ARTICLES

The pattern of fatal fibrinous pneumonia (shipping fever) affecting calves in a large feedlot in Alberta (1985–1988)

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Abstract

Data from a retrospective field study were used to describe the epidemiology of fatal fibrinous pneumonia as it affected beef calves entering a large commercial feedlot in southwestern Alberta during the fall months of y 1985 to 1988. A chute-side computer system was used to record processing and health data on 58 885 calves during this period. The large annual variation (10%–57%) in the proportion of total mortality due to fibrinous pneumonia indicated that crude mortality cannot be used in epidemiological studies as a surrogate measure of fibrinous pneumonia mortality. Yearly epidemic curves for fatal fibrinous pneumonia were very similar, with a short time interval (median, 19–22 d) between arrival and fatal disease. Fully 75% of the calves that died of fibrinous pneumonia already were sick within 2 weeks of arrival. Studies of the biological, environmental, and population factors that are present before and shortly after arrival at the feedlot are needed to identify strategies for reducing the incidence of fatal fibrinous pneumonia.

Résumé

Épidémiologie de la pneumonie fibrineuse fatale chez la veau en parc d'engraissement en Alberta (1985–1988)

Les auteurs décrivent l'épidémiologie de la pneumonie fibrineuse fatale chez le veau en parc d'engraissement commercial. Les données proviennent d'une étude rétrospective effectuée dans le sud-ouest de l'Alberta lors de la saison automnale des années 1985 à 1988. Tous les dossiers de régie et le bilan de santé des 58 885 veaux ont été enregistrés sur un système informatisé. Les auteurs ont noté une grande variation annuelle (10–57 %) dans le pourcentage du taux de mortalité relié à la pneumonie fibrineuse et ils en déduisent que le taux brut de mortalité ne peut être utilisé lors d'étude épidémiologique comme mesure subrogée du taux de mortalité relié à la pneumonie fibrineuse. Les courbes épidémiques annuelles étaient semblables et présentaient un court intervalle entre le jour de l'arrivée des animaux en parc d'engraissement et celui de l'apparition de la maladie fatale (médian, 19–22 jours). Soixante-quinze pour cent des veaux morts de la pneumonie fibrineuse étaient malades en moins de deux semaines après leur arrivée. Les auteurs s'entendent enfin sur la nécessité d'effetuer des études sur les facteurs biologiques, environnementaux et de population présents avant et peu après l'arrivée des animaux en parc d'engraissement afin d'élaborer des stratégies pour diminuer l'incidence de la pneumonie fibrineuse fatale.

(Traduit par docteure Thérèse Lanthier)

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Introduction

In feedlots in western Canada, the morbidity from shipping fever in calves can exceed 50% (1), and crude mortality rates can range from 2.4% to 5.3%, with 35% to 50% of this mortality being due to fibrinous pneumonia (1–3). Development of a thorough understanding of the epidemiology of shipping fever in these high risk calves would increase the likelihood that reliable methods can be found for controlling and preventing the disease, other than the prophylactic use of antibiotics at arrival (1,4).

Surprisingly, given the amount of veterinary literature containing references to the terms "shipping fever" and "fibrinous pneumonia," very little is known about the natural history of the disease. The literature contains few epidemiological studies that describe any of the diseases specific to feedlots in terms of their temporal or spatial patterns, using simple techniques like epidemic curves (2,3,5) or disease-specific incidence rates (1,2). There are many published studies of morbidity and mortality in North American feedlots, but most authors have used the crude measures of total morbidity and total mortality as their outcomes, and the definitions for these have varied considerably (6). This makes comparisons among papers difficult. Furthermore, no descriptive epidemiological study has concentrated specifically

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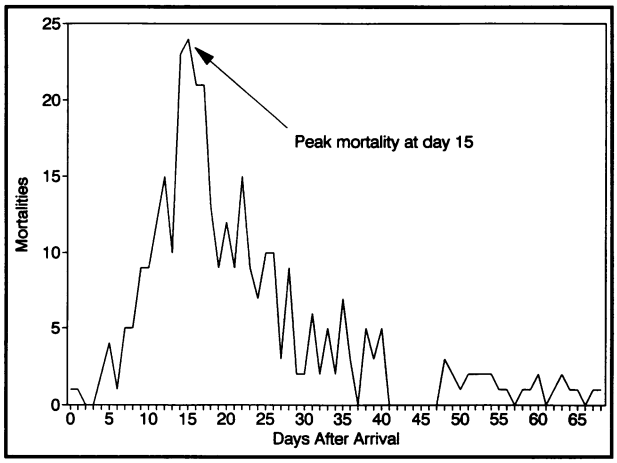

