Comparison and Verification of BSE Surveillance in USA and Japan

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Abstract

Objective: The objectives of this study are to (1) compare the BSE surveillance systems of Japan and the United States (US), and to (2) validate the US enhanced BSE Surveillance program.

Methods: This study compares the BSE surveillance systems in Japan and the US, specifically focusing on the procedures of initial test, diagnosis and confirmation. The study further examines the validity of statistical conclusions made in the US enhanced surveillance program based on the data collected from the BSE inspection performed by the Ministry of Health, Labor and Welfare of Japan (MHLW) and the Ministry of Agriculture, Forestry and Fisheries of Japan (MAFF) between October 18, 2001 and July 31, 2004. The inspection targeted all slaughtered healthy and high risk cattle.

Results: The US enhanced surveillance program assumes no BSE occurrence in the normal adult cattle population and thus its inspection focuses only on high risk cattle. The BSE inspection performed in Japan, however, revealed that 0.00022% of the normal adult cattle were BSE-infected using the US criteria. Assuming that the same ratio of cattle was BSE-infected in the US, the Japan finding indicates that approximately 30% of the US slaughtered normal cattle population aged 30 months and over needs to be tested to satisfy the statistical condition used by the US (i.e., 99% confidence level).

On the other hand, in order for Japan to perform the surveillance with a 99% confidence level (the statistical condition used by US), Japan needs inspect: (1) 60,539 high risk cattle (i.e., 60% of 100,583 high risk cattle); (2) 78% of normal adult cattle aged 30 months and over (1,088,589/1,387,522) and (3) 90% of normal cattle aged 30 months or less (1,845,138/2,050,154).

Conclusion: The US enhanced surveillance program launched in July 2004 is based on the premise that no BSE occurs in normal adult cattle population. In Japan, however, BSE cases satisfying the US criteria have been found among the normal adult cattle. This fact suggests that the US needs to consider inspections targeting the normal adult cattle in the future. At the same time, for more efficient surveillance, Japan may need to consider BSE inspections targeting the high risk cattle population with a higher confidence level and normal adult cattle with a lower confidence level.

Key words: BSE, surveillance, USA, Japan, verification

1. Introduction

Since the first BSE case was reported in Japan in September 2001, consumer anxiety over the safety of beef has soared; consumption of beef has sharply declined. On December 24, 2003 (Japan Standard Time), the first BSE case in the US was reported, which accelerated the decline of beef consumption in Japan and severely damaged meat related industries in Japan.

Given that approximately 40% of Japan's imported beef was from the US, the BSE occurrence in the US caused both social and economic problems, not only in meat-related industries but also among consumers.

On March 1996, as a safeguard against a BSE epidemic, Japan banned the import of beef products, meat and bone meal (MBM), as well as other feed ingredients from the UK; it also prohibited feeding MBM to ruminants. Starting January 2001, Japan additionally banned the import of all beef products, MBM, etc. from EU countries. The Japanese government considered these safety precautions would be sufficient. However, the first BSE occurrence was reported in Japan in September 2001, and consequently the government lost a great deal of consumers' trust. The MHLW immediately developed a surveil-

Received Dec. 22, 2004/Accepted Feb. 22, 2005

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lance and inspection system targeting (i) cattle aged 24 months and over that died on the farm, (ii) cattle showing clinical signs such as central nervous system disorders, and (iii) slaughtered cattle aged 30 months and over. However, being unable to regain the consumers' trust in the government and in its food safety policies, the Japanese government started inspections targeting all slaughtered cattle regardless of their age on October 18, 2001. Such inspections were considered necessary by most consumers to guarantee the complete safety of Japanese beef and beef products.

BSE surveillance systems in BSE-affected and susceptible countries are diverse. This fact complicates the disputes over the trading of beef and beef products. The US, which considers itself a BSE-free country, conducts selective inspections targeting high risk cattle (e.g., "downer" cattle aged 24 months and over, cattle that died on the farm, cattle that show signs of central nervous system disorders, etc.). The subjects of inspection under the US surveillance program are solely high risk cattle aged 30 months and over and the inspection excludes all normal slaughtered cattle. The US increased the number of cattle inspected, testing a little more than 20,000 in 2003. In March 2004, the Secretary of the US Department of Agriculture (USDA) Ann M. Veneman announced that an enhanced BSE surveillance program would be launched in June 1, 2004 as a strengthened safeguard for the current system (1). In the announcement, she commented that the sampling of some 268,000 cattle could detect BSE even if there were 5 positive cattle in the entire country.

