The Costs and Predictive Factors of Bovine Respiratory Disease in Standardized Steer Tests

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Summary

A retrospective study of 2,146 feedlot cattle in 17 feedlot tests from 1988 to 1997 was conducted to determine the impact of bovine respiratory disease (BRD) on veterinary treatment costs, average daily gain, carcass traits, mortality, and net profit. Morbidity caused by BRD was 20.6%. The average cost to treat each case of BRD was $12.39. Mortality rate of calves diagnosed and treated for BRD was 5.9% vs. .35% for those not diagnosed with BRD. Average daily gain differed between treated and non-treated steers during the first 28 days on feed but did not differ from 28 days to harvest. Net profit was $57.48 lower for treated steers. Eighty-two percent of this difference was due to a combination of mortality and treatment costs. Eighteen percent of the net profit difference was due to improved performance and carcass value of the non-treated steers. Data from 496 steers and heifers in nine feedlot tests were used to determine the effects of age, weaning, and use of modified live virus or killed vaccines prior to the test to predict BRD. Younger calves, non-weaned calves, and calves vaccinated with killed vaccines prior to the test had higher BRD morbidity than those that were older, weaned, or vaccinated with modified live virus vaccines, respectively. Treatment regimes that precluded relapse resulting in re-treatment prevented reduced performance and loss of carcass value. Using modified live virus vaccines and weaning calves 30 days prior to shipment reduced the incidence of BRD.

Introduction

Bovine respiratory disease (BRD) is the leading cause of disease-induced economic loss in feedlots. Financial losses attributable to BRD include mortality, and medication, veterinary, and labor costs for treatment. Other losses are difficult to demonstrate. These include reduced feed efficiency (FE=pounds of feed required per pound of gain), lower average daily gain (ADG), increased days on feed, decreased weight at harvest, carcass trim and possible condemnation, and reduced carcass quality grade. It is difficult to demonstrate the effect of BRD on ADG and FE because these production parameters are usually measured by pen average rather than by differences between individual animals (Jim et al., 1993).

Bovine respiratory disease is of multi-factorial origin. Onset of disease depends on a complex interaction between viruses, bacteria, the environment, and the host. Disease onset is thought to begin by reduced host resistance and infection with one or more viral agents such as Infectious Bovine Rhinotracheitis (IBR), Bovine Virus Diarrhea (BVD), or Bovine Respiratory Syncytial Virus (BRSV). Viral infection compromises resistance to bacterial infection in a variety of ways, facilitating subsequent infection with pathogenic bacteria. Bacteria such as *Pasteurella haemolytica*, *Haemophilus somnus*, and *Pasteurella multocida* can become established in the lung, causing pneumonia and fibrinous pleuritis. However, *pasteurella* pneumonia can occur without previous viral infection. Cattle with pneumonia are usually febrile, inappetant, depressed, and exhibit labored, shallow, and rapid breathing.

The ability of infectious agents to establish themselves in the body is dependent upon many factors related to the immuno-competance of the animal. Temperature fluctuations, humidity, rainfall, mud, nutritional status, age, length of time weaned, number and virulence of organisms shed by herd mates, vaccination and other factors interact and affect the resistance of individual calves. Exposure to a variety of infectious agents upon entry into feedlots is often extensive. Defining the specific role of factors that predispose cattle to respiratory disease is difficult. Morbidity and mortality are usually not repeatable from one group of cattle to the next because of inability to control multiple variables at the micro level. Few studies have analyzed the effect of the many factors that could affect the incidence, severity, and economic implications of BRD because they must be conducted over several years.

Iowa State University Extension, with support from several county cattlemen's organizations and agri-businesses, has helped organize and conduct feedlot tests for Iowa cow-calf producers from 1983 to the present. These tests have been administered under two programs: Tri-County Steer Carcass Futurity (TCS) located at Oakland, Iowa, and Midcrest Area Cattle Evaluation Program (MACEP) at Creston, Iowa. These tests provide producers a comparison of performance in a feedlot environment, carcass information, and a demonstration of the economics of retained ownership. Consignors' calves are managed and fed for maximum gain so genetic differences for ADG are fully expressed and non-feed costs are minimized. Producers are given a detailed accounting of feed, yardage and medicine charges for each steer.

For each steer, cumulative ADG is calculated at least four times during each test and FE is calculated at the end of each test. Thus, producers can learn about the pattern of their steers' ADG as days on feed increase. Value-based marketing is demonstrated by selling the cattle on a carcass weight and grade basis with packer discounts for less desirable quality and yield grades and carcass weights. Breeding and management programs are compared with those of other producers and with industry benchmarks. Informed decisions about breeding, feeding, health programs, management, and marketing can then be made to improve productivity and profitability.

The objectives of this retrospective study were to:

1. Determine the effect of Bovine Respiratory Disease on economic and performance parameters in a standardized steer test.
2. Determine factors that most accurately predict the incidence of Bovine Respiratory Disease in a standardized steer test.

Materials and Methods

A retrospective study of health, performance, and carcass records on 2,544 calves in twenty feedlot tests was conducted. TCS calves entering the tests originated in southwest Iowa, primarily from Cass, Shelby, Pottawattamie, Page, Mills, and Montgomery counties. MACEP steers could originate from any county but those from Adair, Adams, Clarke, Decatur, Madison, Ringgold, Taylor, and Union counties were given preference if space was limited. The number of calves per consignor ranged from one to 43 for all tests. The average number of calves per consignor per test was 4.2. Producers were encouraged to enter calves that were representative of their herd's genetics so that performance and carcass data were useful for later decision-making. However, it is likely that some producers were also interested in being recognized for having steers that rank high for retail value produced per day on feed. Therefore, some producers were likely to consign what they believed to be their highest quality, fastest gaining steers.

