Health performance of feeder calves sold at conventional auctions versus special auctions of vaccinated or conditioned calves in Ontario

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Objective—To compare health performance during the first 28 days in the feedlot for vaccinated or conditioned feeder calves sold through special auctions in Ontario with health performance for calves sold through conventional auctions in the province.

Design—Cohort study.

Animals—12,313 calves sold through conventional and special auctions at the Keady Livestock Market during the fall of 1999 and 2000.

Procedure—Buyers of calf groups were approached at the auction market or contacted by telephone and asked to record the number of calves requiring treatment for bovine respiratory tract disease (BRD) during the first 28 days after purchase.

Results—211 calf groups (≥ 20 calves/group) were followed up for 28 days after purchase. Multivariate logistic analysis indicated that vaccinated calves purchased through special auctions were 0.68 (95% confidence interval, 0.50 to 0.93) times as likely to receive treatment for BRD as were calves purchased at conventional auctions and that conditioned calves were 0.22 (95% confidence interval, 0.12 to 0.38) times as likely to receive treatment. Groups that received antimicrobials by injection on arrival at the feedlot were 0.64 (95% confidence interval, 0.43 to 0.96) times as likely to be treated as were groups that did not.

Conclusions and Clinical Relevance—Results suggest that vaccinated and conditioned calves were less likely to receive treatment for BRD during the first 28 days in the feedlot; however, there was no difference in mortality rate. (J Am Vet Med Assoc 2003;223:677–683)

In commercial beef herds in North America, spring-born calves are typically weaned at 6 to 8 months of age. Most are sold at public auction markets immediately after weaning to backgrounding operations and feedlots, and during this time, calves are at a high risk of developing undifferentiated bovine respiratory tract disease (BRD).

Bovine respiratory tract disease is 1 of the most important diseases for the beef industry, with millions of dollars spent each year on prevention and control.1 Morbidity rates range from 15 to 45%, and the mortality rate has been estimated to be 1.5%.2 The underlying cause of BRD varies from calf to calf, but a variety of viral and bacterial infectious agents play a role, along with intrinsic host defenses and environmental stressors.3 Viruses isolated from calves with BRD include infectious bovine rhinotracheitis (IBR) virus, bovine respiratory syncytial (BRS) virus, bovine viral diarrhea (BVD) virus, and bovine parainfluenza 3 (BPI-3) virus.1 Bacterial pathogens include Mannheimia haemolytica (previously Pasteurella haemolytica), P multocida, Haemophilus somnis, Mycoplasma bovis, and M dispar.4 Risk factors for development of BRD among calves that have recently entered a feedlot include mixing of calf groups, large group sizes, metaphylactic use of medications in the water source, administration of vaccines against respiratory tract pathogens on arrival at the feedlot, and feeding corn silage as the major roughage component in the diet within the first 2 weeks after arrival.5

In the past, government extension groups have encouraged implementation of conditioning programs in cow-calf enterprises in the hopes of reducing the incidence of BRD. These programs generally require producers to castrate and dehorn calves at an early age, vaccinate them against a number of respiratory tract pathogens, and wean them onto a diet of roughage and concentrates at least 30 days before shipment. The concept behind these conditioning programs is that weaned and vaccinated calves should be better equipped to handle the stress of auctions and commingling in feedlots.6 However, such programs have failed to gain popularity among cow-calf producers because of the uncertainty of whether they will receive an adequate premium, in terms of sale price at the auction market, for their efforts. Furthermore, many cow-calf producers do not have the facilities to produce conditioned calves.

An alternative to adoption of presale conditioning programs by cow-calf producers is the use of presale vaccination programs. Requirements for presale vaccination programs generally include castration, dehorning, and vaccination, but these programs do not involve weaning the calves as is required with conditioning programs. The theory behind presale vaccination programs is to give calves a chance to develop protective immunity to pathogens associated with BRD before they are exposed to these pathogens in the environment.7 Presale vaccination and, to a lesser extent, conditioning programs are growing in popularity in southern Ontario, with an increase in the number of special call auctions that exclusively offer calves produced...
according to requirements established by the auction barn or sale committee. There is evidence that calves sold through these special auctions receive a premium, compared with calves sold through conventional weekly auctions. However, the question remains as to whether calves purchased through these special auctions yield an increase in profits to backgrounds and feedlot operators large enough to justify their higher prices. Specifically, it is unclear whether calves sold through these special auctions have fewer health problems and lower production costs because of the procedures that were performed prior to their transport to market.

