Risk factors for Bovine Johne's Disease in NSW North Coast Beef herds–an example of a low cost retrospective case study technique

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Background

Johne's disease is a slowly progressive enteropathy of predominantly ruminants due to infection by *Mycobacterium avium subsp. paratuberculosis (Map.)*. *Map*. is an obligate intracellular pathogen. The disease occurs in most livestock producing countries and the prevalence is rising globally (Collins, 2003). Bovine Johne's disease (BJD) is predominantly associated with specific strains of *Map*. designated as C (cattle) compared to S (sheep) strains (Whittington et al, 2000).

Widely accepted epidemiology regarding BJD includes features such as:

- » High concentrations of *Map*. are deposited in the environment by shedders and environmental survival of up to 270 days in water and 11 months in faeces is reported (Clarke, 1997).
- » Cattle are most susceptible to infection in the first few months of life and animals over 12 months of age are resistant to infection (Larsen et al, 1975).
- » Transmission largely ocurs by oral ingestion followed by a prolonged incubation period of 3-5 years. Shedding of the pathogen in faeces does not not occur before 12-18mths of age and precedes clinical signs by up to 3 years (Chiodini et al, 1984).
- » Clinical signs occur only in a minority of animals. Within an infected herd animals can be classified as uninfected, non-shedding carriers, subclinical shedders or clinical cases (Clarke, 1997). Onset of clinical disease is dependent on agent-host interactions and a number of risk factors that influence the onset such as farming sytems, acid soils, farming management, nutrition and stress (Clarke, 1997; Collins et al 1994 and Lugton, 2004).

Risk factors investigated in this study

1. There is a signficant increase in the risk of BJD in beef herds if local cattle are introduced.
2. There is a significant increase in the risk of BJD in beef herds which have had dairy cattle exposure.
3. There is a significant increase in the clinical expression of BJD in those beef herds with a higher stocking rate.
4. There is a signficant increase in BJD infection in particular beef breeds

Hypothesis 2 has aready become assumed knowledge by industry bodies and State animal health authorities but it is still useful to determine to what extent locally held data supports the assumed knowledge.

Method

A case control study was chosen as the most appropriate design to initially improve undertanding of these risk factors. In this type of study the investigator starts with identifying individuals or herds that are known to have the disease. Cases are selected from this group of diseased animals and are compared to a selection of non-diseased individuals or herds. The two groups are compared for the frequency of risk factors (Dohoo et al, 2003).

Beef herds known to have been infected with BJD in the region were selected as the disease cases. The definition of 'Infection' as listed in the most recent "National Standard Definitions and Rules for Johne's Disease in Cattle" was used to identify infected herds. Control herds included those with no history of BJD and at least one negative whole herd serological test using an ELISA.

2 x 2 tables were generated summarising data for diseased, non-diseased, exposue and non-exposure groups, as follows.

	Disease	
	+ve	-ve
Factor +ve	A	B
Factor –ve	C	D

From these tables an odds ratio (OR) was calculated to measure the strength of association between the factor and disease.

OR = (A X D)/(B X C)

This allowed a statement such as "The disease is x times more likely in animals exposed to the factor y".

To measure the proportion of disease attritutable to the factor an attributable fraction (AF) was calculated.

AF = (OR-1)/OR

The attributable fraction is useful as it indicates the benefit of controlling exposure to the factor.

Results

Introductions

The author randomly selected files of 21 beef herds which had at some time been infected with BJD and 45 control herds known to have had at least one negative ELISA herd test. In 19 (90%) of the BJD infected herds an infected introduced bovine was the probable route of entry. No source was determined for one herd as it was a closed herd and one herd had infection introduced by sharing yards for management tasks. In 16 (84%) of the 19 herds where infection came from an introduced bovine the bovine was from the local North Coast area. Unfortunately from the available data of the 45 control herds it was not possible to determine if only local cattle were introduced into the herds.

Dairy exposure

The author looked at the files of 15 beef herds which had been infected with BJD in the last 5 years and 45 control herds known to have had at least one negative ELISA herd test. Herds were considered to have had dairy exposure if they had known contact with dairy cattle, they grazed dairy land or contained dairy or dairy cross breeds. Herds were sorted on the basis of exposure to dairy cattle. Results can be summarised in a 2 x 2 table (Table 1).

