Case Report Rapport de cas

Blastomycotic osteomyelitis associated with severe lameness in a horse

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Abstract — A 12-year-old Quarter horse gelding was presented for evaluation of severe right forelimb lameness, 2 draining tracts over the lateral aspect of the right proximal antebrachium, and weight loss. A presumptive diagnosis of blastomycotic osteomyelitis was established based on radiographs and cytology of the exudate. This diagnosis was confirmed at necropsy.

Résumé — Ostéomyélite à *Blastomyces* associée à une boiterie grave chez un cheval. Un hongre Quarter horse âgé de 12 ans a été présenté avec une boiterie grave du membre antérieur droit, 2 faisceaux de drainage sur l'aspect latéral de l'avant-bras droit proximal et une perte de poids. Un diagnostic par inférence d'ostéomyélite à *Blastomyces* a été posé en se fondant sur les radiographies et la cytologie de l'exsudat. Ce diagnostic a été confirmé à la nécropsie.

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A 12-year-old, 490-kg Quarter horse gelding was presented to the University of Minnesota Equine Center for evaluation of severe right forelimb lameness, 2 draining tracts over the lateral aspect of the right proximal antebrachium, and weight loss. Nine weeks before presentation the horse was found at pasture exhibiting acute non-weight-bearing lameness of the right forelimb and had an area of hair loss (2 × 2 cm) over the lateral aspect of the right elbow. A kick injury was suspected by the owner and the horse was treated with phenylbutazone (Phenylbutazone; Bimeda, Le Sueur, Minnesota, USA), 2.2 mg/kg body weight (BW), PO, q12h and stall rest for 2 wk. No improvement was noted and, by the end of the 2 wk, the horse had developed a 5 × 5 cm firm swelling at the hairless area and fever (rectal temperature 38.9°C). Phenylbutazone was discontinued and a 3-week course of trimethoprim/sulfamethoxazole (Sulfamethoxazole and trimethoprim; Qualitest Pharmaceuticals, Huntsville, Alabama, USA), 20 mg/kg BW, PO, q12h was administered. The swelling continued to increase in size and 5 wk after the first onset of clinical signs, radiographs of the right elbow revealed periosteal reaction and bony proliferation at the level of the proximal metaphysis of the radius, and a radiolucent area approximately 2 cm distal to the elbow joint. A fine-needle aspirate of the suspected lytic area was attempted by the referring veterinarian at that time but no sample was obtained. Antibiotic therapy was discontinued due to the lack of improvement.

Seven weeks after the initial lameness, serous yellow discharge developed at the site of the aspirate and a smear of this exudate revealed fungal organisms compatible with *Blastomyces dermatitidis*. A week later, a second draining tract developed 5 cm distal and 2 cm caudal to the initial tract. The owner began flushing the draining tracts with hydrogen peroxide and sterile saline once daily and wrapping the leg with an absorbent bandage. No other treatment was administered in the 2 wk prior to referral. Increased respiratory rate and effort developed in the week before presentation to our hospital, and ventral edema developed 3 d prior to presentation. Significant weight loss (approximately 90 kg) was reported by the owner, despite an excellent appetite for free-choice grass hay supplemented with 7 kg of Equine Senior (Purina, Gray Summit, Missouri, USA) pelleted ration per day. The horse had been pastured with 1 other horse in eastern Minnesota. The pasture did not contain any bodies of water or disturbed earth, but 3 mo prior to the onset of lameness the affected horse was trail ridden in an area of northwestern Wisconsin that is endemic for blastomycosis. At the time of writing, no illness was reported in the pasture mate, the owner, or the owner's dog.