Figure 1. Epidemic curve for mortalities due to fibrinous pneumonia at a feedlot in Alberta in 1987.

on shipping fever mortality in recently weaned calves. The descriptive work that has been previously reported may not be relevant to this high-risk group.

The objectives of the present study were three-fold. First, to describe the pattern of disease for fatal fibrinous pneumonia (FFP) over a 4-year time period at a large feedlot in Alberta. Second, to determine how well crude mortality represents FFP mortality in feedlot studies. Third, to determine, on a truckload basis, whether there was a simple association between the proportion of calves treated for pneumonia (pneumonia morbidity) and the proportion of calves that subsequently died of fibrinous pneumonia.

Materials and methods

Feedlot data

The subjects of this study were 58 885 spring-born calves that entered a large feedlot in southwestern Alberta between September 1 and December 31, 1985 to 1988, inclusive. In 1985 the feedlot had a capacity to feed 15 000 head at one time. The capacity was increased to 18 000 head in 1988. Most of the animals in the feedlot during the fall and early winter were recently weaned calves that had been purchased from auction markets. The feedlot owner used 8 primary order-buyers who purchased recently weaned calves from 42 auction markets located in Manitoba, Saskatchewan, Alberta, and British Columbia.

Details have previously been described on how the calves arrived in transport trucks capable of handling 75–90 calves per load, how they were processed upon arrival at the feedlot, how they were diagnosed and treated for illness, and how the mortality data were collected and tabulated (7).

Pattern of disease

The temporal pattern of disease occurrence for fatal fibrinous pneumonia (FFP), relative to the time of arrival at the feedlot, was examined by setting the date of arrival for each truckload of calves as day 0 (8). To discover when calves that died of fibrinous pneumonia first became ill, relative to their arrival at the feedlot, the day of first treatment of all calves that subsequently died of fibrinous pneumonia was recorded as the day of fatal disease onset (FDO) (2,5). An epidemic curve was created for the FDO parameter and compared to the curve for fibrinous pneumonia mortality. Time-specific incidence rates of disease were calculated for the FDO of all fibrinous pneumonia mortalities. A radix of 10 000 was used, so that the reported incidence rates indicated the number of new cases of FFP that occurred per 10 000 bovine weeks at risk during that time period.

Table 1. Descriptive statistics for days from arrival at the feedlot until death for cases of fatal fibrinous pneumonia in an Alberta feedlot by study year (1985–1988)

	Days from arrival to death			
Statistic	1985	1986	1987	1988
25th percentile	15	16	14	14
Median	19	22	19	19
75th percentile	32	41.5	28.5	30
Mode (peak)	16	16,22[a]	15	16–19[b]
Range	(4–197)	(0–183)	(0–220)	(4–178)

[a]Bimodal distribution
[b]Four-day peak (no pronounced one-day peak)

The temporal pattern of FFP was further investigated by describing for each of the 4 y how long after arrival calves with FFP died, and the time between first treatment for all FFP cases and death. All of the epidemic curves were skewed heavily to the right, minimizing the usefulness of the mean as a descriptive statistic. As a result, means are not presented. Instead, medians are presented, as well as the 25th and 75th percentiles, and the mode.

The potential association between the proportion of a truckload of calves that was treated for pneumonia and the proportion of the truckload that went on to die of fibrinous pneumonia was assessed graphically. Treatment rate data on a truckload basis were available for only 2 of the study years (1987 and 1988). The risk of treatment for pneumonia in each truckload of calves was plotted against the risk of fibrinous pneumonia mortality for each of the 2 years.

