Factors Related to Sickness and Death in Feedlot Calves

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Introduction

The Bruce County Beef Project is a three-year study designed to elucidate factors influencing morbidity, mortality and productivity in calves entering feedlots in Bruce County each fall. The factors investigated include management techniques, ration, prophylactic and therapeutic regimes, demographic factors (age, weight, breed, etc.), housing and transportation.

The study was initiated during the summer of 1978. Data for each of the 1978-79 and 1979-80 seasons have been analyzed and reported separately.[1,2] However, the relative importance of each factor examined could change from year to year. This report is based on analysis of the combined data from the first two years of the project and identifies those variables consistently associated with mortality.

Materials and Methods

Data used in this study were from the combined 1978-79 and 1979-80 investigations. The data were obtained from 'daily logs' maintained by the farmer, personal interviews and surveys conducted by project veterinarians. The majority of animals which died were examined at the Ontario Veterinary College (OVC).

The combined data set consisted of data on groups of calves provided there were at least 30 animals per group. BVD vaccine was used by feedlot owners in the first year of the project and was associated with excess mortality. Cattle from eastern Ontario or Quebec were purchased in significant numbers only in the second year of the project and experienced very high death losses. Since these factors were present in only one of the two years, groups of cattle with these factors were deleted also.

Groups of cattle are designated as either 'lots' or 'pens' with lots having similar characteristics with respect to source, transportation, housing, feeding and management. By definition, all pens are comprised of 'mixed groups' of cattle.

Combining the two years' data involved identifying those variables not significantly altered between years, adjusting other variables in order to achieve consistency between the two years and deleting those variables whose interpretations were significantly different between the two years. The variables (or factors) used in the combined data base are shown in Table I.

There were 212 groups of cattle in the combined data base. From the original 66 farms containing 104 groups of cattle in the 1978-79 survey, the selection procedures permitted the inclusion of 87 groups from 54 farms. From the 1979-80 survey, 63 of the original 69 farms were included adding a further 125 groups of cattle (see Table II).

Cross-tabulation, discriminant and/or regression analyses and odds ratio techniques were utilized to assess and describe the association between the independent variables and mortality.

Using the median mortality rate, the groups were classified as either high or low mortality rate groups. Discriminant analysis was then performed to identify those variables best able to differentiate between the two groups. The latter process weights and mathematically combines the independent (discriminating) variables (Table I) to make the equations (functions) for high and low mortality categories as distinct (statistically) as possible. Those variables significantly contributing to this separation are identified and their association with mortality disregarding the effect of all other variables is assessed using the univariate F ratios. Stepwise analysis and the resulting standardized discriminant function coefficients are used to identify the association between a variable and mortality, taking into account its association with all other variables.

In the stepwise multiple regression analyses, the dependent variable was $\log_{10}$ (mortality rate +1). Variables were entered into the regression equation based on the magnitude of the F statistic. In both discriminant and regression analyses, variables were allowed to enter the

Table I. Variables included in the combined two year study of factors influencing mortality in feedlot calves. Data from Bruce County Beef Project, 1978-79/80

I. Management related variables

PASTURE	Pastured next summer? /Yes=1, No=0
FINISH	Finish these Cattle? /Yes=1, No=0
GOAL	Fatten=1, Grow=0
OFFFARM	Employed Off-Farm? /Yes=1, No=0
ANYHELP	Hired Help Used? /Yes=1, No=0
SEGREG	Sick Cattle segregated? /Yes=1, No=0

II. Demographic variables

RAISONT	Were the cattle raised in Ontario? /Yes=1, No=0
RAISWEST	Were the cattle raised in the western provinces? /Yes=1, No=0
PURCONT	Were the cattle purchased from a source in Ontario? /Yes=1, No=0
PURCFARM	Were the cattle transported directly from their source farm to the feedlot? /Yes=1, No=0
TRANSPOR*	How were the cattle shipped to the feedlot? /Truck=1, Train=0
CONDITN*	Condition of cattle upon arrival? /Excellent=1, Good=2, Poor=3, Very Poor=4
PURELINE	One major breed or cross-breed=1, Else=0
SEXNUM	One sex per group=1, Else=0
LIVE	Number of live cattle in group on arrival
WEIGHT*	Average weight of cattle in lbs.
POOL	Cattle groups mixed within three weeks of arrival? /Yes=1, No=0

III. Variables related to Ration

CORNSILE	Cornsilage is fed? /Yes=1, No=0
HAYSILE	Haysilage is major roughage? /Yes=1, No=0
HAYDRY	Baled Hay (or pasture) is major roughage? /Yes=1, No=0
MIXGRAIN	Oats or barley fed? /Yes=1, No=0
CORNGRAN	Corngrain fed? /Yes=1, No=0
PROTSUPP	Protein supplement fed? /Yes=1, No=0
NONPROT	Nonprotein nitrogen fed? /Yes=1, No=0
STARTER	Commercial starter fed? /Yes=1, No=0
ANTISTAR	Starter contains antimicrobial? /Yes=1, No=0

