Economic analysis of an acute outbreak of bovine viral diarrhoea virus (BVDV) in a South Australian dairy herd - a case study

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Summary

Herd history A previously closed South Australian dairy herd, milking 320 predominantly Friesian cows, was expanded in early 2008 by purchase of 129 females and 11 bulls. In April and early May 2009, the farmer observed substantial increases in the incidence of abortions and neonatal calf mortality. There was also a reduced calving rate. The bulk milk somatic cell count and incidence of mastitis increased.

Cost to producer The combined direct and indirect costs of this outbreak were estimated to be $144,700. Costs incurred related to production losses (calves, milk), the need to replace cows, the veterinary costs related to diagnostic testing, and the losses incurred from secondary infections. The indirect costs, primarily related to an increased incidence of mastitis exceeded the direct costs from reproductive disorder and calf losses.

Findings Post-mortem examination of four of the clinically affected calves revealed cerebellar hypoplasia and hydrocephalus, consistent with foetal infection with bovine viral diarrhoea virus (BVDV). Diagnostic testing identified one of the introduced bulls to be viraemic for BVDV which is likely to have been the source of infection in this herd. Further testing confirmed the presence of persistently infected calves born in 2009.

Keywords: BVDV; Pestivirus; cattle; economics; mastitis; SCC

Introduction

Bovine viral diarrhoea (BVD) is a disease caused by a *Pestivirus* (BVDV) of the family *Flaviviridae*[1], to which approximately 82% of beef and 97% of dairy properties in South Australia show evidence of exposure (Anderson *et al.* unpublished data). Upon infection of a naïve animal with BVDV strains that are endemic in Australia, a wide range of generally mild clinical signs including enteric or respiratory disease can be observed[2-4]. However, infection during pregnancy can result in severe reproductive disease: abortions, extended calving-to-conception intervals, early embryonic loss, still births and congenital defects[5]. During the first 120 days of gestation, before the calf becomes immunocompetent, infection can result in the calf being born immunotolerant and persistently infected (PI) to BVDV. Persistently infected individuals continue to shed the virus in all bodily fluids throughout their life, and as such, are a source of infection and maintain BVDV in cattle populations[5]. Bovine viral diarrhoea may have significant negative financial impact arising from decreased production, early death of PI animals, reproductive losses and an increased susceptibility to other diseases[6], including mastitis, due to immunosuppression. Consequent increases in the occurrence of mastitis may lead to increases in somatic cell count (SCC), if not managed appropriately.

Herd History

An acute BVD outbreak occurred on a dairy property located near Meningie, South Australia. Surrounding properties are utilised for cropping, sheep and some beef farming. In the past, a herd of 320 predominantly Friesian cows were milked, with calving occurring in two periods - autumn and spring. Home bred Murray Grey bulls or artificial insemination were used, resulting in overall pregnancy rates of approximately 90 percent. In the three years before the outbreak all calves delivered appeared normal, with abortions limited to only two or three each year. In the previous three years bulk milk SCC levels were maintained below 200,000 cells/mL, resulting in a 3% price premium. From January to March 2008 an additional 129 females were purchased, followed by 11 bulls arriving in May. In April 2009 the farmer noticed a significant increase in abortions, moribund calves dying with neurological signs, and a reduced calving rate. One of the introduced bulls was BVDV antibody negative and antigen positive. The PI bull appeared healthy, but was smaller in stature than the other bulls despite similar history, suggesting stunted growth.

Costs of infection

The costs arising from this BVD outbreak stem from a variety of direct and indirect costs which include production losses, replacement costs and diagnostic costs, and totalled approximately AU$144,700.

Under South Australian milk payment schemes, a 2% price premium is paid for maintaining SCC below 200,000 cells/mL. As illustrated in Figure 1, the herd's SCC was above 200,000 cells/mL (averaging 299,241 cells/mL) for approximately 22 months, over which time, total volume of production was 5.39 ML. This rise was observed from May 2008 when the PI bull was introduced rather than the earlier introduction of 129 females, supporting the hypothesis that the rise is a result of the introduction of BVDV to the herd. As a result of the increased SCC during the outbreak, the herd's bonus payment was reduced by 2%, equating to 0.66c/L (2010 mean price 33c/L) - a total loss of AU$35,500.

