FRENCH BSE HISTORY

September 1990: Meat and bone meal (MBM) ban into cattle feed
December 1994: MBM ban into ruminant feed
July 1996: Specified-offal ban into animal and human food chains
November 2000: MBM ban into animal feed

FRENCH BSE SURVEILLANCE:

June 1990: BSE disease was made notifiable
December 1990: Passive surveillance (PS): veterinary practitioners and farmers were required to report animals with clinical signs
June 2000: Pilot study of rapid test was implemented on cattle at risk
January 2001: Targeted screening (TS) on all cattle over 30 months of age at abattoirs
July 2001: Targeted screening on all cattle over 24 months of age (abattoirs and at risk)

The French BSE epidemic from 1980 to June 1997

In a previous study [1], from the 103 cases identified by passive surveillance between 1991 and June 2000, we estimated age- and year-specific incidence rates of BSE infection using a back-calculation method. This approach relies on the principle that the number of BSE-infected cattle is the consequence of the number of BSE-infected animals after a known incubation time, defined as the time between infection and clinical onset. We generalised this model to take into account epidemiological characteristics of BSE, such as French cattle mortality, BSE case reporting probability, and age-dependent susceptibility and/or exposure to the BSE agent.

The model that minimized the mean square error between the predicted and observed BSE cases in abattoirs from January 2001 to June 2003 was considered as the most likely. Various methods were tested to fit the data: on the one hand, the age distribution of animals with clinical signs, and on the other hand, the BSE infection number from July 1997 to December 2001, and then no infection.

Three schemes were assumed to extrapolate the BSE infection incidence from July 1997:
- Scheme 1: linear decrease of the BSE infection number from July 1997 to December 1998 and then no infection;
- Scheme 2: linear decrease of the BSE infection number from July 1997 to December 2001 and then no infection;
- Scheme 3: constant BSE infection number from July 1997 to December 2001 and then no infection;

These linear extrapolations were implemented from the estimated mean number of BSE-infected cattle, and 95% confidence interval values, in June 1997 (Figure 4).

The best model, according to the Akaike’s Information Criterion, suggests that:

- Age at infection:
- Period of incubation:
- Reporting of cases:
- Estimated (red) annual incidence of BSE infection:

ASSUMPTIONS ON WHAT HAPPENED AFTER JUNE 1997

We considered two key dates: December 1998 and December 2001. December 1998 was chosen as up to April 2004, no reported BSE case was born after this date. Note that in April 2004 a cow born in October 1999 was tested BSE positive at abattoir. In addition, the MBM ban was extended to all animal species in November 2000, so we chose December 2001 to take into account the effects of this ban, one year after no recall of MBM stocks was done.

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PREDICTION OF THE NUMBER OF LATE-STAGE BSE CASES SLAUGHTERED FOR CONSUMPTION

From these dynamics of the BSE infection, we simulated the future of BSE-infected animals. To each infected animal, we randomly assigned an infection age (Figure 1), an incubation period (Figure 2) and a lifetime, viz. an age at slaughtering given that the animal was alive at infection age. Bearing in mind the mortality directly attributed to BSE, we imposed that lifetime ranges between age at infection and age at infection plus incubation period. We thus obtained the number of BSE-infected cattle at time t at age x at infection with an incubation period of duration a and a lifespan up to age x. We were thus able to deduce the number of infected cattle slaughtered at time t (x = x<sub>a</sub>(t)) times before the clinical onset of BSE (x = x<sub><sup>a</sup>-d</sub>(t)), and slaughtered at age x<sub>a</sub>. From July 2000, we assumed that only 30% of BSE cases are detected in abattoirs, as observed since 2001. For each model, we performed 100 simulations from which we ascertainment mean value and the 95% confidence interval (CI).

The model that minimized the mean square error between the predicted and observed BSE cases in abattoirs from January 2001 to June 2003 was considered as the most likely. Various assumptions on the detection ability of rapid tests were examined; we assumed that cases detected at abattoirs were only animals at clinical onset or within 6 months of clinical onset or within 12 months of clinical onset. Regarding the specificity of tests, we assumed 100%.

RESULTS & DISCUSSION

The best-fitting was obtained under the following assumptions: mean estimate of the number of BSE-infected cattle, linear decrease of the BSE infection number from July 1997 to December 1998 and then no infection (scheme 1), systematic tests detected BSE cases within 6 months of clinical onset and only 30% of BSE cases are detected in abattoirs. Under these assumptions, we predicted that no BSE case aged less than 36 months should be observed from 2001.

In the most optimistic case scenario, when considering the lower bound of the 95% CI of the number of BSE-infected cattle up to 1997 and linear decrease of the infection number from July 1997 to December 2001 and then no infection (scheme 1), systematic tests detected BSE cases within 12 months of clinical onset and 30% of BSE cases are detected in abattoirs, we predicted that no BSE case aged less than 36 months should be observed from 2004.

In the worst case scenario, when considering the upper bound of the 95% CI of the number of BSE-infected cattle up to 1997 and constant BSE infection number from July 1997 to December 2001 and then no infection (scheme 3), systematic tests detected only animals at clinical onset and 30% of BSE cases are detected in abattoirs, we predicted that no BSE case aged less than 36 months should be observed from 2004.

Age (in months) of BSE cases reported from 2001 (TS at abattoirs, on cattle at risk and passive surveillance):

| Age | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 |
| From January to June 2001 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

Whatever the reporting system, no BSE case aged less than 36 months has been detected in France since 2001, which confirms our results. In addition, one observes that there is no BSE case aged less than 46 months has been detected in France since 2002.

However, the detection of 77 "super-rare" BSE cases, i.e. BSE cases born after July 1996 (specified-offal ban, including a cow born in October 1999) suggest that there was cross-contamination between ruminant and non-ruminant feed. This cross-contamination probably continued up to November 2000, date to which the MBM ban was extended to all animal species, and maybe beyond as no recall of MBM stocks was done. Nevertheless, the assumption of constant risk of bovine infection between 1996 and 2000 is not very probable as normally only accidental occurrence occurred.

CONCLUSION

Under the assumption that there is no contamination via the MBM since December 2001 and in absence of other BSE sources and sporadic cases, it is possible to increase the age of tests at 30 months without identifiable impact for the public health. The increase of age of tests must be simultaneously effective in abattoirs and in the fallen-stock to prevent that cattle at risk to be sent to abattoirs.

In addition, our results should be updated from the most current data. For example a significant inflexion of the mean age of reported cases should incite to reconsider the scheme of the epizooty. In consequence it is important to maintain the evaluation means of the BSE epidemic trend.


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