Feedlot Session I

"Diagnostic Tests in the Feedlot – Antemortem and Postmortem"

Moderator: **D. G. Miles**

Using Epidemiology as an Aid in Feedlot Disease Management

Carl S. Ribble, *DVM, MSc*[1]
Joyce Van Donkersgoed, *DVM, M Vet Sc*[1]
Richard J. Harland, *DVM, M Vet Sc*[2]
Eugene D. Janzen, *DVM, M Vet Sc*[1]
[1]Department of Herd Medicine and Theriogenology
Western College of Veterinary Medicine
University of Saskatchewan
Saskatoon, Saskatchewan S7N OWO Canada
[2]Veterinary Infectious Diseases Organization
124 Veterinary Road
Saskatoon, Saskatchewan S7N OWO Canada

Introduction

The recent introduction of computers to the feedlot industry for monitoring animal health has markedly improved the efficiency with which we can use epidemiology as a means for developing new management techniques to prevent disease. With the computer we can keep accurate health records which can be analyzed rapidly by the attending veterinarian on a regular basis. We describe the kind of system we find useful for recording data on a computer in the feedlot. We also describe how those data can be summarized to help develop an epidemiological approach to disease management in the feedlot, using respiratory disease and hemophilosis as specific examples. Our experience is based upon working in medium-sized feedlots with capacities of several thousand to 15,000 or more head.

A System for Recording Quality Data

To effectively use epidemiology as part of a regular health management program, you first need a reliable system for recording the health records of animals placed in the feedlot. To more precisely answer our epidemiological questions, we have found it useful to identify animals individually as they enter the feedlot. This involves placing a large plastic tag containing a unique easy-to-read alphanumeric code in the ear of each animal. The tags can also be color coded so one can quickly identify animals by their pen of origin. Where tag loss is high, different kinds of tags can be substituted, or animals can be tagged twice with one tag in each ear. Newer electronic transponder technology may someday replace this simple tagging system, but the technology is not yet reliable nor economical enough to warrant its large-scale use in commercial feedlots.

Several feedlot owners have installed computers containing a hardware system that can support chute-side terminals. With terminals placed at chutes located in the processing and treatment areas, feedlot crews processing incoming cattle enter the new tag numbers and other processing information directly. The personnel treating sick cattle call up the health records of individual animals to help determine their next treatment. Entering information directly into the computer eliminates intervening paperwork and reduces errors.

The software database used in such a system is written so that the identification, processing procedures, and treatments for an individual animal are maintained in the computer as a single record. Most of the old software programs were written to handle feedlot financial records and had a rather basic animal health capability; as a rule, these programs could not handle the "one animal-one record" approach. Enterprising feedlot owners and veterinarians have recently attempted to correct this deficit by hiring their own programmers and creating the necessary software. Software programs based on these attempts written for microcomputers are just now becoming available on the commercial market. This kind of system is not essential for practicing "quality" epidemiology in the feedlot; however, we have found that it increases the speed and accuracy with which records can be regularly summarized in a variety of ways, and in so doing it increases the probability that the veterinarian will find the time to carry out such an analysis despite a busy practice schedule.

A System for Creating Quality Data

From an epidemiological perspective, to monitor sickness one must investigate "treatment and mortality rates". This involves finding the answers to the "W5" set of questions: who is getting treated, when are they being treated, what are they being treated with, where are they getting sick, and why are they being treated? The first four "W" questions can be answered easily using the recording system we have described above. But the fifth "W" —Why are they being treated?— requires more preparation before a useful answer develops.

The veterinarian is seldom present when feedlot treatment crews pull sick animals and make their decisions concerning diagnosis and treatment. Yet, in order to develop a meaningful analysis of the records, the veterinarian must have a clear understanding of why animals are being treated. It is therefore essential that standardized case definitions be established for the disease commonly seen at the feedlot, and a diagnosis or "reason for treatment" always be recorded by the crews for each animal treated. Only then can the veterinarian be confident that the crews are categorizing diseases in a meaningful way.

A structured (or a so-called "cook book") approach to treating these diseases must also be developed so that "arbitrary" decisions about treatments are strongly discouraged. Only by developing logical consistent approaches to treating the common diseases can these approaches be rigorously assessed for their effectiveness. If the feedlot crew is forever arbitrarily changing the treatment protocols it becomes hopeless to try and discern whether or not a specific treatment protocol really reduces repull and mortality rates.

