PEER REVIEWED

A Survey of the Relationship Between Management Practices and Risk of Acute Interstitial Pneumonia at US Feedlots

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Abstract

Acute interstitial pneumonia (AIP) is a recognized cause of feedlot morbidity and mortality, but the cause is unknown. Management practices have been suggested to contribute to the pathogenesis of AIP, but little supportive data exists. A cross-sectional survey of US feedlots evaluated the relationship between management practices and subjective and objective measures of AIP risk. Of 65 respondents, 75.4% recognized AIP as a cause of morbidity or mortality in their feedlot. Managers reported that 80.5% of AIP deaths occurred in cattle on feed over 60 days, 62% of AIP deaths occurred in the summer and 62.2% of AIP deaths were heifers. Thirty-three feedlots reported the percent of placements that died of AIP, which ranged from 0.001-0.75%. Feedlots in northern states were less likely to report AIP as a cause of morbidity/mortality, while larger feedlots and feedlots placing higher proportions of yearlings more often recognized AIP as a cause of morbidity/mortality. Although heifers were recognized to account for 62% of AIP deaths, feedlots placing a large proportion of heifers were not more likely to recognize AIP as a cause of morbidity/mortality than feedlots placing a small proportion of heifers. Feedlots that vaccinated over 95% of cattle for *Mannheimia haemolytica / Pasteurella multocida* were less likely to recognize AIP as a cause of morbidity/mortality than feedlots who vaccinated less than 95% of cattle for these pathogens. The percent of cattle dying of AIP in feedlots that vaccinated over 95% of cattle for *Mannheimia / Pasteurella* was 0.06%, compared to 0.14% for feedlots vaccinating less than 95% of cattle for these pathogens. Although these data must be interpreted in light of the limitations of a survey as a data collection device, results suggest the impact of feedlot location and size, animal gender and vaccination strategy merit further scrutiny in research to determine the cause of feedlot AIP.

Résumé

La pneumonie interstitielle aiguë (PIA) est une cause établie de morbidité et de mortalité dans les parcs d'engraissement mais son origine n'est pas bien connue. La régie d'élevage a été impliquée dans la pathogenèse de la PIA mais il existe bien peu de données pour supporter cette hypothèse. La relation qui existe entre la régie d'élevage et des mesures subjectives et objectives reliées au risque de PIA a été évaluée à l'aide d'une étude transversale de parcs d'engraissement aux États-unis. Parmi les 65 répondants, un total de 75.4% indiquaient que la PIA était une cause de morbidité/mortalité dans leur établissement. Selon les gestionnaires, 80.5% des cas de mortalité causée par la PIA impliquaient du bétail en engraissement depuis au moins 60 jours, 62% des cas prenaient place l'été alors que 62.2% des cas touchaient des taures. Le pourcentage d'animaux détenus qui mouraient suite à la PIA variait de 0.001 à 0.75% dans un ensemble de 33 parcs. Les parcs des états du nord rapportaient moins de morbidité/mortalité reliée à la PIA. Les parcs plus volumineux et ceux qui détenaient une plus grande proportion d'animaux de l'année constataient plus de morbidité/mortalité reliée à la PIA. Bien que les taures représentaient 62% des cas de mortalité associée à la PIA, la morbidité/mortalité n'était pas associée à la proportion de taures détenues dans un parc. La morbidité/mortalité associée à la PIA était moins fréquente dans les parcs qui vaccinaient plus de 95% du bétail contre *Mannheimia haemolytica / Pasteurella multocida* que chez ceux qui vaccinaient une proportion moindre du bétail. Le pourcentage de morbidité/mortalité causée par la PIA dans les parcs qui vaccinaient plus de 95% du bétail

contre *Mannheimia/Pasteurella* était de 0.06% par rapport à 0.14% pour ceux qui vaccinaient moins que 95% du bétail. En tenant compte des limites imposées par une étude transversale, les résultats suggèrent que l'impact de la localisation des parcs et leur taille de même que le sexe et la stratégie de vaccination devrait être le sujet de plus d'études afin de cerner les causes de la PIA dans les parcs d'engraissement.