The purpose of the study reported here, therefore, was to determine whether health performance during the first 28 days in the feedlot for vaccinated or conditioned feeder calves sold through special auctions in Ontario was significantly better than health performance for calves sold through conventional auctions in the province. In addition, we wanted to determine whether other management procedures were associated with the health performance of feeder calves during the first 28 days after purchase.

Materials and Methods

Information was obtained on feeder calves sold at a single livestock market in Ontario during the fall of 1999 and 2000. All information was collected by a single individual (JEM) who attended 5 conventional feeder calf auctions and 4 special feeder calf auctions between October 19 and November 23, 1999, and 5 conventional and 4 special auctions between October 17 and November 27, 2000. Details of the auction market have been published, along with associations between sale price, sale type, and physical characteristics of the lots of calves auctioned.

Calves sold at special auctions held at this market during 1999 and 2000 were required to have received primary and booster doses, according to label recommendations, of killed-virus vaccines against IBR, PI-3, BVD, and BRS viruses and vaccines against H somnus and M haemolytica. Booster vaccinations must have been given at least 2 weeks prior to auction and 2 to 4 weeks after the initial dose. Consignors were required to verify that vaccinations had been administered. Calves were also required to have been castrated at least 2 months prior to auction and dehorned as indicated. The fourth special auction during 1999 and 2000 included calves that fulfilled all of these requirements and, in addition, had been weaned at least 4 weeks prior to auction. During all 8 special auctions, with the exception of the fourth auction during 2000, calves from different consignors were commingled by employees of the auction market so that lots offered for sale were as uniform as possible in regard to sex, frame size, body weight, and color. There were no specific requirements for calves sold at the conventional auctions.

To draw attention to the study and identify potential participants, a notice was attached to the sale catalogue. Prior to each sale, an announcement was made to attract attention to the study, and the investigator was available to answer questions regarding the study during the course of each auction.

Data collection—Buyers of calf lots larger than 20 head for which mean body weight was between 182 and 318 kg (400 and 700 lb) were approached after they settled their accounts to solicit their participation. At this time, they were provided with a questionnaire and a calendar to record information related to health performance of the calves. Prospective participants were apprised of the full expectations associated with participation in the study. Buyers who did not decline to participate at this time were contacted by telephone within a week to confirm their willingness to participate in the study. Because a large percentage of calves were purchased for the owners through professional contract buyers, also known as order buyers, some participants had to be traced through contact with the order buyers. The questionnaire was mailed to these individuals.

Twenty-eight days after purchase of each calf group, a phone call was placed to each participant to gather data. The number of calves in the group, the date of purchase, and the dates that any calves were added to the group were confirmed with the owner. Owners were asked to indicate the number of calves treated for BRD, the number that had a relapse, and the number that died. A call was considered to have a relapse if the owner had to treat the animal a second time after completion of an initial course of treatment after which the animal was determined to be healthy. If available, necropsy results were recorded. Metaphylactic use of antimicrobials, in the form of injections or the addition to feed or water, was recorded, as well as any vaccines administered after arrival at the feedlot. We recorded the date hay was removed as the major roughage component of the diet. During 2000, the number of calves castrated and the number dehorned within the first 28 days were also recorded.

Three measures of the mixing of calves were recorded. From sale records provided by the auction market, we recorded the numbers of calves from each original farm source that made up each calf group. We also recorded whether unvaccinated or unconditioned calves were added to any groups of vaccinated or conditioned calves on the same feedlot. Finally, we recorded the day on which any additional calves were added to each group.