Case description

At presentation, the horse was non-weightbearing on the right forelimb and had a firm swelling (15 × 15 cm) with 2 malodorous ulcerated draining tracts on the lateral aspect of the limb, approximately 6 and 11 cm distal to the elbow joint,

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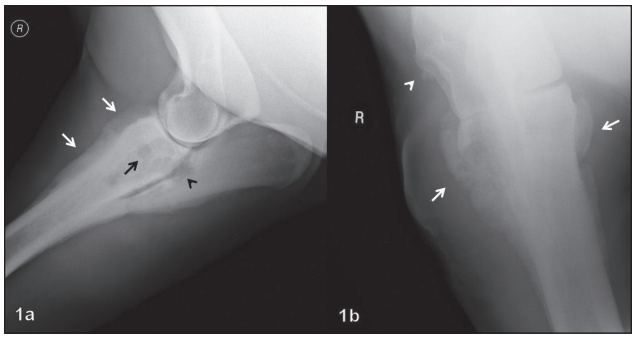


Figure 1. (a) Lateromedial, and (b) craniocaudal radiographs of the right forelimb taken on admission (9 wk after initial onset of lameness). Marked periosteal reaction and bone proliferation (white arrows), radiolucent areas (black arrow), and loss of bone cortex (black arrowhead) are present in the radius and ulna. Mild local bone proliferation is present on the lateral epicondyle of the humerus (white arrowhead).

respectively. Clinical examination identified increased rectal temperature (38.7°C), tachycardia (76 beats/min), and tachypnea (60 breaths/min). The oral mucous membranes were pink and moist with normal capillary refill time (< 2 s). Body condition was poor (3/9). The horse exhibited a moderate increase in respiratory effort characterized by greater than normal thoracic and abdominal excursion. Thoracic auscultation revealed diffusely harsh bronchovesicular sounds with coarse inspiratory crackles identified over the craniodorsal lung fields. Results of abdominal auscultation were normal. Ventral abdominal edema was noted; its distribution was asymmetrical with the left side of the abdomen more severely affected. Multiple pressure sores were present over the left tuber coxae, spine of the scapula, and lateral aspect of the hock. The left forelimb and both hind limbs had subjectively increased digital pulses.

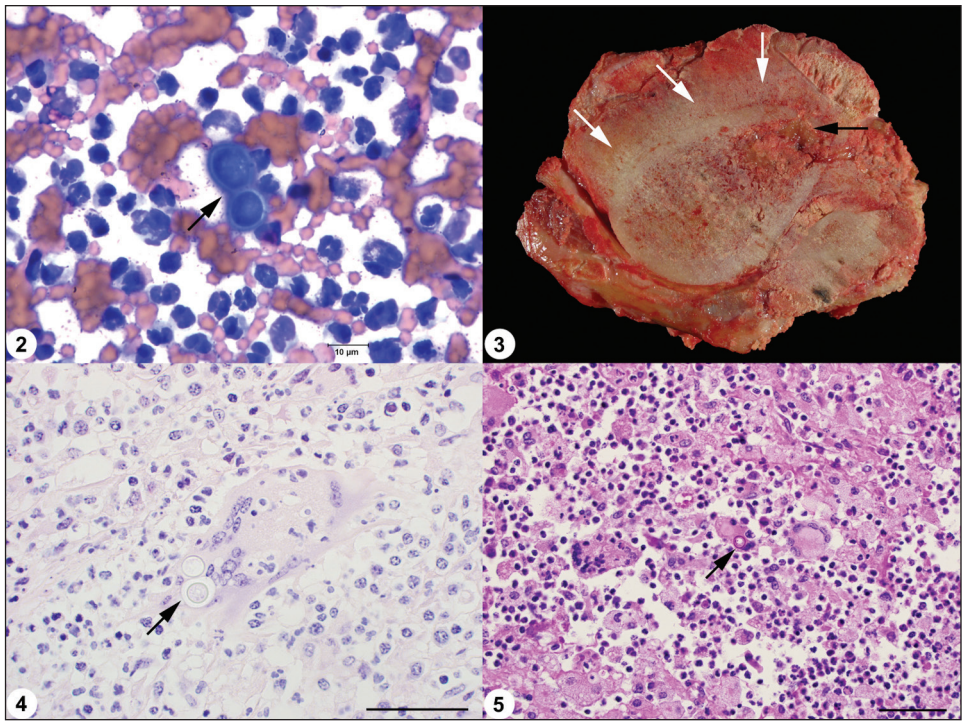
On hematology, packed cell volume was 30% [reference interval (RI): 29% to 44%], total plasma protein concentration was 86 g/L (RI: 61 to 79 g/L), and there was a leukocytosis (23 500/μL; RI: 5100 to 11 700/μL) characterized by a mature neutrophilia (21 400/μL; RI: 2400 to 8000/μL). Serum biochemistry revealed hypoalbuminemia (24 g/L; RI: 29 to 39 g/L), hyperglobulinemia (62 g/L; RI: 19 to 39 g/L), and hyperfibrinogenemia (26.5 μmol/L; RI: 2.9 to 11.8 μmol/L). There were increases in alkaline phosphatase (268 U/L; RI: 48 to 148 U/L) and creatine kinase (421 U/L; RI: 82 to 303 U/L) activities. Serum immunoglobulin concentrations were determined using a radial immunodiffusion assay (SRID Kit; Veterinary Medical Research and Development, Pullman, Washington, USA): IgA concentration was 0.44 g/L (RI: 0.60 to 2.40 g/L), IgG concentration was 18.0 g/L (RI: 9.8 to 16.8 g/L), and IgM concentration was 0.41 g/L (RI: 0.9 to 1.5 g/L).