From 1988 to 1997, eight MACEP tests at three different feedyards were analyzed. The MACEP tests began in early September each year. Twelve TCS tests at three different feedyards, conducted from 1990 to 1997, began in either October or November each year. The "year" is when the test ended. A major difference between the tests was that only 2% of MACEP steers were weaned 10 days or more prior to delivery to the test feedlot, whereas 92% of the TCS steers were weaned. The average age and weight at the beginning of the tests were 195 days and 572 pounds, respectively. Upon arrival at the test feedlot, calves were vaccinated for IBR, PI3, BVD, BRSV (vaccines for these four were MLV), *Haemophilus somnus*, and *Pasteurella haemolytica*, were treated for internal and external parasites, were given a unique identification tag, and were implanted and weighed. Calves were weighed three more times during each test at approximately 28, 100 and 200 days and were harvested at one of two times approximately 35 days apart. Harvest times averaged 180-220 and 210-240 days on feed. Participants selected the harvest dates they considered most beneficial for each steer. In the TCS tests, producers were encouraged to not sell cattle that had < .35 inches of backfat. A disposition score was assigned to 1178 calves in nine tests at each weigh period. Disposition scores were based on a subjective appraisal of disposition while being processed. Disposition scores ranged from 1 to 5: docile=1, fractious=5. Birth dates were provided for 83% of the calves.

Rations averaged 62 Mcal Neg/pound after 14 days. Rations and gain were periodically monitored with the Iowa State University Extension Feedlot Monitoring[R] program. Feed intake for maintenance was assigned to each calf by weight using National Research Council requirements. After feed for maintenance was calculated for the entire pen, the remaining feed was allocated for gain, with the assumption that feed for gain was used equally efficiently by all animals. Carcass weight, quality grade, and yield grade were used to calculate carcass value. Select quality grade carcasses were discounted relative to the choice-prime base. Yield-grade 4 and 5 carcasses were discounted relative to yield grade 1, 2, and 3 carcasses. For this study, live selling price per pound was reverse calculated from the carcass weight, yield, and revenue. To determine net profit for this analysis, the beginning value, feed costs, yardage costs ($.25/head/day), miscellaneous costs, transportation costs, carcass data collection costs, vaccination, veterinary treatment costs (other than for BRD), implanting and identification tag costs, interest opportunity cost (6% amortized over the number of days on feed) on the initial feeder calf value, and costs to treat BRD were subtracted from the total carcass value (carcass price per pound multiplied by carcass weight).

All costs were recorded and added to the beginning value of the cattle that died (n=23, 1.1% of all steers) to determine net profit (loss). Nine (0.4%) calves with chronic disease conditions were removed from the test at the discretion of the owner. One-half of the beginning value per pound of culled steers was multiplied by the weight at removal and designated as the "sale" value. All costs plus beginning value was subtracted from this standardized sale value to determine net profit (loss). The figure of one-half of the beginning value per pound was an estimate of what the selling price would have been if culls had been marketed as single lots at an auction market.

At least two weeks prior to entering the tests, steers were vaccinated for IBR, PI3, BVD, BRSV, *Haemophilus somnus*, *Pasteurella haemolytica*, and 7-way Clostridia, and were dewormed, and treated for lice and grubs. (Not all calves were vaccinated for *Pasteurella haemolytica*) Castration and dehorning were required if necessary. Health procedure requirements were based on rules of the Iowa Beef Cattle Pre-Conditioning program. Only 1995, 1996, and 1997 tests were used to analyze vaccine effects because specific vaccine product information was not recorded prior to that time. For these 3 years, 73% of the calves had papers signed by a veterinarian stating the vaccine product used and the date it was administered. For some producers, the veterinarian did not administer the vaccinations but advised which product should be used, sold the product, and issued a certificate stating the date and specific product used by the owner. Although owner vaccination does not meet the requirements of the Iowa preconditioning program, these calves were included in the analysis of factors that affect feedlot respiratory disease.

Calves were treated for a variety of conditions, including respiratory disease, bloat, acidosis, footrot, and central nervous system disorders. Consulting veterinarians and feedyard managers did not use a predefined standard for identifying cattle with respiratory disease for all tests. Diagnosis of respiratory disease was based on observation of clinical signs including inappetence, labored breathing, depression, and elevated body temperature. Some calves were treated based upon the visual signs of respiratory disease without measuring body temperature. Steers were observed for signs of disease twice each day. Treated steers were generally not isolated in a sick pen.

Cattle diagnosed with respiratory disease were treated with pharmaceutical products recommended by the consulting veterinarian. For each treatment, the animal ID, medication and dosage used, cost, date, and diagnosis were recorded. If a veterinarian provided treatment, the call charge for that feedlot visit was amortized over all cattle treated that day. For this analysis a chute charge of $1.00/head was charged if the feedlot manager performed the individual treatments. The consulting veterinarian performed approximately 17% of individual treatments for all conditions. The feedlot manager treated the remainder. Treatments performed within two days on the same calf were considered to be one treatment, inasmuch as treatment protocols often required routine re-treatment. This is in accordance with label recommendations of several commonly used antibiotics. Morbidity of respiratory disease was defined as the number of treatments. Costs to treat diseases and disorders other than BRD were reported in the miscellaneous cost category for each animal and therefore affected net profit.

Calf value at the beginning of the each test was based on USDA Oklahoma City reported prices. For the week and year that each test began, USDA price quotes for calves in each 50-pound weight range were matched to each calf.

Four hundred ninety-six (496) steers and heifers in nine tests at five different feedlots had known birth and weaning dates, beginning weights, and vaccine products used. This included two tests in which only heifers were fed. These two heifer tests were used only to determine predisposing factors to respiratory disease. These cattle were vaccinated at least two weeks prior to each test. These 496 calves were used to analyze the effects of age, weaning status, and vaccine type on BRD. The multiple logistic regression procedure of SAS was used; BRD was the dependent variable and was defined as the occurrence or non-occurrence of BRD. Year, test center, weaning status (weaned or non-weaned), age when the test began, beginning weight and vaccine type (MLV or killed) were initially included in the model as independent variables. Three test centers, age, weaning status, and vaccine type were the only independent variables that resulted in a maximum likelihood estimate chi-square value of $p<.05$ and these were the variables used in the final model.