Introduction

In many feedlots, acute interstitial pneumonia (AIP) is a common cause of death of cattle late in the feeding period.[6,7] Affected cattle may show signs of severe respiratory distress that are acute in onset; in some cases, affected cattle are unexpectedly found dead[5]. The response to treatment by animals suspected to have AIP is unpredictable and typically poor, thus efforts should be focused on preventing the disease. Unfortunately, the cause of feedlot AIP is unknown. Because of this, it is difficult to make science-based recommendations regarding prevention. Bacterial respiratory pathogens and bovine respiratory syncytial virus (BRSV) have been associated with AIP in some reports,[2,5,8,17] but it is not clear whether infection with these agents is causal or occurs as a consequence of AIP. In one study, groups of cattle in which one or more animals died from a digestive disorder were 1.7 times more likely to experience AIP,[7] suggesting that dietary factors may impact feedlot AIP. Certain feed additives have been suggested to increase[1,10-12] or decrease[11] occurrence of feedlot AIP. Other management factors, such as implant strategies, have been proposed to contribute to development of the disease.[11] Unfortunately, studies testing many of the above hypotheses are lacking. These variables are not easily tested because AIP occurs sporadically in feedlot cattle and experimental reproduction of the disease has not been accomplished. Observational studies are needed to identify factors associated with disease risk.

In an effort to construct a preliminary characterization of management factors influencing risk of feedlot AIP, a questionnaire was developed and sent to managers of feedlots in several states. The objective of this study was to obtain a preliminary snapshot of relationships between management practices and risk of AIP by surveying feedlot managers. The questionnaire was designed to collect data regarding type of cattle placed, therapeutic and preventive health practices administered to cattle at arrival (processing practices), characteristics of the summer finishing diet and general causes of morbidity and mortality. The descriptive data from all feedlots responding to the survey have been presented previously.[18] In this report, data are presented regarding the relationship between certain management practices and risk of death due to AIP as reported by participating feedlots.

Materials and Methods

The method by which participating feedlots were selected, details regarding the questionnaire sent and data analysis methods were previously reported.[18] Briefly, questionnaires were sent to managers of 561 feedlots in 21 states. Feedlot managers were requested to complete the questionnaire and provide data for lots of cattle placed in the year 2000. Subjective AIP risk for cattle in each feedlot was determined by asking managers to answer "yes" or "no" to the question: "Is AIP a cause of morbidity or mortality in your feedlot?" An objective measure of risk was determined by asking managers to report the percentage of cattle placed that died due to AIP.

Respondents were also asked questions regarding various aspects of feedlot management, including total number of cattle placed, number of steers, heifers, Holsteins and other type cattle placed, and number of cattle purchased through sale barns, direct farm purchase, or other means. Respondents were asked to give the number of yearlings, calves and other age cattle placed, as well as to estimate percent of English or Continental-type cattle, *Bos indicus* (Brahman)-type cattle and dairy breeds placed. Managers were asked to report the percent of cattle vaccinated against infectious bovine rhinotracheitis virus (IBR), bovine viral diarrhea virus (BVD), parainfluenza virus (PI3), bovine respiratory syncytial virus (BRSV), clostridial diseases, *Haemophilus somnus,* or *Mannheimia haemolytica / Pasteurella multocida*. Respondents were asked to report whether any cattle were mass-treated at arrival to prevent pneumonia, and if so, the percent treated. Managers were asked what percent of steer, heifer and other placements received implants for growth promotion, and the final implant used for each category of placement. They were asked to report the percent on a dry matter basis of roughage, grain, protein sources and by-products included in the summer finishing ration. They were asked to indicate whether monensin or other ionophores were included in the summer finishing ration and, if so, to report the dose. If they noted that heifers were placed, they were asked to indicate whether melengestrol acetate (MGA®) was included in the summer finishing ration, and if so, at what dose.

In addition to the aforementioned management-related questions, respondents were also asked to report the percent of cattle placed that were treated for bovine respiratory disease (BRD), AIP, digestive disorders, or other diseases, and the percent that died of each of these disorders. They were asked to report the percent of animals that died from AIP at less than 60 days on feed, and the percent that died in each of three quarters of the calendar year.