Buyers at conventional and special auctions were solicited to participate in the study. Individuals who bought calves through special auctions as well as through conventional auctions were asked to record information on all groups of calves. Calves obtained through conventional auctions by these individuals were used as a control group for the calves obtained through special auctions, so long as groups were assembled within 2 weeks of each other. Groups of calves that originated in western Canada or were purchased directly from cow-calf producers were not included in the study.

Data analysis—Data from each year of the study were entered into a separate spreadsheet and checked for errors. Descriptive statistics were then calculated. Calf groups originating from conventional auctions were denoted as control groups. Calf groups originating from the first 3 special auctions each year were denoted as vaccinated groups, and calf groups originating from the fourth special auction each year were denoted as conditioned groups.

To investigate possible associations between sale type and the risk of treatment for BRD while controlling for other risk factors, data for the 2 years were merged and imported into a statistical software package. Only data for number of calves treated for BRD were analyzed, as the percentage of calves that had a relapse and the percentage that died were low.

A multivariate logistic model was built with the binomial variable of treatment for BRD (yes vs no) as the outcome variable. The response was modeled from the number of animals that were treated for BRD and the number that could have been treated (ie, the number of calves in each group). Continuous variables entered in the model included group size, mean body weight of the group at the time of purchase, number of calves treated for BRD, number of calves that had a relapse, number of calves that died, number of original farm sources for calves in each group, number of days needed to assemble the group, and number of days after purchase that hay was removed. Class variables entered in the model...
included year (1999 or 2000), owner (owners were assigned numbers), sex (steers or heifers), sale type (conventional, vaccinated, or conditioned), metaphylactic treatment with antimicrobials by injection (yes or no), metaphylactic treatment with antimicrobials by addition to the feed (yes or no), metaphylactic treatment with antimicrobials by addition to the water (yes or no), whether the group contained calves from different sale types (yes or no), whether calves were vaccinated after purchase (not vaccinated, vaccinated with modified-live virus vaccines, or vaccinated with killed-virus vaccines), whether calves were castrated (yes or no), and whether calves were dehorned (yes or no). All 2-way interactions were also entered into the model. Standard software was used. Variables for which the P value of the F-to-remove test was greater than 0.05 were manually removed until all fixed-effects variables left in the model had P values ≤ 0.05.

Year was entered in the model as a random variable to control for the effects of year. Similarly, owner was entered in the model as a random variable to control for the effects of the different management styles of each individual owner. There were owners who contributed information for control and vaccinated groups and, in a few cases, conditioned groups. To control for the matching of these groups, group nested within owner was also entered as a random variable in the model.

Partial budget analysis—A partial farm budget was developed to determine the economic consequences of buying vaccinated or conditioned calves through special auctions versus buying calves through conventional auctions. In many instances, reliable dollar value estimates were not available; therefore, estimates were based on the authors’ consensus unless otherwise stated.

The initial cost for each calf entering the feedlot was estimated from a previous study. The difference in mean body weight of conditioned calves, compared with control and vaccinated calves, reflected the longer period required to prepare conditioned calves for auction. For purposes of analysis, we assumed that conditioned calves would be purchased at least 45 days later than control and vaccinated calves and, therefore, would be approximately 40.5 kg (90 lb) heavier (assuming a mean weight gain of 0.9 kg/d [2 lb/d]).

We assumed that control calves would be vaccinated with a modified-live virus vaccine upon arrival at the feedlot, receive metaphylactic treatment with a long-acting antimicrobial, be treated with an endectocide, receive a growth implant, and be castrated or dehorned, if required. The cost of labor was estimated at $2.00/call on the basis of 2 individuals gathering and processing 15 calves/h at a cost of $15.00/h/person; we accepted that this would be an underestimate: mortality, treatment, implantation of a growth implant, and be castrated or dehorned, if required. The cost for processing calves obtained through a large percentage of calves required castration or dehorning. The cost for processing calves obtained through a large percentage of calves required castration or dehorning. The cost for processing calves obtained through special sales was assumed to include costs for endectocide treatment, implantation of a growth implant, and labor. All prices for vaccines, antimicrobials, and endectocides were estimated from wholesale prices of products available to veterinarians in Ontario during 2001.

