Practical Application of Epidemiology in Veterinary Herd Health/production Medicine

Calvin W. Booker, *DVM, MVetSc*[1]; **Guy H. Loneragan,** *BVSc, PhD*[2]; **P. Timothy Guichon,** *DVM*[1]; **G. Kee Jim,** *DVM*[1]; **Oliver C. Schunicht,** *DVM, BSc*[1]; **Brian K. Wildman,** *DVM*[1]; **Tom J. Pittman,** *BScAgr, DVM, PAg*[1]; **R. Kent Fenton,** *DVM*[1]; **Eugene D. Janzen,** *DVM, MVS*[1]; **Tye Perrett,** *BScAgr, DVM*[1]

[1]*Feedlot Health Management Services, Bay 7 - 87 Elizabeth Street, Postal Bag Service #5, Okotoks, Alberta, T1S 2A2*
[2]*Feedlot Research Group, West Texas A&M University, Box 60998, Canyon, Texas 79015*

Abstract

Practical application of formal epidemiology can be a very useful tool in private practice for food animal veterinarians working in the field of herd health/production medicine. Careful and deliberate determination of the outcome variables of interest in each production situation or application provides a logical starting point for establishing the information requirements necessary to measure the defined outcome variables. Subsequently, the collected data can be used for a wide variety of purposes, including disease investigation, monitoring, forecasting and commercial field trials. The successful application of formal epidemiology in herd health/production medicine can serve as a solid basis for establishing long-term productive business relationships with animal agriculture enterprises.

Introduction

Most veterinarians only use their epidemiologic tools in an *ad hoc* manner during the course of their day-to-day activities in large animal practice, rather than as a regular, planned management tool. It is common for a client to verbally relay something he or she has observed and then have the veterinarian involved use deductive reasoning based on the verbal information and cues provided by the client, the clinical experience of the veterinarian, and, occasionally, other supportive evidence such as laboratory results, to arrive at a diagnosis and proceed with development of an action plan for treatment and/or prevention based on the presumptive diagnosis. This approach is an extrapolation of individual animal medicine, without the benefit of the observations that arise from a thorough clinical exam. Only rarely do most veterinarians use formal epidemiologic methods to fully investigate a presenting complaint, calculate meaningful indices to define the populations affected and analyze data to accurately describe the pattern of disease in a herd or production unit.

Epidemiologic investigations involve describing the level and pattern of disease (or other outcome of interest) and discovering those factors that influence the observed disease distribution. In herd health/production medicine, the use of epidemiologic analysis is the parallel to the use of the thorough clinical examination in individual animal medicine. That is, epidemiologic analysis forms the basis from which all other herd health/production medicine activities are derived, including disease investigation, monitoring and field trials. However, without the benefit of accurate information to characterize the level and patterns of disease that occur, it is virtually impossible to practice credible herd health/production medicine. As a result, the fundamental effort that should be put forth when applying epidemiologic analysis in veterinary medicine should be centered on defining what information is required for each monitoring/investigation situation and developing accurate, efficient methods of data collection. In other words, the veterinarian must clearly define the goals, outcome measures and desired outputs of each epidemiologic investigation. Subsequently, data analysis, summary and interpretation will follow in an orderly, logical manner. Without the required pre-investigation planning, it is unlikely that the data collected will adequately address the problem at hand. Unfortunately, the approaches commonly used by veterinarians in all types of practice either ignore epidemiologic analysis altogether and accept the observations and information provided by the producer as factual and in need of a solution, as opposed to critical evaluation, or focus on analysis of readily available data that may or may not be relevant or accurate to the situation of interest. In our opinion, these approaches represent critical obstacles that preclude the successful implementation and application of sound data-based decision-making in a sustainable business or scientific model.

Defining Outcome Measures

Building on the premises put forth in the introductory paragraphs of this manuscript, the first step in practical application of formal epidemiology in food animal medicine is to **clearly define the critical, specific outcome measures that are relevant to each production or research application**. Obviously, this requires a detailed, comprehensive understanding of the situation of interest, so that appropriate outcome measures can be selected. Subsequently, it becomes straightforward and logical to determine the requirements necessary to measure the defined outcome variables. For example, if clinical respiratory disease requiring therapy (and all of the associated, descriptive information) is an outcome measure of interest in a feedlot research project or a commercial feedlot, it is critical to precisely define what constitutes respiratory disease, identify a suitable disease detection method and then develop a data acquisition tool capable of collecting the required information. In order for a *case* of respiratory disease to be satisfied, the animal must show characteristic clinical signs and have a rectal temperature greater than or equal to a defined level (e.g., ≥ 104.5°F). In a feedlot, the use of trained animal health personnel to identify sick animals and the application of formal case definitions for each disease (including respiratory disease) could be used for disease detection and an individual animal data collection system could be used to record the diagnosis and treatment information. The specific diagnosis and treatment information collected should include all of the details that are required to define an animal as a *case* and have been previously defined to be important or of interest in terms of associated descriptive information. Minimally, the information collected in this example would likely include individual animal identification, date, time, location, diagnosis, rectal temperature, body weight, days on feed, treatment and disposition. In a more detailed project, the data collected for each animal may include other vital statistics, microbiologic information from collected samples, blood or serum parameters, etc., as determined prior to data collection during the process of defining the outcome measures of interest.