Radiographs of the right proximal radius revealed marked periosteal reaction and bony proliferation, radiolucent areas, and loss of bone cortex in the proximal radius and ulna (Figures 1a and 1b). Mild local bone proliferation was present on the lateral epicondyle of the humerus (Figure 1b). The extent of the bony reaction was more significant than in the radiographs taken 4 wk prior to presentation. The polyostotic nature of the lesion suggested a possible fungal osteomyelitis, but a soft-tissue neoplasm could not be excluded. Thoracic radiography was performed to rule out the possibility of pulmonary involvement, but no significant abnormalities were identified.

Ultrasonographic evaluation of the thorax and abdomen revealed no abnormalities. An impression smear of exudate from the draining tracts was performed; low to moderate numbers of round, basophilic, thick-walled, refractile structures (10 to 15 μm in diameter), often exhibiting broad based budding were identified (Figure 2). These morphologic characteristics suggested *Blastomyces dermatitidis.* Serologic testing for *Blastomyces dermatitidis* using an agar gel immunodiffusion assay (Immuno-Mycologics, Norman, Oklahoma, USA) yielded negative results. Based on the severity of the bony lesions, a tentative diagnosis of blastomycotic osteomyelitis, chronic severe pain, and a poor prognosis for recovery, humane euthanasia was recommended.

On postmortem examination, abundant beige to yellow, viscous fluid exuded from a network of fistulous tracts which coursed through and expanded the subcutis and fascia of the right disto-lateral humeral and proximo-lateral antebrachial regions. A 9 × 5 × 3.5 cm thick-walled abscess expanded the subcutis of the caudal antebrachium, and contained a similar fluid to that within the draining tracts. The fistulous tracts extended into and focally replaced the underlying cortical and medullary bone of the proximal right radius and ulna. The periosteum of the proximal 1/3 of the radius and ulna was markedly expanded by dense trabeculae of new bone with an irregular surface. This periosteal proliferation extended outward 1.5 cm from the original cortex of the radius (Figure 3). Multiple lymph nodes in the right forelimb, axillary region, and thoracolumbar area were enlarged (ranged in size from 2.4 × 1.5 × 1.3 cm to 8 × 5.5 × 2.7 cm), firm, multilobulated, and on cut surface, exuded a yellowish, thick viscous fluid. Centrally within the superficial parenchyma of the left caudal lung lobe, there was a single, 15 × 20 × 15 mm, ovoid, beige, firm, well-demarcated nodule that extended up to the overlying visceral pleura. Two additional small (1 to 2 cm) nodules with similar characteristics were present in the parenchyma of the same lung lobe. No significant abnormalities were detected in other body systems.