Significant differences in subjective AIP risk for feedlots reporting various management practices were deter-

mined by the Chi-square test, with significance set at $p < 0.05$. Because of the relatively small number of respondents reporting the percent of placements that died due to AIP, evaluation for statistically significant differences was not done for the objective measure of risk.

Results

AIP at Responding Feedlots

Seventy-two questionnaires were returned, and 66 contained sufficient data for inclusion in the analysis, although not all questions were answered by all respondents. Sixty-five managers responded to the question "Is AIP a cause of morbidity or mortality in your feedlot?". Twelve (18.5%) said that AIP was not a cause of morbidity or mortality, 49 (75.4%) said that AIP was a cause of morbidity or mortality and four (6.1%) said they did not know if AIP was a cause of morbidity or mortality at their feedlot. Respondents reported that 19.4% (standard error [SE], 2.9) of AIP deaths at their feedlots occurred in cattle on feed less than 60 days, and 80.5% (3.0 SE) occurred in cattle on feed 60 days or longer. Sixty-two percent (3.8 SE) of AIP deaths occurred in the summer (June-September), 17.1% (1.9 SE) occurred in the fall and winter (October-January) and 18.6% (2.5 SE) occurred in the spring (February-May).

To determine whether the degree to which AIP was recognized as a cause of morbidity and mortality varied by region, the responding feedlots were divided into those located in the North region (including Nebraska, Utah, Idaho, South Dakota, North Dakota, Montana and Washington; n = 29) or all other states (n = 32). The four feedlot managers who responded "don't know" to the question of whether AIP was a cause of morbidity and mortality in their feedlot were excluded from evaluations of factors associated with subjective risk. Thus, the total number of feedlots included in the regional breakdown was 61. States in the North region were less likely to recognize AIP as a cause of morbidity and mortality at the feedlot, with 19 of 29 (65.5%) northern feedlots reporting that AIP was a cause of morbidity and morality, while 30 of 32 (93.8%) feedlots in other regions reported that AIP was a cause of morbidity and mortality in their feedlot ($p < 0.01$).

Thirty-three respondents reported the percent of placements that died of AIP in their feedlots. The reported percent of placements dying of AIP for all feedlots ranged from a minimum of 0.001% to a maximum of 0.75%; mean percent of placements dying of AIP for all feedlots reporting was 0.13% (0.04 SE).[18] Percent of placements that died of AIP was evaluated by aforementioned region of the reporting feedlot. There was little difference in the reported mean percent of placements dying from AIP at feedlots in the North (mean percent dying 0.13%, 0.07 SE) and for feedlots elsewhere (mean percent dying 0.13%, 0.05 SE). For the states with the most responses, Kansas and Nebraska, the percentage of placements that died of AIP was 0.13% (0.05 SE) for Kansas (n = 13) and 0.11% (0.04 SE) for Nebraska (n = 5).

Risk of AIP and Number and Type of Cattle Placed

Feedlots placing larger numbers of cattle were more likely to report that AIP was a cause of morbidity and mortality in the feedlot. Of the 61 respondents who answered "yes" or "no" to the question regarding whether AIP was a problem for their feedlot, 21 respondents placed less than 10,000 cattle annually, and 13 (61.9%) reported that AIP was a cause of morbidity and mortality. In contrast, of 40 respondents that placed 10,000 or more cattle annually, 36 (90%) reported that AIP was a cause of morbidity and mortality in the feedlot ($p < 0.01$). For the 33 feedlots reporting the percentage of placements that died of AIP, the breakdown of responses by feedlot size is presented in Table 1.

Because heifers have been reported to be disproportionally affected by AIP,[9,10] the percent of heifers placed by responding feedlots was evaluated, as was the subjective and objective risk of AIP for feedlots placing various proportions of heifers. Overall, the percentage of heifers placed as a proportion of all placements was 40.5% (3.2 SE). Respondents reported that 62.2% (6.7 SE) of cattle dying of AIP were heifers, while 37.8% (6.8 SE) were steers. There was not a notable difference in subjective risk for AIP between feedlots placing various proportions of heifers. Of 38 feedlots where less than 50% of placements were heifers, 31 (81.6%) reported that AIP was a cause of morbidity or

Table 1. Mean percent of placements that died of AIP as reported by feedlots placing various numbers of cattle.