To monitor the severest form of disease—mortality—and thereby gain crucial informaton about morbidity as well, a necropsy should be performed on every dead animal to establish a diagnosis. We believe this to be the most important "clinical" task that is physically performed by a feedlot veterinarian. If the veterinarian does not necropsy every dead animal, epidemiological conclusions concerning mortality are pure conjecture, and musings about morbidity are on very shaky ground.

Having set such a recording system up, the feedlot veterinarian can then rapidly and regularly describe the patterns for various diseases, look for changes in these patterns as time progresses, and assess the effectiveness of new preventive techniques.

Looking for Patterns of Disease

The key "W5" questions that must be answered when looking for patterns of disease in the feedlot are who, when, and where. We can ask these questions with respect to morbidity (or treatment rates) and mortality, but for the purposes of brevity we will concentrate here exclusively on mortality as the outcome of interest. The examples we present are based on data generated from western Canadian feedlots purchasing calves in the fall (September to December inclusive) from auction markets and placing them into pens of 200-300 head for the duration of the feedling period.

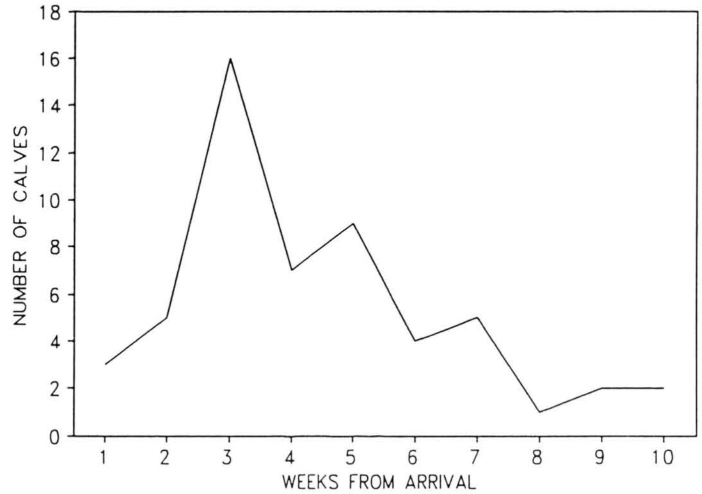
When are they getting sick?

The first question one could ask here is whether mortalities concentrate or "cluster" within certain time periods of the year. By drawing epidemic curves and calculating the risk of mortality for different times during the year we have found, for example, that auction market calves entering one feedlot in SW Alberta during the month of November have a mortality risk due to fibrinous pneumonia four to eight times greater than for calves entering the feedlot in September. This finding has been consistent for four years. Clearly, something puts the calves placed in November at much higher risk to mortality, the nature of which should be investigated; also, the finding suggests that perhaps November calves should be managed differently than September calves.

When drawing other mortality curves we have found it useful to make two adjustments to the basic measure of mortality. The first is to look at all the fatalities from all of the pens on one curve by adjusting for days in the feedlot. Therefore, the first day a calf spends in the lot becomes day 0 (rather than the actual calendar day), and all calves, regardless of when they actually arrived in the feedlot, can be plotted out on one curve. The second "adjustment" involves creating a second epidemic curve—the curve of fatal disease onset (FDO), or the "first treatment for all mortalities" curve.[1]

The utility of these two mortality adjustments is best demonstrated using an example. Figure 1 is a mortality curve for bovine respiratory disease (BRD) for all calves entering a Saskatchewan feedlot from September 1st to December 31st. The mortalities have not been plotted by calendar date, but they have been adjusted for "days-in-the-lot". Thus, one can see that, over the fall period, there was a prominent peak in mortality, on average, three weeks after calves arrived at the feedlot. This curve suggests that, in this feedlot (like many others), BRD fatalities occur fairly soon after calves arrive at the feedlot. Clearly, management techniques designed to prevent these losses must be focussed upon the early part of the feeding period. However, a mortality curve like this can be slightly misleading in that it only shows you the end-stage of the di-

