The cost of enteric salmonellosis in ewes

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Abstract

INTRODUCTION: Enteric salmonellosis typically occurs in outbreaks in Autumn, costing farmers in losses, diagnostics, and management. Carrier animals are important in its transmission. It was first described in NZ in 1949, and has increased in incidence in the intervening time. \textit{S. Hindmarsh} is currently the most common enteric serovar in NZ. Otago-Southland also commonly sees the abortion-causing strain \textit{S. Brandenburg}.

DISCUSSION: On a typical Clutha district farm of 2400 sheep, an average outbreak from the 2013 season affecting 30 ewes is estimated to cost over $6000NZD, magnified at the national level. Vaccinating all ewes with a single dose of Salvexin+B after the start of an outbreak reduces losses markedly after 7-14 days. Prophylactic vaccination may be economic on farms having regular (less than six years) outbreaks of any form of salmonellosis (at \textasciitilde$816/year on a typical farm). Disease typically occurs after exposure to stressors, such as yarding, decreased feed intake, transportation etc. Costs from forced changes to management may be significant. Cost at a national level is difficult to quantify due to severe underrepresentation of lab submissions. The role of \textit{Salmonella} as a zoonosis has management expenses and costs secondary to human disease regardless of the role of common ovine serovars.

CONCLUSION: Enteric salmonellosis has a difficult to quantify cost at the farm and national level, with both overt and covert components. Prevention measures also have a cost associated, and are not always applicable or effective in any given scenario. Control measures should be aimed at prompt diagnosis and vaccination. Prophylactic vaccination is likely to be cost effective in some areas.

Introduction

Enteric salmonellosis typically occurs between January and May (Kane 1979), and has been associated with stressors including yarding, high stocking rates, transportation, changes in nutrition, and facial eczema control measures (Neilson \textit{et al.} 1985, West 1988). These practices act as stressors, and may act to increase environmental exposure to the bacteria. Clinical signs are typically acute diarrhoea and severe systemic illness, with high case-fatality (Kerslake 2003). Carrier animals, which shed \textit{Salmonella} intermittently, are thought to be important in disease transmission (Kerslake 2003). Clinical disease typically affects only mixed age sheep (West 1988).

Over each of the last five years, an average of 21 cases of enteric salmonellosis have been diagnosed in laboratories in New Zealand (Surveillance 2009-2012). This figure is likely to reflect only a proportion of affected farms, with many going undiagnosed by labs. With a case-fatality between 50 and 100\%, and even a conservative on-farm incidence of 2\% (lower end of range from Wallace and Murch 1967, Robinson and Royal 1971, Surveillance 1980), economic losses from livestock deaths alone are significant. The cost of salmonellosis stretches beyond livestock losses, and into farm management changes, human health and food safety regulation. Management of the disease on-farm is the most basic level at which to manage the economic impact of the disease in New Zealand.
History

Enteric salmonellosis was first described in sheep in New Zealand in 1949 (Josland 1950). The incidence of salmonellosis in NZ increased steadily from the mid 1960s, accelerating in 1996 with the arrival of an abortion causing strain of S. Brandenburg in the South Island (Clark 2002). Economics have driven the development of vaccines since the late 1960s, and in 1999-2000 a multivalent vaccine (vs. S. Bovis-morbificans, S. Hindmarsh, S. Typhimurium, S. Brandenburg) was developed (Salvexin+B, Intervet, Schering-Plough Animal Health) (Marchant 2000).

In Otago-Southland, both forms of salmonellosis are common compared to other areas, particularly compared to the North Island (Surveillance 2009-2012). This makes the South an efficient area for targeted Salmonella management. The incidence of enteric Salmonellosis in the area had declined sharply between 1998 and 2007, possibly in association with increased vaccination following the emergence of S. Brandenburg, or development of natural immunity to enteric strains secondary to exposure to S. Brandenburg (Gill and Kelly 2011). The incidence has since risen, with 2014 no exception to the trend (Smart, pers com 2014).

Nationally in 2011, of the 49 cases of salmonellosis diagnosed at laboratories, 27 of 33 enteric cases were confirmed as S. Hindmarsh (Surveillance 2011), making S. Hindmarsh currently the most common enteric serovar of Salmonella in sheep in New Zealand.

Discussion

In order to make useful a discussion of a simultaneously esoteric and run-of-the-mill, topic, a set of crude calculations are outlined below.

Taking a typical flock size in the Clutha district (2400), typical ewe mob size (800), and a typical number of affected ewes in each case during the 2013 outbreak season (30) (Smart, pers com 2013), provides the basis for estimating on-farm costs for an outbreak of enteric salmonellosis on an average farm in the area. It is estimated that one post mortem and one culture is performed to support the diagnosis, that 90% of affected sheep will die, that 50% of affected sheep are treated, and that all remaining ewes in the mob are vaccinated after the start of the outbreak.

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost/item</th>
<th>x</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct cost of ewes</td>
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<td>27</td>
<td>$5400.00</td>
</tr>
<tr>
<td>Post mortem cost</td>
<td>$75/ewe</td>
<td>1</td>
<td>$75.00</td>
</tr>
<tr>
<td>Culture</td>
<td>$30/sample</td>
<td>1</td>
<td>$30</td>
</tr>
<tr>
<td>Treatment cost</td>
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<td>$82.50</td>
</tr>
<tr>
<td>Cost of vaccine</td>
<td>$0.85/dose</td>
<td>773</td>
<td>$654.00</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td><strong>$6246.50</strong></td>
</tr>
</tbody>
</table>

Whilst this crude estimate can provide some idea of the cost on a typical farm, individual cases will vary markedly. Within the author’s district alone, it would imply an annual direct fiscal cost of the region of $60,000-150,000, depending on the season.

