Bovine spongiform encephalopathy identified in a cow imported to Canada from the United Kingdom — A case report

Steve S. Chen, Kenneth M. Charlton, Arumuga V. Balachandran, Brendan P. O'Connor, Chris C. Jenson

Bovine spongiform encephalopathy (BSE) was first reported in the United Kingdom (UK) in 1987 (1). Exposure of cattle, particularly within the first 6 mo of life, to protein supplements derived from rendered ruminant materials has been incriminated as the cause of infection (2–4). The disease not only reached epidemic proportions in Great Britain, but also occurred in native cattle in France, Switzerland, Portugal, Northern Ireland, and the Republic of Ireland (5). Single cases in cattle imported from the UK have been identified in Denmark and the Falkland Islands; 2 cases have occurred in Oman and Italy and 4 in Germany (5–7). Pursuant to the Reportable Diseases Regulations of the Health of Animals Act, Agriculture and Agri-Food Canada, BSE has been a reportable disease in Canada since 1990. Any suspect case must be reported and the diagnosis confirmed. This report presents the history and histological findings of the 1st case of BSE observed in Canada.

The affected cow was born in August 1986 and raised on its farm of origin in the UK. She was 1 of 8 Salers cattle imported into Canada from the UK on January 27, 1987.

During a snow storm in November 1993, the owner found the cow laying in the laneway as he returned from giving supplemental feed. The cow was unable to rise and incapable of moving her left hind limb. Realizing that this animal was one of the UK imports that had been under federal surveillance since 1990, he informed the federal district veterinarian. On the advice of this officer, the cow was killed and the head removed .

The head was submitted to the Animal Health Laboratory, Airdrie, Alberta, by a federal inspector on November 22, 1993. The left cerebral hemisphere was sectioned and examined for lesions of *Hemophilus somnus* and for polioencephalomalacia using a Wood's lamp. Samples were submitted to the federal rabies laboratory at the Animal Diseases Research Institute (ADRI), Lethbridge, Alberta. The remainder of the brain was fixed in 10% neutral buffered formalin. The brain was reported as negative for rabies by the fluorescent antibody test on November 24, 1993.

Selected pieces of brain, including midbrain and medulla oblongata, were dehydrated and embedded in paraffin using routine histological procedures. Sections were cut and stained with hematoxylin and eosin (H&E). On histological examination, bovine spongiform encephalopathy was suspected, and on November 30, 1993, the remaining fixed brain, all of the H&E sections, and the wax blocks were forwarded to ADRI, Nepean, Ontario for examination. There, a series of coronal slices of brain were cut at different levels and embedded in paraffin. Five-micron sections were cut and stained with H&E and by an immunohistochemical procedure for astrocytes (8).

Stained sections (H&E) from a confirmed case of BSE (88-0012) from the UK were used as references with which to compare the type and extent of lesions in selected areas. A diagnosis of BSE was made at ADRI, Nepean; a set of slides of H&E stained sections, some wax blocks, and pieces of frozen brain were referred to the Central Veterinary Laboratory, Weybridge, UK for confirmation of the diagnosis.

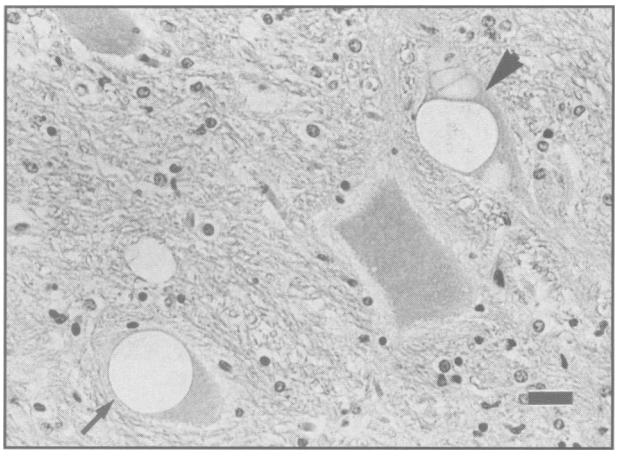

Figure 1. Single (arrow) and multiple (arrowhead) vacuoles in the neuronal perikarya in the lateral vestibular nucleus. Hematoxylin and eosin. Bar = 25 μm.