The number of days on feed for a calf that was castrated and dehorned prior to purchase and did not require treatment for BRD was estimated as follows. For a final body weight of 570 kg (1,250 lb), a 250-kg (550-lb) calf would need to gain 320 kg (700 lb). Assuming an average daily gain (ADG) of 1.36 kg/d (3 lb/d), this calf would be on feed for 233 days. For purposes of the partial budget analysis, we chose to illustrate the cost of reduced gain in calves that required castration, dehorning, or treatment for BRD as extra days on feed. In reality, producers have 2 choices: keep the animal on feed for a longer time until it reaches a specified slaughter weight or sell the animal at the same time at a reduced slaughter weight. For our analysis, we assumed that calves castrated at the feedlot would have a 10% reduction in ADG, that calves dehorned at the feedlot would have a 3% reduction in ADG, and that calves treated for BRD at the feedlot would have a 5% reduction in ADG. When calculating the number of days on feed for conditioned calves, it was assumed that these calves would have slightly higher gains when first arriving at the feedlot, as they would already have been familiar with feed bunks and automatic waterers. Therefore, the 45-day conditioning period was subtracted from the number of days on feed for control calves to determine the number of days on feed for conditioned calves.

The cost of treatment for BRD was estimated from the risk of treatment. We chose to compare control calves that received metaphylactic injections of antimicrobials on arrival to vaccinated and conditioned calves that did not receive antimicrobials, as this appeared to be common practice in the industry. Mean cost of treatment included cost for initial treatment with a first-line drug, costs for treatment with a second-line drug for the 10% of calves that were expected to have a relapse, and original price of the calves for the 1% of calves that were expected to die. Higher mean treatment costs for vaccinated and conditioned calves reflected the higher purchase price of these calves.

To validate the outcome of the partial budget, we performed a limited sensitivity analysis on the values we thought were estimated with the least confidence: mortality rate and the effect of BRD on ADG. The effects on budget outcome for mortality rates of 0.1 and 2% were calculated, along with the effects of assuming that BRD would have no effect on ADG, would decrease ADG 5%, or would decrease ADG 10%.

Results—During the 2 years of study, 211 calf groups bought by 112 individual owners were followed up for 28 days after purchase (Table 1). Of these, 114 groups were purchased at special auctions. This accounted for 79% of calves sold in eligible groups of ≥ 20 head in the desired weight range at the special auctions.

Information was recorded on 12,313 calves, of which 2,526 (21%) were treated for BRD at least once. During 1999, 32 calves (0.5%) died; during 2000, 18 calves (0.3%) died. A postmortem examination was performed on only 1 calf; the calf was determined to have died of BVD virus infection.

Results of the multivariate analysis indicated that sale type was significantly associated with treatment for BRD (Table 2). Vaccinated groups were 0.68 times as likely to be treated for BRD as control groups, and conditioned groups were 0.22 times as likely to be treated. Metaphylactic use of antimicrobials by injection on arrival at the feedlot was also significantly associated with risk of treatment for BRD. Groups receiving antimicrobials by injection on arrival were 0.64 times as likely to be treated for BRD as groups that did not receive antimicrobials. Observation of the variance components of the random effects—owner, group within owner, and year—showed that owner accounted for a large portion of the variation in the outcome, while only a small portion of the variation was attributable to year.

Partial budget analysis indicated that compared with control calves, vaccinated calves had the potential to be less profitable for purchasers by almost $30/head, whereas conditioned calves had the potential to be more profitable by $20/head (Table 3). Sensitivity
Discussion

The present study was unique in that calves were tracked from an auction market to separate private feedlots and followed up for the first 28 days after entering these feedlots. To the uninitiated, following up calves from auction markets to feedlots may not seem like a daunting task, but in actuality, tracking the distribution of calves among private and order buyers is a difficult chore. One of the reasons for this difficulty is the distribution of calves at conventional auctions. Because calves are sold by owner lots and sorted by sex, weight, color, and size, there is a tendency for each individual owner’s calves to be divided into many sale lots. This means there is great opportunity for calves to be split among many different buyers, with smaller groups leaving the auction market at the end of the day.