In the example above, collecting simple descriptive information (and more detailed ancillary information) on animals with respiratory disease in a commercial feedlot is straightforward (i.e., it is relatively easy to count the number of respiratory disease events over a period of time). However, in order to be able to properly interpret this "numerator" information, it is necessary to have relevant data that describes the denominator (and/or those animals that did not get respiratory disease depending on whether the goal was to describe the occurrence of the disease or investigate risk factors involved). In some scenarios, the denominator may simply be the number of animals at risk of developing the disease in a defined time frame; such a measure could be as simple as the percentage of a group of cattle that developed respiratory disease. However, in other scenarios, the appropriate denominator may be a combination of number of animals and days at risk (animal days at risk; this measure is formally known as an incidence rate because a measure of time is included in the denominator). In the final assessment, the denominator used should be reflective of the context in which the data will be viewed. For example, if the risk of death in a feedlot is not a time dependent event (i.e., if an animal enters the feedlot the risk of death is constant regardless of the length of the feeding period), then the number of animals entering the feedlot is a suitable denominator and the feeding period is the risk period. However, if the risk of death in a feedlot is a time dependent event (i.e., the risk of death increases the longer the feeding period because there are more days at risk), then a denominator such as animal days may be a more appropriate denominator. Although the latter method of expression may be cumbersome in terms of ease of understanding and application, categorization of the risk of death in feeding periods of defined lengths results in a death loss value that is both accurate and useable.

For example, a researcher wanted to compare the risk of feedlot respiratory disease from two sources of cattle. The sources did not arrive at the feedlot on the same day; therefore, at any point in time, the cattle from each source will have a different days on feed at the feedlot. In Table 1, a point in time summary of respiratory disease occurrence for each source of cattle is presented. Upon examination of the percentage of cattle treated to date, there appears to be very little difference in the rate of respiratory disease between the East Ranch and the South Ranch. However, when incidence is evaluated, it is apparent that the South Ranch cattle have experienced a greater incidence of respiratory disease than the East Ranch cattle to the point in time when the data were summarized.

Practical Applications

Subsequent to the determination of what should be measured and how it can be measured, there is a wide range of possibilities in terms of how the collected data may be used, depending on the application of interest or opportunity available. As a veterinary production consultant, the four most obvious uses of applied epidemiology are 1) disease investigation; 2) monitoring; 3) forecasting; and 4) field trials. In the classical sense, disease investigation is the original application of epidemiology, with John Snow removing the handle of the Broad Street pump as the defining moment of applied epidemiology (note – if you have never heard of John Snow, search for "John Snow Broad Street Pump" at www.google.com). While the methods used have evolved since that time period, the approach is still much the same. In food animal veterinary medicine, disease investigation in herds/production units continues to be a challenge and opportunity for practicing veterinarians and diagnosticians. In many cases, a disease outbreak is the issue that eventually leads a producer to seek out the expertise of a veterinarian. All too often, this opportunity for developing a long-term, productive business relationship based on data collection and analysis is overshadowed by the short-term goal of trying to come up with an immediate diagnosis and action plan. At times, the latter approach is effective at identifying the correct problem, the population affected and the most appropriate solution. However, in many of the disease investigations referred to veterinary schools or diagnostic laboratories, a detailed epidemiologic description of what has actually happened in the herd or production unit is the critical component of the investigation that provides the basis for clearly identifying what the problem is (rather than what it is correctly or incorrectly perceived to be) and developing a logical, rational approach to solving it. In situations where good production records have been kept, this process is straightforward, but in other situations, the investigator must rely on his/her resourcefulness to try and recreate what has actually occurred. Nonetheless, this can be a good opportunity to emphasize or re-emphasize the importance of data collection and analysis to the client involved. In addition to use for disease outbreak investigation, accurate relevant records can provide the basis for simple or complex analyses to determine the risk factors associated with specific disease or production outcomes of interest.