In the meantime, none of the 11 cows diagnosed with BSE in Japan by the end of July 2004 showed any clinical BSE-related symptoms; all of them were detected through tests (i.e., ELISA, Pathological examination of tissue, and Western blot test) and determined as BSE-infected. Thus, the surveillance systems in Japan and that of the US are somewhat different.

On May 27–28, 2004, the World Organization for Animal Health (OIE, i.e., Office Internationale des Epizooties) held a general meeting in Paris, during which members discussed revising requirements for statistical procedures and proposed clarifying sample numbers of the high risk as well as the slaughtered cattle for surveillance. Although this revision proposal for the sample number did not pass, it will be discussed again, and the procedures are planned to be revised significantly at the 2005 meeting. In August 2004, the European Food Safety Authority (EFSA) officially reported that it raised the rating of the US Geographical BSE-Risk (GBR) from level II to level III, i.e. it is likely, but not confirmed, that domestic cattle are (clinically or pre-clinically) infected with the BSE-agent (2). OIE is currently evaluating the possibility of consolidating its rating scale from five to three levels. Based on the GBR assessments, it is expected that Japan and the US would receive the same rating. This in turn indicates that both countries will need to follow the same surveillance system. From this point of view, we believe that it is important to compare and identify the differences in the current BSE surveillance systems between Japan and the US. In doing so, we find it necessary to validate the statistical conclusions made in the US enhanced surveillance plan and examine the current Japanese surveillance system on the same basis.

2. Method

This section reviews and compares the surveillance system in Japan and the US in terms of its subjects, diagnostic criteria and the intensity of the surveillance system. The comparison of the systems is considered valid only when the two systems use the same inspection measures. The last part of this section briefly summarizes the statistical/probabilistic method used by the USDA to measure the effectiveness of its enhanced surveillance system. This paper applied this method to validate the statistical conclusion made by the USDA in the announcement of the enhanced surveillance plan.

Subject of diagnostic test

(i) Japan

(a) All normal adult cattle

(b) Cattle with clinical signs and cattle that died on farms

All farms are required to report all cattle cases with BSE-related clinical signs to the Regional Laboratories for Livestock Hygiene. Law prohibits the slaughter of these cattle. Instead these cattle are required to be incinerated and disposed. Entire cattle herds have been inspected since April 2004.

(ii) US

(a) High risk cattle

- Cattle exhibiting signs of a central nervous system disorder
- Cattle exhibiting other signs that may be associated with BSE, such as emaciation or injury
- Dead cattle
- Non-ambulatory cattle

(b) Normal adult cattle aged 30 months and over (breeding male/female cattle)

Diagnosis of BSE

Both kits used in Japan and "Prionics" are approved for use by the European Union Scientific Steering Committee and have a reputation of having 100% sensitivity and specificity (3).

(i) Japan

Cattle are diagnosed with BSE if either of the following tests is positive:

- Rapid test (ELISA) + Immunohistochemical (IHC) test
- Rapid test (ELISA) + Western blot test

* Two test kits are used in Japan are: Enfer BSE (Abbott Laboratories, Abbott Park, IL) and Platelia ELISA-kit (Bio-Rad, Hercules, CA)

(ii) US

- Rapid test + Immunohistochemical (IHC) test
- Rapid test + Western blot test (UK version)
- Immunohistochemical (IHC) test only

* Second method is performed when a sample is not appropriate for IHC.

* Third method is performed when brain tissue for the rapid test or Western blot test (UK version) is not available.

* USDA approves the following five tests for the rapid test including the two test kits used in Japan: IDEXX HerdCheck BSE Antigen EIA test kit (IDEXX Laboratories, Inc., Westbrook, ME); Prionics-Check WEST-

ERN (Roche Diagnosis, Indianapolis, IL); Prionics-Check LIA (Roche Diagnosis, Indianapolis, IL); Enfer BSE (Abbott Laboratories, Abbott Park, IL); Platelia ELISA-kit (Bio-Rad, Hercules, CA).