## Table 1—Median rates of treatment for bovine respiratory tract disease (BRD), relapse, and death among groups of feeder calves (≥20 calves/group) followed up for 28 days after purchase from an auction market in western Ontario during 1999 and 2000

<table>
<thead>
<tr>
<th>Factor</th>
<th>Conventional</th>
<th>Vaccinated</th>
<th>Conditioned</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of groups</td>
<td>60</td>
<td>37</td>
<td>54</td>
</tr>
<tr>
<td>Total number of calves</td>
<td>3,366</td>
<td>2,652</td>
<td>2,902</td>
</tr>
<tr>
<td>Median treatment rate (%)</td>
<td>23.0</td>
<td>16.7</td>
<td>15.9</td>
</tr>
<tr>
<td>Median relapse rate (%)</td>
<td>12.0</td>
<td>7.7</td>
<td>16.7</td>
</tr>
<tr>
<td>Median mortality rate (%)</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

*Calves were purchased at conventional auctions, for which there were no special requirements for refires, or special auctions, for which calves were required to be vaccinated against common respiratory tract pathogens, castrated, and dehorned (vaccinated) or vaccinated, castrated, dehorned, and weaned (conditioned).

Table 2—Logistic regression analysis of the effect of sale type and metaphylactic administration of antimicrobials on arrival at the feedlot on the treatment rate for BRD among groups of feeder calves purchased at an auction market in western Ontario during 1999 and 2000

<table>
<thead>
<tr>
<th>Variable</th>
<th>Category</th>
<th>Estimate</th>
<th>P value</th>
<th>OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>NA</td>
<td>−1.29</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Sale type</td>
<td>Conventional Reference</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Vaccinated</td>
<td>−0.38</td>
<td>0.017</td>
<td>0.66 (0.50–0.93)</td>
<td>NA</td>
</tr>
<tr>
<td>Conditioned</td>
<td>−1.52</td>
<td>&lt; 0.001</td>
<td>0.22 (0.12–0.38)</td>
<td>NA</td>
</tr>
<tr>
<td>Metaphylactic administration of antimicrobials on arrival</td>
<td>No</td>
<td>Reference</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>−0.44</td>
<td>0.031</td>
<td>0.64 (0.43–0.96)</td>
</tr>
</tbody>
</table>

OR = Odds ratio. CI = Confidence interval. NA = Not applicable.

Table 3—Partial budget analysis of costs associated with feeding calves obtained through conventional auctions versus vaccinated or conditioned calves obtained through special auctions held at an auction market in western Ontario during 1999 and 2000

<table>
<thead>
<tr>
<th>Factor</th>
<th>Conventional</th>
<th>Vaccinated</th>
<th>Conditioned</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean weight (lb)</td>
<td>550</td>
<td>550</td>
<td>640</td>
</tr>
<tr>
<td>Price ($/lb)</td>
<td>1.49</td>
<td>1.57</td>
<td>1.43</td>
</tr>
<tr>
<td>Price ($/calf)</td>
<td>820</td>
<td>864</td>
<td>915</td>
</tr>
<tr>
<td>Total cost for processing ($)</td>
<td>10.46</td>
<td>6.84</td>
<td>6.84</td>
</tr>
<tr>
<td>Days on feed†</td>
<td>233</td>
<td>233</td>
<td>188</td>
</tr>
<tr>
<td>Feed and yardage per day ($)</td>
<td>2.15</td>
<td>2.15</td>
<td>2.15</td>
</tr>
<tr>
<td>Total days on feed</td>
<td>240.31</td>
<td>234.92</td>
<td>188.60</td>
</tr>
<tr>
<td>Total cost of feed and yardage ($)</td>
<td>516.67</td>
<td>505.08</td>
<td>405.49</td>
</tr>
<tr>
<td>Percentage treated for BRD‡</td>
<td>15</td>
<td>16</td>
<td>6</td>
</tr>
<tr>
<td>Mean cost of treatment for BRD ($)¶</td>
<td>9.96</td>
<td>10.52</td>
<td>9.74</td>
</tr>
<tr>
<td>Total expenses ($)</td>
<td>1,357.09</td>
<td>1,386.44</td>
<td>1,337.07</td>
</tr>
<tr>
<td>Difference ($)</td>
<td>−29.35</td>
<td>20.02</td>
<td>20.02</td>
</tr>
</tbody>
</table>

