Monensin toxicosis in 2 sheep flocks

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Abstract — Several lambs in 2 sheep flocks died suddenly and others were examined for generalized weakness and dyspnea. Postmortem findings were suggestive of degenerative myocardial and skeletal muscle myopathy, which was confirmed histologically. Feed analysis revealed toxic levels of monensin and ionophore toxicosis was diagnosed.

Résumé — Toxicose au monensin chez 2 troupeaux de moutons. Quelques agneaux appartenant à deux troupeaux meurent soudainement et d'autres sont examinés parce qu'ils manifestent des signes de faiblesse généralisée et de dyspnée. L'examen postmortem laisse supposer une myopathie dégénérative du myocarde et des muscles squelettiques, hypothèse confirmée par l'analyse histologique. L'analyse des aliments révèle une concentration toxique de monensin, et un diagnostic de toxicose à l'ionophore est posé.

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Two sheep flocks near Lake Nippising in northern Ontario had suffered losses from coccidiosis. An off-label prescription was written for feed to be medicated with monensin at a dose of 22 ppm. For reasons of practicality, the 2 producers (A and B) agreed to share feed shipments.

The sudden death of a lamb and observation of 6 poor-doing lambs in May of 1999 prompted producer A to contact a veterinarian. Approximately half of the 600 sheep on this farm were spring lambs. When examined on day 1, 6 lambs appeared equally affected; they were very weak, falling over easily when gently pushed. Rectal temperatures were normal, but heart and respiratory rates were elevated (80 to 100 beats/min and 20 to 45 breaths/min, respectively). The lambs were dyspneic with clear, viscous discharges from their mouths and nostrils and increased, moist lung sounds. Mucous membranes were pink and capillary refill times were approximately 1 s.

One lamb was euthanized and necropsied. There was excessive, clear, serum-colored fluid in the thoracic cavity and pericardial sac. The lungs were congested, particularly on the left side (the animal had been in left lateral recumbency), but were normal on palpation and showed no evidence of pneumonia. The myocardium was pale and had many tiny, pale streaks throughout its mass. The intercostal muscles and the quadriceps muscles of both hind limbs were pale, and there were many white streaks in the semimembranosus and semitendonosus muscles. A necropsy was also performed on the lamb that was found dead; it appeared to have died from chronic interstitial pneumonia.

Differential diagnoses considered at this time were monensin toxicosis, interstitial pneumonia, and white muscle disease, which was considered unlikely, as vitamin E and selenium were supplemented in the feed and had also been provided to all lambs by injection at birth.

Producer A was still feeding the prescribed monensin-medicated feed, and a new shipment of feed had been started 2 d earlier. The feeding of the new monensin-medicated ration was discontinued, and a treatment plan was initiated. The 5 affected lambs were treated with furosemide (Lasix; Hoechst Roussel Vet Canada, Regina, Saskatchewan), 6 mg/kg body weight (BW), IM, q24h, for 3d; dexamethasone (Predef 2X; The Upjohn Company, Animal Health Division, Orangeville, Ontario), 0.24 mg/kg BW, IM, q24h, for 3d; oxytetracycline (Liquimycin LP; rogar/STB, London, Ontario), 12 mg/kg BW, IM, q24h, for 3 d; and vitamin E (136 IU) and selenium (3 mg) (Dystosel; rogar/STB), IM, q24 h, for 3 d.

Producer B was contacted and instructed to stop feeding the ration until further notice. She reported that she also was having problems in her flock. A Nubian goat and a lamb had died suddenly overnight. Approximately 10 of the 150 lambs were coughing and appeared ill. When examined on day 2, 15 lambs appeared depressed and weak. Spontaneous, moist coughs could be heard intermittently throughout the barn. Necropsy of the goat revealed patchy, pale musculature, but no other significant findings. Necropsy of the lamb revealed only congested musculature and a rumen significantly distended with barley. Differential diagnoses were monensin toxicosis and grain overload. Producer B was advised to discontinue feeding the medicated feed. Use of activated charcoal, PO, or saline cathartics was not attempted on either farm, as several days had already passed since the initial ingestion of the medicated feed.

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Andria Jones will receive a copy of Saunders Comprehensive Veterinary Dictionary courtesy of Harcourt-Brace Canada.

On day 3, the animals on farm A were reassessed; they had made no obvious response to treatment. One lamb was found in lateral recumbency and another in sternal recumbency. These lambs were euthanized and necropsied. The musculature of both carcasses was notably pale, especially the semimembranosus and semitendonosus muscles. The myocardia were also pale, with many tiny, pale streaks. The lungs appeared grossly normal, except for evidence of resolved cranioventral enzootic pneumonia in 1 lamb.

