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# An Outbreak of Encephalitic Listeriosis in Holstein Bulls

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## Abstract

Five Holstein bulls in a herd of 478 bulls were diagnosed with clinical encephalitic listeriosis. Four bulls survived after intensive therapy with oxytetracycline, dexamethasone, and oral fluid with electrolytes. The bull which did not survive had histologic findings of lymphoplasmocytic encephalitis and inflammation of the trigeminal ganglion, which were consistent with the diagnosis of clinical listeriosis.

A suspect silage sample was submitted for laboratory evaluation. The silage had a pH of 6.9 and was positive for *Listeria monocytogenes*. *In vitro* antibiotic testing of the organism isolated revealed resistance to penicillin, the drug commonly recommended for the treatment of listeriosis. Caution must be exercised, however, when evaluating *in vitro* susceptibility results associated with a listeriosis outbreak because multiple ribotypes may be involved.

## Introduction

Listeriosis is a sporadic bacterial infection with worldwide distribution affecting many animals and birds, including humans. Listeriosis is caused by *Listeria monocytogenes,* which is a small, motile, gram-positive, nonspore-forming, facultative intracellular, environmentally resistant, diphtheroid coccobacillus. The organism can invade and cause pathology in different systems of the body; those systems typically affected are nervous (encephalitis), circulatory (septicemia), and reproductive (abortion) systems. This report will describe an outbreak and review bovine encephalitic listeriosis.

## History

Five Holstein bulls in a herd of 478 bulls were diagnosed with clinical encephalitic listeriosis during an 18 day period. The age of bulls in the herd ranged from 10 months to 13 years; the bulls affected with listeriosis were 19 to 32 months of age. Four of the bulls were housed in groups of 3 to 15 bulls per pen while one bull (case #4) had been housed in an individual stall. All the bulls were fed the same ration consisting of corn silage, grass hay, and a pelleted protein supplement.

## Clinical Findings

The five bulls exhibiting signs of neurologic disease had varying degrees of fever, facial paralysis, salivation, strabismus, head tilt, circling, ataxia, anorexia, depression, disorientation, and recumbency. A summary of clinical findings are found in Table 1.

**Table 1.** Initial physical examination findings

| Case no. | Day of presentation | Temp. (F/C) | Other observations |
|---|---|---|---|
| 1 | Day 1 | 103.4/39.7 | left facial nerve palsy, medial strabismus of left eye, tongue protrusion toward left, right head tilt, circling to right, anorexia, depression |
| 2 | Day 5 | 102.4/39.1 | excessive salivation, nervousness, anorexia, disorientation |
| 3 | Day 7 | 102.6/39.2 | circling to left, disorientation, anorexia |
| 4 | Day 8 | 103.4/39.7 | excessive salivation, ataxia, depression, anorexia |
| 5 | Day 18 | 103.4/39.7 | right lateral recumbency |

## Therapeutic Management

Four bulls survived after intensive therapy with oxytetracycline (9mg/lb [20 mg/kg], administered IV

or SC, q 24 to 48 h) and dexamethasone (0.1 mg/lb [0.22 mg/kg], IM, q 24h). Dexamethasone was administered only until clinical improvement was noticed (2 to 4 days), while treatment with oxytetracycline was continued until the bulls showed no clinical signs (6 to 12 days). To treat and prevent dehydration secondary to excessive salivation, all bulls were offered water supplemented with a balanced mix of powdered electrolytes.[a]

Based on previous clinical experience, a bull with listeriosis that is nervous and disoriented can be easily agitated and die acutely if stressed. Therefore, affected bulls were not administered fluid therapy using an orogastric tube. The intravenous route was not used for fluid administration because of patient instability, the size of the bulls, and facility inconvenience. Affected bulls were not evaluated for systemic acidosis, which is a frequent sequella to excessive salivation.

## Laboratory Data

One bull (case #3) was euthanized after becoming recumbent and moribund following two days of therapy with oxytetracycline, dexamethasone, and drinking water with added electrolytes. The bull was submitted to the local university for gross and histopathologic evaluation. No significant lesions were identified grossly. The histologic findings of lymphoplasmocytic encephalitis with microabscesses and ganglionitis of the trigeminal ganglion were consistent with the clinical diagnosis of listeriosis. The culture of the brainstem was *Listeria* negative.[b]

A silage sample was collected on day 6 of the outbreak and submitted to a diagnostic laboratory[c] for pH determination and culture for *Listeria monocytogenes*. The pH was 6.9. The silage sample contained a bluish-gray moldy-appearing growth on the surface. It had been collected adjacent to an old, poorly fitted door in an upright conventional silo, which allowed the entry of air and interfered with normal silage fermentation.

