Bovine spongiform encephalopathy (BSE) was first confirmed in the United Kingdom in November 1986. BSE is a progressive and fatal nervous disease found mainly in adult dairy cattle, and can result in changes in behaviour, mental status, posture, and gait. The first case of BSE in Japan was confirmed in September 2001. The Japanese government implemented several important interventions, though the disease nevertheless had serious economic and social consequences. We closely examine these consequences in this paper, as well as the interventions taken by the Japanese government. We use Japan’s experience to extract lessons on how best to communicate, implement, and standardise disease control interventions.
Introduction to BSE-related diseases and TSE including CJD

Bovine Spongiform Encephalopathy (BSE) was first confirmed in the United Kingdom in November 1986, though the first clinical case probably occurred in April 1985. BSE is a progressive and fatal nervous disease found mainly in adult dairy cattle. It can result in changes in behaviour, mental status, posture, and gait. BSE was subsequently reported in cattle in several EU Member States as well as Switzerland, but on a much smaller scale. BSE is a new member of the group of diseases known as transmissible spongiform encephalopathies (TSE), or prion diseases. The most well-known TSE include scrapie of sheep and goats, and Creutzfeldt-Jakob disease (CJD) of man. New forms of TSE have been reported in captive wild ruminant species in UK zoos, as well as in domestic cats and captive wild Felidae in the United Kingdom and elsewhere. These reports have been comparatively small in number, but have been shown to be aetiologically related to BSE.

Epidemiological studies (Wilesmith et al., 1988) conclusively demonstrated that the cause of BSE (and BSE-related diseases) was oral exposure to a scrapie-like agent. In the case of cattle and captive wild ruminants, BSE is transmitted through consumption of meat-and-bone meal (MBM). MBM is derived from unwanted animal slaughter products and fallen stock that are rendered (cooked) to evaporate water as steam. Fat (tallow) is then separated to leave a protein-rich material called greaves. Greaves is ground to form MBM, which was included in the concentrate rations of young dairy cattle. MBM was also fed to pigs and poultry, though neither species is naturally susceptible to BSE through oral transmission.

The mean incubation period of BSE in cattle is 60 months. It follows from this that UK cattle were first exposed to BSE around 1980, leading to the eventual epidemic. There was therefore a window between 1980 and 1988 (when controls were first established in the United Kingdom) during which infected feed or cattle could have been exported in the belief that they were not infected. Thus, all countries without BSE are at risk of the disease if they import BSE-infected cattle and retain them until the incubation period is complete. They also are at risk of introducing BSE into indigenous susceptible species if products from such cattle, infected MBM imports, or feed are fed to indigenous susceptible species. Risks to animals can be reduced by having an effective feed ban, for example, and by restricting imports of germ plasm to semen and embryos rather than live cattle, as these are not known to transmit BSE (even from infected donors). It is still not known how the BSE epidemic started in the United Kingdom.

Research has established that at the clinical stage of disease, the highest agent concentrations are found in the central nervous system (CNS), with lesser amounts in some lymphoreticular tissues such as spleen, tonsil and Peyer’s patches in the distal ileum, or any tissues contaminated by them. The latter tissues may be infected at an earlier stage of disease than the CNS, and before clinical signs are evident.

BSE attracted worldwide attention in March 1996, when the UK Secretary of State for Health announced the occurrence of the first ten human cases of a new variant form of CJD that was linked to BSE of cattle origin. Hitherto, sporadic CJD — the most common form of the disease in man — occurred mostly in elderly patients, with a worldwide distribution and incidence of around one per million. By contrast the new variant form of CJD (variant CJD or vCJD) found in the United Kingdom (and subsequently in a number of other countries) affected mostly young people below the age of 30 years. The most plausible exposure pathway is thought to be through consumption of meat products (e.g. mechanically recovered meat derived from the vertebral column) contaminated with BSE-infected tissue and, in particular, CNS. A small number of human-to-human vCJD transmissions have since been identified as a result of blood transfusions or use of blood products derived unknowingly from a vCJD-infected donor.
Simply put, interventions to control BSE might include the following.