A tentative diagnosis of monensin toxicosis was made. Four samples of the feed from different bags were collected and submitted (Elanco, Division of Eli Lilly Canada, Guelph, Ontario) for determination of the monensin concentration.

On day 4, producer B reported that another lamb had died overnight. Necropsy of this lamb revealed hydrothorax, pericardial effusion, and white streaking with overall paleness of the myocardium and quadriceps muscles. Approximately 10% of the lambs appeared lethargic and depressed. Physical examination of 3 affected lambs revealed tachycardia (heart rate 180 beats/min, reference range 80 to 100 bpm) and increased, moist lung sounds. One lamb was euthanized; postmortem findings included pericardial effusion, congested lungs, pale biceps and quadriceps muscles, pale streaking of the atria, and pale kidneys. Feed samples were also submitted for a monensin assay.

Over the next 3 d, an estimated 20% to 30% of the lambs in both flocks became lethargic and exhibited moist coughs. On day 7, necropsies were performed at farm A on 1 lamb found dead, and on another that was euthanized. The myocardium and semimembranosus and semitendinosus muscles were pale and white-streaked, and the lungs were congested in both carcasses. These findings were consistent with monensin toxicosis.

Microscopic examination of tissues from both flocks showed diffuse hyalin and granular degeneration and fragmentation of muscle fibers, with minimal to moderate dystrophic mineralization. There were focal areas of hyalin degeneration of the smooth muscle in the muscularis of the small intestine, and nephrosis of some cortical tubules, many of which contained proteinaceous material believed to be myoglobin. There were no other abnormal findings.

The final diagnosis was degenerative myocardial and skeletal muscle myopathy, which could have been caused by either vitamin E/selenium deficiency or ionophore toxicity. Ionophore toxicity was the more likely cause, as vitamin E and selenium had been adequately supplemented, and there was only mild mineralization of the affected muscles of the lambs. On day 22, monensin toxicosis was confirmed by the analysis of the feed samples. The actual concentration of monensin in the feed was 438 ppm, nearly 22 times the level prescribed.

Three months later, conditions on these farms had worsened significantly. At least half of the lambs in each flock had either died or had short, choppy, stiff-legged gaits and significantly decreased growth rates compared with lambs usually raised in these flocks. The number of clinically affected lambs is unknown, but the incident was devastating to both farms.

Clinical signs in the lambs on these sheep farms was typical of degenerative myocardial and skeletal muscle myopathy caused by ionophore toxicity. Monensin, a polycyclic antibiotic produced by *Streptomyces cinnamonensis*, is commonly used to treat ruminant coccidiosis and to improve feed efficiency. It improves feed efficiency by increasing production of propionate in the rumen at the expense of butyrate and acetate. Lipid-soluble complexes of monensin with metal cations, especially sodium and potassium, are selectively transported across membranes. When intracellular potassium decreases, adenosine triphosphate synthesis decreases, causing decreased cellular function and/or cellular death (1). Increased intracellular sodium results in mitochondrial swelling, and intracellular calcium concentration increases because of the change in osmotic pressure. The excess calcium is initially sequestered within the mitochondria; however, once cells are overloaded, irreversible defects in oxidative phosphorylation occur (1,2). Eventually, the calcium leaks from the mitochondria, and free cytoplasmic calcium increases, inducing a short period of hypercontraction in a segment of the muscle fiber, and eventual cell death (2). Myocytes of heart and skeletal muscle require normal calcium metabolism and rely heavily on mitochondrial oxidative phosphorylation for proper function. The changes seen in other tissues are more likely due to loss of osmotic control and cellular swelling than to altered calcium metabolism (2).

Monensin toxicity varies considerably among species, with horses being the most sensitive. Toxicoses have occurred due to accidental access to medicated feed, errors in feed mixing, and deliberate feeding of a ration formulated for a less sensitive species (2,3). Monensin toxicity may be potentiated by the concurrent use of tiamulin, oleandomycin, chloramphenicol, erythromycin, and sulfonamides (3).

There is no antidote or proven treatment regimen for monensin toxicosis. The use of emetics (in small animals only) and activated charcoal or mineral oil, PO, in combination with saline cathartics, may decrease the absorption of monensin (3). Blood electrolytes should be monitored and imbalances corrected. Affected animals should have 6 to 8 wk of cage/stall rest. However, continued degeneration of myocytes and myocardial fibrosis is common for up to 4 mo after elimination of monensin from the diet (3,4).

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