Tissue specimens for histological examination were fixed in 10% neutral buffered formalin, processed, embedded in paraffin, sectioned at 4 to 5 μm, stained with hematoxylin and eosin (H & E), and examined microscopically. Selected sections of the lungs, axillary lymph nodes, right proximo-lateral antebrachial fascia, and right proximal radius were stained with Gomori methenamine silver (GMS) and periodic acid Schiff (PAS). Histologically, the subcuticular soft tissues of the right proximo-lateral antebrachium and the cortex and medulla of the proximal right radius were effaced by multifocal to coalescing inflammatory foci with neutrophils circumferentially surrounded by marked infiltrates of macrophages, moderate infiltrates of lymphocytes, plasma cells, and a lesser number of multinucleated giant cells (foreign body and Langhans type) within a lattice of fibrous connective tissue (Figure 4). The centers of these foci contained aggregates of pale eosinophilic, homogeneous to coarsely granular material interspersed with basophilic cellular debris and rare circular (10 to 25 μm) GMS- and PAS-positive yeast bodies with a refractile, double contour wall (1 to 2 μm)



Figures 2. Smear of the exudate from the draining tract performed on admission. The round, basophilic, thick-walled, refractile structures with broad based budding located at the center of the image (arrow) are cytologically consistent with *Blastomyces dermatitidis.* Modified Wright's stain; bar = 10 µm. **Figure 3.** Cross-section of the proximal right radius and ulna. Marked bony proliferation is present around the dorsal and lateral aspects of the radius (white arrows) and a well-demarcated area of bone lysis is visible on the radius laterally (black arrow). **Figure 4.** Right proximal radius subcutis/fascia showing multifocal infiltrates of macrophages, neutrophils, and lymphocytes with multinucleated giant cells containing spherical, intracytoplasmic yeast bodies (arrow); Hematoxylin & eosin; bar = 50 µm. **Figure 5.** Axillary lymph node; extensive inflammation (lymphadenitis) predominantly with neutrophils and macrophages. Note multinucleated giant cell with intracytoplasmic PAS-positive oval yeast body (arrow); periodic acid Schiff stain; bar = 50 µm.

and pale eosinophilic cytoplasm (Figure 4). Numerous intra- and extracellular, brightly eosinophilic, long filamentous rod-shaped bacteria were also observed in these regions. Similar inflammatory foci were observed in the axillary lymph nodes (associated with rare yeast bodies) (Figure 5) and the left lung lobe (no yeast bodies observed). There was no histological evidence of lymphoid depletion in any of the sections of lymph node or spleen examined. The periosteal proliferation overlying the proximal radial cortex was composed of numerous loosely, but well-organized, trabeculae of new woven bone with extensive interconnecting streams of fibrous connective tissue. Fungal cultures of the axillary lymph nodes and radial subcuticular abscess yielded small numbers of *Blastomyces dermatitidis.* No fungal organisms were isolated from the lung.

Discussion

Blastomycosis is an uncommon fungal infection caused by the dimorphic fungus *Blastomyces dermatitidis* that infects humans and animals (1–3). It is endemic in the wooded areas of Manitoba, northwestern Ontario, the Great Lakes, and the Mississippi, Missouri, and Ohio River valleys (1,2,4). Inhalation is the primary route of infection in humans (5) and dogs (6), and pneumonia and weight loss are the most common clinical signs. Higher risk of blastomycosis has been demonstrated in humans and dogs living near lower elevation waterways or on sandy soils prone to drought (7). This fungal disease has become increasingly recognized as a serious infection in immunocompromised hosts (8). The acute pulmonary phase may be subclinical or self-limiting (9); in certain patients, however, lesions become chronic and can spread to almost any location in the body, with bone being the third most common location in human patients (10). In dogs, bone involvement has also been described in several reports (11–14). Cases of blastomycosis involving the thorax, abdomen, mammary gland, joint, skin, and other soft tissues have been reported in horses (3,15–18). To our knowledge, this is the first report of blastomycotic osteomyelitis causing severe lameness in a horse.