IV. Variables related to Processing

INJVIT	Cattle given vitamin ADE? /Yes=1, No=0
RESPVAC	Cattle given vaccine against respiratory disease? /Yes=1, No=0
SOMNUGEN*	Cattle given Somnugen? /Yes=1, No=0
IMPLANTD	Cattle Implanted? /Yes=1, No=0
INTPARA	Cattle dewormed? /Yes=1, No=0
EXTPARA	Cattle deloused or dewarbled? /Yes=1, No=0

*Information not available for all groups.

respective equations until the next variable added did not contribute significantly (at $p \leq 0.05$) or until a maximum of six variables had been entered.

Results and Discussion

Summary information regarding the Bruce County Beef Project including morbidity and mortality rates are shown in Table II.

The average mortality rate, based on $\log_{10}$ transformations of rates in groups of cattle in the combined file was 0.63%. On a per animal basis it was 421 ÷ 39000 = 1.1%.

The management factors associated with mortality are shown in Table III. Those farmers who wished to pasture their cattle during the subsequent summer, not finish their cattle and only 'grow' their cattle during the first winter experienced relatively low mortality rates. These latter factors were strongly related to ration content and 'processing' factors both thought to be more directly associated with mortality; thus, they were deleted from further analyses.

Farmers who did not segregate treated animals also tended to experience relatively low death losses in their cattle. We infer from this that segregation of treated animals

Table II

A Summary of Cattle group morbidity and mortality in the Bruce County Beef Project

	1978-79	1979-80
No. Farms	66	69
No. Cattle groups	104	133
No. Cattle	19,600	19,400
No. Deaths	230	191
% Mortality	1.3%	1%
No. Animals examined at post mortem	168	167
% Morbidity	---	28%
Cost per head: prevention	---	$0.94±0.71
Cost per head: treatment	---	$2.92±2.61

Table III

The Average Values of Management Factors in 214 Groups of Cattle in Bruce County Beef Project, 1978-79/80

Management Factors	Average Value [a]
PASTURE	0.50*
FINISH	0.38*
GOAL	0.26*
OFFFARM	0.16
ANYHELP	0.27
SEGREG	0.44*

*Significant difference (at $p < 0.05$) between high and low mortality groups (1.61% versus 0.01% mortality respectively)

[a] these values represent the proportion of cattle groups having the management factors present

is not necessary to control morbidity and mortality in the population; although such segregation allows easier treatment of sick calves.

The association between ration and mortality is presented in Table IV. Calves fed cornsilage in the first month post arrival had, on average, the highest death rates; those fed haysilage had intermediate levels and those fed only dry hay had the lowest rates. These ration variables were the most important in terms of differentiating between the high and low mortality groups. For further analyses, the ration was categorized as being primarily dry hay-based or primarily silage-based without differentiating silage type.

The results of the discriminant and regression analyses are shown in Table V. All variables used in these analyses are shown. From the eight variables unconditionally related to mortality (those marked with an asterisk in Table V), it appears that western-raised calves had higher mortality than Ontario raised calves. The larger the number of calves per group the higher the mortality. Mixed cattle groups had higher mortality than non-mixed groups and calves fed only hay and/or mixed grains had relatively low death losses, whereas calves fed nonprotein nitrogen had relatively high death losses. Calves vaccinated against respiratory disease and/or calves treated for external parasites had relatively high death losses. (In Table V, + indicates an increase in mortality, whereas - indicates that mortality decreases when the factor is present). We have examined each type of vaccine separately (IBR intramuscular versus IBR intranasal, etc.) but have not observed obvious differences in their apparent effects. In addition, most vaccination takes place within two days of arrival (70% of groups vaccinated) and our data suggest that delaying this may prevent the apparent negative effects of vaccination in silage-fed but not in hay-fed cattle.[2]

When the interrelationships among variables are considered (Table V) feeding dry hay and not mixing groups of cattle are the two most important factors influencing mortality. (These inferences are based on entry sequence into the discriminant function or regression equation and the magnitude of the discriminant coefficients or beta.) The importance of transportation and other stresses is apparent in that western-raised calves have high mortality rates even when consideration has been given to ration content and mixing of cattle groups. Likewise, the use of respiratory vaccines also continues to be associated with excess mortality after statistical control of type of roughage and mixing of cattle. The number of cattle per group remained important in differentiating low from high mortality rate groups but not in the regression analysis. In the regression analysis, the reason calves raised in Ontario have an apparent detrimental effect appears to be that mixing western and Ontario calves in the same group is more harmful than 'mixing' in general (see Table IV). Feeding a starter ration appeared to be beneficial based on the results of the regression analysis.