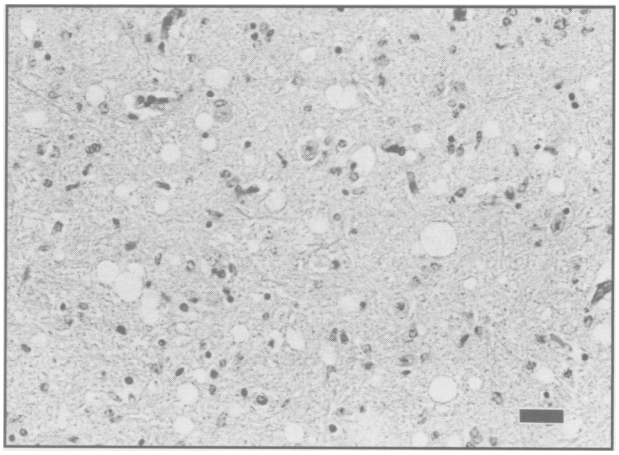

Figure 2. Spongiform change in the nucleus of the solitary tract. Hematoxylin and eosin. Bar = 25 μm.

Can Vet J 1996; 37: 38–40

Animal Diseases Research Institute, Health of Animals Laboratory Division, Food Production and Inspection Branch, Agriculture and Agri-Food Canada, Nepean, Ontario K2H 8P9 (Chen, Charlton, Balachandran); Airdrie Veterinary Laboratory, Animal Health Division, Animal Health Laboratories Branch, Alberta Agriculture Food and Rural Development, Airdrie, Alberta T4B 2C1 (O'Connor); and District Office, Animal Health Division, Food Production and Inspection Branch, Agriculture and Agri-Food Canada, Red Deer, Alberta T4N 2N1 (Jenson).

Bilaterally symmetrical vacuolation in neuronal perikarya (Figure 1) and neuropil (Figure 2) was observed at different levels of the brain stem and spinal cord. Vacuolation of neuronal perikarya was characterized by single or multiple vacuoles in the cytoplasm of neurons in various brain stem nuclei, especially in the lateral vestibular nucleus, dorsal motor nucleus of the vagus nerve, red nucleus, spinal tract nucleus of the trigeminal nerve, pontine nucleus, reticular formation, and periaqueductal grey matter. A few neurons with vacuoles were also observed in the ventral horn of the spinal cord and in the following brain stem nuclei: cuneate, facial, trochlear, oculomotor, supraoptic, and solitary tract, as well as in the thalamus and hypothalamus.

Spongiform change, consisting of small vacuoles in the neuropil of the grey matter, was present in several brain stem nuclei. It was most severe in the nucleus of the solitary tract, spinal tract nucleus of the trigeminal nerve, dorsal motor nucleus of the vagus nerve, and periaqueductal grey matter. The immunostaining of astrocytes demonstrated both astrocytosis and astrogliosis.

Other findings included neuronal degeneration, axonal spheroids, ceroid-lipofuscin granules, and astrocytosis. Frequently, degenerating neurons contained vacuoles and aggregations of ceroid-like pigment.

The histological diagnosis of BSE was confirmed, prion protein (PrP) was demonstrated in the brain stem, and fibrils identical to scrapie-associated fibrils were detected by electron microscopic examination at the Weybridge Central Veterinary Laboratory (personal communication, GAH Wells and AC Scott). A case of BSE in the UK had previously been linked with the farm of origin of this case (personal communication, JW Wilesmith and D Matthews).

The diagnosis of BSE was based on the histological demonstration of neuronal vacuolation and spongiform change in the above mentioned nuclei of the brain stem. All of the criteria used in the neuropathological case definition (4,9) were detected in this case, which was equivalent to the confirmed case (88-0012) from the UK. A high correlation between clinical features and histological diagnosis has been reported (4,10,11). The microscopic changes in the central nervous system (CNS) are highly specific and considered to be pathognomonic (10,11).