*Listeria monocytogenes* was isolated from the sample by successfully growing the organism on both trypticase soy agar with 5% sheep blood and Modified Oxford agar.[d,e] Antimicrobial susceptibility to different antimicrobials was determined using an automated broth microdilution minimum inhibitory concentration (MIC) determination method (Table 2).[f]

Additional feed samples, including the hay, pellets, and silage, were collected on day 9 of the outbreak and submitted for pH determination and culture for *Listeria*. The pH of the hay, pellets, and silage were 6.2, 6.2, and 3.9, respectively. All samples were *Listeria* culture negative.

**Table 2.** Antimicrobial susceptibility profile of cultured *Listeria monocytogenes*

| Antimicrobial | Sensitivity | MIC (mcg/ml) |
|---|---|---|
| Ampicillin | Resistant | 4.0 |
| Ceftiofur | Resistant | > 4.0 |
| Cloxacillin | Resistant | > 4.0 |
| Erythromycin | Susceptible | ≤ 0.5 |
| Florfenicol | Resistant | > 1.0 |
| Penicillin | Resistant | > 2.0 |
| Spectinomycin | Resistant | > 16.0 |
| Tetracycline | Susceptible | ≤ 4.0 |
| Tilmicosin | Intermediate | 16.0 |
| Trimeth/Sulfa | Susceptible | ≤ 0.5 |

## Discussion

Silage properly stored and sealed to prevent aerobic deterioration should ferment actively and produce lactic acid. This lowers the pH below 4.2, which is inhibitory to the growth of *Listeria monocytogenes*.[4] Previous research has shown that *Listeria monocytogenes* grows optimally in spoiled vegetation having a pH ≥ 5.5.[7,9,15] The spoiled silage sample which may have caused this outbreak had a pH of 6.9.

Antimicrobial selection for the treatment of listeriosis is based on the drug's ability to cross the blood-brain barrier and inhibit further growth of the *Listeria* organism. However, culture and sensitivity testing are frequently not useful because the clinical outcome of a single listeriosis case is often determined before the organism can be recovered.

Penicillin is often recommended as the treatment of choice for listeriosis.[11,12] *In vitro* antibiotic susceptibility testing of the *Listeria monocytogenes* isolate recovered from the silage sample in this report revealed resistance to penicillin at > 2 mcg/ml. The organism was sensitive to tetracycline at 4 mcg/ml; therefore oxytetracycline was the antibiotic used in this outbreak.

Dexamethasone was administered to affected animals in hopes of decreasing the degree of inflamed neural tissue. The use of steroids for the treatment of encephalitic listeriosis was contraindicated in one report;[2] however, other references reviewed[5,6,11,12] did not address the subject. Interestingly, the administration of dexamethasone has been shown to significantly increase the shedding of *Listeria* organisms in milk of cows experimentally infected with *Listeria monocytogenes*.[14]

The prevalence of *Listeria monocytogenes* in feces of healthy cattle in Japan has been shown to be 1.9%.[8] If cattle affected with encephalitic listeriosis were shedding *Listeria* organisms in their feces, steroid administration to these individuals may increase the degree of fecal

shedding. If this would occur, measures such as animal segregation, prompt disposal of fecal material, and proper human hygiene would be warranted to minimize animal as well as human exposure.

Analgesics and vitamin E-selenium injections may be beneficial to an animal with exertional myopathy caused by excessive muscular activity secondary to neurologic disease,[12] but these drugs were not included in this treatment protocol.

The most likely route of *Listeria* organisms into nervous tissue is an ascending infection from the trigeminal nerve rootlets along the trigeminal nerve to the brain stem.[1] A higher incidence of infection in young animals would be expected because of increased exposure of trigeminal nerve rootlets associated with the eruption of teeth.[6] The eruption of permanent bovine teeth occurs between 12 and 48 months of age.[3] The bulls with clinical listeriosis in this report were 19 to 32 months old. Encephalitic listeriosis would be classified as an infectious but not contagious disease because a break in the buccal mucosa is considered necessary for its pathogenesis.

Encephalitis due to listeriosis may have many different clinical manifestations, depending on which nuclei or adjacent nerve tracts located in the brain stem are damaged. Common sites affected are cranial nerves (CN) V through X and XII. Another common site within the brain stem for lesions is the ascending reticular activating system. Injury to this area causes mild to severe depression.[12]

Lesions of the trigeminal nerve (CN V) cause facial hypalgesia and paresis of the muscles that control mastication. Animals exhibit asymmetric closure of the jaw which leads to difficulty when eating or drinking. Abducens nerve (CN VI) involvement may cause an ipsilateral medial strabismus. Facial nerve (CN VII) palsy causes loss of menace response, absent palpebral reflex, a drooped ear, ptosis, a flaccid lip, and paralysis of the orbicularis oculi muscle which may lead to exposure keratitis.