In the present case, a tentative antemortem diagnosis of blastomycotic osteomyelitis was made on the basis of radiographic and cytologic findings, and this diagnosis was confirmed with histopathology and fungal culture. Serological testing for *Blastomyces* spp. was negative in this horse. Little information is available on the sensitivity and specificity of serologic testing in affected horses, but in humans and dogs it is considered an insensitive and unreliable diagnostic method (19,20). In humans, although there is no typical radiographic appearance of blastomycotic osteomyelitis, lesions can be classified as either local or diffuse (21). Local osteomyelitis may have a sclerotic rim

and periosteal reaction is commonly present in the long bones but absent from the short bones. The diffuse pattern is similar to that seen in the horse presented here, and is characterized by rapid bone destruction (moth-eaten pattern), marked periosteal reaction, and infection that may invade other joints or create draining tracts. Metaphyseal involvement is also common in human blastomycosis, and is attributed to the slow circulation in metaphyseal vascular loops (22,23). Radiographic findings of blastomycosis can be misinterpreted as neoplastic processes, thereby contributing to a delay in diagnosis and treatment. This emphasizes the importance of identifying the organism by cytologic examination, histopathology, or by fungal culture (the gold standard for diagnosis) (22).

The source of infection in this horse was not identified. Trauma was highly suspected by the owner of this horse. Although it could be coincidental, a history of previous trauma was reported in 22% of the cases in a study of human blastomycotic osteomyelitis (24). A local inflammatory reaction caused by trauma could have attracted neutrophils carrying *B. dermatitidis* to the site, leading to seeding and consequent infection (25). On the other hand, direct inoculation is also possible in this horse because osseous and/or cutaneous blastomycosis without other sites of involvement has been reported in dogs and in human patients as a result of direct inoculation or dog bites (12,26–28). A comprehensive assessment of immune function in this horse was not performed, so it is unclear whether or not immunodeficiency played a role in development of disease. The high IgG concentration, prominent lymph nodes, and substantial inflammatory response in the right forelimb, right axillary, and thoracolumbar region, suggested some degree of immune reaction against the fungal organism. Low serum IgA and IgM concentrations were identified, but this may reflect a transient secondary response to chronic fungal infection rather than a primary immunodeficiency state. In horses, low IgM concentrations have been identified in association with lymphoma and other disorders of the gastrointestinal, respiratory, ophthalmic, endocrine, hematopoietic, neuromuscular, and dermatologic systems (29). The horse in this report had no history of infection or illness in the 2 previous years.

Pharmacological treatment (amphotericin B, itraconazole, and ketoconazole) with or without surgical debridement yielded excellent results in humans with blastomycotic osteomyelitis when severe pulmonary lesions were not present (22,24). In addition, severe lameness caused by patellar blastomycosis in a dog was successfully treated with surgical debridement, oral itraconazole, and physical rehabilitation (14). Itraconazole has gained popularity for the treatment of canine blastomycosis because of its oral administration, low toxicity, and effectiveness against isolates of *B. dermatitidis* in vitro (30). In dogs, recommended doses of oral itraconazole vary from 5 to 10 mg/kg BW, q24h for 60 to 90 d or for 2 to 4 wk beyond resolution of clinical signs (31). In contrast, none of the reported equine cases has been treated successfully, suggesting a poor prognosis for this disease in the horse (3,15–18). Treatment was not attempted in the case presented here due to the chronic severe pain and the severity of the radiographic findings at the time of admission. However, based on the results of human and canine osseous blastomycosis, prompt recognition of this rare equine disease and antifungal therapy (itraconazole) might allow successful therapeutic intervention in horses.

