

Risk assessment on the occurrence of bovine spongiform encephalopathy in Canada.

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## **Summary**

A probabilistic risk assessment of the factors related to bovine spongiform encephalopathy (BSE) for Canada was conducted to estimate the risk of BSE occurring. The steps included the hazard identification, release, exposure and consequence assessments and the risk estimation. A scenario tree for the release and exposure assessments was used to model the events emanating from the initiating failure event of importing cattle potentially infected with BSE. The consequence assessment described the costs and losses associated with the introduction and establishment of BSE in other countries. The risk estimate, integrating the release, exposure and consequence assessments, estimated the probability that BSE was introduced and established in Canada and elaborated the economic consequences.

## **Introduction**

Bovine spongiform encephalopathy (BSE) is recognised as an animal and zoonotic disease with extreme economic and public health consequences. Past and current trade in cattle, other ruminant animals and rendered animal proteins, all of which may be potentially infected with the BSE agent, has resulted in the introduction of the disease in some countries and necessitated the assessment of BSE factors by all countries. BSE is spread to cattle through the feeding of contaminated meat-and-bone meal (MBM), originating from cattle with previously unidentified BSE infection. Offal tissues of particular risk include the brain, spinal cord, dorsal root ganglia and trigeminal ganglia. Semen and embryos/ova are not seen as effective transmission vectors. BSE does not appear to be spread horizontally, but some studies suggest that maternal transmission may occur at an extremely low level. No detectable infectivity has been found in the blood or blood components of cattle infected with BSE, although experimental transmission of BSE has been achieved by blood transfusion between sheep. The authors present a probabilistic risk assessment of the factors related to BSE occurrence in the cattle population in Canada. This assessment, which follows the risk analysis guidelines of the Office international des epizooties (OIE), may serve as an approach to be considered by other countries.

## **Materials and Methods**

The release assessment described the potential of a risk source to introduce the BSE agent into Canada. The risk source constituted the past imports of cattle from BSE-infected countries or countries likely to be infected. Maternal transmission was not factored into this risk assessment, despite the evidence suggesting a low probability of developing BSE in offspring born closer to the onset of the disease in the dam. The

importation of MBM and feeds containing MBM into Canada from BSE-infected countries did not occur and thus, did not represent a risk source for this release assessment. Figure 1 portrays the release and exposure assessment scenario tree emanating from the initiating failure event of the importation of cattle from countries between 1979 and 1997 which were potentially infected with BSE. The scenario tree comprised eight model inputs and branch points and nine end-states. The initiating frequency ( $\Phi_0$ ) represented the number of cattle imported while the model input  $f_1$  represented the probability that the imported animal was infected with BSE. The release assessment consisted of these two inputs. The risk scenario pathways  $S_5$  and  $S_9$  were the pathways of interest in this scenario tree.