The clinical and neurologic signs, such as, apprehension, hyperesthesia, and gait ataxia, have been well documented and are considered criteria of clinical case definition for BSE in the UK (1–4). Careful observation for characteristic signs is considered the most reliable method of antemortem diagnosis (10). The apparently sudden onset of recumbency in this cow, without other signs of altered behavior, raises concern over recognition of the clinical signs of BSE in beef cattle. This case occurred in a range cow being fed on pasture under winter conditions, where subtle changes in behavior and temperament would not be as obvious as in dairy cows being handled regularly for milking. The slippery conditions in the laneway may have precipitated the 1st fall and aggravated the difficulty in rising. In the cases in the UK, splaying of the hind limbs tended to occur on wet surfaces (3).

Since early signs of BSE in beef cattle could be overlooked due to range conditions, a 2-pronged BSE surveillance program was initiated by Agriculture and Agri-Food Canada in 1990. One part of the program focuses on continual monitoring by owners and district veterinarians of bovine imports that have entered from the UK since 1982. This part of the program can be credited with uncovering the affected animal. The other part focuses on native stock. It is carried out by district veterinarians and Agriculture and Agri-Food Canada Laboratories, in conjunction with the national rabies diagnostic program. Animals exhibiting signs of a CNS disorder are examined for BSE, if they turn out to be negative for rabies. Pathologists in the extensive system of provincial veterinary diagnostic laboratories maintain similar vigilance. In addition, 95% of all cattle slaughtered in Canada receive antemortem inspection by federal veterinarians. The composite effect of these initiatives is to decrease the likelihood of cases of BSE going undetected, even in the absence of characteristic clinical signs.

There is no antemortem laboratory test for BSE. When BSE is considered as a differential diagnosis, veterinarians should report it to Agriculture and Agri-Food Canada. The lesions of BSE are confined to specific sites, but representative sections from all areas of the brain must be examined histologically to reach a diagnosis.

In the UK, the BSE epizootic has clearly been linked to the consumption of contaminated feeds (2,4). To avoid the introduction of potentially contaminated feed, Canada discontinued the importation of live cattle, beef, and beef products from the UK and the Republic of Ireland, effective February 9, 1990. The importation of animal offal into Canada from countries other than the United States of America is not permitted. There is little or no possibility of BSE developing from indigenous sources because of Canada's small sheep population, low prevalance of scrapie, low level of incorporation of sheep-meat meal into cattle feed, and for more than 25 years, the discontinuation of solvent extraction in the rendering process (personal communication, JA Kellar).

Studies are continuing to investigate the possibility of other means of spread, such as vertical or horizontal transmission (12). In order to eliminate any possibility of vertical or horizontal transmission in this case, the offspring and herdmates were destroyed. Furthermore, all cattle imported from the UK since 1982 were ordered destroyed or returned to the UK after the confirmation of the case on December 7, 1993.

In conclusion, the risk of BSE developing in Canadian native cattle is extremely low because of strict import controls, a 2-pronged surveillance program, safe rendering practice in the formulation of cattle rations, and swift response in emergency situations.

Acknowledgments

We thank Drs. GAH Wells, AC Scott, JW Wilesmith (Central Veterinary Laboratory, New Haw, Addlestone, Surrey, UK), D Matthews (Ministry of Agriculture, Fisheries and Food, Hook Rise South, Tolworth, Surbiton, Surrey, UK), and JA Kellar (Animal Health Division, Food Production and Inspection Branch, Agiculture and Agri-Food Canada) for consultation, and Katarina Batta, Vita Radzius, Barbara Stewart, Albert Bourgon, and Susie Becker for technical assistance. CVJ