- Removal and safe destruction of risk material (SRM) in BSE-infected tissues. If effectively enforced, this ban would protect all species, including man, from exposure to BSE-infected material.

- Active and passive surveillance for BSE

- Prohibition of the use of MBM in fertilisers

- Improved and safe control of rendering waste animal material to produce MBM

- Testing of brains from animals at risk of BSE to detect those infected and ensure their safe destruction

**Geographical distribution of BSE and vCJD with dates**

BSE was first identified in the United Kingdom in 1988, Ireland in 1989, Portugal and Switzerland in 1990, France in 1991, Germany in 1992 and most other EU member states in subsequent years. It was identified in Japan in 2001, Canada in 2003, the United States in 2005 and Brazil in 2012. More than 190,000 cases of BSE have been diagnosed worldwide. All these countries now have little or no BSE; the United Kingdom, for example, had three cases in 2012 and one case in 2013 (as of 30 June 2013). Data on the geographical distribution of BSE are available from the World Organisation for Animal Health (OIE) website (OIE, 2013a).

As of 30 June 2013, 225 vCJD cases have been identified worldwide since 1996: 177 in the United Kingdom, 27 in France, four in Ireland, two in Italy, three in the United States, two in Canada, one in Saudi Arabia, one in Japan, three in the Netherlands, two in Portugal, five in Spain and one in Taiwan. Most of these patients had been resident in the United Kingdom for more than six months during the period 1980-1996. Data on the geographical distribution of vCJD cases are available from the National CJD Research and Surveillance Unit website (NCJDRSU, 2013).

**BSE in Japan**

The first case of BSE in Japan was confirmed in September 2001, some 15 years after the first case in the United Kingdom. Following the experience with vCJD in the United Kingdom in 1996, the Japanese public was somewhat apprehensive about the future outcome in their country. The Japanese government’s position had been that the risk of BSE occurring in Japan was remote. To the public, it was unclear whether there were any contingency plans to be implemented in a worst-case scenario.

When the first BSE case occurred, the government made no attempt to conceal it. Consumers had little confidence in the government’s plans to arrest the progress of the disease, or to protect consumers from exposure, and panic soon set in. It was clear that to shift the balance from mistrust to confidence, rapid and strong action had to be taken. The government took the view that the cost of any intervention, while important, could not be the driver behind any decisions. It was imperative to restore public confidence in the safety of food and particularly cattle products, as well as in the ability of the Japanese government to manage risks by establishing effective control and elimination policies in the country. The government called upon the wealth of information and experience on BSE controls both in Japan and elsewhere — available from the OIE and EU Member States — resulting in rapid and commendable action.
The Japanese government introduced the following interventions within the month following the announcement of the first case of BSE.

- 27 September 2001: The mandatory removal and incineration of SRM from all cattle slaughtered for human consumption (MHLW, 2001). SRM includes the brain, the spinal cord, eyes and the distal ileum, and was expanded later to include the vertebral column. SRM definitions vary across agencies (Table 1).
- 4 October 2001: A ban on the importation and domestic use of all processed animal proteins (PAP) for the production of feed for ruminants, pigs and chickens, as well as fertiliser production (MAFF, 2001b).
- 18 October 2001: Mandatory reporting and investigation of all clinical BSE suspects (passive surveillance), testing of fallen stock and all cattle slaughtered for human consumption and active surveillance (using an OIE-approved test to detect prion protein PrPSc in the brain) (MAFF, 2001c).