Surveillance measures

(i) Japan

Japan's BSE surveillance involves testing of all normal adult cattle at slaughter facilities. The surveillance launched on May 2001 targeted: (i) cattle that show signs of nervous system disorder, etc. and (ii) cattle aged 24 months and over that died on the farm. Starting April 1, 2004, the initial rapid screening test targeting all cattle has been performed at the Regional Laboratories for Livestock Hygiene.

(ii) US enhanced surveillance program

Prior to June 2004, the US did not perform any BSE surveillance, assuming that there was no BSE case in the country. However, responding to Japan's ban of the US beef import after the first BSE case in December 2003, the USDA made an announcement on the enhanced surveillance program that was designed to be comparable with the inspection measures practiced in Japan. The USDA claims that, under the enhanced program, sampling some 268,000 animals would allow for the detection of BSE at a rate of 1 positive in 10 million adult cattle with a 99% confidence level. The program was launched on June 1, 2004 and tested 40,000 cattle during the year 2004 (1). The US Government is currently considering the possibility of enhancing the program further based on the recommendations made by the Harvard Center for Risk Analysis (4).

Basis for statistical conclusions under the USDA enhanced surveillance program

The statistical statement made by the USDA in the announcement of the enhanced surveillance plan is based on the calculation method developed by the Australian government (5). We will briefly summarize this method below.

Statistically, the USDA's objective is to find the smallest sample size (n) that detects the BSE existence with a 99% confidence level. The objective is restated using a statistical expression as follows.

$$\text{Prob(at least 1 BSE cow is sampled)} > 0.99 \quad [1]$$

The above probability is equal to $1 - \text{Prob}(\text{no BSE cow is sampled})$. Thus, equation [1] is rewritten as:

$$\text{Prob}(\text{no BSE cow is sampled}) < 0.01 \quad [2]$$

It is known that the left hand side of [2] (i.e., the probability of no cow included in the sample) follows a hyper-geometric distribution represented as follows:

$$\begin{aligned} \text{Prob}(\text{no BSE cow is sampled}) &= \frac{N-d}{N} \frac{N-d-1}{N-1} \frac{N-d-2}{N-2} \dots \frac{N-d-n+1}{N-n+1} \\ &= \frac{(N-d)!(N-n)!}{N!(N-d-n)!} \end{aligned} \quad [3]$$

The equation states that the probability that there are no positive cows in the sample is equal to the probability that a positive is not the first cow sampled times the probability that a positive is not the second cow sampled, and so on. Using equations [2] and [3], our objective is rewritten as:

$$\text{Prob}(\text{no BSE cow is sampled}) = \frac{(N-d)!(N-n)!}{N!(N-d-n)!} < 0.01 \quad [4]$$

There is an approximation for equation [4] given as:

$$\begin{aligned} \text{Prob}(\text{no BSE cow is sampled}) &= \frac{(N-d)!(N-n)!}{N!(N-d-n)!} \approx \left(\frac{N-d-(n-1)/2}{N-(n-1)/2} \right)^n \\ &= \left(1 - \frac{d}{N-(n-1)/2} \right)^n \end{aligned} \quad [5]$$

Thus, if we denote $\text{Prob}(\text{no BSE cow is sampled}) = \beta$, we have:

$$d \approx (1 - \beta^{\frac{1}{n}}) \left(N - \frac{n-1}{2} \right) \quad [6]$$

Noting that, in equation [4], n and d are interchangeable, we finally have the sample size, n , that is necessary to detect the BSE existence with a given β as:

$$n \approx (1 - \beta^{\frac{1}{d}}) \left(N - \frac{d-1}{2} \right) \quad [7]$$

In equations [6] and [7], β is interpreted as $1 - \text{confidence level}$. Thus, for the sample size that is large enough to detect BSE 99% of the time (i.e., 99% confidence level), β should be set as 0.01 ($=1 - 0.99$).

