Specified Risk Material: Public Health Implications

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Outline

• Introduction to the National Collaborating Center for Environmental Health (NCCEH) and projects

• Background on Bovine Spongiform Encephalopathy (BSE)

• Regulations governing the disposal of Specified Risk Material

• Possible routes of entry of prions into the human food chain (direct and indirect)
NCCEH

- Funded by the Public Health Agency of Canada (PHAC)
- One of Six National Collaborating Centres
- Each focuses on a different aspect of public health
NCCEH

- Our scope is EH
- Focus on health risks associated with the physical environment (natural and built)
- Identify evidence-based interventions to reduce those risks
NCCEH

- **Getting useful information to Environmental and Medical Health Officers**
  - Succinct evidence-based documents on topics ranging from home drinking water filters to indoor radon
  - A directory of Canadian environmental health legislation
  - A directory of training and practicum opportunities
  - Environmental health news
  - Links to useful documents produced by others
  - Course on safe drinking water systems
  - Summaries of recent journal articles in EH
  - List of Public Health Agencies in Canada
Visit our website @ www.ncceh.ca
What is BSE?

- Bovine Spongiform Encephalopathy (mad cow disease)
- Belongs to the group of prion diseases (Transmissible Spongiform Encephalopathies: TSE)
- Neurodegenerative diseases affecting both humans and animals
Prion diseases

**Human Prion diseases:**
- Creutzfeldt-Jakob Disease (CJD)
- vCJD
- Gerstmann-straussler-scheinker syndrome
- Fatal familial insomnia
- Kuru

**Animal diseases:**
- BSE (cattle)
- Chronic waste disease (cervids)
- Scrapie (sheep)
- Transmissible mink encephalopathy
- Feline spongiform encephalopathy
- Ungulate spongiform encephalopathy
Kuru disease

- Kuru (Papua New Guinea, 1957) was the first human disease associated with a prion.

- Carleton Gajdusek received the 1976 Nobel prize for showing that the Kuru was transmitted by the cannibalistic ritual eating of brain from dead relatives.

- Stanley Prusiner received the 1997 Nobel prize for the discovery of prions.
BSE

• Initially reported in the UK in 1986
• Linked to the use of Meat-and-Bone-Meal (MBM, high protein supplement)
• Higher incidence in dairy than in beef cattle
• Oral route of transmission
• Infective dose > 1 g
• Other routes? (atypical cases)
What does BSE mean for Public Health?

In 1996, Spongiform Encephalopathy Advisory Committee (SEAC) announced a link between the new variant Creutzfeldt-Jakob Disease (vCJD), and exposure to the infective agent (prion) through consumption of beef.
## Variant Creutzfeldt-Jakob Disease

### Current Data (September 2009)

<table>
<thead>
<tr>
<th>Country</th>
<th>Total Number of Primary Cases (Number Alive)</th>
<th>Total Number of Secondary Cases: Blood Transfusion (Number Alive)</th>
<th>Cumulative Residence in UK &gt; 6 Months During Period 1980-1996</th>
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</thead>
<tbody>
<tr>
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<tr>
<td>Spain</td>
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</tr>
</tbody>
</table>

*The third US patient with vCJD was born and raised in Saudi Arabia and has lived permanently in the United States since late 2005. According to the US case-report, the patient was most likely infected as a child when living in Saudi Arabia.

*The case from Japan had resided in the UK for 24 days in the period 1980-1996.*
BSE

• Prion protein \( \text{PrP}^{\text{res}} \) (Protease resistant Prion Protein) is the causative agent

• \( \text{PrP}^{\text{res}} \) is a modified form of a normal membrane associated protein, predominantly located in the Central Nervous System (CNS)

• Long incubation period (5 years for dairy calves), and early clinical diagnosis difficult

• Additional forms of BSE recently identified (atypical: H- and L-type BSE).
endogenous PrP\(^c\)

- Spontaneous generation of PrP\(^c\)
- Conversion of mutant PrP to PrP\(^c\)
- Inoculation of PrP\(^c\)

Interaction between PrP\(^c\) and PrP\(^\ast\)

- Conversion of PrP to PrP\(^c\)
- Accumulation of PrP\(^c\)

Prion_propagation.svg (SVG file, nominally 579 × 768 pixels, file size: 26 kB)
Microscopic "holes" are characteristic of prion-affected tissue sections, causing the tissue to develop a "spongy" architecture.
BSE

- PrPres very difficult to inactivate

- Uneven distribution in tissues of infected animals (Specified Risk Material)

- Specified Risk Material (SRM) include 99% of the infectivity
Specified Risk Material (SRM)

Source: CFIA
SRM have been the basis for measures to protect consumers from infected tissues of pre-clinically affected cattle.
BSE events & Canadian Government Initiatives

1993
• First case of BSE, in an imported cow (1987)
  • Ruminant-to-ruminant feed ban
  • Primary goal: protect Animal Health

1997
• Ruminant-to-ruminant feed ban

2003
• First identified case of BSE, found in a Canadian-born cow
  • Human food chain Ban
  • Primary goal: protect Public Health

2007
• 15 other indigenous cases between 2003-2009
  • Enhanced Feed Ban + regulations on SRM disposal
  • Primary goal: protect Animal Health

2008
• Permit for handling SRM
  • Primary goal: protect Animal and Public Health
Etiological links challenged by:

• absence of detection in food
• absence of historical samples to test for infectivity
• lack of knowledge regarding the dose of prion that causes vCJD
Upstream Indicators of Human Exposure