Number of cattle placed annually	Number of feedlots responding	Mean percent of placements dying of AIP (standard error, SE)
< 5,000	6	0.18 (0.12)
5,000 – 9,999	3	0.07 (0.04)
10,000 – 29,999	12	0.26 (0.12)
> 30,000	12	0.11 (0.04)

mortality, while 18 of 23 (78.3%) feedlots where heifers made up 50% or more of placements reported that AIP was a cause of morbidity and mortality ($p = 0.75$). Eleven feedlots reported placing 25% or fewer heifers, and all of these considered AIP to be a cause of morbidity and mortality, while five feedlots reported placing 75% or more heifers, and only two of these considered AIP to be a cause of morbidity and mortality. For the 33 feedlots reporting the percent of placements dying of AIP, the breakdown by proportion of heifer placements is presented in Table 2.

There was a trend toward an association between feedlots placing few cattle of salebarn origin and recognizing AIP as a cause of morbidity and mortality. Of 25 feedlots that purchased less than 50% of the cattle placed from salebarns, 22 (88%) reported AIP as a cause of morbidity and mortality. In contrast, of 36 responding feedlots that purchased 50% or more cattle from salebarns, 27 (75%) reported that AIP was a cause of morbidity and mortality at the feedlot ($p = 0.21$). Feedlots placing a larger proportion of yearling cattle were more likely to report AIP as a cause of morbidity and mortality: 64.7% of 17 feedlots placing less than 50% yearlings reported that AIP was a cause of morbidity and mortality, while 86.4% of the 44 feedlots placing 50% or greater yearlings reported that AIP was a cause of morbidity and mortality in the feedlot ($p = 0.06$). For the 33 feedlots reporting percent of placements that died of AIP, the breakdown by proportion of cattle purchased through salebarns is presented in Table 3, and the breakdown by proportion of yearling cattle placed is presented in Table 4.

Respondents were asked about the proportion of cattle of English or Continental breeds (such as Angus or Charolais, respectively), as opposed to *Bos indicus* or Brahman-type cattle, that were placed in the feedlot. Only 11 respondents placed less than 50% English-type cattle. Of these, all 11 (100%) reported that AIP was a cause of morbidity and mortality. Of the 54 feedlots placing 50% or greater English-type cattle, 42 (77.8%) reported that AIP was a cause of morbidity and mortality in the feedlot ($p = 0.08$). For feedlots reporting, the percent of cattle placed dying of AIP by breed type of cattle placed is presented in Table 5.

Table 2. Mean percent of placements that died of AIP as reported by feedlots placing various proportions of heifers.

Proportion of heifer placements	Number of feedlots responding	Mean percent of placements dying of AIP (SE)
< 25%	5	0.11 (0.04)
26 – 50%	14	0.11 (0.06)
51 – 75%	13	0.22 (0.10)
> 75%	1	0.10 (N.A.)[1]

[1] N.A. = not applicable.

Table 3. Mean percent of placements that died of AIP as reported by feedlots placing various proportions of cattle purchased through salebarns.

Proportion of salebarn placements	Number of feedlots responding	Mean percent of placements dying of AIP (SE)
< 25%	8	0.11 (0.06)
26 – 50%	6	0.15 (0.09)
51 – 75%	4	0.26 (0.25)
> 75%	15	0.10 (0.03)

Table 4. Mean percent of placements that died of AIP as reported by feedlots placing various proportions of yearling cattle.