To elucidate components of the net profit difference between steers treated or non-treated for BRD, five categories were used. These were all costs associated with treated steers that died, BRD treatment costs of steers that survived to harvest, performance, carcass quality grade, and marketing time differences between treated and non-treated steers. Costs associated with treated steers that died or left the test due to chronic disease included their value loss, their feed and yardage charges, and their BRD treatment costs. Performance costs were feed, yardage and non-BRD veterinary charges of the steers that survived to harvest. Differences in net profit due to improved carcass quality grade of the non-treated steers were calculated such that they were independent of the improved marketing time of non-treated steers. Differences in net profit due to improved marketing time of the non-treated steers were calculated such that they were independent of improved carcass quality grade of the non-treated steers.

One thousand seven hundred eighty-two steers from 17 tests and six different feedlots were used to determine if weight per day of age at the beginning of the test differed between steers treated or non-treated for BRD. The GLM procedure of SAS was used; year and test center were included in the model statement.

Complete records on gain, yardage, feed, veterinary costs, and slaughter information were available on 2,114 of 2,146 steers in 17 tests at six different feedlots. Twenty-three steers died and nine left the test due to chronic disease. For the 2,114 steers that finished the test, the GLM procedure of SAS was used to analyze the effects of BRD status (those not treated, treated once, treated twice, and treated >=3 times) on beginning ADG (gain during the first 28 days of the test), test ADG (gain from 28 days after arrival to harvest), days on feed to harvest, final weight at harvest, and selling price. For all 2146 steers, the GLM procedure of SAS was used to analyze the effects of BRD status on net profit. Bovine respiratory disease was not used as a continuous variable because of the low number of animals treated >= 3 times. For all analyses, year and test center were included in the model statement. For selling price and days on feed, year, test center, and age when the test began were included in the model statement. Differences between BRD status group least squares means were considered significant if $p<.05$ for the pairwise comparison of least squares means.

The GLM procedure of SAS was used to determine the effect of disposition scores (1, 2, 3, or >=4) on ADG and net profit for 1178 steers in 9 tests. Disposition scores were not used as continuous variables because of the low number of steers that were disposition scored 4 or 5. Differences between disposition score groups were considered significant if $p < .05$ for the pairwise comparison of least squares means.

Results and Discussion

Unadjusted data for all the tests appear in Table 1. Respiratory (BRD) morbidity was 20.6%. Although this seems high relative to other trials (Bechtol et al., 1991), cattle originated from many sources, and 38% were less than 200 days of age when delivered. BRD morbidity for the various tests ranged from 0 to 59%. These large differences clearly demonstrate the importance of numerous replicates when examining the effect of variables on BRD. The large variation in morbidity may be due to differences in weather, ration, stress on individual animals, level of exposure to pathogens, and possibly to virulence of those pathogens. Relapse rate ranged from 0 to 81 percent. Much of the variability in net profit was due to variation in cattle market and feed prices among years and tests.

Table 1. Overall performance, BRD morbidity, costs, and profitability of steers in the TCS and MACEP steer tests.

Test and year [a]	BRD Morbidity[b,c] (%)	Case Fatality[d] (%)	First Treatment Relapse Rate (%)[e]	BRD Treatment Costs ($/ All Head) [f]	ADG[g]	Total Cost of Gain ($/Cwt)	Selling Price ($/Cwt)	Net Profit ($/ Head)
MACEP 88	7	20	0	2.10	3.0	43.2	61.8	32
MACEP 89	9	0	25	3.30	3.4	49.9	71.3	47
MACEP1-90	40	10	40	9.60	3.2	44.4	76.9	123
TCS 90	18	5	32	2.50	3.3	40.6	75.7	93
MACEP 1-91	53	15	22	18.60	2.8	53.1	75.5	-7
TCS 91	26	0	12	1.70	3.1	46.6	69.9	-60
TCS 92	16	0	0	1.20	3.4	47.5	70.5	45
TCS 93	0			0.00	2.9	46.2	74.2	46
MACEP 94	30	7	24	5.80	3.3	43.6	67.7	-2
TCS 94	20	0	17	2.50	3.4	48.0	59.4	-134
MACEP 95	7	17	25	2.20	3.3	37.3	63.0	81
TCS 95	21	6	44	3.90	3.2	47.4	60.3	47
MACEP 96	37	8	32	8.6	3.2	53.0	56.7	-40
TCS 1-96	59	5	68	17.2	3.1	57.0	57.5	-70
TCS 2-96	4	22	11	1.00	3.2	66.2	56.7	-121
MACEP 97	5	0	0	0.60	3.1	50.7	65.2	104
TCS 1-97	26	0	81	4.30	3.1	46.5	65.3	95
Weighted Averages	**20.6**	**6.0**	**39.2**	**4.30**	**3.2**	**49.0**	**64.7**	**18**

[a] Year is the year the test was completed.
[b] BRD (Bovine Respiratory Disease) morbidity: percentage of cattle treated for respiratory disease.
[c] BRD morbidity, case fatality, BRD treatment costs and net profit reflect the average of all steers, including those that died.
[d] Of the cattle treated for BRD, the percentage that died or left the test due to chronic disease.
[e] Percentage of calves treated that required treatment again.
[f] Costs to treat BRD amortized over all steers in the test.
[g] ADG (average daily gain), total cost of gain, and selling price reflect only steers that finished the test.

The average cost of BRD treatments for all steers that were treated was $21.06/hd. The average number of treatments for each animal treated was 1.7. Therefore, the cost to treat each BRD case was $12.39 ($21.06/1.7). Of this amount, 81% was for drug costs and 19% was for veterinary and feedlot services. Treatment for BRD was 87% of the cost of treatment for all diseases. Figure 1 depicts the trend and variation for BRD treatment cost and the number of treatments per animal that required BRD therapy. More treatments per animal meant higher relapse rates. Neither the cost per treatment nor the number of treatments per animal treatment showed an explainable trend. Table 2 depicts various costs, and performance and economic parameters for calves sold at harvest (n = 2114) by BRD status (not treated for respiratory disease, treated once, twice, or 3 or more times). Data from steers that died or left the test were not included. Although ADG was reduced for treated steers for the first 28 days after arrival at the test center, treated and non-treated steers did not differ for the test period, which was from 28 days after arrival to harvest. One study demonstrated that 68% of steers that did not have overt clinical signs of BRD had lung lesions at harvest. These steers gained .17 pounds per day less than steers that did not have lung lesions (Wittum et al., 1996).