• No native case of vCDJ
• 15 indigenous cases of BSE (11 born after the 1997 feed ban including two cases of atypical strain)

A stricter feed ban was introduced in 2007, however it is too early to draw any conclusions to the effectiveness of the enhanced feed ban
Low level of prions in Canadian herds

- The Canadian BSE surveillance program only tests higher-risk animals.
- Higher risk animals are: 4-D categories of >30 months old and animals of all ages displaying clinical signs.
- Prevalence of prions is probably underestimated (Japanese situation).
Possible routes of human exposure

• Direct consumption: meat-related products

• Indirect consumption: crops, ground water, wastewater and air
Direct consumption
Possible breaches of SRM regulations

- Federally registered plants
- Provincial slaughter houses
- Unlicensed plants or illegal slaughter houses
Slaughter houses in Canada

Federally registered plants
- Account for 95% by volume of meat produced in Canada
- Market their meat internationally and inter-provincially
- Subject to CFIA inspections
- On-site veterinarian ensures compliance with the legislation and supervises operations

Provincial slaughter houses
- Market meat within their province
- May or may not be licensed
- May or may not have compulsory meat inspections
Voluntary breaches of the SRM regulations

Illegal slaughter houses

• Unlicensed slaughter houses
• Establishments doing custom slaughter
• Cattle slaughtered on farms
Involuntary breaches of the SRM regulations

During the pre-slaughter screening step

3 animal groups:
- Non infected (the majority)
- Infected but not detectable (incubating of the disease)
- Pre clinical/clinical group (detectable)
Progression of BSE in infected cattle

- Period of greatest Susceptibility
- No signs of infection
- Pre-clinical
- Clinical

Adapted from West Texas A&M University
What are “infected” cattle?

If clinical signs present:

- 95% probability of correctly identifying an ambulatory animals with clinical signs
- 85% probability for downer cattle

- Removal of non-ambulatory cattle from human supply led to reduced exposure to BSE-contaminated material by 3% in the US

Cohen & Gray, 2005
What are “infected” cattle?

Animals less than 30 months old can be BSE positive:

• In Japan, there have been two cases of BSE found in 21 and 13 month old bulls
• In the UK, there have been 49 cases of BSE in cattle younger than 30 months
What are “infected” cattle?

- In Canada, the majority of cattle slaughtered are less than 30 months old.

- The distal ileum is removed in cattle of all ages while other SRM is taken out from Over Thirty Months (OTM).

- It is possible for prions of infected cattle with no clinical signs and < 30 months to be introduced into the food chain.
What are “infected” cattle?

- Cattle can also be BSE positive, OTM and show no clinical signs
- In Japan, 9 of the 15 BSE cases in cattle did not show any clinical signs

(Iwata et al., 2006)
Non compliance with SRM regulations

Non compliance (inadvertent or voluntary) during the stunning and slaughtering process:

• Cross-contamination of muscle with CNS tissues

• 3% non compliance in Federally registered plants (2% considered minor)
Canadian population could be exposed to low levels of prions

As indicated by:

- The occurrence of BSE in Canadian herds
- Possible breaches that may occur in the SRM regulations

Canadian population could be exposed to very low levels of prions

The risk of Canadians contracting vCJD when exposed to contaminated cattle products is currently under study by Dr Dan Krewski
Indirect consumption
Other food?

Products that have been in contact or fertilized with infected material

- crops
- compost (most provinces don’t have any farm management regulations)
Wastewater

Prion may enter wastewater through:
- Slaughter house drains
- Rendering and meat packing plants

One study indicates that prions are not likely to be discharged into local bodies of water (Hinckley et al., 2008)
Wastewater and ground water

• Ground water and wastewater contamination may occur through improper SRM disposal

• To be approved by CFIA, SRM disposal methods must present a very low risk of potential BSE transmission to ruminants
Regulatory Gap?

Highly regulated environment
• a risk of 1 in 10,000 or less of potential transmission to ruminants is not tolerated

Unregulated environment
• illegal abattoirs, cattle producers
• On farm (this matter falls under provincial regulation)

Current federal regulations favour the on-farm disposal of SRM
What will happen in cases of Foot-and-Mouth-Disease (FDM)?

- Mass composting is not permitted for SRM removal, because associated with a probability of 1/1000 to 1/10,000 of possible transmission to ruminants

- However, the same level of risk is tolerated on farms
Regulatory Gap?

- It is important that provinces have emergency response plans in place.
- Agriculture and Agri-food Canada is consulting with stakeholders to identify the best options for SRM disposal in each province (Senate, 2005).
Main concern comes from the incineration of SRM

Controlled incineration using two-chamber fixed facilities is the only incineration approved by CFIA

Open pile and air curtain are not permitted

No regulation prevents burning SRM on farms
• Possible routes of entry into the food chain include direct and indirect consumption of prions:

**Direct consumption:**
- There is a low level of prions in Canadian herds
- The Canadian population may be exposed to a very low levels of prions through meat consumption

**Indirect consumption:**
- Linked to survival of prions in the environment.
- Major issues in determining risk for humans is the lack of scientific evidence and clear transmission related to prion survival in the environment
CONCLUSION

• SRM disposal laws are based on a risk of transmission to ruminants (animal health risk not public health risk)

• Discrepancy between the highly regulated environment that falls under the scrutiny of the federal government and the poorly regulated environment that falls under the provincial government

• Important that provinces have an emergency response plan in case of Foot-and-Mouth-Disease (FDM)
References


Any question?