Results

Fibrinous pneumonia was the most common diagnosis made at necropsy during the first 3 y of the study, comprising 48%, 30%, and 57% of all mortalities in 1985, 1986, and 1987, respectively. In 1988, myocarditis and pericarditis combined were the most common diagnosis (37%), followed by fibrinous pneumonia (10%). Crude mortality (from all causes) varied from 2.44% in 1988 to 4.78% in 1987. The mortality due specifically to fibrinous pneumonia was 2.13%, 1.22%, 2.73%, and 0.25% in 1985, 1986, 1987, and 1988, respectively. Therefore, FFP mortality was more than 10-fold greater in 1987 compared with 1988.

Despite differences in scale, there was a remarkable similarity in the temporal pattern of fibrinous pneumonia mortality across all 4 study years (Table 1). The epidemic curves for mortality due to fibrinous pneumonia were skewed to the right, with peak mortality occurring approximately 16 d after arrival at the feedlot (Figure 1, Table 1). Fifty percent of the deaths due to fibrinous pneumonia occurred within 3 wk of arrival at the feedlot (Table 1).

Table 2. Descriptive statistics for days from arrival at the feedlot until first treatment for all cases of fatal fibrinous pneumonia (FFP) in an Alberta feedlot by study year (1985–1988)

	Days from arrival to first treatment for all FFP mortalities[a]			
Statistic	1985	1986	1987	1988
25th percentile	4	5	1	3
Median	8	8	3	5
75th percentile	15	12	5	10
Mode (peak)	4	5,8[b]	0	3

[a]If a case was not treated prior to death, then the day of first treatment was set equal to the day of death
[b]Bimodal distribution

Table 3. Descriptive statistics for days from first treatment until death for cases of fatal fibrinous pneumonia in an Alberta feedlot by study year (1985–1988)

	Days from first treatment until death			
Statistic	1985	1986	1987	1988
Mode (peak)	0	0	15	9,13[a]
25th percentile	4	6.5	10	8
Median	13	13.5	16	13
75th percentile	75	29	27	21

[a]Bimodal distribution

The epidemic curves showing when calves that eventually died of fibrinous pneumonia were first treated for pneumonia at the feedlot were skewed even further to the right, with peak fatal disease onset (FDO) occurring within 8 d of arrival (Table 2). Cases of fatal fibrinous pneumonia were first treated sooner after arrival in 1987 compared with the other 3 y; 75% of the mortalities due to fibrinous pneumonia in 1987 had been treated for pneumonia within 5 d of arrival (Table 2). The time that elapsed between 1st treatment and death in FFP cases is also presented (Table 3).

A comparison of the proportion of each truckload that was treated for pneumonia with the proportion of the truckload that subsequently died of fibrinous pneumonia is presented for 1987 (Figure 2) and 1988 (Figure 3). In both years, the range for pneumonia treatments was extremely large (0% to 100% in 1987, 0% to 85% in 1988) in truckloads that experienced no mortality due to fibrinous pneumonia. The graph for 1988 appears to be a true scattergram (Figure 3). The graph for 1987 (Figure 2), which covered a much wider range of mortality due to fibrinous pneumonia than that for 1988, suggests that there may have been an association between pneumonia treatments and mortality due to fibrinous pneumonia, but the relationship was neither simple nor linear.

Discussion

The mortality and FDO data demonstrated a consistently short time interval between arrival and fatal disease. This is in agreement with the few necropsy studies that have presented some data on the temporal pattern of fatal shipping fever in other feedlots (9–11). However, the singular nature of the mortality curves in this study were striking. Despite large annual differences in the number of cases of FFP, the basic shape of the mortality curves did not change; therefore, there was no fundamental difference in the temporal pattern of mortality, relative to arrival, that might explain, for example, the marked difference in mortality due to fibrinous pneumonia between 1985 or 1987, and 1988. Something acted to change the overall risk of the disease from year to year, without affecting the temporal pattern of that mortality.