The question of whether farmers in the area should vaccinate annually is an important one. Vaccinating all ewes after an outbreak of enteric salmonellosis has begun has been shown to reduce deaths by up to 97% by two weeks after administration (Beckett 1967), and it is likely to provide equivalent or better efficacy if administered prior to an outbreak. The efficacy of vaccinating ewes against S. Brandenburg is less clear-cut, and appears primarily to prevent deaths (by about 65-70%), and has lesser effect in preventing abortions (Marchant et al. 2002). The concern of increasing transmission and incidence of disease by yarding is a valid one, but it is the anecdotal consensus that this risk pales in comparison to the risk of not vaccinating at all. On our example typical farm the cost of giving an annual vaccination is $1.02/year/sheep ($816 total), assuming that the cost of the vaccine is $0.85/dose, that the average lifespan of the ewes is a generous six years, and that she receives two doses as a two-tooth. It follows...
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that to cover the cost of vaccination (by preventing death by any of the serovars covered by the vaccine, including Brandenburg), that four in-lamb ewes at $200 must be saved each year on average. For the example farm, what this means practically is that vaccination becomes economic if a moderate outbreak (e.g. 24 affected out of 800 in the mob) of any form of salmonellosis occurs more often than every six years. Therefore, the area incidence, environmental and management stressors, and farm history must be taken into account when making the decision to vaccinate prophylactically on a given farm. An important consideration is the timing of such a vaccination. Enteric salmonellosis typically occurs in late summer to early autumn, whilst Brandenburg typically occurs in winter. Anecdotally, the period of protection against enteric serovars by a single dose with Salvexin+B is longer than that against Brandenburg, which also parallels what is known about the relative effectiveness as described above. What this implies is that a single booster vaccination prior to the risk period for enteric salmonellosis may not provide adequate duration of protection against Brandenburg later in the year. Therefore, the area incidence, environmental and management stressors, and farm history must be taken into account when making the decision to vaccinate prophylactically on a given farm. An important consideration is the timing of such a vaccination. Enteric salmonellosis typically occurs in late summer to early autumn, whilst Brandenburg typically occurs in winter. Anecdotally, the period of protection against enteric serovars by a single dose with Salvexin+B is longer than that against Brandenburg, which also parallels what is known about the relative effectiveness as described above. What this implies is that a single booster vaccination prior to the risk period for enteric salmonellosis may not provide adequate duration of protection against Brandenburg later in the year. However, vaccinating prior to the risk period for Brandenburg may provide protection against enteric salmonellosis in the season following. More data is required to confirm these reports.

Unquantifiable opportunity costs also affect the farm economy. The broadest of these is an involuntary change to management (Stewart 2013). Spreading ewes out has been recommended as a potential control measure for salmonellosis (Robinson 1970). However, autumn conditions are not always conducive to this practice for a variety of reasons, including drought, parasitism, and a need to conserve pasture going into winter. It has also been recommended to increase the plane of nutrition of the sheep as part of the control plan. The same reasons as described above often preclude this, and given that disease often affects high condition ewes, increasing their nutrition may be of dubious use. In any season regardless, involuntary changes to management have the potential to force changes to feed stores for other ewes and other classes of stock, having knock-on effects into the spring, e.g. reduced pasture covers, changes in pasture quality, and soil damage. There may be subclinical production losses due to exposure to S. Hindmarsh, but little literature is available to support this. Other unquantifiable costs include added stress to farmers and staff, both during the outbreak and in the coming season, having the potential to influence other areas of life.

Effects on the national economy due to enteric salmonellosis are difficult to quantify, but likely to be significant. It is expected that the number of cases diagnosed by laboratories represents a small proportion of the true number. In an outbreak situation, it is usual for only one or two samples to be submitted from each farm, even where many ewes may be affected. It is also probable that, after the start of an outbreak, veterinarians may be diagnosing the disease based on history and clinical or post mortem findings alone. Because of these factors it is impossible to estimate the true number of cases and thereby fiscally estimate the cost of livestock and other losses at the national level. It is reasonable to assume that the cost is a multiple of the scenario described above.

Zoonotic potential

In addition to these costs associated directly with outbreaks, the presence of ovine Salmonella in the food chain, which is a zoonotic pathogen, requires monitoring and management (Fenwick 1996). Briefly, these measures include random meat sampling and culture, and regulation of the entry of affected animals to the meat processing chain, all of which bear a cost (Armitage 2000). In 1994-95, 1500 cases of human salmonellosis were diagnosed, of which 60% were S. Typhimurium, and most of the remainder S. Enteritidis (Fenwick 1996). The role of these less common serovars (in sheep) as food-borne pathogens is unclear at this stage. Nonetheless, the cost of monitoring for Salmonella in sheep meat remains real. Whilst more common ovine serovars, e.g. S. Brandenburg and S. Hindmarsh, cause human disease less commonly, the potential for human infection is tangible, particularly as an occupational hazard as a veterinarian or farmer (Davies 2000). Treatment cost for human illness and time off work must be considered.

Conclusion

In conclusion, enteric salmonellosis represents an expensive problem to the individual farm in direct and indirect ways, and to the national economy as a whole, both from lost production and costs incurred in management of animal and human disease. Vaccinating ewes with a single dose of Salvexin+B as soon as possible after the start of an outbreak is an effective control measure, preventing new deaths after 7-14 days. Preventative vaccination may be economic on some farms, especially in areas affected by S. Brandenburg and those with regular outbreaks of enteric salmonellosis. Spreading ewes out is an effective, but not always practical, control measure.
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