Figure 1. Cost for each BRD treatment and number of treatments per head treated by year in TCS and MACEP tests, 1988 to 1997.

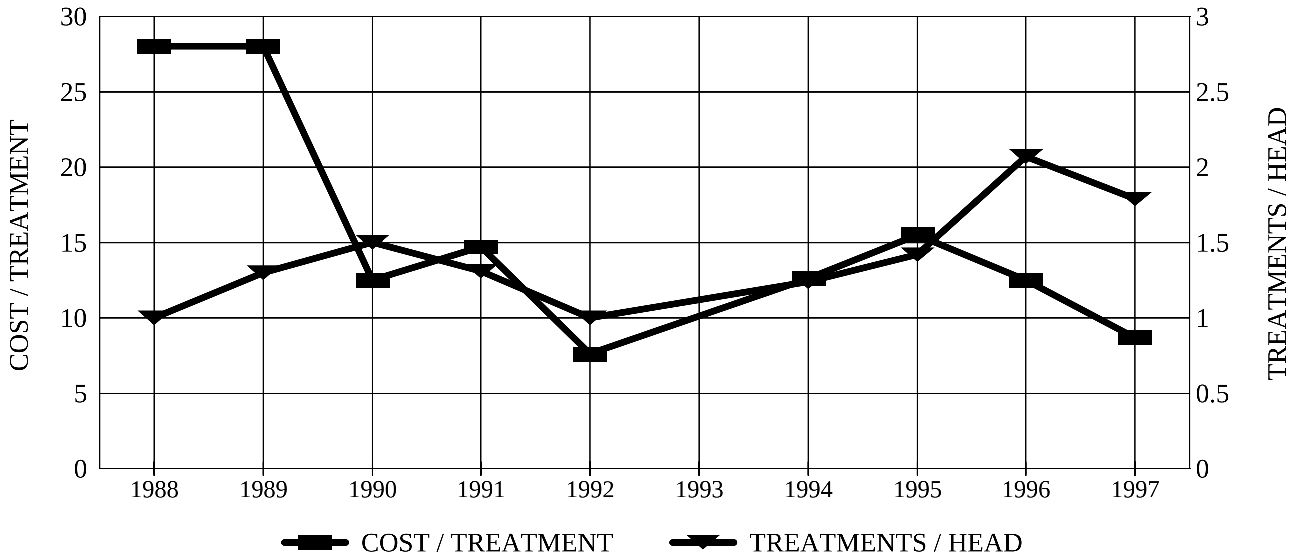


Table 2. Least squares means for performance parameters of 2,114 steers in the TCS and MACEP steer tests, 1988-1997. These data do not include steers that died.

BRD status (Number of treatments)	Number of steers	28 day ADG[a]	Test ADG[b]	DOF[c]	% >= Choice-QG[d]	Sell Price ($/Cwt)	Final Wgt (#)	BRD treatment costs ($/Head)
Not Treated	1699	2.72[e]	3.22[e]	207[e]	54 %	68.58[e]	1226[e]	0[e]
1	261	2.19[f]	3.24[e]	209[e]	49 %	67.97[f]	1227[e]	13[f]
2	98	1.94[f,g]	3.30[e]	209[e,f]	51 %	68.14[e,f]	1230[e]	24[g]
>=3	56	1.66[g]	3.16[e]	216[f]	45 %	66.20[g]	1193[f]	40[h]
All Treated	415	2.06[i]	3.24	212[i]	49%	67.90[i]	1223	18.1[i]

[a] ADG from arrival at the test center to 28 days.
[b] ADG from 28 days after arrival to harvest.
[c] Number of days on feed from arrival at the test center to harvest.
[d] Percentage of steer carcasses that were at least Quality Grade Choice minus.
[e-h] Least-squares means within a column without a common superscript differ (p<.05).
[i] Least squares means differ between treated and non-treated steers (p<.05).

The difference in early ADG (Table 2) is explained by Figure 2, which shows that in tests with either high (>20 %) or low (<20%) BRD morbidity, most of the treatments occurred early in the feeding period. Specifically, 40% of first treatments occurred within 14 days of arrival for either high or low BRD-morbidity tests (Figure 3). In high morbidity tests, 81% of first treatments occurred during the first 42 days (Figure 3). It seems that compensatory gain throughout the test period made up for the BRD-induced reduction in ADG during the first 28 days. These data show that cattle that are treated effectively do not experience a reduction in ADG.

Figure 2. Percentage distribution of the number of days to the first BRD treatment for calves in TCS and MACEP tests, 1988 to 1997, with high (>=20%) or low (<20%) levels of BRD morbidity.