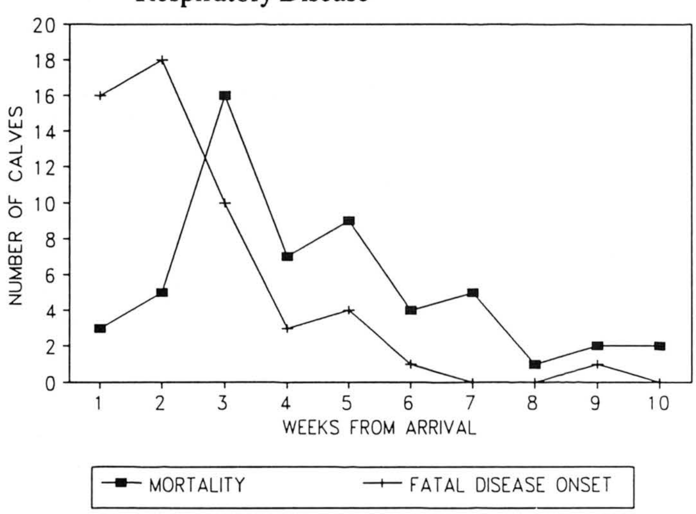
Figure 1. Mortality Curve for Bovine Respiratory Disease (BRD)



sease process—it might be more helpful to see when these mortalities were experiencing the initial stages of disease.

The curve for fatal disease onset (or FDO) for BRD is superimposed on the mortality curve in Figure 2. We created this curve by looking exclusively at the records for all those calves that died from fibrinous pneumonia, and plotting the first day post-arrival that they were treated for pneumonia. If a calf was treated at arrival "off-the-truck", then its day of FDO was day 0. If a calf died peracutely seven days post-arrival without treatment, then its day of FDO was day seven, the same day as the day it died.

Figure 2. Fatal Disease Onset and Mortality for Bovine Respiratory Disease

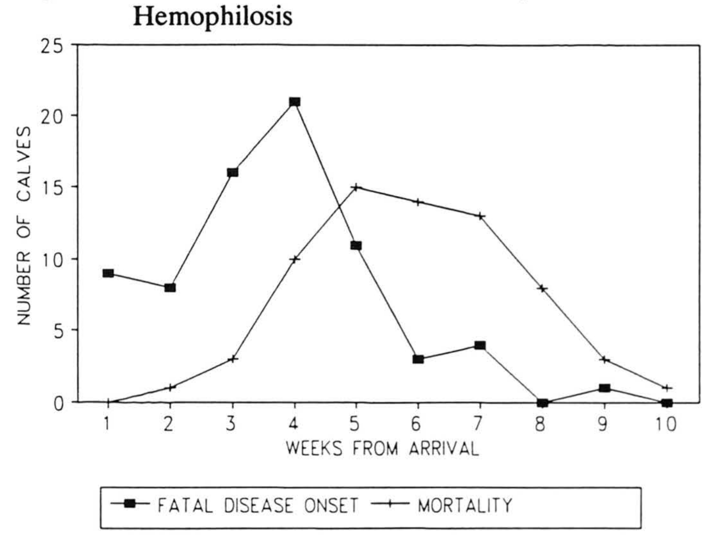


Perusal of Figure 2 shows that the FDO curve peaks much sooner than the mortality curve. Indeed, for some feedlots the FDO curve peaks as early as day 4 post-arrival,[1] indicating that a large proportion of BRD mortalities are first treated within four days of their arrival at the feedlot. This finding indicates that the initiating factors for BRD mortality were closely associated with the event of arrival; therefore, the problem was arriving "on-the-truck". The early FDO peak also shows why the implementation of a control measure like the injection of all auction market calves with a long-acting antibiotic at high-risk times of the year (November) is so effective in reducing mortality.[2] If, on the other hand, one is working in feedlots where the FDO peak for BRD occurs much later than this, long-acting antibiotic injections at arrival would likely not be a useful or cost-effective method of reducing mortality associated with BRD.

Answering the "when" question in this way has helped us develop rational strategies for controlling the "traditional" disease of BRD in the feedlot. It has also been useful for investigating new disease problems. A variety of manifestations of hemophilosis have become a significant problem for some feedlot owners in western Canada in recent years.[3,4,5,6] Drawing the epidemic curves for mortality and FDO for this disease results in a different picture than for BRD.

The mortality and FDO curves for hemophilosis (occurring in the same feedlot as did BRD in the previous example) are shown in Figure 3, while a comparison of FDO curves for BRD and hemophilosis appear in Figure 4. Mortality and FDO peak later for hemophilosis compared to BRD. The factors that initiate fatal hemophilosis do not appear to be closely associated with the arrival event as for BRD, suggesting different management strategies are likely in order. This comparison is further developed during our investigation of the next "W" question: where?