*For conventional sale groups, includes administration of modified-live vaccines ($1.16/dose), a long-acting antimicrobial ($2.20/dose), an anthelmintic ($3.70/head), and a growth implant ($1.14/implant) and labor ($2.00/head). For vaccinated and conditioned groups, includes administration of an anthelmintic and a growth implant and labor. Estimated days on feed for a calf castrated and dehorned prior to purchase that did not require treatment for BRD during the feeding period. Estimated additional number of days on feed to reach predetermined slaughter weight for calves that were castrated, dehorned, or treated for BRD at the feedlot because of a decrease in average daily gain. It was assumed that 15% of control steers would require castration, and 23% would require dehorning. Estimated on the basis of risk of treatment for BRD. †Cost includes initial treatment ($9.90/dose), second-line treatment ($18.50/relapse) for those that relapse, and initial cost of the calf for those that died. *See Table 1 for remainder of key.
Because we decided at the beginning of the study to follow groups of 20 calves or more, there were fewer buyers to contact at the end of a conventional auction than at the end of a special auction, at which calves were sorted and, therefore, sold in larger lot sizes. Records were kept on the size of calf groups purchased by individual buyers. If an individual bought a group of < 20 calves 1 week but purchased another group of cattle the following week so that the total number of calves was ≥ 20, that buyer was contacted and asked to participate in the study.

In the present study, control groups consisted of calves purchased at conventional auctions in western Ontario. Most of these calves were castrated and dehorned prior to sale, but some were not. Through conversations with buyers at these conventional auctions, we estimated that 10 to 15% of male calves were bulls. Analysis of data from the livestock market indicated that approximately 23% of the calves sold through conventional auctions had horns.5 Analysis of sale catalogues for the livestock market also indicated that approximately 6% of the lots of calves at conventional auctions had been vaccinated against IBR, BVD, BRS, and BPI-3 viruses.6 However, because vaccinated calves sold at conventional auctions were not identified, it was impossible to know what percentage of the control calves in the study had been vaccinated.

Studies such as the present one are uncommon as it is difficult to identify a large number of feeder calves that have been vaccinated prior to auction. Ideally, we would have identified prior to the study the number of groups needed to be able to find a statistical difference between groups if one truly existed.14 At the beginning of the study, however, we did not know how many groups of calves we would be able to follow up. Therefore, we initially set out to follow up as many groups as possible each year.

In the early 1980s, Martin et al.15,16 examined the effect of vaccination on the health of calves shipped from western Canada to Ontario feedlots, and in both studies, vaccination prior to shipping was not found to have any significant effect on health of the calves. However, the authors were able to obtain records on only small percentages (15 and 41%) of the calves originally enrolled in the study, making it difficult to obtain adequate statistical power to find an effect of vaccination.

Two other studies7,18 tried to evaluate the usefulness of presale vaccination, but results are difficult to compare with results of the present study, because these studies did not follow up calves from the auction market, and calves were not necessarily mixed with calves from other farm sources. Following calves directly from the ranch to the feedlot increases the number of calves that are available for comparison, but limits the validity of the findings when extrapolated to calves that have traveled through the market system. In addition, these studies were investigating vaccination for a single antigen and did not compare calves that had received a complete vaccination program with unvaccinated control calves. In the present study, calves were required to be vaccinated with 4 viral and 2 bacterial antigens.