The US enhanced BSE surveillance program states that the sampling 268,000 cows from high-risk cattle population detects the existence of BSE even if there is only one BSE case in 10 million cows (which is equivalent to detect a BSE case even if there were only 5 positive animals in the entire country) with a 99% confidence level. This statement can be validated using Equation [7]. The data necessary for the validation was obtained from the report prepared for USDA by the Harvard Risk Analysis Center (4). The following table summarizes the basic BSE statistics provided in the report.

High Risk Population	445,886
Adult cattle that died on the farm	251,532
Cattle that satisfied FSIS (Food Safety and Inspection Service) condemnation criteria*	194,225
Foreign disease investigation animals	129
Normal Adult Cattle Slaughtered = (A)	5,800,000
Other Normal Adult Cattle = (B)	38,754,114
Total Adult Cattle	45,000,000

Normal Adult Cattle = (C) = (A) + (B) **44,554,114**
Percentage of Normal Cattle in Total Cattle **99%**

* includes downer cattle, cattle showing clinical signs such as central nervous system disorders and cattle that died on farms.

Table 1 Result of BSE test in Japan from October 18, 2001 to July 31, 2004

tested period	cattle with clinical symptoms	cattle without clinical symptoms		total	Fallen stock (Surveillance test)	BSE
		≥30 months	<30 months			
2001 10/18–2002 3/31	1851	215548 (2)	306192	523591	1095	2
2002 4/ 1–2003 3/31	2973 (3)	517767 (1)	733071	1253811	4315	4
2003 4/ 1–2004 3/31	6266 (1)	494987	751377 (2)	1252630	48411(1)	4
2004 4/ 1– 7/31	2386	159220	259514	421120	33286	0
total	13476	1387522	2050154	3451152	87107	10

() ; No. of BSE cattle

Another BSE cattle was detected on September 10, 2001.

Prepared by authors based on the data provided by Ministry of Health, Labor and Welfare of Japan (MHLW) and the Ministry of Agriculture, Forestry and Fisheries of Japan (MAFF).

Table 2 BSE cases in Japan

No	age (M)	sex	breed	clinical signs	signs like BSE	diagnosis method		
						WB	IHC	HP
1	64	♀	Holstein	+	–	+	+	+
2	67	♀	Holstein	–	–	+	+	–
3	68	♀	Holstein	–	–	+	+	+
4	73	♀	Holstein	+	–	+	+	+
5	80	♀	Holstein	+	–	+	+	–
6	83	♀	Holstein	+	–	+	+	+
7	81	♀	Holstein	–	–	+	+	–
8	23	♂	Holstein	–	–	+	–	–
9	21	♂	Holstein	–	–	+	–	–
10	95	♀	Holstein	+	–	+	+	+
11	94	♀	Holstein	+	–	+	+	+

Diagnosis; WB; Western Blot method, IHC; Immunohistochemical examination, HP; Histopathological examination Clinical symptoms; Astasia, Sepsis, Muscular split of limb, Joint dislocation etc.

Prepared by authors based on the data provided by Ministry of Health, Labor and Welfare of Japan (MHLW) and the Ministry of Agriculture, Forestry and Fisheries of Japan (MAFF).

3. Result

The results of the BSE surveillance conducted by MHLW and MAFF in Japan are shown in Table 1 and 2. Both tables were prepared by the authors based on the information collected from the publicly available materials prepared by the Japanese government.

Result of the inspection in Japan (Table 1)

On September 10, 2001, the first case of the BSE-infected Holstein was reported in Shiraishi-city, Chiba. On September 19, MHLW announced that it would start BSE screening tests for cattle aged 30 months and over. The MHLW further directed that all relevant industries dispose and incinerate the skull (including brain), spinal cord, and distal parts of the ileum of cattle aged 12 months and over. Yet the dissatisfaction of consumers remained. Finally, the MHLW launched an all cattle inspection at slaughter facilities starting October 18, 2001. In the meantime, the Regional Laboratories for Livestock Hygiene under the MAFF conducted inspections targeting a part of the cattle population with symptoms of central nervous system disorders as well as adult cattle that died on the farm; the inspection subjects were later expanded to the entire cattle population starting April 1, 2004.