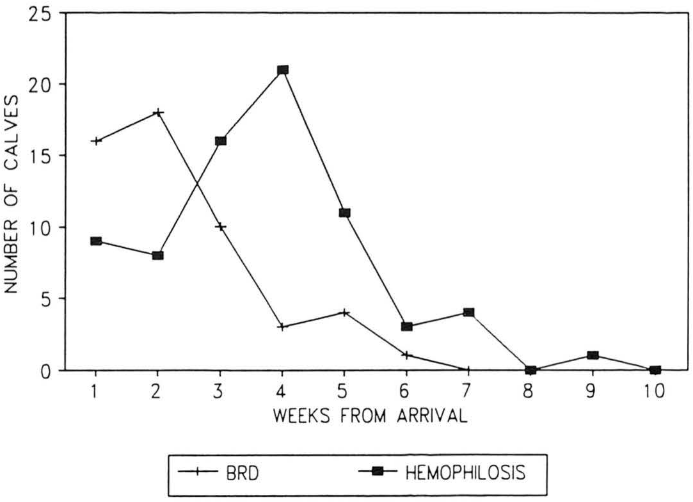
Figure 3. Fatal Disease Onset and Mortality for Hemophilosis



Where Are They Getting Sick?

By asking the question "Where are the animals getting sick?" we try to determine whether the disease clusters in space. Specifically, we determine whether mortality

Figure 4. Fatal Disease Onset for BRD and Hemophilosis



tends to cluster (or concentrate) within certain truckloads of calves, or within certain pens of calves at the feedlot. Clustering within either truckload or pen suggests one or both of the following two alternatives: either the disease is acting like a contagious disease, or there are risk factors acting on that particular management group which should be investigated and identified. This is important from a management perspective because if the disease clusters, control measures designed to prevent contagious spread should be instituted or, given the alternative explanation for clustering, factors affecting calves at the truck or pen level should be investigated.

One can begin to determine whether fatal BRD clusters within pen by calculating and examining the proportion of mortality due to BRD for all pens over the feeding period. We have found that this simple calculation may show many pens with little or no mortality, while a few approach 10-20% or even higher. This finding is supported by anecdotal evidence from feedlot personnel and veterinarians alike who often talk of so-called "wreck pens" that contained groups of calves suffering abnormally high death losses due to BRD. However, this is only the first epidemiological step towards trying to answer the where question with respect to pen. Two other factors must also be considered before one can be more thoroughly convinced that the disease is, in fact, clustering in space, within certain pens. These two factors are the effect of time, and the effect of chance.

We have already noted that pens of calves placed in November have a much higher risk of BRD mortality than pens placed in September. By ignoring when the pens of calves were placed, we might erroneously conclude that the disease was clustering in space, when it was really clustering in time. In epidemiological terms then, pen is totally confounded by time. The simplest method of correcting for this problem is to stratify or divide the feeding period into high and low-risk periods for the disease, and then look for clustering in space within those two periods.

The effect of chance must also be considered when looking for clustering in space. It may be that fatal BRD is distributed fairly randomly across pens throughout the feedlot and the number of pens containing relatively high mortality rates is no more than one would expect by chance variation alone. To assess the role of chance in the distribution of disease across pens we run a fairly simple statistical test called a "test for homogeneity for binomial samples" using the proportion of mortality for each pen.[7,8] A significant chi-square suggests that the mortality rate is not "homogenous" across pens, but that it tends to cluster within certain pens.

Finally, one should be aware that clustering within pen might, in fact, be due to clustering within truck. It takes four or more truckloads of calves to fill up one pen containing 300 head. Certain pens might have particularly high mortality rates because they were filled with one or two "wreck" trucks that experienced very high mortality, while the remaining trucks had no mortality.[7] One would then direct efforts to determine the cause of this high mortality to the truck and not the pen.

Our work in one feedlot in SW Alberta carried out over four years indicates that fatal BRD did cluster, within trucks, or pens, or both, when the incidence of the disease was high. This suggests that the disease is either truly contagious and passed from animal to animal within the same pen or truck or that important initiating factors work at the truck and pen level to put groups of calves within the same pen or truck at much higher risk to fatal disease. Further research is clearly needed to determine which of these two hypotheses (or a combination of the two) more correctly describes reality.