Based on the results of regression analysis, we note that feeding dry hay reduces the rate of mortality by 0.18%, whereas mixing cattle groups increases it by 0.11% and using respiratory vaccines increased it by 0.14%.

Table IV

Average Mortality Rates for Selected Ration and Demographic Factors. Data from Bruce County Beef Project 1978-79/80

	Group Mortality Rate (%)
Ration Factors	
CORNSILE = 1	0.94 ± 0.82 (92)
HAYSILE = 1	0.64 ± 0.63 (15)
HAYDRY = 1	0.41 ± 0.70 (105)
Demographic Factors	
RAISONT = 1	0.35 ± 0.74 (15)
RAISWEST = 1	0.62 ± 0.71 (186)
RAISONT and RAISWEST = 1	1.65 ± 1.16 (11)
POOL = 1	0.85 ± 0.85 (114)
POOL = 0	0.40 ± 0.64 (100)

( ) number of groups

In Table VI and Figure I, an attempt is made to demonstrate the singular and combined effects of CORNSILE, POOL and RESPVAC. The relative increase in mortality rate (RR) is demonstrated by comparing the observed rate in the various factor groupings to that of hay-fed, nonmixed, nonvaccinated cattle.

The importance of these factors as contributors to death (PAR%) if one believes they are causally related to mortality, is also shown. The PAR% basically takes account of the increase in risk when a factor or factor grouping is present (RR) and the prevalence of that factor or factor grouping. For example, the risk of mortality in mixed cornsilage-fed cattle is not much greater than in vaccinated cornsilage-fed cattle. However, because the farmer is more prevalent, it accounts for over four times the number of deaths. In total, we estimate that approximately 58% of all deaths are attributable to these three risk factors.

As of this date, we can only speculate on why these factors might produce negative effects. Initially, cattle fed cornsilage may be in a negative energy balance either because they don't eat sufficient amounts and/or they cannot digest what they have eaten. Mixing may be important because of the introduction of new strains of pathogens that can overcome the stressed calves' limited ability to respond to them. Although attenuated, live vaccines may produce additional stress, including mild disease in calves vaccinated in temporal proximity to weaning and/or transportation. In addition, negative effects of giving Pasteurella bacterins under these conditions have been reported since as early as 1932. In a field-trial of intranasal IBR in yearling cattle, similar negative effects of vaccination were observed although the differences in morbidity and mortality rates were not statistically significant. Drs. Thomson and Wilkie have previously commented on some of these factors.

TABLE V

The Average Values for Factors used in and results of, Stepwise Discriminant and Regression Analyses. Data from Bruce County Beef Project 1978-79/80

Factor	Average Value of Factor	ENTRY SEQUENCE and DISCRIMINANT COEFFICIENT	ENTRY SEQUENCE and BETA
MORTALITY	0.63[a]	0.49/—0.49[b]	0.02[c]
Demographic Factors			
RAISONT	0.12		5(+0.16)
RAISWEST	0.92*	3(+0.34)	4(+0.32)
PURCONT	0.20		
PURCFARM	0.22		
PURELINE	0.71		
SEXNUM	0.87		
LIVE	141.26*	5(+0.30)	
POOL	0.53*	2(+0.36)	2(+0.11)
Ration Factors			
HAYDRY	0.49*	1(—0.61)	1(—0.18)
MIXGRAIN	0.49*		
CORNGRAN	0.35		
PROTSUPP	0.72		
NONPROT	0.22*		
STARTER	0.07		6(—0.15)
ANTISTAR	0.02		
Processing Factors			
INJVIT	0.61		
RESPVAC	0.38*	4(+0.38)	3(+0.14)
SOMNUGEN	0.07		
IMPLANTD	0.40		
INTPARA	0.44		
EXTPARA	0.84*		

a Average mortality rate - calculated by average $\log_{10}$ (mortality rate)
b Group Centroids - High mortality group/Low mortality group (1.61% and 0.01% mortality rates respectively)
c Mortality rate constant "a" from equation $y = a + \sum b_i X_i$ (b_i = beta, X_i = ith variable)
* Significant difference (at $p \leq 0.05$) between high and low mortality groups

TABLE VI

A summary of the effects and importance of CORNSILE, POOL and RESPVAC on mortality rates in feedlot calves. Data from Bruce County Beef Project 1978-79/80

Factor(s)			Prevalence of Factor(s)[a]	Mortality Rate (%)	Relative Risk (RR)[b]	Population Attributable Risk % (PAR%)[c]
CORNSILE	POOL	RESPVAC				
+	+	+	0.14	1.55	5.2	26.1%
+	+	—	0.20	0.80	2.6	15.9%
+	—	+	0.07	0.67	2.2	3.9%
+	—	—	0.10	0.45	1.5	2.2%
—	+	+	0.08	0.54	1.8	2.9%
—	+	—	0.12	0.52	1.7	3.9%
—	—	+	0.10	0.39	1.3	2.8%
—	—	—	0.20	0.30	1.0	0.0%

[a] the proportion of groups treated in this manner

[b] average rate of mortality in each CORNSILE - POOL - RESPVAC group divided by the rate of mortality in dry hay-fed, nonmixed, nonvaccinated cattle groups. The latter is arbitrarily set to '1' so that the RR are 'indexed' to this base.