Proportion of yearling placements	Number of feedlots responding	Mean percent of placements dying of AIP (SE)
< 25%	6	0.37 (0.16)
26 – 50%	5	0.06 (0.07)
51 – 75%	10	0.11 (0.01)
> 75%	12	0.13 (0.06)

Risk of AIP and Processing Practices

Respondents were asked about the proportion of cattle received that were administered vaccines for bovine herpesvirus-1 (BHV-1, also known as infectious bovine rhinotracheitis virus, IBR), bovine viral diarrhea virus (BVDV), parainfluenza type 3 virus (PI3), bovine respiratory syncytial virus (BRSV), *Haemophilus somnus, Mannheimia haemolytica, Pasteurella multocida* and clostridial organisms. As previously reported,[18] most yards vaccinated most cattle placed for IBR and BVD, while fewer yards vaccinated most cattle placed for the remaining pathogens. Because infection with BRSV[2] and bacterial respiratory pathogens[5,8,17] have been associated with AIP in some reports, it was of interest to determine whether any apparent relationship existed between vaccination for respiratory pathogens and risk for AIP. Regardless of the percentage of cattle vaccinated against IBR, BVD, PI3, BRSV, *Haemophilus*, or clostridial organisms, feedlots were similarly likely to report AIP as a cause of morbidity and mortality. Feedlots vaccinating over 95% of cattle against *Mannheimia/Pasteurella* were less likely to report AIP as a cause of morbidity and mortality than feedlots vaccinating less than 95% of placements against these agents ($p < 0.001$, Table 6). For the feedlots reporting the percent of placements that died of AIP, the breakdown by proportion of cattle vaccinated for the pathogens listed above is presented in Table 7.

Table 5. Mean percentage of placements that died of AIP as reported by feedlots placing various proportions of English or continental-type breeds (such as Angus or Charolais cattle).

Proportion of English-type placements	Number of feedlots responding	Mean percent of placements dying of AIP (SE)
< 25%	3	0.02 (0)
26 – 50%	1	0.75 (N.A.)[1]
51 – 75%	6	0.11 (0.02)
> 75%	23	0.13 (0.05)

[1] N.A. = not applicable.

Table 6. Percent of feedlots reporting that AIP was a cause of morbidity or mortality for feedlots that vaccinated 95% or less of placements for the pathogens listed, and for feedlots vaccinating greater than 95% of placements for the pathogens listed.

Proportion of cattle vaccinated	Number of feedlots responding	Percent reporting AIP as a cause of morbidity or mortality
IBR		
≤ 95%	4	75.0
> 95%	57	80.7
BVD		
≤ 95%	9	88.9
> 95%	52	78.9
PI3		
≤ 95%	20	80.0
> 95%	41	80.5
BRSV		
≤ 95%	19	84.2
> 95%	42	78.6
Clostridial organisms		
≤ 95%	21	85.7
> 95%	40	77.5
Haemophilus somnus		
≤ 95%	38	84.2
> 95%	23	73.9
Mannheimia/Pasteurella		
≤ 95%	44	90.9[a]
> 95%	17	52.9[b]

[a,b] Groups with different superscripts are significantly different ($p < 0.05$).

Because bacterial respiratory pathogens have been associated with development of AIP in some reports,[5,8,17] it was of interest to evaluate the relationship between strategies used to prevent bacterial respiratory disease, such as mass antimicrobial treatment at arrival, and risk for AIP. Feedlot managers were asked if any cattle were mass treated with antibiotics on arrival and, if they were, what percent of cattle received mass treatment. The mean percentage of placements dying of AIP and the mean percent of placements dying of bovine respiratory disease complex (BRD) at yards that mass treated cattle, and at yards that did not mass treat cattle, are shown in Table 8. The means shown are weighted for number of cattle treated. At feedlots that mass treated cattle, the percent of placements that died of AIP was somewhat lower, and the percent of placements that died of BRD was somewhat higher, than at feedlots that did not mass treat cattle.

It has been suggested that implant strategy may be linked to the development of AIP.[11] Feedlot managers were asked whether implants were used, and if so, what brand of implant was used for the terminal implant. Managers were queried regarding the terminal implant because AIP most commonly occurs in cattle late in the feeding period.[6,8] As previously reported, 92% of feedlots reported using implants, and over 90% of steers and heifers were implanted.[18] When the terminal implants used by reporting feedlots were categorized by active ingredient, it was evident that feedlots commonly use terminal implants containing trenbolone acetate (TBA). Implants containing higher doses of TBA were more often used in heifers than in steers.[18] The percent of placements that died of AIP by level of TBA in the terminal implant used for heifers, and for the terminal implant used for steers, is shown in Table 9.