Dysfunction of the vestibulocochlear nerve (CN VIII) causes ataxia, circling, head tilt, and a nystagmus that changes as the position of the head is changed. The circling and head tilt are usually toward the side with the lesion, but may be directed away from the side of the lesion when the pathology involves the cerebellar peduncles (case #1).[13]

Dysphagia and salivation are the primary clinical signs observed with the acute loss of the glossopharyngeal (CN IX) and vagus (CN X) nerves. Injury to the hypoglossal nerve (CN XII) causes paresis or paralysis of the tongue and causes the tongue to protrude from the side of the mouth ipsilateral to the lesion. Dysphagia may cause the animal to become dehydrated. Supplementation with oral or intravenous fluids may be necessary in the treatment protocol. Chronic loss of salivary fluid may predispose to metabolic acidosis because of the significant bicarbonate content of saliva. The addition of bicarbonate to the fluid therapy may be necessary if this condition exists.

In this outbreak, affected animals exhibited different clinical signs. Cases 1, 2, 3, and 4 had clinical signs consistent with specific cranial nerve dysfunction. The same four bulls were also anorexic, which was directly caused by a lesion in the nerve responsible for mastication (CN V), and indirectly by involvement of the reticular activating system which caused depression. Cases 2, 3, and especially 5 had conscious proprioceptive deficits which were caused by dysfunction of the descending motor pathways and the ascending proprioceptive fibers in the brain stem.

Isolation of *Listeria monocytogenes* from the brain stem of a patient with clinical encephalitis is the definitive method for diagnosing listeriosis. *Listeria monocytogenes* was not isolated from the single bull submitted for necropsy, perhaps because the bull had been treated 2 days with oxytetracycline before it was euthanized. *Listeria monocytogenes* was only isolated from one silage sample. Since the silage sample was collected 5 days after the presentation of the first encephalitic bull, the isolated *Listeria* organism which presumably caused this outbreak may have been responsible for all, part, or none of the diseased bulls in this review. Other investigations have found a variety of *Listeria* ribotypes from a single silage sample implicated in a listeriosis outbreak.[10,15] Because a single, common isolate may not be identified in both the feed source and affected animal(s), the clinician must be cautious when evaluating *in vitro* susceptibility results from the feed source suspicious of causing a listeriosis outbreak.

Ingestion of the *Listeria* organism may cause septicemic (visceral) listeriosis or abortion. The primary sites of entry are presumed to be the intestinal epithelium and the specialized epitheilial cells covering the Peyer's patches.[5] Infection is usually inapparent, but fatal septicemia may develop. If entry to the uterus is achieved, *Listeria monocytogenes* can cause significant pathology including metritis, placentitis, fetal infection and death, abortion, stillbirth, and neonatal death.

## Conclusion

Cases of encephalitic listeriosis, or "silage sickness," may be presented to bovine practitioners when improper silage fermentation permits the growth of *Listeria monocytogenes*. Young animals may be more susceptible to contracting the disease due to tooth eruption. Listeriosis has many different clinical presentations depending on which cranial nerve nuclei

and adjacent nerve tracts located in the brain stem are damaged. The definitive method for diagnosing listeriosis is isolation of *Listeria monocytogenes* from the brain stem of an affected patient. The practitioner must be careful when evaluating *in vitro* susceptibility results from a *Listeria* positive feed source or brain stem because multiple *Listeria* ribotypes may be involved in a single outbreak.

## Footnotes

[a]Electrolyte Powder 8X, Phoenix Pharmaceutical, Inc., St. Joseph, MO.
[b]Rush L, Stromberg P, Department of Veterinary Biosciences, College of Veterinary Medicine, The Ohio State University: Necropsy report, 1998.
[c]Division of Animal Industry, Ohio Department of Agriculture, Reynoldsburg, OH.
[d]Difco, Detroit, MI.
[e]BBL, Becton Dickinson Microbiology Systems, Cockeysville, MD.
[f]Sensititre®, Accumed, Westlake, OH.

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13. Roeder BL, Johnson JW, Cash WC: Paradoxic vestibular syndrome in a cow with a metastatic brain tumor. Compend Cont Educ Pract Vet 1990, 12:1175-1181.
14. Wesley IV, Bryner JH, Van Der Maaten MJ, et al.: Effects of dexamethasone on shedding of *Listeria monocytogenes* in dairy cattle. Am J Vet Res 1989, 50(12):2009-2013.
15. Wiedmann M, Bruce JL, Knorr R, et al.: Ribotype diversity of *Listeria monocytogenes* strains associated with outbreaks of listeriosis in ruminants. J Clin Microbiol 1996, 34:1086-1090.