Possibilities to Manage the BSE Epidemic: Cohort Culling versus Herd Culling – Experiences in Switzerland

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Bovine spongiform encephalopathy (BSE), a disease of cattle first reported in 1986 in the UK [1], has been found in the cattle populations of most European countries. To date, Japan, Israel and Canada are the only non-European countries where BSE has been reported in indigenous cattle [2].

Given all available evidence, the BSE agent is not transmitted horizontally between cattle; rather it is primarily transmitted through feed. Meat-and-bone meal (MBM) is the main source of infectivity and cattle [3] are usually infected during calf-hood. Although it is likely that the other calves in a herd of a similar age to a BSE case also consumed feed from a contaminated batch of MBM, the incidence of BSE within most herds is very low. The most probable explanation is that exposure to the BSE agent was, on average, very low. Recycling of the BSE agent is likely to have resulted in an increased number of ‘packets’ of infectivity rather than an increase in the average titre of infectivity within a contaminated batch of MBM. As a result, the average within-herd incidence would be unlikely to increase [4] (see also the chapter of Bradley).

Several strategies, including those that focus on feed as a source of infection and various culling programmes, have been adopted with the aim of eradicating BSE. Culling strategies vary from culling the affected animal only, to culling all animals within the birth cohort of the BSE case, to culling the entire herd.

Objective of a Culling Strategy

The primary objective of a culling strategy is to eliminate animals epidemiologically linked to an index case so that the number of BSE-infected animals
entering the human food or animal feed chain is minimised. The most efficient strategy would be one that maximises the number of BSE cases eliminated from the food and feed chain while minimising the number of uninfected animals that are culled. To achieve this, a culling scheme should target those animals that have the highest chance of being infected.

**The Likelihood of Additional Cases of BSE in an Infected Herd**

Following the detection of BSE in a herd, how many additional cases linked to the index case are there likely to be? This is not an easy question to answer. Currently available tests, which are all undertaken post-mortem, are only able to detect clinical cases and animals within approximately the last 6 months of their incubation period [5] (fig. 1). With the exception of the UK [6], in those herds where more than 1 case of BSE has been detected, the additional case(s) have inevitably been born within ±1 year of the index case [7, 8]. Just how many of these ‘birth cohort’ animals were originally infected is likely to be related to the size and stage of the BSE epidemic during their exposure to contaminated MBM. The number of infected animals that are likely to still be in the herd when an index case occurs depends on the probability of them surviving as herd members. They may be slaughtered, culled or die from non-BSE-related causes prior to the occurrence of the index case. As a result, the number of cattle originally infected with BSE is likely to be much greater than the number of confirmed cases. In fact, a simulation model, based on Swiss data, showed that almost 90% of BSE cases from an original birth cohort are likely

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**Fig. 1.** An outline of the course of BSE infection in an animal and the relative sensitivity of currently available laboratory tests for detecting a case of BSE.
to have left the herd before an index case is detected. Of the 10% of BSE cases that are likely to still be present, approximately one third would be detectable if they were immediately culled after the detection of the index case and tested. The remainder would not be detected by currently available tests, as they would be more than 6 months from the end of their incubation period. If they were allowed to remain alive until the end of their productive lives, approximately 75% would be detectable.

**Alternative Culling Programmes**

Each country has adopted a different approach, which has changed over time. The main culling strategies that have been applied are as follows:

- **Culling**: (a) the index case only; (b) all cattle on the case farm where the index case was diagnosed; (c) all cattle on the farm where the index case was born and raised; (d) all cattle on the index case farm and on the farm, where the index case was born and raised; (e) all susceptible animals on the index case farm (including sheep, goats and cats); (f) ‘feed cohort’ (cattle that could have been exposed to the same feed as the index case), and (g) ‘birth cohort’ (all cattle born 1 year before or 1 year after the index case and raised on the same farm).

**Experiences Gained in Switzerland**

In the first 6 years following the diagnosis of BSE in Switzerland in November 1990, only BSE cases were culled. During this period, 12 farms had more than 1 case of BSE (11 farms with 2 cases and 1 farm with 3 cases). All of these animals were born within 1 year and were raised on the same farm as their respective index case. As a result, they could be assigned to a defined risk group, that is a birth cohort, which is made up of all animals born in the period from 1 year before to 1 year after the birth of the index case.

In December 1996, the Swiss parliament introduced a herd-culling programme in response to concerns surrounding the cases of the variant Creutzfeldt-Jakob disease (vCJD) reported in Great Britain, an increasing number of BSE cases born after a feed ban (BAB) introduced in 1990, and, most importantly, the measures imposed in export markets. Once a BAB case was reported, the whole herd was culled. If the index case originally came from another farm, all the cattle on the farm where it was born and raised were also culled. Herd culling was adopted retrospectively, so that all Swiss herds that had ever had a case of BSE were included.

Herd culling was restricted by the Swiss parliament to run until June 30, 1999. During the 30 months it was in effect about 3,000 animals that were
culled and disposed of. Most were examined clinically and brain tissue samples from a total of 1,761 cows were tested. Four of these cows, which were all clinically normal, were positive. Since they were all born within the period from 1 year before to 1 year after the birth of their respective index case, they could also be assigned to the same risk group (birth cohort) as the additional cases that were seen before herd culling began. As a result, from July 1999, it was decided to cull birth cohort animals rather than the whole herd. A cohort is defined as all animals that were either born or reared as calves on the farm within the year prior to or following the birth of the index case. It also includes those animals from the original cohort that no longer reside on the farm where the index case was born and reared.

