Prediction of future BSE spread

Sia — Spontaneous encephalopathies are progressive diseases caused by unknown chronic processes, now generally characterized as multifactorial processes. At present, there is no test for infection; there is generally a long incubation period between infection and onset of symptoms and the condition can only be confirmed after death. In 1990, a new form of this disease, bovine spongiform encephalopathy (BSE), was identified in cattle in the United Kingdom. The origin of this disease is believed to be food contaminated with the remains of sheep, and later cattle, that were infected with either scrapie or the BSE agent. As July 1998, the UK government banned the addition of material derived from ruminants to cattle feed. To date, about 160,000 cases of BSE have been reported in the United Kingdom, out of which at least 28,000 occurred in animals born after the food ban; there has been a continuing use of contaminated food. Most animals are likely to have been infected but were slaughtered before symptoms developed.

Science data are now available on the number of BSE cases in different age groups of cattle in the past 5 years (we are most grateful to J. Wilkinson, J. Ryan, L. Faureville, and their colleagues at the Central Veterinary Laboratory for their generous help with data), and we report here results of the simplest of the initial analyses on the dynamics of the disease. Making certain assumptions, we determine if these changes have been in the age pattern of cases and can predict the number of future cases in different age classes. The figure (a) shows the number of cattle born at age x (animal born is an age group). The slopes of these curves are very similar, with a peak between 4 and 6 years of age. The data provide information on age, the number of BSE cases with a clinical onset in year i at animals aged i years. Here, i goes from 5 to 11 years and i from 1989 to 1994.

The figures for 1995 are not yet final, because there are still some cases being reported with an onset in 1995. Most animals are infected within the first year of life, when the use of feed containing ruminant proteins is high! If there is a non-varying age-dependent frequency of expression of disease, then \( x_i \) can be written in \( x_i = x_i(1 + f(i)) \), where \( f(i) \) is the probability that an animal infected in the first year of life exhibits the disease at age i. We can then estimate the relative incidence rate, \( r_i = x_i(1 + f(i)) \), and make predictions for subsequent years. There is, however, a slight over-fit by (i) to increase with \( f(i) \), which indicates a small shift of the incubation period to a disease expression of statutory age 0 in figure.

Therefore, we present two types of predictions. For the first prediction we use the average \( f(i) = \frac{1}{5} x_5 + \frac{1}{6} x_6 + \frac{1}{7} x_7 + \frac{1}{8} x_8 + \frac{1}{9} x_9 + \frac{1}{10} x_{10} \) as the most recent estimates. In both cases, we then predict \( x_{i+1} = x_i(1 + f(i)) \), and similarly each subsequent year using the prediction for the previous year. Because of this values are increasing slowly with time, the second model gives a lower estimate. This trend reflects a change in the underlying dynamics during the course of the epidemic, the relative incidence shows signs of maximum.

In the table, we give, for each cohort, the number of cattle predicated to develop BSE over the next 5 years. A comparison of the predicted number of cases for 1995 and 1996 for the same age-incidence data for 1995 gives close agreement: 13,267 confirmed cases, which are likely to constitute at least 96% of the total cases, compared with 13,360-16,110 predicted. From 1996 until 1999, we expect between 15,000 and 24,000 cases of BSE to arise in animals before 1995. This prediction is a representation of the total number of animals infected from 1989 onwards.

The basis of our predictions and the knowledge of the age distribution of adult animals in UK cattle, we can calculate that the highest incidence per capita will be in those animals born between 1987 and 1990, with a marked peak in 1988, the year in which the ban on animal supplements in feed was introduced. The lowest per capita and absolute incidence will be in cattle currently aged 10 or more years, as the age-dependent frequency of disease expression is less i.e. peak. About 7% of future cases will occur in animals born in 1989 or later (at least 1 month after the food ban), the mid-life peak of the age expression for the distribution of the disease (see Figure) and the continuing decline, the feeding rate, of affected feeding rate, of affected cattle.

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