Those working in the industry in western Canada continue to debate whether BRD spreads from animal to animal at the feedlot. The suggestion that contagious spread is one alternative explanation for why fatal BRD clusters has encouraged feedlot owners and veterinarians to (once again) carefully reassess their disease management procedures. One practice that has come under closer scrutiny is that of establishing a "hospital pen" where all sick animals are placed for the three or four day duration of their antibiotic treatment. At the end of the mandatory treatment period, presumably recovered animals are sent "home" to their original pen. The intention behind this recommendation was to ensure that sick individuals were quickly removed from their home pen and placed in a pen where they could be more closely observed and treated. Unfortunately, if BRD is truly contagious at this stage, this procedure may do more harm than good by ensuring that all calves in all stages of morbidity, with a variety of pathogenic processes, coming from all over the feedlot, mix intimately in the hospital pen. This procedure may increase the risk of mortality for the sick calves, and it may also promote the spread of new or resistant pathogens to healthy calves when the apparently recovered calves are returned to their home pens.

The hospital pen may itself, then, be an important "iatrogenic" contributor to BRD mortality. It might be better to markedly reduce the flow of calves through these hospital pens by changing treatment from a short-acting to a long-acting antibiotic and, after injection, sending the calves back to their home pen immediately. It might also be better to look for ways to reduce the mixing that occurs upon arrival, between different truckloads of calves.

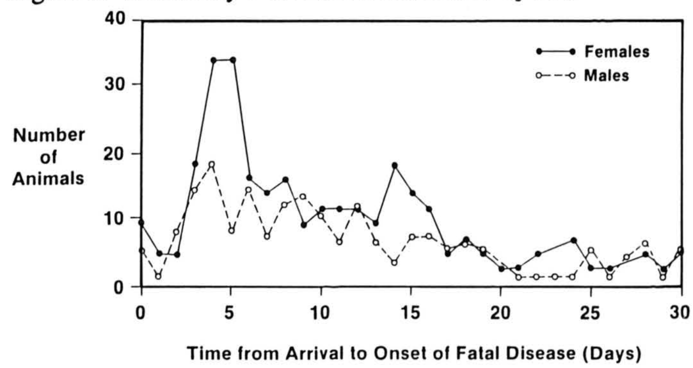
We have used the same approach to try to determine whether hemophilosis clusters in space. The effect of time is important here and the data must be stratified because in our initial work at one Saskatchewan feedlot hemophilosis clustered within calendar time: calves entering the feedlot in September were at one-half the risk to fatal hemophilosis compared to calves entering later in the fall. After stratifying, it appeared that the disease did not cluster within pens, acting like a random event across the feedlot. The work is still preliminary, and we have only looked at pens without taking into account the effect of trucks. However, further corroboration of this finding would suggest that animal-to-animal transmission may not be an important part of the natural history of fatal hemophilosis. Management techniques that effectively reduce BRD mortality may not be useful here: the epidemiology of the two diseases appears to be very different.

Who is getting sick?

The computer system we have described makes it fairly easy to ask the question "Who is getting sick or dying?". By doing this, we differentiate animals with respect to their age groups (calves versus yearlings), sex, and vaccine status. The risk of mortality can be calculated for each "Who" category and compared to other categories. If important differences between the categories are noted, then mortality and FDO curves can be drawn for each category to investigate possible reasons for those differences.

During a field trial carried out to determine the efficacy of a commercial *Haemophilus somnus* bacterin, we found that the bacterin significantly reduced mortality in steers, but not heifers (1). Drawing the FDO curve for the two sexes provided us with a possible explanation for this sex difference (Figure 5). The pattern of fatal disease was very different for the two sexes: the incidence of FDO during the first week was much greater for the heifers in the trial than it was for the steers (Figure 5). Assuming it might take a minimum of one week for a bacterin that was given to calves upon their arrival at a feedlot to "become protective", then a much greater proportion of the heifers became fatally ill before the bacterin had a chance to work. Because the disease behaved differently in the heifers in this trial, the bacterin was not afforded the "opportunity" to be effective. If this sex difference for FDO curves is consistent from year to year, and from feedlot to feedlot, then we would conclude that heifers will not benefit from the bacterin. However, if the FDO pattern for heifers was an

Figure 5. Morbidity Curve for Fatal Cases by Sex



Note: Heifer population adjusted to 7423 to coincide with steer population.

"anomaly" specific to the trial, then there may be circumstances where the bacterin reduces mortality in heifers just as it did in steers. More research is required to validly distinguish between these two possibilities.