Table 1 shows the result of the BSE inspection performed

by the MHLW and MAFF between October 18, 2001 and July 31, 2004. In the slaughter facilities, 3,451,152 cows were tested; 9 cows were diagnosed as having BSE. As to the cattle with clinical signs and those that died on the farm, 87,180 cows were tested by the end of July 2004 (87,107 since October 18, 2001); 2 cows were diagnosed as BSE positive.

Test result of the BSE positive cattle (Table 2)

As of July 31, 2004, all 11 BSE-infected cattle were Holstein: 9 dairy cattle and 2 male castrated cattle. Although none of them showed BSE-specific clinical symptoms, 6 of them showed the symptoms such as difficulties in rising, hip joint dislocation, muscle split of foreleg, blood-poisoning/sepsis, and so on. The 2 male castrated cattle were the 8th (23 months old) and the 9th case (21 months old), respectively. Compared to the other 9 cases, the amount of BSE prion detected from the tested body parts of these 2 cows was small and was 1/500 to 1/1000. After July 31, 2004, the following BSE cases were reported: (i) a 62 month-old female Holstein (slaughtered on September 10, 2004), (ii) a 103 month-old female Holstein (slaughtered on September 21, 2004), and (iii) a 48 month-old female Holstein (died on the farm). This study, however, excludes these three cases that occurred after July 31, 2004.

Examining statistical conclusions under the US enhanced BSE surveillance program

The US enhanced BSE surveillance program states that the sampling of 268,000 cows from the high-risk cattle population detects the existence of BSE even if there is only one BSE case in 10 million cows with a 99% confidence level. The specific statement made by USDA is presented below:

“Under the enhanced program, using statistically geographic modeling, sampling some 268,000 animals would allow for the detection of BSE at a rate of 1 positive in 10 million adult cattle with a 99% confidence level. In other words the enhanced program could detect BSE even if there were only 5 positive animals in the entire country....”

Applying formula [7], we have:

$N = 445,886$ (High risk population)

$d = 5$

$\beta = 0.01$

$n \approx (1 - \beta^{\frac{1}{d}}) \left(N - \frac{d-1}{2} \right) = 268,374$, which is approximately

match the sample size mentioned by USDA.

The number of total adult cattle in the US (denoted as G below) is about 45,000,000, and thus we have:

$\frac{d}{G} = \frac{5}{45000000} \approx 0.0000001$, which is equal to 1 in 10 million.

Therefore, the statement by USDA indicates that sampling 268,000 **high risk cattle** detects BSE from the **entire population of US cattle** with a 99% confidence interval level **assuming that no BSE case is in the normal adult cattle population**. We would like to emphasize here that the announcement made by the USDA is not clear on this rather important assumption that asserts “**no BSE cow exists in the normal adult cattle population**”.

4. Discussion

Differences in BSE diagnosis procedure

Japan and the US practice different procedures for BSE diagnosis and confirmation testing. In the US, the testing procedure requires the following steps: cattle with positive test results on the initial rapid screening test are further tested by the immunohistochemical (IHC) test; those cattle with positive test results of IHC are diagnosed as having BSE. In Japan, the diagnosis procedure involves the following steps: cattle whose test results are positive on the initial tests are further tested by the immunohistochemical (IHC) or Western blot test; those cattle with positive test results in IHC or Western blotting are diagnosed with BSE. Accordingly, Japan's 8th (23 months of age) and 9th (21 months of age) cases would not be considered BSE cases based on the US criteria.

In the UK, in which most of the BSE cases have occurred, cattle with BSE-specific clinical symptoms are all diagnosed as having BSE.

Comparison of the age of cattle subject to inspection

In the US and EU countries, excluding Germany, Italy, Spain, and Slovenia, cattle aged 30 months and over are inspected at slaughter facilities. In Japan, the inspection is conducted regardless of cattle's age. However, the Food Safety Committee of Japan announced in its September 2004 interim report that the current inspection measures cannot detect BSE infection of cattle aged 20 months or less (7).

In almost all countries except Japan, the inspection subjects are cattle aged 30 months and over. In Germany, the inspection subjects are currently cattle aged 24 months and over; however, the government has been discussing a possible change in inspection measures and has started testing only cattle aged 30 months and over. Given the above circumstances, inspecting cattle aged 30 months and over should be based on some scientific grounding.