For example, a client was concerned that the mortality rate in heifers was too high relative to steers in his feedlot. In Table 2, an overall summary of mortality rates in heifers and steers at the client feedlot is presented. Ostensibly, it would appear that the client is correct in that heifers appear more likely to die than steers. However, arrival weight is a strong predictor of death and it is possible that the heifers in this client's feedlot were lighter on average at feedlot entry than the steers. As a result, the difference in mortality observed by the client between heifers and steers may be due to differences in arrival weight rather than the sex of the animal. In Table 3, the mortality data have been *stratified* by broad arrival weight categories. The results of this stratified summary yield a much clearer picture of mortality rates in heifers and steers at the client feedlot. Within each arrival weight category, the mortality rate between heifers and steers are very similar. Based on these results, it is unlikely that the risk of mortality in heifers is higher than the risk of mortality in steers at this feedlot; rather, arrival weight is a strong predictor of the risk of mortality and its effect is *confounded* with sex because arrival weights in this feedlot are different for heifers than steers. These data illustrate the critical need for collection of quality data and a mechanism that enables timely and accurate data retrieval.

In terms of monitoring, applied epidemiology provides the necessary tools. As discussed above, once a

Table 1. Point in time summary of respiratory disease occurrence in feedlot cattle from two sources.

Measure	Origin	
	East ranch	South ranch
Initial number of animals	1,400	600
Percent treated for respiratory disease	27.7	26.6
Days on feed	38	29
Head days at risk	53,200	17,400
Incidence rate (cases per 1,000 head days)	8.6	10.3

Table 2. Overall summary of mortality rates in heifers and steers at a client feedlot.

Measure	Animal type	
	Heifers	Steers
Initial number of animals	10,132	19,987
Number of dead animals	151	202
Percentage dead (mortality)	1.49%	1.01%

Table 3. Summary of mortality rates in heifers and steers at a client feedlot, stratified by arrival weight category.

Weight category	Sex	Measure: Initial number of animals	Number of dead animals	Mortality (%)
< 500 lb	Heifers	4,998	101	2.02
	Steers	5,012	100	2.00
500 - 649 lb	Heifers	2,574	42	1.63
	Steers	4,988	76	1.52
≥ 650 lb	Heifers	2,560	8	0.31
	Steers	9,987	26	0.26

determination has been made as to what should be measured and how it can be measured, the monitoring process itself is often quite simple. The challenges are to determine the goal(s) of the monitoring program, define what is "normal" for each monitored variable and to develop appropriate action plans for intervention. While these may seem like insurmountable challenges to come up with all at once, determining the goal and initiating the monitoring program often provide the basis and the impetus for coming up with boundaries for normality and options for intervention.

Closely related to monitoring is the use of data collection and analysis for forecasting. In any production system, accurate prediction of production outcomes and production costs are essential components of running a sustainable, modern business. The most obvious and direct method of accomplishing this is by using relevant, accurate data from previous experiences producing the same products under the same production conditions. The existence of a suitable data collection and analysis system for monitoring also provides the necessary information for predicting production outcomes and production costs. For example, in a feedlot or stocker procurement model for "southeast" calves, accurate information is needed to predict the morbidity and mortality rates that are likely to occur so that these factors can be appropriately factored into the production cost calculation used in the determination of the target purchase price and predicted break-even price. In addition, the predicted morbidity rates in the same calves can be used to forecast the resources required (labor, pharmaceuticals, hospital pen space, etc.) to adequately deal with the anticipated health problems.

Finally, data collection and analysis facilitates the conduct of field trials in commercial production scenarios, which yield results that are the most applicable for subsequent interpretation and application. The ideas or hypotheses tested in each field trial model may involve manipulation or management of risk factors for disease or production outcomes identified in disease investigation applications described previously or they may be independently generated production questions. It is important to note that the existence of a functional data collection and analysis system in a commercial production unit does not preclude the need to have scientifically valid study designs that are properly conducted using standardized procedures and principles in an unbiased application. While a data collection system is a tool for facilitating the occurrence of commercial field trials, the methods used to conduct each study are of critical importance to the usefulness of results obtained.

Conclusion

Practical application of formal epidemiology can be a very useful tool in private practice for food animal veterinarians working in the field of herd health/production medicine. Careful and deliberate determination of the outcome variables of interest in each production situation or application provides a logical starting point for establishing the information requirements necessary to measure the defined outcome variables. Subsequently, the collected data can be used for a wide variety of purposes, including disease investigation, monitoring, forecasting and commercial field trials. The successful application of formal epidemiology in herd health/production medicine can serve as a solid basis for establishing long-term productive business relationships with animal agriculture enterprises.

Additional Reading

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