<table>
<thead>
<tr>
<th>Countries</th>
<th>Definition of SRM which should be removed from food chain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Japan</td>
<td>Head (excluding tongue and cheek meat), brain, spinal cord, eyes, distal ileum and vertebral column from cattle of all ages slaughtered for human consumption*</td>
</tr>
<tr>
<td>European Union</td>
<td>Skull (excluding lower jaw and including brain and eyes) and spinal cord, tonsils, vertebral column and ileum from cattle over 12 months of age**</td>
</tr>
<tr>
<td>OIE Terrestrial Animal Health Code</td>
<td>Brains, eyes, spinal cord, skull and vertebral column from cattle over 30 months of age for human consumption, and tonsils and distal ileum from cattle of all ages***</td>
</tr>
</tbody>
</table>

* Definition of SRM as of September 2001 when systematic removal of SRM was introduced in Japan.
** Definition of SRM as of October 2000 when systematic removal of SRM was introduced in the EU.
*** Definition of SRM which should be removed from meat from countries, zones or compartments with controlled risk of BSE.


Collectively, these interventions led to a massive and no doubt unwelcome increase in government expenditure. Among other things, this stimulated the establishment of the Food Safety Commission in Japan, an independent agency for risk assessment, in 2003.

BSE results in both direct and indirect losses. Direct losses result from human deaths and the death or destruction of cattle affected by BSE. Indirect losses include the cost for destruction of cohort animals (cattle that, during their first year of life, were reared on the same farm and fed the same rations as cattle that later developed BSE) and the exclusion of MBM from animal feed and fertiliser. Other indirect costs result from the interruption in trade (both internal and external) and the reduction in beef consumption.

Thus, in Japan as in other countries, BSE has resulted in serious social and economic consequences.
Government agencies involved in BSE decision making

Until July 2003, the Ministry of Health, Labour and Welfare (MHLW) had been responsible for decision-making to protect public health from zoonoses, while the Ministry of Agriculture, Forestry and Fisheries (MAFF) was responsible for protecting animal health. After the detection of the first case of BSE, the MHLW and MAFF set up a committee composed of veterinarians, journalists and consumer group representatives to conduct an inquiry into the government’s decision-making process for BSE interventions, in order to glean lessons and formulate recommendations.

The committee submitted a report in April 2002 (Committee for Investigation of BSE Issues, 2002). They identified the following problems with the decision making process by the MHLW and MAFF:

- lack of crisis management system in the government;
- decision-making that prioritised producer interest over consumer interest;
- a lack of transparency in the decision-making process;
- insufficient collaboration between the MHLW and MAFF;
- decision making that did not reflect scientists’ comments; and
- insufficient disclosure of information to improve consumers’ understanding.

The committee emphasised the importance of a risk analysis approach composed of risk assessment, risk management and risk communication in food safety decision making. It also recommended that a new law be enacted to improve food safety based on a risk analysis approach, and called for the establishment of a new government agency for risk assessment. Based on this recommendation, the Basic Law on Food Safety was enacted and the Food Safety Commission, an independent agency for risk assessment, was established in July 2003.

At the same time, the MHLW and MAFF were re-organised to strengthen their risk management capabilities. Since July 2003, whenever a change to BSE interventions is proposed, FSC conducts an assessment of the risk mitigation effect of the proposed changes. However, cost-benefit analysis or other economic analysis is not within the scope of the FSC. In May 2005, for instance, the FSC assessed the revised BSE interventions at the request of the MHLW and MAFF, and recommended a more complete removal of SRM, a more robust implementation of the feed ban and more BSE research. This was done without analysing the additional cost involved and the economic benefits the revisions might bring (Food Safety Commission, 2005).

Cost and effect of BSE interventions

Annual government expenditure for these interventions amounted up to JPY 140 billion — equivalent to EUR 1.1 billion, USD 1.4 billion or GBP 0.95 billion — in fiscal years 2001 and 2002 (Table 2). These amounts included not only expenditure for public health and animal health interventions, but expenditure for market intervention, financial support to economically damaged farmers, renovation of slaughterhouses and rendering plants, and establishment of a cattle traceability system. These amounts do not include expenditure on interventions taken by local government and the private sector, such as the labour cost for BSE testing and costs for production of uncontaminated feed.