In the UK, in which over 180,000 BSE cases have occurred, inspection subjects are also slaughtered normal cattle aged 30 months and over. The UK's inspection regulation presumably stands on the following facts: only 32 BSE cases have occurred among cattle aged 30 months or less between 1986 and 1996, after which no such case has been reported to date. This means that, as of July 2004, 99.98% of all BSE cases occurred among cattle aged 31 months and over (8).

In the US, the stage of dental development determines the cattle's age and separates cattle aged 30 months and over from cattle aged less than 30 months. In Japan, the Law for Special Measures Concerning the Management and Relay of Information for Individual Identification of Cattle (a.k.a., the Beef Traceability Law) has been enacted, and under the Traceability Law, recording of Individual Cattle Identification information in the production stage has been enforced since December 2003. The government plans to launch similar tracing measures targeting the distribution stage starting in December 2004. This traceability system enables the determination of the accurate birth date of individual cattle. When the first BSE case was reported in Japan, the system for tracing accurate age of cattle was not sufficient, and this fact, to some degree, pressured the government to launch the all-cattle inspection. The US, as being a self-proclaimed “provisional BSE free country,” currently does not have a traceability system, which is considered as one of the obstacles for Japan to lift the beef import ban from the US.

Validity of the size of the inspection sample in the US based on surveillance outcomes in Japan

(i) The US enhanced surveillance program

The US enhanced its surveillance program on June 1, 2004. The USDA announced that 85,812 cows have been tested as of October 17, 2004, and that the test results of all inspected cattle were negative (http://www.aphis.usda.gov/lpa/issues/bse_testing/test_results.html).

When discussing the confidence level of BSE detection of the USDA enhanced surveillance program, it should be noted that the population used in its calculation is not the entire adult cattle in the US, but solely high risk cattle. Specifically, the statement of “...detect BSE even if there were 5 positive cattle in the entire country” in the above USDA announcement is

based on the assumption that no BSE case is found in normal adult cattle (i.e., 44,554,114 out of 45,000,000 = 99%). This assumption implies that normal adult cattle can be excluded from the inspection subjects as is performed in the current surveillance program in the US. If BSE cases are present in the normal cattle population (as in Japan), the statistical conclusion derived by USDA would be questionable, and the adequate sample sizes for both high risk and normal cattle populations would need to be reevaluated.

(ii) Confidence level of the US enhanced surveillance program

In Japan, since the beginning of the full inspection, which started on October 18, 2001, 3,451,152 cows were tested for BSE infection as of July 31, 2004. Within this group, the number of the normal cattle aged 30 months and over comprised of 1,387,552, out of which three BSE cases were identified. These three cows, however, did not show any clinical signs. Although these cows do not meet the definition of high risk cattle (and thus would have been excluded from inspection if they were in the US), they would be confirmed as BSE positive using the US criteria (i.e., positive IHC test).

As mentioned earlier, the US statement on the sample size assumes that no BSE is found in normal adult cattle. The following section examines how the statistical significance changes if BSE occurs among normal cattle aged 30 months and over, at the same incidence as in Japan.

In Japan, cattle identified as BSE positive are $3/1387552 = 0.000022$ (0.00022%) of normal (i.e., > 30 months) adult cattle. In the US, the number of slaughtered normal adult cattle is 5,800,000. Assuming that 0.00022% (approximately 13 cows) of cattle is BSE-infected, in order for the US to detect BSE incidence in the normal cattle population with the 99% confidence level (i.e., the same level of statistical significance as the surveillance targeting high risk cattle), 1,730,116 cases (i.e., 30% of the slaughtered normal cattle) in the normal adult cattle population need to be tested. This calculation is based on formula [7] in chapter 3. It should be noted, however, that this calculation is based on the assumptions that feed control and feed ingredients are the same in Japan and the US, which is to say that the condition of feed contamination by MBM and the feeding pattern and condition of the two countries are the same.