A puzzling finding was the change in pattern of FDO in 1987. Cases of fatal fibrinous pneumonia were treated sooner after arrival in 1987 than in other years. Did this result from a change in the disease in 1987, or from a change in the way that calves were chosen for treatment? Given the marked similarity in mortality curves throughout the years, the latter alternative appears more likely. The incidence of mortality was highest in 1987, and the increased mortality in the feedlot due to fibrinous pneumonia could have influenced the pen-riders to move animals into hospital chutes earlier in the progression of the disease as compared to other years. This possibility is somewhat troubling, because it suggests that earlier treatment had no effect on the pattern of disease, though without controls we do not know whether treatment reduced the incidence of mortality from inflated levels. Alternatively, the animals may have been truly depressed and pyretic early after their arrival in 1987, because the disease was further progressed upon arrival. However, if this had happened, we should have seen a concurrent shift in the mortality curve to the left, toward the time of arrival; the FFP cases should have died earlier in 1987 compared to the other 3 y. The curve was not shifted, providing support for the hypothesis that it was a change in how calves were chosen for treatment that caused the 1987 difference. Other explanations are possible. Future studies may shed more light on these observations.

The consistent and very early occurrence of fatal fibrinous pneumonia in the feedlot indicates that preventive efforts must be directed toward calves at, or even before, the time of their arrival at the feedlot. Similarly, studies designed to identify factors associated with the disease must be directed toward events occurring around the time of arrival. Previous work, for example, has shown that the mixing of different groups or truckloads of cattle after their arrival at the feedlot results in increased total mortality (12–15). Therefore, it seems likely, given the rapid peak in fatal disease onset noted here, that the mixing of calves that occurs at the auction markets prior to their transport could be a significant contributor to disease occurrence.

Other factors that occur just prior to feedlot entry, such as stress induced by the distances trucked from the auction market, and the weather conditions prevalent during and shortly after transport, should also be investigated for their potential influence over disease occurrence. Researchers and veterinary practitioners have been concerned with these factors, and the standard recommendation made to feedlot owners is that calves should be

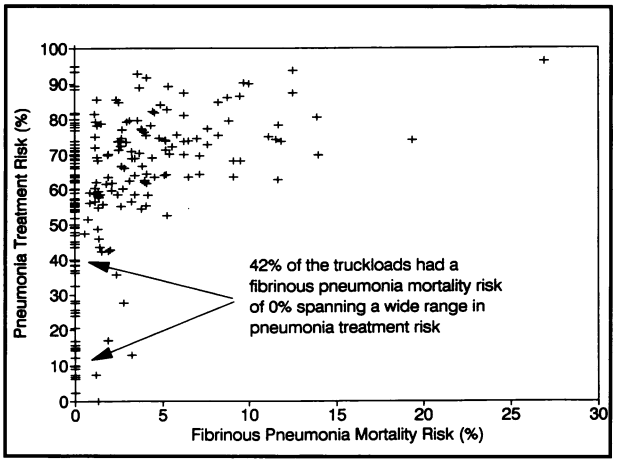

Figure 2. Graph of pneumonia treatment risk versus fibrinous pneumonia mortality risk for truckloads of calves at a feedlot in Alberta in 1987.

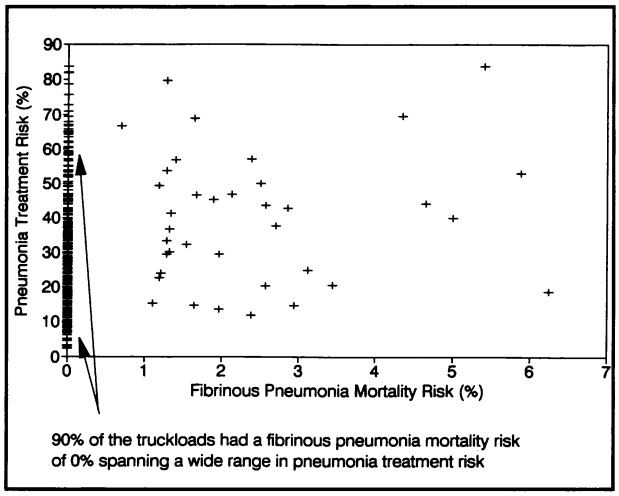

Figure 3. Graph of pneumonia treatment risk versus fibrinous pneumonia mortality risk for truckloads of calves at a feedlot in Alberta in 1988.

purchased directly from farms, bypassing the auction markets (16). However, no epidemiological data have been presented that quantify how important these pre-arrival factors may be in the occurrence of FFP at the feedlot.