During the one-month period between the first BSE case and the initiation of BSE testing on cattle for human consumption, the government asked farmers to refrain from shipping
cattle older than 30 months of age to slaughterhouses, and isolated beef products from the market. These interventions were taken to regain consumers’ confidence in beef by removing all beef products produced from cattle that had not been tested for BSE. Beef consumption recovered in fiscal years 2003 and 2004, so there was no longer a need to support farmers financially. This reduced government expenditure to JPY 43 billion and JPY 29 billion respectively. Government expenditure for BSE intervention has since remained unchanged.

Table 2. Budgetary expenditure by the Ministry of Agriculture, Forestry and Fisheries and the Ministry of Health, Labour and Welfare for BSE interventions during fiscal years 2001-2004 (JPY million)

<table>
<thead>
<tr>
<th>Purpose of interventions</th>
<th>FY2001</th>
<th>FY2002</th>
<th>FY2003</th>
<th>FY2004</th>
</tr>
</thead>
<tbody>
<tr>
<td>BSE surveillance</td>
<td>1 726</td>
<td>981</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Destruction of fallen stock</td>
<td>2 186</td>
<td>1 954</td>
<td>5 489</td>
<td>4 375</td>
</tr>
<tr>
<td>Cattle traceability</td>
<td>3 442</td>
<td>965</td>
<td>1 688</td>
<td>1 357</td>
</tr>
<tr>
<td>Information dissemination</td>
<td>2 155</td>
<td>3 003</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Slaughterhouse renovation</td>
<td>1 707</td>
<td>1 185</td>
<td>704</td>
<td>882</td>
</tr>
<tr>
<td>Market intervention</td>
<td>29 331</td>
<td>512</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Financial support to farmers and distributors</td>
<td>63 756</td>
<td>87 954</td>
<td>149</td>
<td>133</td>
</tr>
<tr>
<td>Incineration of MBM</td>
<td>15 418</td>
<td>19 930</td>
<td>23 200</td>
<td>15 163</td>
</tr>
<tr>
<td>Rendering plant renovation</td>
<td>20 043</td>
<td>11 329</td>
<td>73 17</td>
<td>3 813</td>
</tr>
<tr>
<td>Incineration of fertiliser</td>
<td>0</td>
<td>0</td>
<td>699</td>
<td>0</td>
</tr>
<tr>
<td>BSE testing at slaughterhouses</td>
<td>2 141</td>
<td>5 236</td>
<td>4 017</td>
<td>3 306</td>
</tr>
<tr>
<td>Total</td>
<td>141 905</td>
<td>137 889</td>
<td>43 265</td>
<td>29 029</td>
</tr>
</tbody>
</table>


These interventions reduced mortality among humans. In the United Kingdom, millions of infected cattle were consumed, and the maximum number of vCJD cases predicted was 5 000 (Aignaux et al., 2003). The Japanese Food Safety Commission predicted that considering the number of BSE cases predicted in Japan, the number of vCJD cases would be between 0.1 and 0.9 people (Food Safety Commission, 2004). This number represents the amount of people who could have contracted vCJD and died from eating BSE-contaminated beef in Japan, were it not for public health interventions. In fact, 177 vCJD cases were detected in the United Kingdom by August 2012, and no cases were reported in either 2012 or 2013. In Japan, only one case was detected, though the infected person was likely exposed to the BSE agent while travelling in the United Kingdom in the 1990s (MHLW, 2005). The Japanese government has not only taken interventions to protect the public from oral exposure, but has banned blood donations from people who resided in the United Kingdom for longer than one month between 1986 and 1996 (MHLW, 2005, 2009).