Risk of AIP and Feed Additives

A relationship between the addition of certain feed additives to the diet and the occurrence of AIP at feedlots has been suggested,[1,10-12] with available evidence specifically suggesting that MGA may be linked to the development of AIP.[1,10,12] In contrast, the ionophore

Table 7. Percent of placements that died of AIP for feedlots vaccinating various proportions of placements for each of the pathogens listed.

Proportion of placements vaccinated	Number of feedlots responding	Mean percent of placements dying of AIP (SE)
IBR		
< 75%	1	0.02 (N.A.)[1]
≤ 95%	2	0.08 (0.04)
> 95%	30	0.14 (0.04)
BVD		
< 75%	3	0.04 (0.04)
≤ 95%	2	0.08 (0.04)
> 95%	28	0.14 (0.04)
PI3		
< 75%	7	0.13 (0.09)
≤ 95%	2	0.08 (0.04)
> 95%	24	0.14 (0.05)
BRSV		
< 75%	8	0.09 (0.04)
≤ 95%	3	0.08 (0.03)
> 95%	22	0.18 (0.06)
Clostridial organisms		
< 75%	12	0.12 (0.05)
≤ 95%	1	0.001 (N.A.)[1]
> 95%	20	0.15 (0.06)
Haemophilus somnus		
< 75%	20	0.11 (0.03)
≤ 95%	1	0.01 (N.A.)[1]
> 95%	12	0.28 (0.12)
Mannheimia / Pasteurella		
< 75%	24	0.14 (0.04)
≤ 95%	0	—
> 95%	9	0.06 (0.05)

[1] N.A. = not applicable.

Table 8. Mean percent of placements that died of AIP or BRD at feedlots that mass treated at least some cattle with antibiotics on arrival, and at feedlots that did not mass treat cattle with antibiotics at arrival. Means are weighted for proportion of cattle treated.

	Mean percent of placements (SE)
Feedlots that mass treated (n = 20)	
Percent dying of AIP	0.11 (0.04)
Percent dying of BRD	0.87 (0.08)
Feedlots that did not mass treat (n = 13)	
Percent dying of AIP	0.14 (0.08)
Percent dying of BRD	0.79 (0.10)

monensin has been shown to mitigate the development of pasture-associated AIP.[4] Survey respondents were asked whether monensin or other ionophores were added to the summer finishing diet, and whether MGA was included in the heifer finishing diet. An attempt was made to evaluate the relationship between dose of monensin included in the summer finishing diet and the percent of placements that died of AIP. Although 63 of 65 respondents reported including monensin in the summer finishing diet,[18] only 22 respondents correctly entered the dose. Of these 22 respondents, too few reported the percent of placements dying of AIP for a meaningful relationship between dose of monensin and percent of placements dying of AIP to be determined.

The percent of placements dying of AIP at feedlots that included MGA in the heifer finishing diet, and at feedlots that did not include MGA in the heifer finishing diet, are shown in Table 10, with means weighted for the number of heifers placed. The percent of heifer placements dying was also calculated as follows: (average percent of AIP deaths that were heifers) x (number of AIP deaths) ÷ number of heifer placements. The percent of all placements dying of AIP was somewhat higher for feedlots that did not include MGA in the heifer finishing diet, although the number of feedlots that did not include MGA in the heifer finishing diet was relatively small (eight respondents). The calculated percent of heifer placements dying was also somewhat higher for feedlots not including MGA in the heifer finishing ration (0.30%, 0.11 SE) as compared to feedlots that included MGA in the heifer finishing ration (0.14%; 0.05 SE).

Discussion

Acute interstitial pneumonia has been recognized as a cause of death in feedlot cattle for decades, but the cause of the condition is still unclear. A variety of factors related to feedlot management have been suggested to contribute to the pathogenesis of AIP, but a remarkable lack of data makes it impossible to determine whether there is value in suggesting any specific management change as a means of controlling AIP. The objective of this study was to obtain a preliminary snapshot of relationships between management practices and risk of AIP by surveying feedlot managers. Management practices identified by feedlot managers to have a particular association with AIP could logically be the focus of further research. Although a mail survey has certain weaknesses as a data collection tool, results of this study suggest that the impact of certain factors, including feedlot size and geographic location, animal gender and the use of certain vaccines deserve further study. Because of the large number of possible interactions and potential for wide occurrence of confounding among the many variables examined, evaluation of interaction among factors associated with AIP was considered beyond the scope of this report.