References

1. Wells GAH, Scott AC, Johnson CT, *et al.* A novel progressive spongiform encephalopathy in cattle. Vet Rec 1987; 121: 419–420.
2. Wilesmith JW, Wells GAH, Cranwell MP, Ryan JBM. Bovine spongiform encephalopathy: Epidemiological studies. Vet Rec 1988; 123: 638–644.
3. Winter MH, Aldridge, BM, Scott, PR, Clarke M. Occurrence of 14 cases of bovine spongiform encephalopathy in a closed dairy herd. Br Vet J 1989; 145: 191–194.
4. Wilesmith JW, Wells GAH. Bovine spongiform encephalopathy. Curr Top Microbiol Immunol 1992; 172: 21–38.
5. Anon. Bovine Spongiform Encephalopathy (BSE). 1. Patterns of Selected Diseases. DxMonitor 1995 (Spring): 10–11.
6. Agerholm JS, Krogh HV, Nielsen TK, Ammendrup S, Dalsgaard H. A case of bovine spongiform encephalopathy in Denmark. Acta Vet Scand 1993; 34: 99–100.
7. Kimberlin RH. Bovine spongiform encephalopathy. Rev Sci Tech Off Int Epiz 1992; 11: 347–390.
8. Georgsson G, Gísladóttir E, Árnadóttir S. Quantitative assesment of the astrocytic response in natural scrapie of sheep. J Comp Pathol 1993; 108: 229–240.
9. Wells GAH, Wilesmith JW, McGill IS. Bovine spongiform encephalopathy: a neuropathological perspective. Brain Pathol 1991; 1: 69–78.
10. Wells GAH, Hancock RD, Cooley WA, Richards MS, Higgins RJ, David GP. Bovine spongiform encephalopathy: Diagnostic significance of vacuolar changes in selected nuclei of the medulla oblongata. Vet Rec 1989; 125: 521–524.
11. Davis AJ, Jenny AL, Miller LD. Diagnostic characteristics of bovine spongiform encephalopathy. J Vet Diagn Invest 1991; 3: 266–271.
12. Ministry of Agriculture, Fisheries and Food. Bovine spongiform encephalopathy in the United Kingdom — A progress report. 1993; November: 1–16. Obtainable from Ministry of Agriculture, Fisheries and Food, Hook Rise South, Tolworth, Surbiton, Surrey, UK, KT6 7NF.

Answers to Quiz Corner/Les réponses du Test Éclair

1. b — Acute nosocomial diarrhea caused by *Clostridium* has been reported in dogs, especially those hospitalized in veterinary clinics.
   b — La diarrhée nosocomiale aiguë causée par *Clostridium* a été rapportée chez les chiens, spécialement ceux hospitalisés dans les cliniques vétérinaires.

2. e — The average normal resting heart rate for an adult cow is 60 beats per minute (range, 4–80). The average resting heart rate for a young calf is 120 beats per minute (range, 100–140).
   e — La moyenne de la fréquence cardiaque normale au repos d'une vache adulte est de 60 battements par minute (étendue, 40–80). La moyenne de la fréquence cardiaque au repos d'un veau est de 120 battements par minute (étendue, 100–140).

3. d — Lymphoid hyperplasia, or reactive hyperplasia, is the most common cause of lymphadenomegaly in cats.
   d — L'hyperplasie lymphoïde ou l'hyperplasie réactive est la cause la plus fréquente de lymphadénomégalie chez les chats.

4. b — Respiratory sounds are muted and may not be heard in a resting animal. In practice, if you hear any sounds on auscultation, there is a problem.
   b — Les bruits respiratoires sont effacés et peuvent ne pas être audibles chez un animal au repos. En pratique, si vous entendez des bruits à l'auscultation, c'est qu'il y a un problème.

5. c — If the optic nerve is in focus at −6 diopters instead of 0 diopters, it is displaced caudally. Glaucoma is the only choice that could cause this.
   c — Si le nerf optique est au foyer à −6 dioptries au lieu de 0 dioptrie, c'est qu'il est déplacé caudalement. Le glaucome est le seul choix qui peut causer ce problème.

6. c

7. e — The other choices listed are unnecessary as initial diagnostic procedures.
   e — Les autres choix énumérés ne sont pas nécessaires comme mesures initiales pour le diagnostic.

8. a — Unconjugated bilirubin is not water soluble, so it is not passed into the urine.
   a — La bilirubine non conjuguée n'est pas hydrosoluble de sorte qu'elle ne se retrouve pas dans l'urine.

9. b — Dislodging by pressure from a nasogastric tube causes extensive esophageal damage and may force the impaction into a more distal and less accessible part of the esophagus.
   b — L'enlèvement par pression exercée par une sonde nasogastrique cause du dommage important à l'œsophage et peut déplacer la substance qui fait obstruction dans une région plus distale et moins accessible de l'œsophage.

10. c — Enlarged thyroid glands secondary to low dietary iodine levels can compress the trachea and esophagus at the thoracic inlet, leading to the noted clinical signs.
    c — Une hypertrophie des glandes thyroïdes secondaire à des taux d'iode alimentaire faibles peut comprimer la trachée et l'œsophage à l'entrée de la cavité thoracique, conduisant aux signes cliniques décrits.