Table 1: Dairy exposure and BJD status

	BJD infected	BJD not known infected
Dairy cattle exposure	10	7
No dairy cattle exposure	5	38
TOTAL	15	45

The "odds" calculated are as follows:

- Odds of disease in dairy cattle exposure = 10/7 =1.43.
- Odds of disease in no dairy exposure = 5/38 = 0.13
- Odds ratio = 1.43/0.13 = 11.
- Attributable fraction = (10.86-1)/10 = 0.98.

Stocking rate

Out of 21 BJD herds listed as infected records suggested that spread and clinical expression occurred in 14 of them. These 14 herds were selected as cases. In 7 herds infection was detected in a single animal without any history suggesting clinical expression of disease. These 7 herds and 45 herds with at least one negative whole herd test were selected as controls.

The carrying capacity for lands assocaited with the 14 cases and 52 controls was obtained from the FARMS database. Landowners also need to submit a land and stock return each year indicating how many cattle they are carrying. These were sourced for the 5 years before the first clinical case in the 14 cases. An average figure for number of stock carried over the five years was calculated for each case herd. All clinical cases for the selected infected herds occurred between 1986 and 2003. For the controls an average was taken of 5 land and stock returns between 1981 and 2003. For all herds the figures calculated from the land and stock returns were compared with the reccomended livestock carrying capacity. Results are summarised in Table 3.

Table 3: Stocking rate and BJD clinical expression

	BJD clinical expression	No BJD clinical expression
Stocking rate higher than reccomended	1	3
Stocking rate less or equal to that reccomended.	13	49
TOTAL	14	52

- Odds of disease with a high stocking rate = 1/3= 0.33
- Odds of disease with a recommended or low stocking rate = 13/49= 0.27
- Odds ratio = 0.33/0.27 = 1.22
- Attributable fraction = (1.22-1)/1 = 0.22.

Breed

Records from 19 known BJD infected herds were examined to find the breed of the infected introduced animal (Table 4). In 11 (58%) of Tweed-Lismore herds it was an infected Murray Grey bovine that was introduced. In the 45 control herds it was not possible to determine from records the breed of introduced animals. However, most of these herds appear to be breeding herds which would introduce the same or similar breeds to what they already have. There was inadequate time for this analysis but it is very unlikely that Murray Grey cattle are close to 50% of the cattle breeds.

Table 4: Breed and BJD in beef herds

Breed	**Number of herds with this breed as introduced infected animal**
Murray Grey	10
Angus	2
Hereford cross	1
Friesian	3
AIS	1
Limousine	1
Other Bos Taurus	0
Brahman or Brahman cross	1
TOTAL	19

Discussion

Introducing cattle of unknown BJD status is the primary risk factor for initial infection in a beef cattle herd. The case control study in this paper suggests that beef cattle herds which have exposure to dairy cattle are 11 times more likely to become infected with BJD compared to beef herds who avoid dairy exposure. With 98% of disease attributable to this factor control is likely to be very beneficial.

The case control study in this paper to investigate stocking rate did not show a signficant difference between the disease and control groups. However the recommended carrying capacities in the FARMS database are often higher than they should be. The study design also does not take into consideration divisions within a property and particular grazing strategies. A better design for the case control study on stocking rate would need to include a property visit and an interview of owners and/or managers of all herds to seek retrospective data on stocking rates. Even with this design it is probably unlikley that useful conclusions can be made because in the vast majority of infected beef herds there is little evidence of significant transmission and only one or two clinical cases may have been described.

Over 50% of the BJD infected cattle introduced into Tweed-Lismore infected beef herds were Murray Greys. Such findings are supported by similar work done on Casino herds in 2004. If introduction of Murray Grey cattle is a significant risk factor for BJD it is unlikely to be because of a breed susceptibility. A more plausible alternative to breed susceptibility may be that Murray Greys originated from a small gene pool and there may have been a high Map. prevalence in this source area. This factor may no longer be relevant.

This study demonstarted the usefulness of low cost retrospective observational studies. Undertaking these studies can assist advisory strategies for particular diseases and give further information for resource allocation.

On the basis of this paper North Coast BJD advisory work by veterinarians should continue to suggest that North Coast beef producers wishing to reduce the risk of Map. introduction should avoid exposure to dairy cattle.

References

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