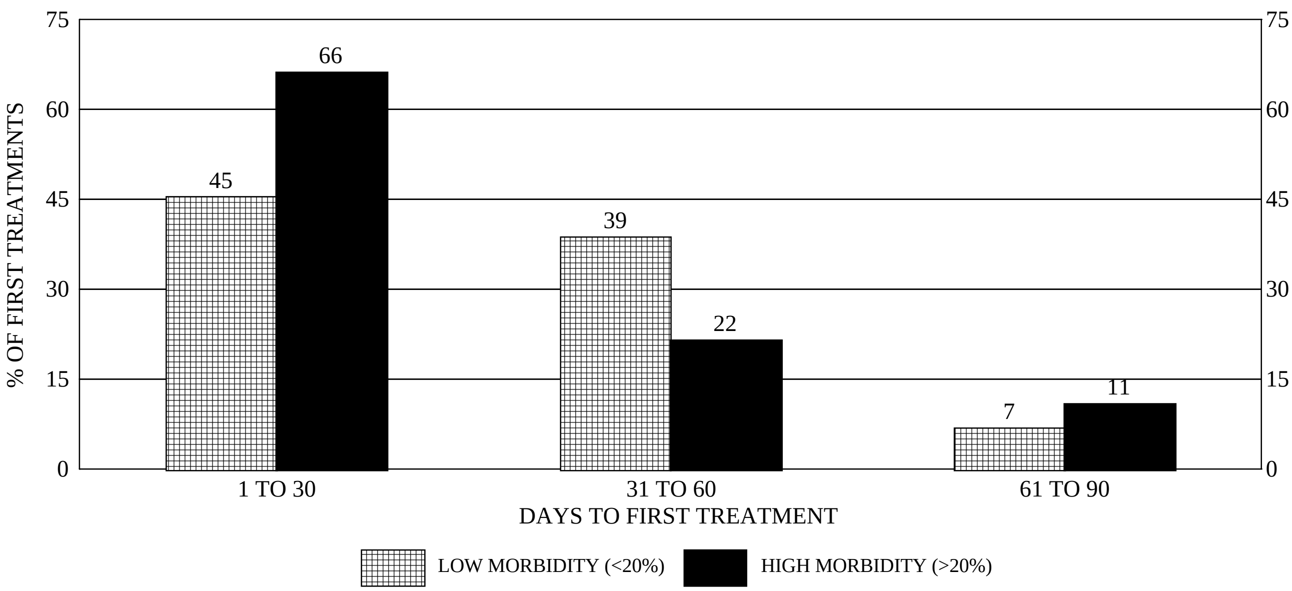


Figure 3. Percentage distribution of the number of weeks to the first BRD treatment for calves in TCS and MACEP tests, 1988 to 1997, with high (>=20%) or low (<20%) levels of BRD morbidity.

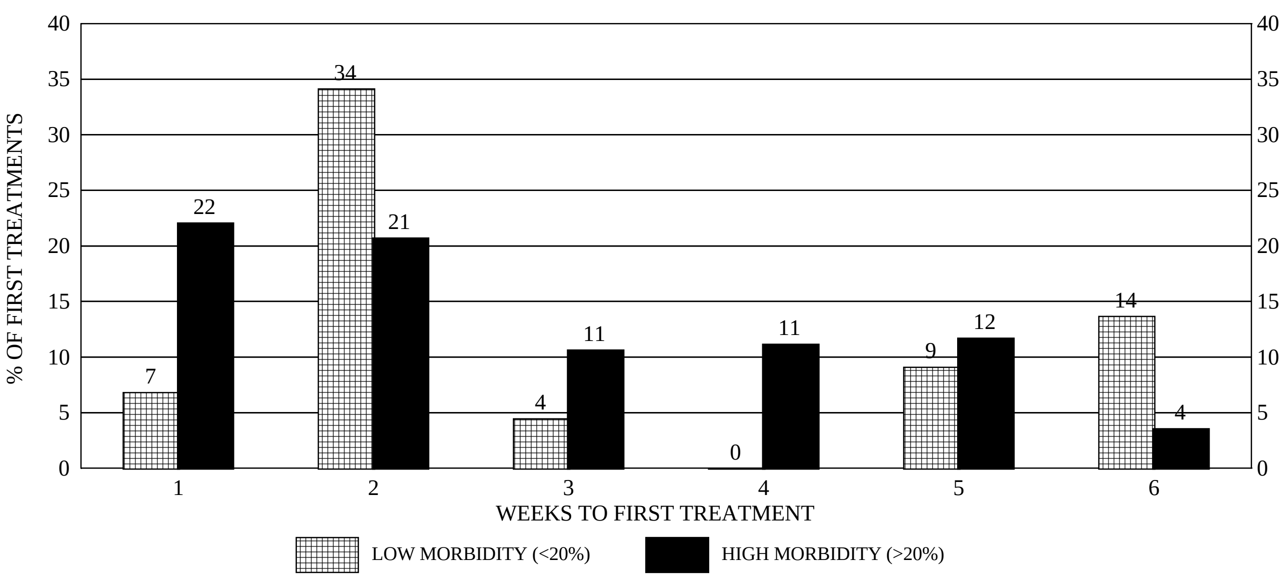


Table 3 depicts all steers, including those that died or left the test due to chronic disease. Net profit differences between BRD treatment group least squares means are greater than in Table 2 because mortality was higher for steers that experienced BRD. This higher mortality caused lower sale values, as demonstrated by the group that was treated 3 or more times (>=3x). Twenty percent of the >=3x group died or were culled before completing the test, which reduced the average gross sale value to $650. Additionally, BRD treatment costs were $53.70/hd for the >=3x group, further reducing their net profit. Tables 2 and 3 demonstrate that BRD does not cause large performance differences but accounts for increased mortality, culling, and treatment costs, significantly affecting net profit.

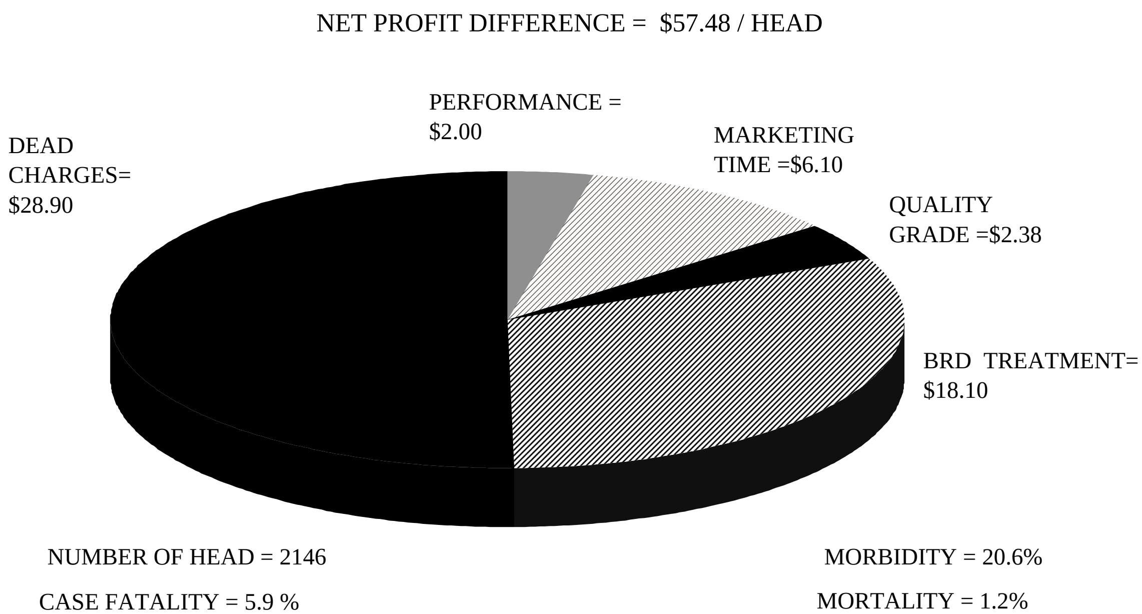
Figure 4 depicts components of the value differences between treated and non-treated steers. Non-treated steers returned $57.48 more per head than treated steers. The largest component of the difference, $28.90, is from value losses, feed and yardage charges, and medicine charges for treated steers that died or left the test due to chronic disease. Costs to treat BRD for treated steers that survived to harvest further reduced the treated steers' net profit by $18.10. Improved ADG and FE of the non-treated steers contributed $2.00 to the net profit difference. Improved quality grade, independent of marketing time, contributed $2.38 to the net profit difference. Earlier marketing, independent of quality grade, contributed $6.10 to the net profit difference.