Two studies19,20 found that conditioned calves derived from auction markets do experience a reduction in health problems when placed in the feedlot, compared with calves that were not conditioned. Another study21 found a significant reduction in treatment rates for conditioned versus nonconditioned calves that were taken directly from a cow-calf operation to a feedlot, but other studies22,23 concluded there was no difference between conditioned and control calves.

The present study found that metaphylactic administration of antimicrobials on arrival at the feedlot resulted in a significant reduction in risk of treatment for BRD, which is consistent with results of other studies.13,24-27 Metaphylactic antimicrobial administration is meant to suppress the exponential growth of bacteria already present in an animal's nasopharynx and, presumably, is effective because auction market calves are already incubating disease when they arrive at the feedlot.

With respect to other factors that have been shown to be associated with BRD, there was little variation among sale group types in the present study. We attempted to evaluate mixing of calves 3 ways in the present study: by recording the number of calves per original farm source that made up each calf group, the mixing of groups from different sale types, and the time period during which additional calves were added to each group. Ribble et al.28 found that the risk of fatal fibrinous pneumonia, a potential sequela of BRD, increased as the number of farm sources that made up a group of calves increased. Mixing of groups from different sale types was measured, as there was concern about possible herd immunity from mixing control calves with vaccinated or conditioned calves. However, groups of all sale types experienced similar events with regard to the 3 types of mixing.

Martin29 and Bateman30 have shown that vaccination of calves for respiratory tract diseases with modified-live virus vaccines shortly after arrival at the feedlot can have a negative effect on health of the calves. It was found in the present study that vaccination for respiratory tract diseases at the feedlot was not associated with risk of treatment for BRD. There was, however, partial collinearity between sale type and vaccination at arrival, in that most control groups were vaccinated at the feedlot (72%), whereas only a small percentage of groups from special auctions were vaccinated on arrival (15%). This made it difficult to separate the effects of sale type from the effects of vaccination at arrival on the risk of treatment for BRD. The fact that buyers choose not to vaccinate groups of calves from special auctions may demonstrate the buyers' confidence in presale vaccination programs.

Processing procedures such as castration and dehorning performed within the first month after arrival at the feedlot have been associated with increased cost of treatment for BRD and higher mortality rates.20 Other studies13,25-27 have also shown negative effects of castration and dehorning on the health and future growth performance of calves when performed at the feedlot. In the present study, castration and dehorning were not evaluated in groups followed up during 1999. There was concern, however, that the
high prevalence of treatment for BRD in control calves may have been due to castration and dehorning procedures performed at the feedlot. Therefore, during 2000, a question was added for producers to indicate whether they had castrated or dehorned calves within the first month after arrival and, if so, the number of calves requiring these procedures. The variables castrated and dehorned were analyzed separately with data from year 2 of the study, but were not significantly associated with risk of treatment for BRD. However, only a small number of groups were available for comparison, so the power to detect a difference in risk of treatment between groups from different sale types was low.

One issue with this study was the definition of treatment rate. In many controlled field trials, the case definition for BRD includes signs of depression and anorexia with no other clinical signs referable to other organ systems and a rectal temperature > 39.5 to 40°C (103 to 104°F). In the present study, calves were considered to have been treated for BRD any time a producer administered an antimicrobial in response to clinical signs that were not referable to a specific organ system other than the respiratory system. Individual producers may or may not have based their diagnosis on additional clinical signs (eg, rectal temperature), leaving the potential for a wide variation in the criteria producers used as a case definition. This could explain the significant variation in outcome that is attributable to individual owners in the final logistic regression model.

All calves sold through special auctions at the Keady Livestock Market during the time of this study were identified with special ear tags. For our purposes, this identifying tag was essential for tracking calves from the auction market to the feedlot. The special tags facilitated the identification of groups from special auctions when mixed with calves from conventional auctions. Unfortunately, this also could have been a source of bias, because producers were not blinded to the vaccination status of the calf groups. As a result, producers could have managed groups differently, possibly influencing the difference in treatment rates among vaccinated, conditioned, and control groups. For example, producers purchasing calves from special auctions may have believed that because the calves had been vaccinated, they should have been healthier and, as a result, may have relaxed their criteria for treatment and not treated as many vaccinated calves. If this did occur, the treatment rate for vaccinated groups would have been underestimated, the difference between calves from special auctions and control calves would have been inflated, and the odds ratio would have artificially been decreased for vaccinated and conditioned groups.