Due to increased abortion and decreased pregnancy rates (see 'Herd History'), forty cows failed to calve additional to previously observed rates. With the average volume/lactation in this herd approximately 2500L/lactation, these empty cows resulted in approximately 0.1ML lost milk production, equating to a financial loss of $33,000 (2010 mean price 33c/L). Amongst the cows that delivered a calf, severe and prolonged mastitis infections occurred in 20 cows that were ultimately culled.

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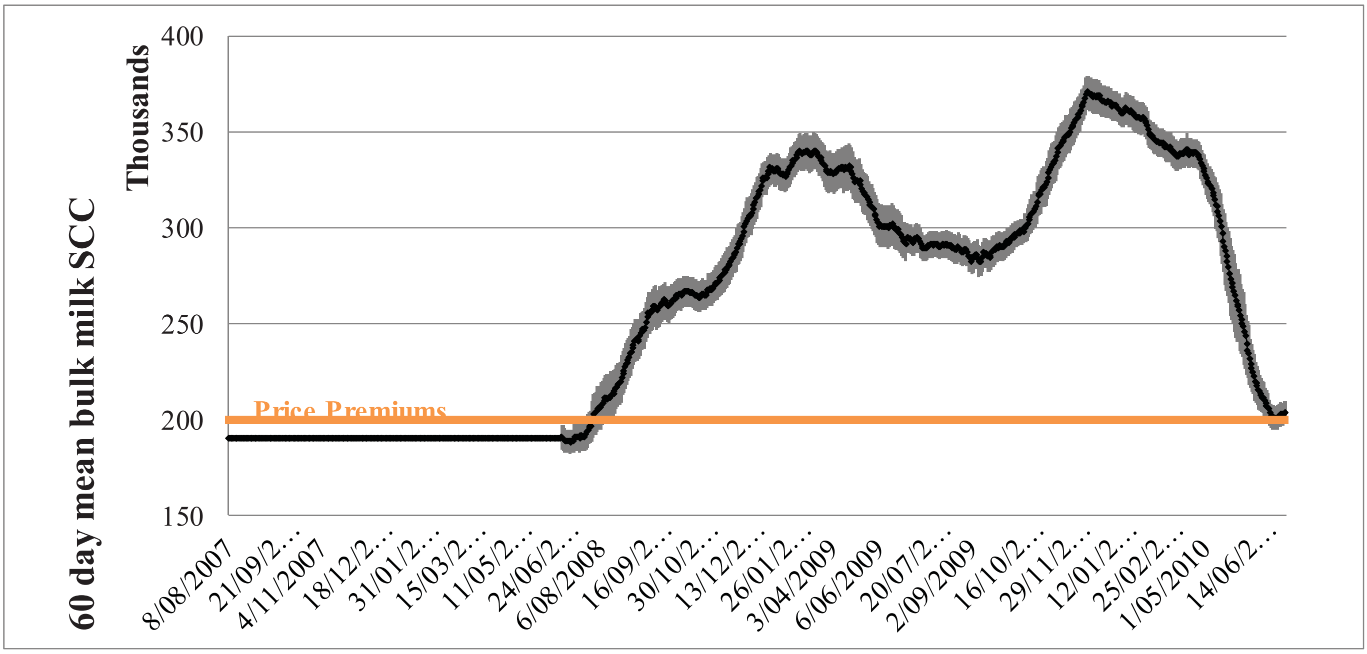

Figure 1 *The somatic cell count (SCC) response to an acute bovine viral diarrhoea outbreak in a 320 cow milking herd in the Meningie area, South Australia. The virus was introduced to the herd in May 2008 via introduction of a persistently infected bull. Prior to June 2008, data is anecdotal based on the farmer's recollection. From June 2008 onwards, data was sourced from milk company records. Grey bands indicate 95% confidence intervals. Below 200,000 cells/mL, price premiums are available for*

These cows were culled before the end of their lactations, resulting in approximately $1000/cow lost milk production. Furthermore, the purchase of replacement cows amounted a cost of $1000/cow. This totals a cost of $40,000 in lost production and replacement of cows culled for mastitis.