Since cohort culling began, more than 600 animals from 115 cohorts have been culled and tested for BSE with only 1 additional case being detected. Additional cases of BSE, that were not part of the birth cohort of an index case, have never been observed in any herds in Switzerland.

Experiences gained in Switzerland support birth cohort culling on the farm where the index case was born and raised as a targeted risk management strategy that focuses on those animals within a herd that have the greatest chance of having BSE. On average, about one-fifth of a herd is likely to be culled. The rationale of such a program is easier to explain and much more acceptable to farmers. Since its introduction, markedly more suspect cases have been reported in Switzerland, although part of this increase may be attributable to a concurrent enhancement in disease surveillance activities including the introduction of targeted surveillance in 1999.

Figure 2 shows that most of the additional cases of BSE that have been detected in Switzerland were born in the two time periods (1988–1991 and 1994/1995) when exposure to the BSE agent was highest. It appears that the chances of finding additional cases amongst birth cohort animals born after approximately 1996, by which time exposure was at its lowest, is likely to be negligible. As a result, there may be little advantage in culling cohort animals born in the later stages of the epidemic when exposure to the BSE agent would have been minimal.

Choosing a Culling Strategy

A number of factors need to be considered when choosing an appropriate culling strategy including a science-based risk assessment that takes account of the full range of measures applied to BSE, the epidemiology of BSE, the stage of the BSE epidemic, international agreements and standards, societal expectations and political imperatives.
It is important to recognise that a culling strategy is part of a continuum of measures that complement each other to effectively manage the risks associated with BSE for both the human and animal population. The impact of other measures, such as a mammalian animal feed ban, an SRM ban, the incineration of BSE cases and a surveillance program, together with a consideration of the level of exposure to the BSE agent amongst birth cohorts as the epidemic progresses, all need to be considered when deciding on a realistic culling strategy. While it is legitimate ‘to do everything possible to protect consumers’, each of the measures finally chosen needs to be reasonable, otherwise it is likely that the effectiveness of the overall BSE programme will be compromised.

Ideally, all the animals exposed to the same feed as an index case, should be culled [7]. Unfortunately this is rarely, if ever, possible as there are considerable, if not insurmountable difficulties in identifying potentially contaminated batches of feed, determining the distribution of infectivity within contaminated batches and establishing which herd(s) may have been exposed.

While herd culling may be a politically expedient means of increasing consumer confidence and facilitating exports, it is unlikely to be an efficient risk management measure. There are significant problems in implementing such a strategy as the available evidence indicates there is likely to be a considerable wastage of uninfected animals, farmers see it as a radical approach and they may be less willing to notify suspect cases. Although there may be sufficient compensation for culled animals, farmers are less likely to report suspects if they do not believe it is reasonable to cull apparently healthy, productive animals. In addition, they are likely to lose valuable genetics and/or their ‘life’s work’.

Fig. 2. The number of cases of BSE and the additional cases linked to an index case detected in Switzerland by year of birth.
Evidence from a number of countries [7, 8] indicates that, in those herds where more than 1 case of BSE has been detected, the additional case(s) were born within 1 year of the index case. As a result, culling a birth cohort is a more rationale risk management strategy as it focuses on those animals within a herd that have the greatest chance of having BSE. Even so, depending on the initial level of exposure and the original size of the cohort, it is likely that relatively few additional cases of BSE will still be present in the cohort when an index case is seen. Despite this, it is likely to be much more acceptable to farmers compared with herd culling.

It is important to note that even if an infected birth cohort animal was culled immediately and entered the food chain it is likely that it would be in the preclinical phase of BSE. For example, a simulation model based on Swiss data predicts that when an index case is seen, approximately 70% of infected cohort animals are likely to be more than 6 months from the end of their incubation period. Together with an SRM ban and a feed ban, these animals are unlikely to pose any significant risks for human or animal health.

Since BSE is not transmitted by milk [9], semen and embryos [10–12], it is questionable whether birth cohort animals need to be culled immediately following the detection of an index case. If they were allowed to remain in the herd and live out their productive lives before being culled, approximately three-quarters of them would either be within 6 months from the end of their incubation period or have entered the clinical phase of BSE. There is an excellent chance that they would be detected by the currently available tests allowing the BSE status of the remaining animals to be assessed with greater accuracy. As a result, by letting cohort animals remain in the herd until the end of their productive lives, both the impact of BSE on herd management is minimised and the BSE status of the original cohort can be assessed with greater accuracy. This can all be achieved without any additional risk of cohort animals entering the human food or animal feed chain.

**Conclusion**

A culling strategy is part of a continuum of measures that can be employed to effectively manage the risks associated with BSE. The most efficient strategy is one that takes adequate account of the epidemiology of BSE and complements other measures, such as an SRM ban, a feed ban and a surveillance program, to maximise the number of BSE cases eliminated from both the human food chain and the animal feed chain while minimising the impact of BSE on herd management. It should target those animals that have the highest chance of being infected. Following the detection of an index case in a herd, the culling strategy...
that best fulfils these objectives is one that focuses on the birth cohort of the index case. Cohort animals should be allowed to live out their productive lives before being culled or slaughtered. In the later stages of an epidemic, when exposure to the BSE agent is likely to be minimal, the chances that there will be additional cases amongst birth cohort animals born during this time is likely to be negligible. As a result, it may be reasonable to modify the culling strategy so that cohort animals born after a particular date are no longer culled.

References

2. Office International des Epizooties (OIE) 2003: Number of reported cases of BSE worldwide (http://www.oie.int/eng/info/en_esbmonde.htm).

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