonged jugular refill, decreased urine output and hypotension persisting despite adequate fluid resuscitation.

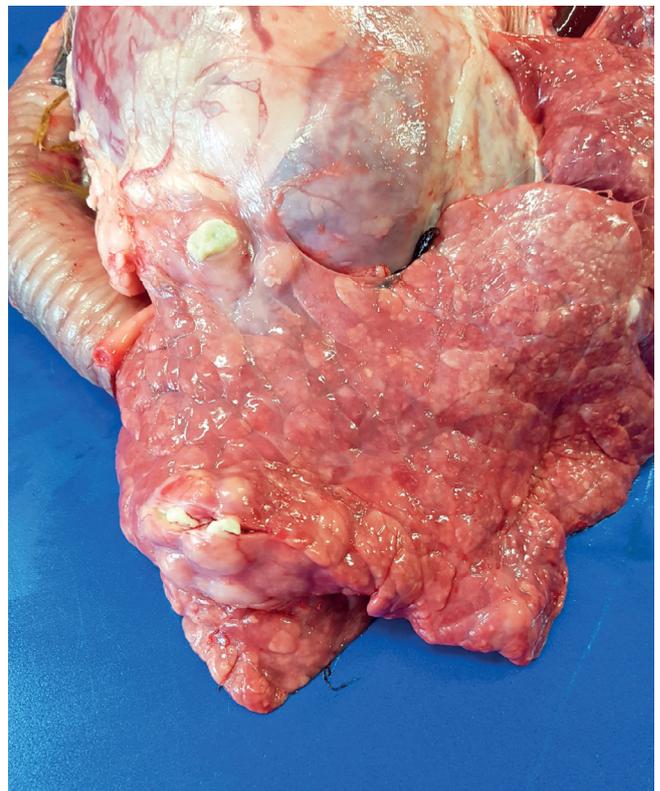
A complete post mortem examination was performed. A big amount of fibrin was found on the pleural surface of the thorax. There were adhesences between the right apical lobe of the lung and the ventral portion of the thorax wall, between pleura and pericardium and between lung lobes (Fig. 1). Interstitial edema and abscesses diffused throughout the lungs were found, suggesting a purulent pneumonia (Fig. 2). The fluid in the pericardium was slightly increased. The thickness of the small intestine wall was increased and the lymphatic vessels were evident on the intestinal serosa. Both kidneys presented multiple suppurative foci suggesting an embolic-metastatic nephritis. The overall post-mortem findings confirmed the clinical diagnosis of sepsis.

## DISCUSSION

Calf diarrhea is a very common and multifactorial disease in bovine practice. It has been estimated that 75% of early calf mortality in dairy herds is caused by acute diarrhea in the pre-weaning period<sup>8</sup>. The most common pathogens involved in calf diarrhea are *Rotavirus*, *Coronavirus*, *Cryptosporidium parvum* and *Escherichia coli*, especially in animals less than 1 month old<sup>9,10</sup>. Bacteremia is a frequent complication of diarrhea in calves<sup>6,10</sup>. Colibacillosis (*Escherichia coli*) has been implicated as a major cause of scours in calves, however in this study the ELISA results excluded an *E. coli* implication. Generally, the diagnosis is based on history, clinical findings, evidence of a severe deficiency of circulating IgG, serological



**Figure 1** - Necropsy of a 21 days old Holstein Friesian calf with sepsis: multiple adhesences between lung lobes secondary to severe pleuropulmonary inflammation.



**Figure 2** - Necropsy of a 21 days old Holstein Friesian calf with sepsis: interstitial edema and multifocal abscesses diffused throughout the lungs, especially localized in the right apical lobe.

test (e.g. serotyping for K99) and culture of the organism in blood, feces or tissues. Other organisms that must be excluded in a case of neonatal septicemia are Enterobacteriaceae, *Streptococcus* spp, *Pasteurella* spp and *Salmonella* spp. A definitive diagnosis of colibacillosis is sometimes hard to achieve, especially in field conditions. Thus, despite the ELISA result, a colibacillosis might not be completely ruled out in our case.

Control of calves diarrhea in farms represents a big challenge for farmers<sup>11,12</sup>. An improvement in environmental management of calving pens and calf housing reduces calf diarrhea incidence and the extent of outbreaks. A system of "all in all out" calf housing, cleaning, steaming and disinfection of calf housing and calving pens, regular disinfection of utensils and adequate straw were identified as important management factors<sup>11,12</sup>. All these critical points had been discussed with the farm's owner. The incidence rate of diarrhea in pre-weaning calves for this farm has been almost 92%. The highest diarrhea rate is reached when the calf housing is overfull. The general hygiene and disinfection of the calf housing was poor. Another critical point was the colostrum management and the related immunity passive transfer. The lack of supervision on animals during the night impaired calving assistance and early colostrum feeding. Moreover, check on colostrum quality and passive transfer was missing.

Some changes about calves' management have been made by the farmer after this case. A system of "all in all out" calf housing was not possible. However, cleaning and disinfection of pens was largely improved. Five more pens were added in order to decrease the animals density during the very busy periods of the year. A regular disinfection of utensils and an adequate and clean straw bedding was introduced in the daily management of calves. The break point for high-quality colostrum (>50 g of IgG/L) was set at 21% Brix scale<sup>13</sup>. The farmer started to administer 4 L of colostrum 6 to 8 hours after birth<sup>14</sup>. Every calf was checked for the immunity passive transfer by the evaluation of refractometric serum total protein (TP)<sup>14</sup>. TP of <5.5 g/dL were considered predictive value for FPT<sup>15</sup>. Finally, a vaccination protocol has been suggested. However, the owner decided to try first with changing the management and kept the vaccination as a "second-line strategy".

Six months after the first visit, the incidence rate of diarrhea in pre-weaning calves decreased to 78% and no more cases of sepsis have been reported since then. All calves received only a good quality colostrum and the passive transfer has been monitored. The main cause of diarrhea still remains *C.*

*parvum*, despite numerous sanitary interventions. The owner is evaluating to definitely rebuild the calf housing area and to adopt a vaccination protocol. The improving of general calves' management at the farm would be essential for the prevention of septicemia in calves and related economical losses.

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