Comparing feed control of the two countries, the US banned feeding ruminant protein to ruminants in August 1997 while Japan waited to prohibit feeding MBM made from ruminants to ruminants until September 2001, and waited to ban entire MBM for feed until October 2001. The fact that the 8th and 9th BSE positive cases occurred after the ban may indicate the possibility of cross-contamination in the production process of compound feed and/or the transportation process of feed materials.

Calculation of the equivalent sample size in the BSE inspection in Japan to the US enhanced surveillance program

(i) Sample size for high risk cattle population

In Japan, 5 BSE cases were confirmed among 10,538 high risk cattle (the 6th cow was slaughtered prior to the implementation of the all-cattle inspection, as it showed clinical signs

such as difficulty in rising; this case was confirmed as BSE after the slaughter).

Components:

4 cases: Out of 13,476 cattle with clinical signs (result of the inspection from October 18, 2001 to July 31, 2004).

1 case: Out of 87,107 cattle that died on the farm (result of the inspection from October 18, 2001 to July 31, 2004).

If Japan conducts the inspection based on the US sampling practice (i.e., 99% confidence level), 60,539 cows (as opposed to the entire cattle herd) need to be tested according to the calculation using formula [7]. This is approximately 60% of 100,583 high risk cattle existing in Japan.

(ii) Sample size for slaughtered normal adult cattle

In Japan, 3 BSE cases were confirmed out of 1,387,522 slaughtered normal adult cattle aged 30 months and over through the all cattle inspection. With the 99% confidence level of surveillance, the number of inspections ought to be, based on the calculation using formula [7], 1,088,589 (approximately 78%); i.e., the all-cattle inspection is not necessary.

On the other hand, 2 BSE cases were confirmed out of 2,050,154 normal cattle aged less than 30 months old through the BSE diagnosis confirmation tests. Based on the above result, the number of inspections for a 99% confidence level ought to be 1,845,138 (approximately 90%) normal cattle aged less than 30 months. Yet, it should be noted that the above cases in the juvenile cattle population (i.e., cattle aged less than 30 months) are not considered as BSE according to the international standard by OIE. This is because the amount of prion in the obex detected in the juveniles is 1/500 to 1/1000 of that found in a typical BSE-infected cattle aged 30 months and over (6). As noted previously, BSE in the juvenile population hardly occurs even in the countries with BSE cattle. Consequently, it is questionable to perform the surveillance for the juvenile cattle applying the same measures of inspection used for cattle aged 30 months and over. The surveillance for this population needs further discussion in Japan.

(iii) The relation between BSE occurrence rate and the sample size required at the 99% or 95% significance level

In most countries, with the exception of some countries such as the UK, the number of BSE occurrence to the number of slaughtered cattle is marginal. In Japan, only 9 cows were identified as BSE positive in the entire-cattle inspection involving the testing of approximately 3,500,000 cattle at slaughter facilities during a nearly three year period. Of these 9 cases, 7 cases were identified prior to the implementation of feed control; under the current strict regulations regarding feeding, etc., the number of BSE occurrences in the future will be even smaller. This indicates that a considerable number of cattle need to be tested in order to detect BSE cases at the slaughter facilities.

Figure 1 presents the relationship between the number of BSE inspections and BSE occurrences. As the figure indicates, the required sample size to confirm a BSE case with a given confidence level increases as the number of BSE occurrences

Fig. 1 Relationship between No. of cattle with BSE symptoms and required sample size.

become smaller. For instance, if there were 5 BSE cases per 100,000 high risk cattle, the required sample size would be 60,188 with the 99% confidence level. Given this confidence level, in the countries with a relatively large number of BSE cases, such as the UK, Ireland, France, and Portugal, the required sample size would be smaller than in the countries with a relatively small number of BSE cases including Japan.

At the same time, for more efficient surveillance, Japan may want to consider a different confidence level depending on the BSE occurrence rate in each cattle population. Based on the surveillance outcomes to date, the BSE detection rate in Japan in each population group is as follows (highest to lowest): High risk cattle 0.03% (4/13476); Normal adult cattle aged 30 months and over 0.0002% (3/1387522); Normal cattle aged less than 30 months 0.0001% (2/2050154). Therefore, in order to capture the existing condition of BSE-infection more effectively, it is reasonable to perform the surveillance targeting the high risk cattle population with a higher confidence level.