High calf mortality and morbidity resulted in the necessary purchase of 50 replacement heifers, with an estimated cost of $600/heifer above normal raising costs. This resulted in heifer replacement costs of $30,000.

The PI bull succumbed to a short, non-specific illness during a period of extreme heat in summer 2009, at approximately four years of age, resulting in further replacement costs of approximately $1,200. Additionally, farmer time, veterinary and test costs of $4,000 were incurred and bull calves not sold due to high rates of abortion, still birth and calf mortality presented a total loss of approximately $1,000.

Abnormalities as a result of infection

The abnormalities observed in this herd began in May 2008, with the 60 day mean bulk tank SCC rising above 200,000 cells/mL following the introduction of the PI bull to the herd. As the outbreak progressed, the SCC continued to rise, peaking at approximately 370,000 cells/mL in

December 2009, 18 months after the introduction of the PI individual (Figure 1). The SCC returned to levels below 200,000 cells/mL in June 2010.

Bulk milk testing in October 2010 by polymerase chain reaction (PCR) confirmed the milking herd to be PI-free (PCR negative).

Antibody enzyme-linked immunosorbent assay (ELISA) testing of bulk milk at this time showed a sample-to-positive ratio of >1.0 suggesting high levels of immunity continued to be maintained in this herd.

Pathological findings

The range of clinical signs observed in calves included an inability to stand, slow or poor drinkers, scouring, and death. Neurological signs seen in some animals included, ataxia, head nodding and apparent blindness.

Figure 2
Photographs of post-mortem findings in calves following foetal infection with bovine viral diarrhoea virus (BVDV) showing cerebellar hypoplasia (a, b) and severe hydrocephalus (c).

(Continued on page 16)

(Continued from page 14)

Figure 2b

Of four affected animals that were euthanized all displayed varying levels of cerebellar hypoplasia, apparent both grossly (Figure 2), and microscopically (Figures 3 and 4).

None of these calves were antigen positive for BVDV. Subsequent testing of 81 calves from the same affected group via "ear notch" antigen capture ELISA (IDEXX BVDV Ag/Serum Plus) revealed 3 strong positive results, confirming the presence of PI calves in this group. After the introduction of the PI bull, 13 abortions were observed in the existing female herd, compared to 2-3 each year in the past.

Figure 2c

Reduced calving and pregnancy rates were noted from October 2008, with forty non-introduced cows failing to calve, despite the presence of bulls in the herd for longer than usual periods.

Discussion

The first clinical sign of the BVD outbreak experienced by the dairy herd described here was an increased somatic cell count (SCC). The SCC began to rise almost immediately following the introduction of the PI bull in May 2008. However, it was a further six months before any other (clinical) signs became evident, with higher than usual abortion rates (13 abortions compared to 2-3 in past years) over the summer 2008-2009, and the birth of more than 50% abnormal calves in May and June 2009. This case illustrates the importance of early detection of BVDV infection in naïve herds.

High SCC does not appear to be directly related to a high seroprevalence of BVDV specific antibodies[7], possibly because chronically infected herds are unlikely to suffer the secondary infections to the same degree seen in acutely infected herds. However, a sudden, otherwise unexplained increase in SCC (as observed in this case) may be indicative of an infection entering a milking herd, and BVD should be considered. A rise in SCC levels should be followed by testing of bulk milk samples by PCR for viral antigen, and by ELISA for antibody detection. A positive PCR result – indicative of a PI in the milking herd – will immediately confirm BVDV infection in the milking herd, allowing testing of individual animals and preventative measures to be enforced. A negative PCR result, however, does not preclude the possibility of BVDV infection. As seen in this case, the PI animal maintaining the infection (here, a bull) may not be contributing to the bulk milk samples, and therefore would not be detected by bulk milk PCR. As such, additional information can be obtained from antibody testing, with a high (and/or rising) antibody result providing the evidence necessary to justify further testing of individual animals.