Another possible source of bias in the present study was related to the individual producers recruited to participate. Producers with various levels of management experience or ability were likely recruited in this study. However, if the level of management experience or ability had been related to the type of auction from which producers obtained their calves, there would have been some degree of selection bias. For example, producers new to feeding cattle may purchase calves at special auctions because of the presale vaccination or sorting offered at these sales, whereas more experienced producers may purchase calves at conventional auctions, as they are comfortable with their ability to manage these types of calves. As a result, vaccinated calves may have received a lower degree of management, and this difference in management may have been reflected in the health of the calves so that vaccinated calves actually had more health problems than they would have if managed by more experienced producers. Unfortunately, it is difficult to overcome this concern, as judging the management ability of producers is nearly impossible. Nevertheless, we do not believe that this type of selection bias had a significant effect on our study, particularly because some producers managed calves obtained from special and conventional auctions. A variable for owner was also included as a random variable in our analysis.

The partial budget analysis in the present study was performed to demonstrate the economic consequences of feeding calves purchased through special auctions versus conventional auctions. We found that vaccinated calves had the potential to be approximately $30/head less profitable than control calves purchased through conventional auctions. Conditioned calves, on the other hand, had the potential to be approximately $20/head more profitable.

The higher purchase price of vaccinated calves accounted for a large portion of the difference in profitability between vaccinated and control calves, whereas the higher purchase price of conditioned calves was offset by the lower number of days on feed and savings on feed and yardage costs. As indicated by the sensitivity analysis, mortality rate had a great influence on profitability. If calves from special auctions had lower mortality rates, compared with control calves, the profitability of purchasing vaccinated or conditioned calves improved. This is because a large percentage of the cost involved in feeding cattle is the initial investment in calves. In the present study, we did not find a significant difference in mortality rates among sale types. It is possible that the study period was not long enough to observe a difference in mortality rates between calves from special and conventional sales and that the observation period should have been extended to 60 days.

Several issues must be kept in mind when reviewing the partial budget analysis in the present study. For instance, the cost of labor involved in processing control versus vaccinated calves may have been underestimated. If a large proportion of control calves required castration and dehorning, the time involved with processing and, therefore, the cost of labor would have been higher. There was also a higher risk of other health complications associated with processing procedures that producers were assuming when purchasing calves through conventional auctions.

Even if purchasing vaccinated calves does cost feedlot owners approximately $30/head more than purchasing calves through conventional auctions, some producers may deem this to be worth the extra investment. Special calf auctions provided extra benefits to buyers in terms of uniform lots, large numbers of calves offered for purchase, and efficient movement.
of calves through the auction ring. These features aid producers in putting together uniform groups for the feedlot and allow for useful time management.

Feedlot owners must look at their specific situations to evaluate the economics of purchasing calves through special auctions. Since most of the extra cost associated with calves from conventional auctions is labor, producers must put a value on the time required to castrate and dehorn calves and to observe and treat calves for BRD. For producers who feed cattle on a full-time basis and are able to spend more time with their animals, calves obtained through conventional auctions may be the most profitable choice. For producers who feed cattle on a part-time basis and have considerably less time available, calves obtained through special auctions may be the better choice.

In summary, results of this study indicated that sale type and metaphyseal use of antimicrobials by injection on arrival at the feedlot were significantly associated with treatment for BRD in feeder calves. Vaccinated and conditioned calves had a significantly reduced risk of treatment for BRD, compared with control calves. Calves that received antimicrobials on arrival at the feedlot had a significantly reduced risk of treatment for BRD, compared with calves that did not. Other risk factors that have previously been associated with risk of treatment for BRD were controlled for in this project, and the variation in these risk factors among sale types was not significant.

References