In conclusion, although *B. dermatitidis* infection is rare in horses, blastomycotic osteomyelitis should be included in the list of differential diagnoses for horses from endemic areas that develop lameness, rapid bone destruction, and marked periosteal reaction. CVJ

References

1. Rudmann DG, Coolman BR, Perez CM, et al. Evaluation of risk factors for blastomycosis in dogs: 857 cases (1980–1990). J Am Vet Med Assoc 1992;201:1754–1759.
2. Crampton TL, Light RB, Berg GM, et al. Epidemiology and clinical spectrum of blastomycosis diagnosed at Manitoba hospitals. Clin Infect Dis 2002;34:1310–1316.
3. Toribio RE, Kohn CW, Lawrence AE, et al. Thoracic and abdominal blastomycosis in a horse. J Am Vet Med Assoc 1999;214:1357–1360, 1335.
4. Furcolow ML, Balows A, Menges RW, Pickar D, McClellan JT, Saliba A. Blastomycosis. An important medical problem in the Central United States. JAMA 1966;198:529–532.
5. Bradsher RW, Chapman SW, Pappas PG. Blastomycosis. Infect Dis Clin North Am 2003;17:21–40, vii.
6. Bromel C, Sykes JE. Epidemiology, diagnosis, and treatment of blastomycosis in dogs and cats. Clin Tech Small Anim Pract 2005;20: 233–239.
7. Baumgardner DJ, Steber D, Glazier R, et al. Geographic information system analysis of blastomycosis in northern Wisconsin, USA: Waterways and soil. Med Mycol 2005;43:117–125.
8. Pappas PG. Blastomycosis in the immunocompromised patient. Semin Respir Infect 1997;12:243–251.
9. Klein BS, Vergeront JM, Weeks RJ, et al. Isolation of *Blastomyces dermatitidis* in soil associated with a large outbreak of blastomycosis in Wisconsin. N Engl J Med 1986;314:529–534.
10. Lemos LB, Guo M, Baliga M. Blastomycosis: Organ involvement and etiologic diagnosis. A review of 123 patients from Mississippi. Ann Diagn Pathol 2000;4:391–406.
11. Harasen G. Blastomycosis as a cause of lameness. Can Vet J 2007;48: 1291–1292.
12. Marcellin-Little DJ, Sellon RK, Kyles AE, et al. Chronic localized osteomyelitis caused by atypical infection with *Blastomyces dermatitidis* in a dog. J Am Vet Med Assoc 1996;209:1877–1879.
13. Wehner A, Crochik S, Howerth EW, et al. Diagnosis and treatment of blastomycosis affecting the nose and nasopharynx of a dog. J Am Vet Med Assoc 2008;233:1112–1116.
14. Oshin A, Griffon D, Lemberger K, et al. Patellar blastomycosis in a dog. J Am Anim Hosp Assoc 2009;45:239–244.
15. Benbrook EA, Bryant JB, Saunders LZ. A case of blastomycosis in the horse. J Am Vet Med Assoc 1948;112:475–478.
16. Dolente BA, Habecker P, Chope K, et al. Disseminated blastomycosis in a miniature horse. Equine Vet Ed 2003;15:139–142.
17. Wilson JH, Olson EJ, Haugen EW, et al. Systemic blastomycosis in a horse. J Vet Diagn Invest 2006;18:615–619.
18. Stefaniak W. Case of inflammation of the temporo-mandibular joint in horse due to blastomycosis. Med Weter 1950;6:730–732.
19. Chapman SW, Lin AC, Hendricks KA, et al. Endemic blastomycosis in Mississippi: Epidemiological and clinical studies. Semin Respir Infect 1997;12:219–228.
20. Crews LJ, Feeney DA, Jessen CR, et al. Utility of diagnostic tests for and medical treatment of pulmonary blastomycosis in dogs: 125 cases (1989–2006). J Am Vet Med Assoc 2008;232:222–227.
21. Kalbhen C. Radiologic case study. Blastomycotic osteomyelitis. Orthopedics 1991;14:722, 724, 726–728.
22. Saiz P, Gitelis S, Virkus W, et al. Blastomycosis of long bones. Clin Orthop Relat Res 2004;421:255–259.
23. MacDonald PB, Black GB, MacKenzie R. Orthopaedic manifestations of blastomycosis. J Bone Joint Surg Am 1990;72:860–864.
24. Oppenheimer M, Embil JM, Black B, et al. Blastomycosis of bones and joints. South Med J 2007;100:570–578.
25. Ehni W. Endogenous reactivation in blastomycosis. Am J Med 1989; 86(6 Pt 2):831–832.