Table 3. Least squares means for net profit and mortality of 2,146 steers in the TCS and MACEP tests, 1988 to 1997. These data include steers that died.

BRD Status (Number of treatments)	Number of steers	Net Profit ($/Head)	Case Fatality [a] %	Sell Value [b] ($/Head)	BRD Treatment Costs ($/Head)
Not Treated	1705	61[c]	.35 %	840[c]	0[c]
1	270	31[d]	3.3 %	820[d]	12.7[d]
2	102	10[e]	3.9 %	813[d]	24.9[e]
>=3	69	-108[f]	20.3 %	650[e]	53.7[f]
All Treated	441	3[g]	5.9 %	793[g]	20.6[g]

[a] Of the steers in the BRD group (row), the percentage that died or left the test due to chronic disease.
[b] The value of the steers leaving the test, including those sold at harvest, those that died, and those that left the test due to chronic disease.
[c-f] Least squares means within a column without a common superscript differ ($p<.05$).
[g] Least squares means differ between treated and non-treated steers ($p<.05$).

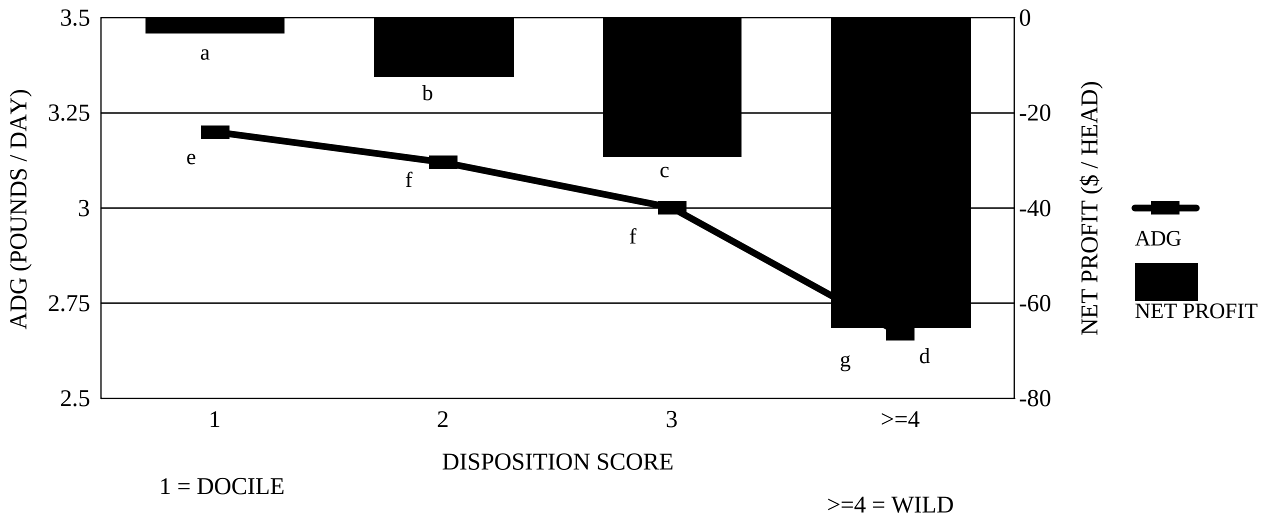
Figure 4. Components of the net profit difference between steers treated or non-treated for BRD, respectively, in TCS and MACEP tests, 1988 to 1997.



Although disposition score did not account for differences in morbidity, ADG and net profit were statistically lower (Figure 5) for wilder steers (disposition scores 2, 3, and >=4) than for docile steers (disposition score 1) on a 5 point disposition scale. The least squares means for net profit for all disposition scores are negative because the nine tests that measured disposition score occurred in low profit years.

Younger calves had higher BRD morbidity than older calves (Figure 6). Although age seems to explain the occurrence of BRD, older calves were also more likely to have been weaned prior to consignment to the tests.

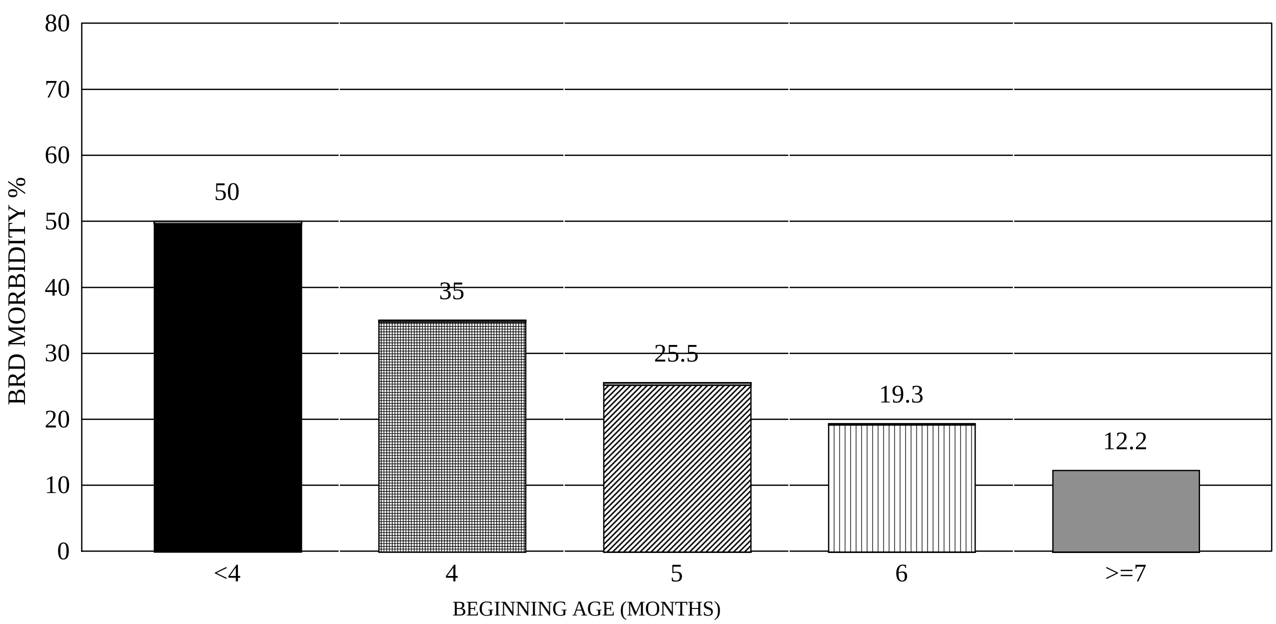
Figure 5. The effect of disposition score on average daily gain and net profit for steers in TCS and MACEP tests, 1988 to 1997. All values are least squares means.