5. Conclusion

Since the first case of BSE was found in the UK, BSE has spread to many countries that imported BSE-infected materials such as MBM. Determining the accurate number of BSE cases and the prediction of future BSE occurrences have been urgent

priority issues in many countries including Japan. Having said that, standardized surveillance measures for BSE need to be developed, and OIE has been investigating the possibility of developing such measures.

This study compared the US enhanced surveillance program and the Japanese surveillance system. We also investigated the validity of the assumptions made in the US enhanced surveillance program, and an efficient surveillance system that may be applied in Japan. The conclusions of our study are summarized below.

(i) The US surveillance program targeting high risk cattle population stands on the assumption that BSE does not occur in the apparently normal cattle population. Assuming that feed control and breeding conditions as well as the ratio of BSE incidence to the normal adult cattle population is the same in Japan and the US, 1,751,838 normal adult cows aged 30 months and over need to be tested in order to achieve the 99% confidence level. This conclusion is based on the scientific facts derived from the inspection of all slaughtered cattle in Japan.

(ii) In order for Japan to perform an equivalent surveillance plan to that implemented in the US (the plan targeting high risk cattle with a 99% confidence level), 60,539 (approximately 60% of the high risk cattle population) could have been tested between October 18, 2004 and July 31, 2004. If Japan intended to perform the surveillance targeting all slaughtered cattle aged 30 months and over with the 99% confidence level during the same period, the sample size would have been 1,088,589 (i.e., 78% of the slaughtered cattle population aged 30 months and over). As to the surveillance of slaughtered cattle aged 30 months or less, the sample would have been 1,845,138 (approximately 90% of the slaughtered cattle aged 30 months or less).

(iii) The required sample size to confirm a BSE case with a given confidence level increases as the number of BSE occurrences becomes smaller. Thus, if inspection is performed based on the same confidence level internationally, the countries with a relatively small number of BSE cases need to conduct substantially larger scale inspections than those countries with a higher BSE infection rate. The ratio of BSE occurrence in Japan is as follows: high risk cattle > cattle aged 30 months and over > cattle younger than 30 months. Hence, in order to detect BSE more effectively in Japan, it may be reasonable to perform the surveillance targeting the high risk cattle population with a high/higher confidence level.

References

- (1) USDA. VENEMAN ANNOUNCES EXPANDED BSE SURVEILLANCE PROGRAM, USDA NEWS RELEASE No. 0105.04. WASHINGTON, March 15, 2004.
- (2) European Food Safety Authority. PRESS RELEASE—EFSA Publishes Geographical BSE-Risk (GBR) assessments for Australia, Canada, Mexico, Norway, South Africa, Sweden and United States of America, August 20, 2004.
- (3) Moynagh J, Schimmel H, Kramer GN. THE EVALUATION OF TESTS FOR THE DIAGNOSIS TRANSMISSIBLE SPONGIFORM ENCEPHALOPATHY IN BOVINES. EUROPEAN COMMISSION, July 8, 1998.
- (4) Cohen JT, Gray GM. Response to "Report on Measures Relating to Bovine Spongiform Encephalopathy (BSE) in the United States" March 2004. at the request of the Secretary of Agriculture, an international Expert Bovine Spongiform Encephalopathy (BSE) panel, 2004
- (5) Cannon RM, Roe RT. Livestock Disease Surveys: A Field manual for veterinarians. Canberra: Australian Government

Publishing Service, 1982.

- (6) Yamakawa Y, Hagiwara K, Nohtomi K, Nakamura Y, Nishijima M, Higuchi Y, Sato Y, Sata T, the Expert Committee for BSE Diagnosis, Ministry of Health, Labour and Welfare of Japan. Atypical proteinase K-resistant prion protein (PrP^{res}) observed in an apparently healthy 23-month-old Holstein steer. *Jpn J Infect Dis.* 2003; 56: 221–222.
- (7) Food Safety Commission (September 9th, 2004). Measures against Bovine Spongiform Encephalopathy (BSE) in Japan (Interim report).
- (8) Department for Environment Food and Rural Affairs, UK. 2004. <http://www.defra.gov.uk/animalh/bse/statisticus/incidence.html>.