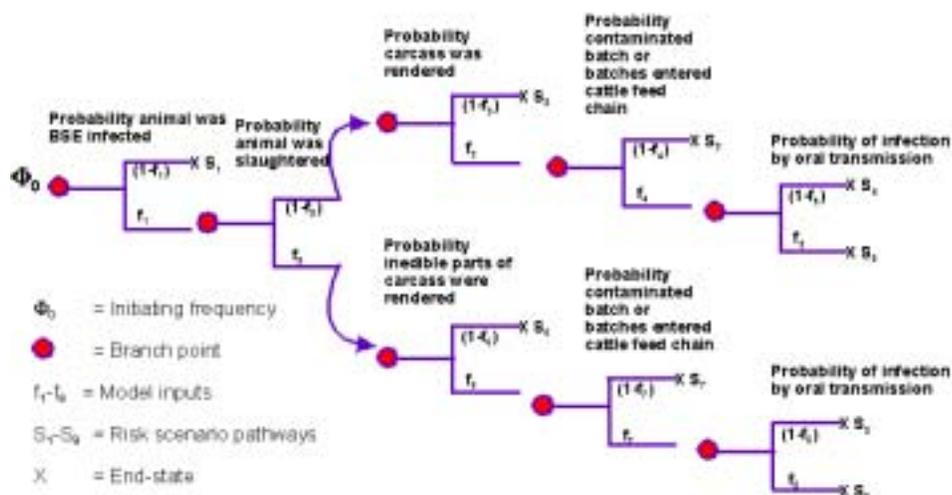


Figure 1. Release and exposure assessment scenario tree emanating from the initiating failure event of importing cattle, potentially infected with bovine spongiform encephalopathy, from Austria, Denmark, France, Germany, the Republic of Ireland, Switzerland, the Netherlands, and the United Kingdom into Canada between 1979 and 1997.

The lifetime cumulative incidences of BSE infection for beef cattle and dairy cattle by year of birth (1, 2) were converted to beta distributions for use as the prevalence for beef and dairy cattle of UK origin. Beta distributions represented the prevalence of BSE infection in the birth cohorts of cattle from the other countries.

The exposure assessment described and quantified the likelihood that BSE infectivity was introduced into the cattle feed chain in MBM before the 1997 MBM feed ban, and the consequent likelihood of infection of at least one animal by oral transmission. It does not account for the potential contamination of blood meals as a result of the stunning procedure at slaughter. The exposure assessment comprised model inputs  $f_2$ – $f_8$  in Figure 1, all of which were probabilities. Estimates were made of the probability that the animal was slaughtered ( $f_2$ ) or died ( $1-f_2$ ), the probability the carcass was rendered ( $f_3$ ), the probability that inedible parts of the carcass were rendered ( $f_6$ ), the probability of a contaminated batch entering the cattle feed chain ( $f_4$  and  $f_7$ ) and the probability of oral transmission of infection ( $f_5$  and  $f_8$ ). A sub-model for the latter probability was estimated from the end consumption of each cattle oral  $ID_{50}$  remaining in the MBM at the time of feeding. The model inputs of this sub-model included a) the number of cattle oral  $ID_{50}$  presented by a BSE-infected rendered carcass, b) the average daily consumption of MBM by age (months), accumulative over 3 days, c) the proportion of dairy cattle population by age (months) and d) the age-dependent susceptibility of cattle to BSE infection.

The consequence assessment consisted of a description of the costs and losses that were incurred in the UK and other countries due to the animal and human health impacts, trade impact, impact on industry and the cost of eradication.

## Results

Risk estimation consisted of integrating the results from the release, exposure, and consequence assessments to produce a measurement of the risk involved. The mathematical model to estimate the probability of at least one infection for  $n$  imported animals was as follows:  $P(I \geq 1) = 1 - ((1 - f_1) + f_1 \times ((1 - f_2) \times ((1 - f_3) + f_3 \times ((1 - f_4) + f_4 \times (1 - f_5)))) + f_2 \times ((1 - f_6) + f_6 \times ((1 - f_7) + f_7 \times (1 - f_8))))^n$ . The risk estimate was based on the expected number of BSE-infected animals which may have been imported, slaughtered or died, and whose carcass was subsequently rendered during 1979 to 1997, and the probability of the exposure of Canadian cattle to any BSE infectivity. Computer simulation using the risk analysis software @RISK (Palisade Corporation, Newfield, New York) gave an estimated mean probability of at least one BSE infection of  $7.3 \times 10^{-3}$  and a 95% confidence level of less than  $2.0 \times 10^{-2}$ . The consequences of BSE introduction into Canada were considered extreme and the costs to date following the discovery of BSE in an indigenous cow in May 2003 substantiate that finding.

## Discussion

The Canadian risk assessment illustrates an approach that can be effectively applied to the assessment of risk factors associated with the occurrence of BSE in a country. A probabilistic risk assessment is the only approach for interpreting evidence and data and estimating the probabilities of a chain of events, actions and states of nature that could lead to the introduction and establishment of a disease such as BSE.

## References

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