Summary

"Quality data" are required for epidemiology to be a useful tool for managing disease in the feedlot. Establishing a system for creating and recording quality data at the feedlot allows for regular and efficient monitoring and investigation of disease problems. Asking the "W5" set of questions and drawing a series of epidemic curves can help attending veterinarians develop rational strategies for managing the diseases commonly found in the feedlots they service.

Describing the epidemiology of mortality associated with BRD in feedlots that purchase a large proportion of newly weaned auction market calves has emphasized how quickly the problem develops after the calves' arrival at the feedlot. Management efforts must be targeted directly towards the arrival event itself. The finding that BRD mortality clusters within truckloads and pens at these feedlots has provided direction for our continuing research. We are now trying to determine why this clustering occurs, attempting to distinguish whether the disease acts like a true contagion, or whether there are other non-contagious factors that might be controlled at the truck and pen level.

These epidemiological techniques can be used to investigate and compare any of the diseases, old and new, appearing in feedlot animals. Our comparison of the pattern of fatal disease for the "emerging" manifestations of hemophilosis with the pattern of fatal BRD suggests the two may be very different. The FDO peak occurs much later for hemophilosis, and the disease may not cluster within pen, two findings which suggest the different management approaches will be necessary to control hemophilosis. Wider application of these techniques, and communication of the results should increase our understanding of general disease management in the feedlot,

and increase our usefulness to the feedlot industry.

References

1. Ribble, C.S., Jim,K.G., Janzen, E.D. Efficacy of immunization of feedlot calves with a commercial *Haemophilus somnus* bacterin. Can J Vet Res 1988; 52: 191-198. 2. Harland, R.J., Jim, G.K., Guichon, P.T., Townsend, H.G.G., Janzen, E.D. Efficacy of parenteral antibiotics for disease prophylaxis in feedlot calves. Can Vet J 1991; 32: 163-168. 3. Janzen, E.D. Myocardial lesions caused by *Haemophilus somnus* in cattle. Can Vet J 1987; 28: 208. 4. Guichon, P.T., Pritchard, J., Jim, G.K. Haemophilus somnus myocarditis in a feedlot steer. Can Vet J 1988; 29: 1012-1013. 5. Groom, S.C. Emerging role of *Haemophilus somnus* in previously unreported manifestations in western Canada. The Bovine Proceedings 1989; 21: 101-103. 6. Van Donkersgoed, J., Janzen, E.D., Harland, R.J. Epidemiologic features of calf mortality due to hemophilosis in a large feedlot. Can Vet J 1990; 31: 821-825. 7. Ribble, C.S., Meek, A.H., Shoukri, M. Clustering of fatal fibrinous pneumonia (shipping fever) in feedlot calves within transport trucks and feedlot pens (abstract). 6th ISVEE Symposium Abstracts, 1991. 8. Snedecor, G.W., Cochran, W.G. Statistical methods, 7th ed. Ames, Iowa: Iowa State University Press, p 201-202.

Abstracts

An atypical case of lymphosarcoma (sporadic bovine leukosis) in a heifer

R. Dalgleish, J. J. Callanan, P. E. McNeil

Veterinary Record (1991) **129**, 308-310

An 18-month-old Friesian heifer had several unusual, raised, black cutaneous plaques, some of which were up to 20 cm in diameter, on its head and neck, limbs, thorax and perineum. There was also generalised lymphadenopathy. A clinical diagnosis of lymphosarcoma (sporadic bovine leukosis) was derived from a fine needle aspiration of a skin lesion. Post mortem and histological examinations confirmed a multicentric lymphosarcoma with widespread infiltration into many of the tissues recognised as predilection sites for this type of tumour. However, in the authors' experience, the presence of tumour masses in the trachea and the right mainstem bronchus was atypical.

Medical treatment of right-sided dilatation of the abomasum in cows

M. Buchanan, D. A. H. Cousin, N. M. MacDonald, D. Armour

Veterinary Record (1991) **129**, 111-112

Twenty-two cows with right-sided displacement of the abomasum were treated with hyoscine-n-butyl bromide and dipyrone (Buscopan compositum; Boehringer Ingelheim). Within 24 hours 11 had recovered completely, three had improved, six had shown no improvement and two had been slaughtered. Within 48 hours 17 of the cows had recovered completely and five had been slaughtered.