a-d Least squares means for Net Profit without common superscripts differ (p<.05)

e-g Least squares means for ADG without common superscripts differ (p<.05)

Figure 6. The effect of age at the beginning of test on BRD morbidity in TCS and MACEP tests, 1988 to 1997.



Both non-weaned calves and calves weaned less than 30 days had higher BRD rates than calves weaned more than 30 days (Figure 7). Again, calves weaned more than 30 days were older than those that were not weaned or weaned fewer than 30 days. The percentage of treated calves that relapsed, or required treatment again was numerically highest for those weaned less than 30 days. Calves vaccinated at least 10 days before the test with killed IBR, BVD, BRSV, and PI-3 vaccines had higher BRD rates than those vaccinated with modified live (MLV) products (Figure 8). Fifty-two percent of treated calves relapsed in each group. The most important difference between the two vaccine groups is the higher percentage of killed vaccine calves that required treatment 3 or more times. Calves treated 3 or more times earned $174 less net profit than those that were not treated (Table 3).

Figure 7. The effect of weaning status on BRD morbidity in TCS and MACEP tests, 1988 to 1997.

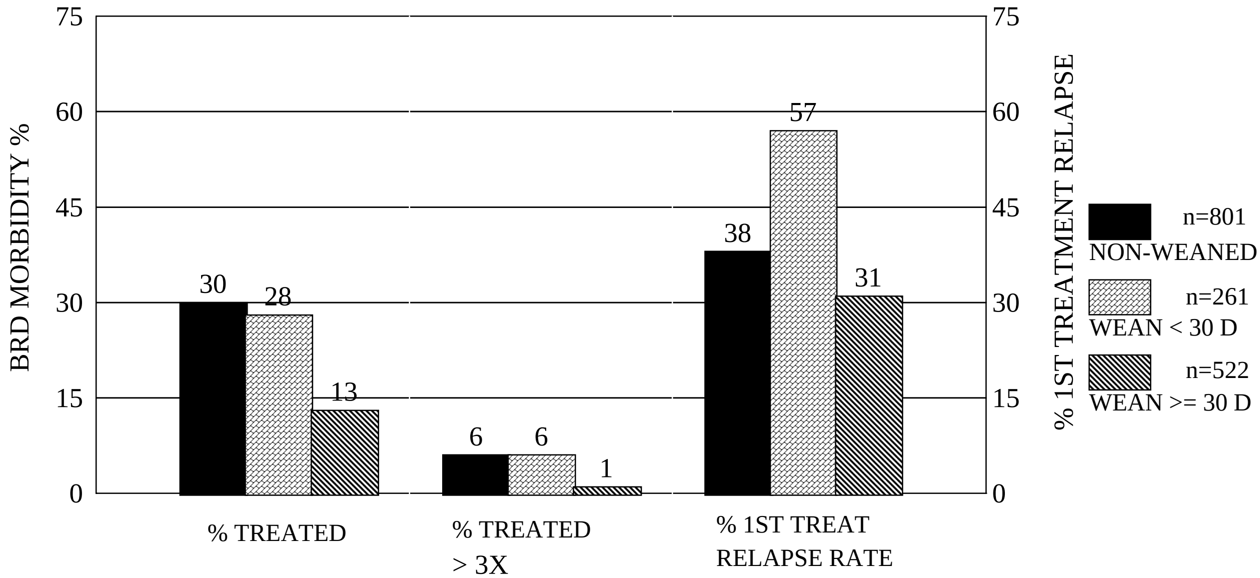
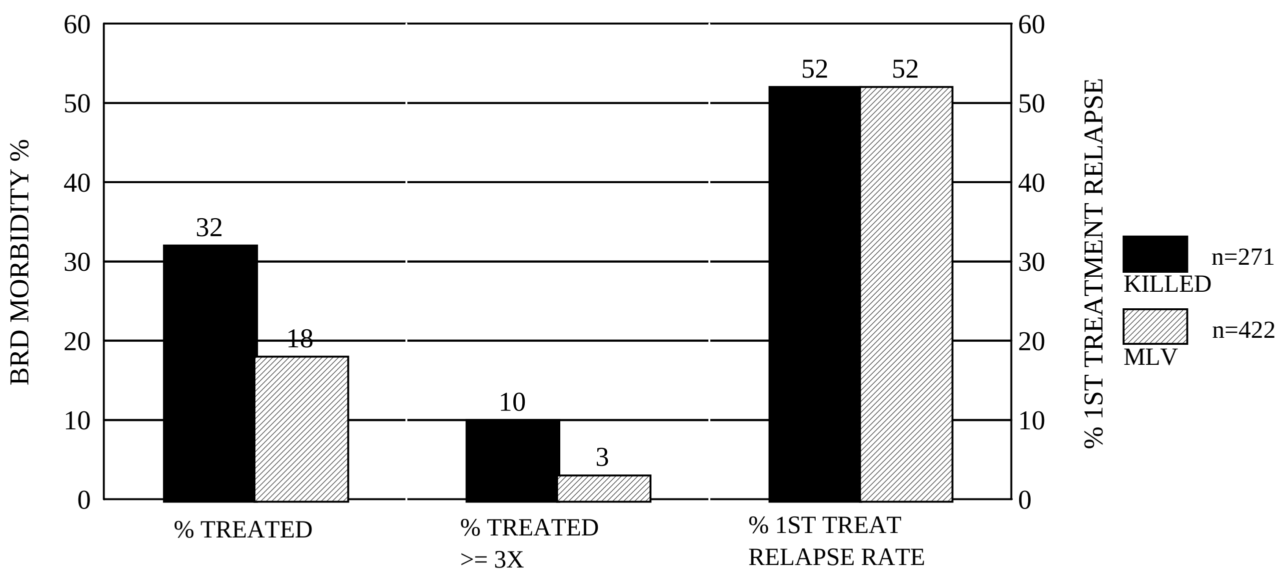