26. Gray NA, Baddour LM. Cutaneous inoculation blastomycosis. Clin Infect Dis 2002;34:E44–9.
27. Larson DM, Eckman MR, Alber RL, et al. Primary cutaneous (inoculation) blastomycosis: An occupational hazard to pathologists. Am J Clin Pathol 1983;79:253–255.
28. Gnann JW, Jr, Bressler GS, Bodet CA, 3rd, et al. Human blastomycosis after a dog bite. Ann Intern Med 1983;98:48–49.
29. Perkins GA, Nydam DV, Flaminio MJ, et al. Serum IgM concentrations in normal, fit horses and horses with lymphoma or other medical conditions. J Vet Intern Med 2003;17:337–342.
30. Chapman SW, Rogers PD, Rinaldi MG, et al. Susceptibilities of clinical and laboratory isolates of *Blastomyces dermatitidis* to ketoconazole, itraconazole, and fluconazole. Antimicrob Agents Chemother 1998;42:978–980.
31. Legendre AM, Rohrbach BW, Toal RL, et al. Treatment of blastomycosis with itraconazole in 112 dogs. J Vet Intern Med 1996;10:365–371.

Answers to Quiz Corner
Les réponses du test éclair

1. **e)** In most reported studies, incarceration of the small intestine in the epiploic foramen adjacent to the caudate lobe of the liver occurs in middle-aged horses.
e) Dans la plupart des études rapportées, l'étranglement du petit intestin dans le trou épiploïque adjacent au lobe caudé du foie se produit chez les chevaux d'âge moyen.

2. **c)** The defensive threat posture of dogs includes a lowered body, tail, and ears.
c) La posture de menace défensive des chiens comprend un abaissement du corps, de la queue et des oreilles.

3. **d)** Installation of a carpeted frame may induce the cat to use the litterbox.
d) L'installation d'une charpente en tapis peut inciter le chat à utiliser sa litière.

4. **b)** An intrathoracic mass does not produce chylous effusion.
b) Une masse intrathoracique ne cause pas d'épanchement de chyle.

5. **a)** *Giardia* organisms have an environmentally resistant cyst that persists well in cool, clear water; hence the concern of a water-source contamination.
a) *Giardia* possède un kyste résistant qui survit dans l'environnement et persiste bien dans de l'eau claire et froide; d'où la préoccupation d'une contamination de source aqueuse.

6. **b)** To prevent infection resulting from contamination introduced during surgery, antibiotics should be administered just long enough before surgey to achieve high serum concentration and administered often enough to maintain levels through the period of possible contamination.
b) Afin d'empêcher l'infection provenant d'une contamination durant la chirurgie, les antibiotiques doivent être administrés suffisamment longtemps avant la chirurgie pour atteindre une concentration sérique élevée et être administrés assez souvent pour maintenir des concentrations durant la période de possibilité de contamination.

7. **a)** Large perireticular abscesses are usually caused by chronic reticuloperitonitis. At surgery a nail or wire is often found in the region of the abscess.
a) De gros abcès périréticulaires sont habituellement causés par une réticulopéritonite chronique. Au moment de la chirurgie, un clou ou un fil métallique est souvent trouvé dans la région de l'abcès.

8. **e)** This is a common cause of subclinical mastitis in goats.
e) Cet organisme est une cause fréquente de mammite subclinique chez la chèvre.

9. **a)** Unilateral facial paresis is a common finding in cattle with listeriosis.
a) La parésie faciale unilatérale est une affection courante chez les bovins souffrant de listériose.

10. **d)** Similar to thiobarbiturates, propofol depresses seizure activity, decreases intraocular pressure, and causes muscle relaxation.
d) Similaire aux thiobarbituriques, le propofol abaisse l'activité convulsive, diminue la pression intraoculaire et provoque la relaxation musculaire.