Figure 3

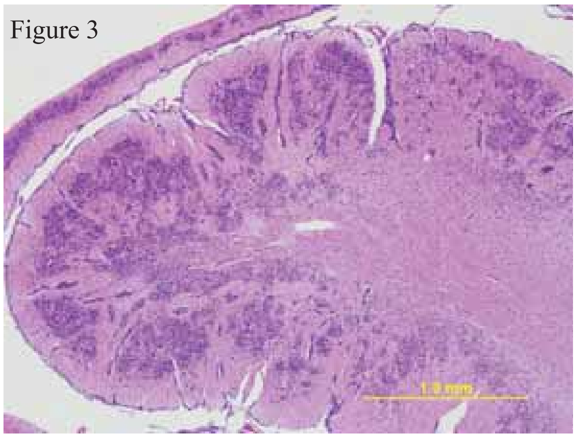

Figure 3 *Histopathology, cerebellum, calf 4: this low power view shows the variable segmental loss and disorganisation of granular cells, and moderate to marked granular and Purkinje cell ectopia, secondary to foetal infection by bovine viral diarrhoea virus (BVDV).*

Figure 4

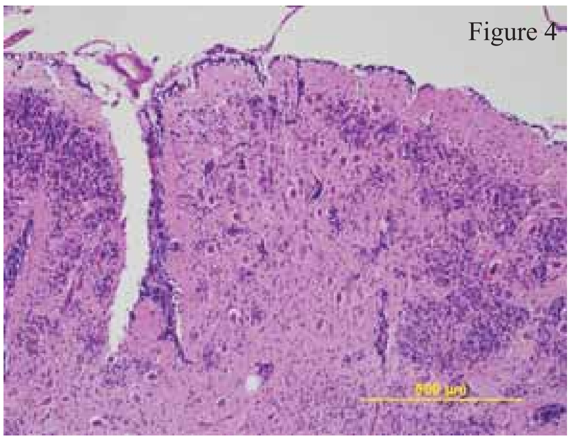

Figure 4 *Histopathology, cerebellum, calf 4: this high power view shows segmental loss and disorganisation of the granular cell layer, as well as cellular ectopia, secondary to foetal infection by bovine viral diarrhoea virus (BVDV).*

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Table 1 Summary of the costs accrued over approximately a two year period, by a dairy property in the Meningie area of South Australia, as both direct and indirect results of the introduction of bovine viral diarrhoea virus (BVDV) to the 320 cow milking herd, through the purchase and introduction of a PI bull. Values are in Australian dollars.

[a]Based on farmer estimate or recollection of cost

Item	Cost/unit	Units	Total Cost
Reduced milk value	0.66 c/L	5.39 ML	**$35,500**
Lost milk production due to empty cows[a]	33 c/L	40 Cows x 2500 L	**$33,000**
Replacement heifers[a]	$600 /heifer *(above rearing cost)*	50 heifers	**$30,000**
Lost milk production from mastitis[a]	$1000 /cow	20 cows	**$20,000**
Replacement cows culled for mastitis[a]	$1000 /replacement	20 cows	**$20,000**
Farmer time, vet and test costs			**$4,000**
Replacement of PI bull[a]	$1200 /bull	1 bull	**$1,200**
Calves not sold[a]			**$1,000**
TOTAL			**$144,700**

In total, this outbreak cost the producer AU$144,700 over a two-year period. This is concurrent with recent estimates made by Reichel *et al.*[8] of the direct costs from PIs during an epidemic infection, and with estimates from outbreaks in Ontario in 1993[9], which estimated the cost at US$40,000 – US$100,000 ($54,800 – $137,000 in 1994 AU$) per herd. This supports the common conclusion that BVDV infection can be very expensive, in particular when introduced to a naïve herd. The indirect effects of BVDV infection are largely underreported in the literature, but have been estimated to exceed the cost of reproductive effects. For example, Heuer *et al.*[7] estimated annual losses in BVDV infected herds of approximately NZ$10,500 from decreased milk production, compared to NZ$6,000 from increased abortions. It is worth noting that the indirect costs relating to this outbreak were significant, accounting for at least $75,000 - more than half the total outbreak cost. These costs were predominantly related to the increases in mastitis occurrence due to the presumed immunosuppressive effect of BVDV infection[10].

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