The average age of death in a vCJD case is 28 years (Andrews, 2012). The average life expectancy of a 28 year old in Japan is 55 years (MHLW, 2011). The number of life years saved (LYS) from the prevention of 0.9 vCJD is therefore 50 LYS, based on calculations. Assuming that the government spent JPY 20 billion on BSE testing to save 50 LYS over four years (data for the labour cost of BSE testing, and SRM removal and destruction are not available), the amount spent to save one LYS would be JPY 400 million, which is equivalent
to USD 4 million. Even though saving one QALY represents a bigger health improvement than saving one LYS, considering that the maximum cut-off value per quality adjusted life year (QALY) for public health programs is USD 50 000 in the United States (Goldman et al., 1992), CAD 20,000 in Canada (Laupacis et al., 1992), GBP 30 000 in the United Kingdom (Nancy and Parkin, 2004) and AUD 36 000 in Australia (George, Harris and Mitchell, 2001), the cost-effectiveness of BSE intervention in Japan deviates two orders of magnitude from regular health economics thresholds applied in these countries.

Animal health interventions, and the prohibition on the use of MBM in particular, contributed to the reduction in the number of BSE cases. The number of BSE cases in Japan peaked in 2006 and started to decline from 2007. No case has been detected since 2009 (Figure 1). An effective ban on the use of MBM as a ruminant feed supplement had been in place for eight years, and no BSE had been detected in cattle born during the previous 11 years. During this time, effective surveillance had been in place. As a result, Japan obtained the highest status of BSE risk (“negligible”) at the World Assembly of the OIE in May 2013 (OIE, 2013b).

Collectively, government interventions, in particular, the testing of 100% of cattle slaughtered for human consumption, helped improve public confidence in the safety of beef and cattle products and subsequently contributed to the recovery of beef consumption, which had slumped by 60% after the detection of the first case (Figure 1).

Figure 1. Number of BSE cases detected in Japan

Source: Japanese Ministry of Agriculture, Forestry and Fisheries.

Figure 2. Evolution of beef consumption in Japan, August 2001-September 2002

Source: Japanese Ministry of Agriculture, Forestry and Fisheries.
Discerning Japanese consumers who lost confidence in the government and in the safety of beef when the first BSE case was reported soon regained their confidence following the various government interventions. They observed that other countries affected by BSE appeared to have controlled the disease effectively. Importantly, they also noted that the interventions used in Japan were more comprehensive than those in the European Union or the international standard recommended by the OIE. This is despite the fact that any additional protection would be marginal at best, because cattle in the early stages of BSE incubation are undetectable using the currently available approved tests.

Conclusions

- BSE caused serious social and economic effects in Japan, as it did in many other countries. This indicates that zoonoses (diseases that can be passed from animals to humans and vice-versa) may cause serious social and economic effects, in particular when the disease is fatal and accompanied by uncertainties.

- The Japanese consumer was exceedingly sensitive to the risks associated with BSE following the first reported case in Japan, and was particularly sensitive to the public health risks associated with consuming cattle products contaminated with BSE-infected SRM. This is claimed to have resulted in panic, and certainly led to a loss of confidence in the government and the safety of beef, as well as a 60% decline in the consumption of beef.

- Interventions included SRM removal from, and BSE testing of, all cattle for human consumption. The government also implemented a feed ban for all farm species, and did so within days following the announcement of the first BSE case in Japan. Over time these interventions, coupled with effective active and passive surveillance, resulted in a rise in confidence, returning beef sales to their previous level.

- No economic analysis was conducted in Japan during and after adoption of these BSE interventions. The Food Safety Commission, an independent agency for risk assessment, has been established, but economic analysis is not within its scope.

- It would be useful to have an independent agency tasked not only with risk assessment, but with economic analysis of decision making, as well. This would ensure that proposed interventions are in the best interests of society.

- The results of these analyses can be presented in risk communication so that the stakeholders will know not only the risk associated with the food, but the costs and benefits of proposed interventions, as well.

- It is unnecessary and economically wasteful to exceed the BSE control interventions recommended by the OIE or those used in EU countries that had the greatest exposure to BSE, the largest epidemic and greatest experience of the disease.

- International standards should be accompanied by scientific supporting documents so that countries that adopted interventions based on international standards will know what level of protection they will provide, and that any additional interventions might provide only a marginally higher level of protection.
THE OCCURRENCE, INTERVENTIONS AND SOCIO-ECONOMIC CONSEQUENCES OF BSE IN JAPAN

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