Feedlot managers responding to this survey described a pattern of AIP occurrence at their feedlots that agreed with previous reports from field studies, where AIP was most likely to occur during the summer months, and in cattle on feed greater than 60 days.[6,8] Managers of feedlots in the northern US were less likely to recognize AIP as a cause of morbidity and mortality. However, the mean percent of placements dying of AIP was essentially the same when reported by northern feed-

Table 9. Mean percent of placements dying of AIP at feedlots using various levels of trenbolone acetate (TBA) in the terminal implant in heifers and steers.

	Trenbolone acetate (TBA) concentration in terminal implant	Number of feedlots	Mean percent of placements dying of AIP (SE)
Heifers	0 mg	3	0.21 (0.21)
	120 – 140 mg	6	0.08 (0.03)
	> 140 mg	14	0.11 (0.05)
Steers	0 mg	4	0.13 (0.18)
	120 – 140 mg	16	0.13 (0.04)
	> 140 mg	7	0.08 (0.02)

Table 10. Mean percent of all placements dying of AIP at feedlots that included melengestrol acetate (MGA) in the heifer diet, and at feedlots that did not include MGA in the heifer diet. Means are weighted for proportion of heifers placed.

	Number of feedlots	Mean percent of placements dying of AIP (SE)
MGA not included in heifer diet	8	
Percent of all placements dying of AIP		0.17 (0.07)
Percent of heifer placements dying of AIP		0.30 (0.11)
MGA included in heifer diet	25	
Percent of all placements dying of AIP		0.13 (0.05)
Percent of heifer placements dying of AIP		0.14 (0.05)

lots and feedlots from other regions. This difference suggests that, while feedlots in the northern region may be less likely to recognize AIP as a significant cause of morbidity or mortality, when AIP occurs, it is likely to have an equal impact in terms of death loss in northern feedlots as in feedlots in other regions.

Feedlot managers reported that 62.2% of cattle dying of AIP were heifers, while 37.8% were steers. Also, in 13 feedlots that reported the percent of placements dying of AIP and that placed 50-75% heifers, the mean percent of placements dying of AIP (0.22%) was nearly twice that of the average for all reporting feedlots (0.13%). Although managers recognized this gender-based difference in predilection for fatal AIP, it was notable that 100% of responding feedlots that placed a majority of steers (< 25% heifers) recognized AIP as a cause of morbidity and mortality, while only two of five feedlots placing a majority of heifers (> 75% heifers) recognized AIP as a cause of morbidity or mortality in their feedlot. This information must be interpreted in light of the fact that only a relatively small number of responses came from feedlots that placed over 75% heifers. However, the data suggest that, while heifers may be more likely to develop AIP, occurrence of the disease at any given feedlot is determined by factors other than the presence of a relatively large proportion of heifers.

Cattle of salebarn origin are typically recognized to be at high risk for BRD, and in this study feedlots that placed less than 25% cattle of salebarn origin reported that 0.63 percent (0.10 SE) of placements died of BRD, while feedlots that placed greater than 75% cattle of salebarn origin reported that 0.90% (0.10 SE) of placements died of BRD. In contrast, the proportion of received cattle of salebarn origin did not seem to increase the likelihood of a feedlot recognizing AIP as a cause of morbidity and mortality. Moreover, of the 15 feedlots that reported the percent of placements dying of AIP and that placed over 75% of cattle of salebarn origin, the mean percent of placements dying of AIP (0.10%) did not differ notably from the average for all feedlots reporting (0.13%). In contrast, feedlots that placed greater than 50% yearling cattle were more likely to recognize AIP as a cause of morbidity or mortality than feedlots placing fewer than 50% yearling cattle.