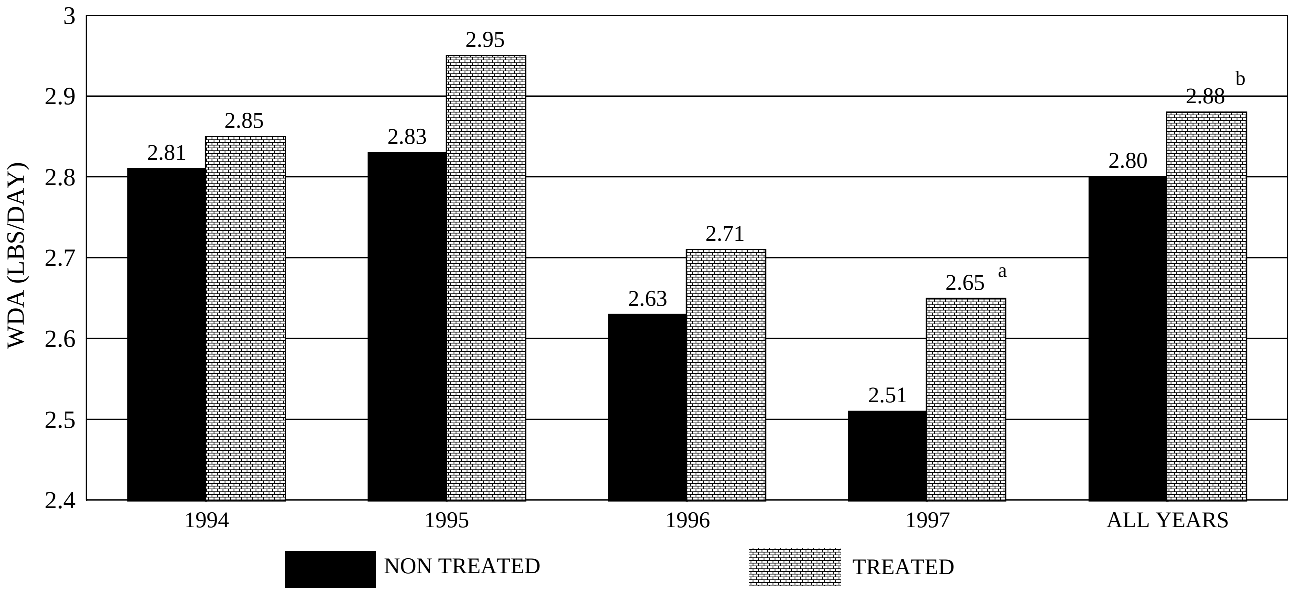
Figure 8. The effect of pre-trial vaccine type (MLV or killed) on BRD morbidity in TCS and MACEP tests, 1995 to 1997.



Although treated steers were younger at the start of the test than non-treated steers, they were not lighter. Weight per day of age at the beginning of the test was higher ($p < .05$) for treated than non-treated steers for all years combined (Figure 9).

The results of the logistic regression analysis of factors that predict BRD are presented in Table 4. The purpose of this analysis was to determine the significance of age, weaning status (weaned or non-weaned), and vaccine group (MLV or killed) on BRD. Age, weaning status, and vaccine group (killed or MLV) were the independent variables and BRD status (whether treatment occurred or not) was the dependent variable. Age was an important predictor of BRD ($p < .01$), but an odds ratio could not be determined because age is not a discrete event like weaning or vaccine status. The result of each factor is presented as an odds ratio, and each result is statistically adjusted for the other factors. Non-weaned calves were 3.4 times more likely to experience BRD than weaned calves, independent of differences in age, test center, or vaccine status. Calves vaccinated with killed vaccines were 2.2 times more likely to experience BRD than calves vaccinated with MLV vaccines, independent of other factors.

Figure 9. Least squares means by year for weight per day of age at test entry for TCS and MACEP tests.



a Least squares means within a year differ (p<.05)

b Least squares means for all years differ (p<.05)

Table 4. Risk of BRD for non-weaned vs. weaned calves and calves vaccinated with killed vs. MLV vaccines in the TCS and MACEP tests, 1995 to 1997.

	Odds ratio[a]
Weaning status	
Weaned	1.0
Non-Weaned	3.4[b]
Vaccine Type	
MLV	1.0
Killed	2.2[c]

[a] The final model adjusts all odds ratios for the effect of age, center, weaning status, and vaccine type.
[b] Odds that non-weaned calves will experience BRD compared with weaned calves ($p < .01$).
[c] Odds that calves vaccinated with killed vaccines will experience BRD compared with calves vaccinated with MLV vaccines ($p < .01$).

Implications

Steers that were diagnosed and treated for BRD were less profitable than steers not diagnosed with BRD, primarily from higher mortality and medicine costs. Treated steers' ADG was similar to non-treated steers. However, lung infections can occur without clinical signs in some animals, and this may cause a reduction in their ADG. Lung infections without overt clinical signs can only be determined by the presence of lung lesions at harvest, which was not performed in this study. Some management and vaccination systems will reduce the occurrence of BRD, and should increase net profit. Culling wild steers will not reduce the occurrence of BRD, but will increase ADG and net profit.

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