[c] This described the percentage of all deaths that is attributable to each of the CORNSILE - POOL - RESPVAC groups. In all, these three risk factors account (directly or indirectly) for 57.7% of all deaths.

Weight does not appear to be related to subsequent mortality. Calves shipped by truck tend (not significant) to have lower mortality rates than train-shipped cattle. Cattle arriving in poor condition tend to experience excess mortality but there was no association between method of transportation and condition on arrival. Housing factors were not related to mortality in either of the first two years of the study and were not analyzed in this report.

The most frequent diseases considered 'causes of death' are shown in Table VII. Fibrinous pneumonia is the predominant disease followed by other respiratory tract conditions such as bronchopneumonia and IBR. The overall rates of these conditions appears to be stable between the two years. ITEME and interstitial pneumonia were more frequent in the second year of the project, whereas only one case of BVD was diagnosed. In year one, vaccination with a BVD vaccine was performed prior to the outbreaks of BVD. No vaccination was used in the second year of the project.

In conclusion, we recognize that productivity and economics must be considered rather than just sickness and death. We are attempting to measure these additional items but obtaining such information is not easy under our conditions. Nonetheless, the collection and organization of data, such as are provided by the Bruce County Beef Project,

should assist veterinarians and farmers in decision-making about the management of feedlot calves.

Figure 1. The effects of feeding cornsilage (CORNSILE), mixing cattle groups after arrival (POOL) and vaccinating against respiratory diseases after arrival (RESPVAC) on mortality in feedlot calves. Data from Bruce County Beef Project 1978-80.

The area of each circle represents the prevalence of the factor. The numbers without units are the rate of mortality relative to hay-fed, nonmixed, nonvaccinated cattle. (ie RR) The % numbers are the percentage of all deaths attributable to that factor or factor grouping (ie PAR%).

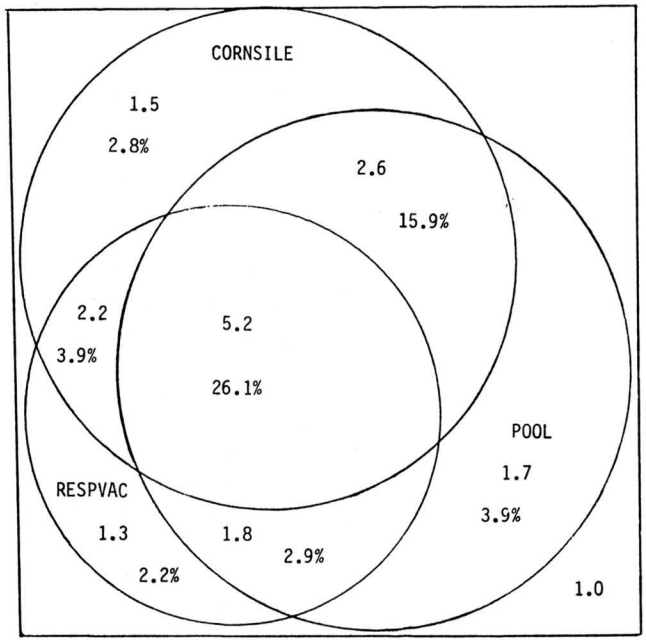

Table VII

The five most frequent diagnoses at postmortem, in feedlot calves. Data from the Bruce County Beef Project 1978-79/80

Diagnosis	1978-79	1979-80
Fibrinous Pneumonia	69(41.1%)	74(45.0%)
Bronchopneumonia	15(8.9%)	22(13.0%)
Interstitial Pneumonia	-	9(5.0%)
Infectious bovine rhinotracheitis	7(4.2%)	5(3.0%)
Infectious thromboembolic meningo-encephalitis	15(8.9%)	22(14.0%)
Bovine virus diarrhea	11(6.5%)	
Total animals examined	168	167
Total animals died	230	191

( ) = proportional mortality rate

References

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Acknowledgements

This study was supported by funds from the Ontario Ministry of Agriculture and Food, the Ontario Cattlemen's Association and the Bruce County Cattlemen's Association. Dr. T. E. Feltmate analized these data as part of his "Diploma in Preventive Medicine" requirements. Dr. J. A. Johnson is coordinator of the pathology and laboratory aspects of this study.