Subjective and objective risk for AIP did not appear to vary notably for feedlots vaccinating various proportions of cattle for respiratory pathogens or clostridial organisms, although for some agents, such as IBR and BVD, the small number of feedlots not vaccinating cattle made it impossible to identify meaningful differences based on vaccination. One notable exception was the difference in subjective risk of AIP at feedlots vaccinating less than 95% of cattle for *Mannheimia / Pasteurella* (90.9%), versus feedlots vaccinating over 95% of cattle for *Mannheimia / Pasteurella* (52.9%). Moreover, there was a notable difference in the percent of cattle dying of AIP in feedlots that vaccinated less than 95% of cattle for *Mannheimia / Pasteurella* (0.14%) and the percent dying of AIP in feedlots that vaccinated over 95% of cattle for these pathogens (0.06%), although the number vaccinating over 95% of placements for *Mannheimia / Pasteurella* and also reporting the percent of placements dying of AIP was relatively small (nine respondents). In previous research, bacterial respiratory pathogens, including *Pasteurella multocida*, were more likely to be isolated from the lungs of cattle with AIP than from the lungs of healthy penmates.[17] Although it is not known whether *P. multocida* is a primary contributing factor in the pathogenesis of feedlot AIP, the data suggest that further evaluation of the role of *P. multocida* and vaccination for *Mannheimia / Pasteurella* in the pathogenesis of feedlot AIP is warranted.

Implant strategies have been suggested to impact AIP.[11] The responses to this survey indicate that feedlot managers commonly use terminal implants containing TBA. Respondents more commonly used implants with higher doses of TBA in heifers. However, it was not possible to determine a clear effect of TBA dosage on AIP; feedlots using high dose TBA implants reported AIP mortality rates that were similar to the mean for all feedlots reporting. While feedlots that used terminal implants containing no TBA reported higher mean percent of placements dying of AIP than feedlots that used implants with TBA, the number of feedlots reporting

the use of implants without TBA was too small to allow meaningful conclusions to be drawn. Further evaluation of the effect of implants containing TBA on the occurrence of AIP may be of value.

Previous research in a sheep model system indicated that feeding MGA increased the severity of experimentally-induced AIP.[12] Some investigators have suggested that MGA may likewise increase the risk of AIP for feedlot heifers,[1,10] but supportive data from well-controlled studies are lacking. In this survey, the percent of all placements and the percent of heifer placements dying of AIP at feedlots that did not include MGA in the heifer finishing ration was somewhat higher than for feedlots that did include MGA in the heifer finishing ration (Table 10). These data should be interpreted with caution, as the number of feedlots not including MGA in the heifer finishing ration was small, and the calculated percent of heifers dying of AIP was likely impacted by a wide range in number of heifers placed by responding yards. If the results are accurate, the significance of this finding in the context of previous research suggesting that MGA increases the risk of AIP is not clear. If MGA has a true effect on the pathogenesis of feedlot AIP in heifers, it may be that the effect is variable and dependent on dose or duration.

The results of this survey must be interpreted in light of the limitations of the study. The response rate for this survey was relatively poor (12.8%); thus the results may not provide an accurate representation of all U.S. feedlots. Managers reported that postmortem examination was performed on 65% of animals that died, and 10 feedlots indicated that no animals received a postmortem[18]; this may have contributed to incorrect identification of some AIP cases, leading to bias in the reported percent of animals dying of AIP, or to mistaken perception about whether AIP was a cause of morbidity or mortality at the feedlot. Additionally, feedlot managers were told that the object of the survey was to characterize risk factors for AIP, thus the responses may have been biased by disproportionate participation by feedlot managers interested in AIP. In spite of these limitations, the responses in this survey agreed well with the larger National Animal Health Monitoring System (NAHMS) feedlot study in 1999[13-15,18] when similar questions were posed in both surveys, suggesting that the data reported here provide a reasonable estimate of the true relationship between management factors identified and risk of AIP.

Conclusion

The results of this survey represent the first detailed description of the relationship between a variety of management practices and the occurrence of AIP in U.S. feedlots. As such, the data provide a valuable basis for future research to determine the cause of AIP in feedlot cattle; they may also aid veterinarians and feedlot consultants in efforts to better characterize management changes that have meaningful impact on the occurrence of AIP in feedlots where the disease is a problem.

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