The proportion of total mortalities that were due to fibrinous pneumonia varied widely from almost 57% in 1987 to only 10% in 1988. This range is consistent with reports from studies of mortality in other feedlots (9,11,17–19). In the only other report that spanned several years, Martin *et al* (15) found that fibrinous pneumonia accounted for 41% to 45% of the mortality during the first 2 y, but only 29% during the final year.

The large variation in mortality due to fibrinous pneumonia documented among years in the present study emphasizes how unrefined crude mortality is as a dependent variable for epidemiological study. Refinement of the diagnosis for a disease is a necessary requirement before the natural history of disease can be adequately described (20). The use of an unrefined dependent variable can seriously weaken the power of any epidemiological investigation, and reduce the probability that important associations and risk factors will be identified (20). The use of computers in the feedlot industry to record animal-specific histories should improve the likelihood that specific factors associated with mortality in the feedlot will be identified.

Refinement of the dependent variable is a problem that is even worse for measures of morbidity. The term morbidity as it is used in the feedlot is a misnomer, and probably should be replaced by terms like treatment or treatment rate (6). The degree to which treatment reflects true morbidity varies according to a range of factors. Decisions about treatment necessarily involve value judgements, and the basis for these judgements can change as the objectives of those involved change (21). In the Bruce county study (14), the authors reported that different feedlot owners used "very different criteria as a basis for initiating therapy." A study that concentrates on morbidity in the feedlot may therefore be more a study of human behavior than of shipping fever. From this perspective, the apparent gain in statistical power to be had by looking at the more prevalent morbidity instead of mortality is likely illusory and may lead to biased or inaccurate conclusions.

A major problem, therefore, is the inability to develop a medically useful case definition for morbidity due to shipping fever. Some workers present morbidity statistics for shipping fever without defining them (19,22,23). Others have used treatment rate (12) or treatment costs (15) without detailing how animals were chosen for treatment. Still others, note that they have incorporated the use of rectal temperature in the case definition, but the temperature cut-off points used for defining a fever vary considerably among studies (4,24–27). No consistent case definition for shipping fever morbidity emerges from these studies, which makes it very difficult to compare studies legitimately.

It makes sense to use rectal temperature to increase the specificity of the case definition for shipping fever. Unfortunately, the true biological significance of fevers that follow shipping remains unresolved, a situation that has existed since the early observations of Hoerlein and Marsh (28). They found that a large proportion of calves can develop fevers after entering the feedlot without serious effect or any correlation with mortality; less frequently, calves can develop clinical signs of shipping fever without having elevated temperatures. There is little published evidence to support the hypothesis that fever postshipping is a sensitive or specific indicator of medically significant respiratory disease morbidity. The lack of a simple relationship in the present study between mortality due to fibrinous pneumonia and treatment rate demonstrated that the 2 outcomes measured different things.

There is increasing evidence linking *Haemophilus somnus* infection with cardiac disease in the feedlot (3,29–31). Cardiac diseases, including cases of myocarditis and pericarditis, were the most common diagnoses at necropsy during the final year of this study, and the population mortality rate from cardiac lesions was greatest during the 2 y that the population mortality rates from fibrinous pneumonia were lowest. It is unlikely that these reciprocal shifts were due to changes in recognition of the 2 diseases at necropsy (32), because they are anatomically distinct. Overall losses from cardiac lesions in 1988

were 2- to 3-fold greater than the 3 previous years, despite the total mortality for that year being the lowest. These diagnostic trends have continued in more recent years at the study feedlot.

Fibrinous pneumonia can be a major cause of death in feedlots in western Canada, especially those where large numbers of recently weaned calves are purchased from auction markets in the fall. The epidemiological description of the disease presented here emphasizes how quickly the problem develops after calves arrive at the feedlot. Studies of the biological, environmental, and population factors that are present before and shortly after arrival are needed to identify strategies for reducing the incidence of the fatal disease. They should specifically examine mortality due to fibrinous pneumonia, because the outcomes of crude mortality and treatment rate appear to be poor measures of this important fatal disease. Refining the measure of disease in this way should lead to a better understanding of shipping fever and improve the chances that useful control or preventive strategies will be identified.

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