Effects of vaccination prior to transit and administration of florfenicol at time of arrival in a feedlot on the health of transported calves and detection of *Mannheimia haemolytica* in nasal secretions

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**Objective**—To determine effects of vaccination prior to transit and prophylactic administration of florfenicol at time of arrival at a feedyard on health of cattle and colonization of the nasopharynx by *Mannheimia haemolytica* (MH).

**Animals**—121 steers from Tennessee and 84 steers from New Mexico.

**Procedure**—Half of the steers were vaccinated before transport to a feedyard. Steers from Tennessee were vaccinated with MH bacterin-toxoid, and steers from New Mexico were vaccinated intranasally with modified-live leukotoxin-deficient MH. Half of the vaccines and nonvaccinates were randomly selected to receive florfenicol on arrival at the feedyard. Steers were observed daily for respiratory tract disease (RTD).

**Results**—Administration of florfenicol at time of arrival reduced the incidence of RTD, delayed the interval before onset of RTD, and reduced the incidence of MH colonization of the nasopharynx for at least 4 days, but vaccination did not have any effect. Vaccination elicited an increase in serum antibody titers to MH. Administration of florfenicol at time of arrival reduced the development of serum antibody titers in intranasally vaccinated steers and both groups of nonvaccinated steers, but intranasal vaccination did not affect colonization by wild-type MH.

**Conclusions and Clinical Relevance**—Administration of florfenicol at time of arrival decreased the incidence of MH organisms in the nasopharynx and delayed the onset of RTD. Prophylactic use of suitable antibiotics is likely to reduce the incidence of acute RTD in calves for several days after arrival at feedyards, which is the period when they are most susceptible to infectious organisms. (Am J Vet Res 2002;63:251–256)

*Manheimia haemolytica* (MH) inhabits the tonsils and nasal passages of healthy cattle and is part of the normal bacterial flora. After transport or during viral-induced illness, MH serotype A1 can undergo rapid selective growth in the nasopharynx. This selective and obvious population increase is a likely prerequisite for the onset of pneumonia pasteurellosis. Prophylactic administration of tilmicosin phosphate to newly arrived calves is a management procedure commonly used to control acute onset of respiratory tract disease (RTD) that is usually seen shortly after arrival of calves at a feedlot. Administration of tilmicosin at the time of arrival can reduce the overall incidence of acute RTD in feedlot calves and extend the mean interval between arrival and day of initial treatment of calves with RTD by several days over that of calves not medicated at time of arrival. Administration of tilmicosin or florfenicol at time of arrival can reduce the overall incidence of RTD in feedlot calves and improve 21-day average daily gain over that of calves not medicated at time of arrival. In another study conducted in a feedlot setting, use of tilmicosin to treat calves with RTD eliminated or reduced detectable colonization of the nasopharynx by MH for up to 6 days. In another study, steers given tilmicosin prophylactically before transit or at time of arrival at a feedyard had a lower incidence of colonization by MH than nonmedicated steers.

Florfenicol, a structural analogue of thiampenicol and chloramphenicol, is effective against MH isolates and is useful in treating cattle with RTD or undifferentiated fever. The study reported here was designed to determine the effects of vaccination against MH prior to transit and prophylactic administration of florfenicol at time of arrival in a feedyard on health and performance of newly received beef steers. We also determined the effects of these procedures on colonization of the nasopharynx of these calves by MH.

**Materials and Methods**

**Animals**—Beef steers (*n* = 205) were obtained from 2 sources for use in the study. Steers were processed prior to transport to a feedyard in New Mexico (day 0 = day of arrival at feedyard).

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Steers from Tennessee (n = 121) that weighed between 170 and 230 kg were accumulated at a local order-buyer barn (OBB) on days –3 and –4. As they were moved through a cattle chute, every other steer was vaccinated IM with a MH bacterin-toxoid in accordance with label instructions; thus, 61 steers were vaccinated. Steers were transported by truck to the feedyard on day –1 and arrived on day 0. At the time of arrival, 60 randomly selected steers were administered florfenicol (40 mg/kg of body weight, SC) as a single injection in the neck region (prophylactically medicated steers). These 60 steers comprised 30 vaccinates and 30 nonvaccinates.

Eighty-four steers from New Mexico originated from 1 ranch. On day –3, cattle were moved through a chute, and every other steer was vaccinated with modified-live MH serotype 1, with approximately a 1-kilobase deletion in the lltA gene encoding for leukotoxin (ie, lltA-deficient MH); thus, 42 steers were vaccinated. The inoculum (3.5 × 10^{7} colony-forming units/ml) was administered intranasally (2 ml/nostril), using an automatic injector-drencher, with the nozzle constricted to enhance projection of the effluent stream. Steers were transported by truck to the feedyard in New Mexico on day 0, and they arrived the same day. At the time of arrival, 42 randomly selected steers were medicated with florfenicol (21 vaccinates and 21 nonvaccinates; prophylactically medicated steers).

Additional products administered prior to transport of all steers included SC injection of a clostridial vaccine, IM injection with a modified-live virus vaccine against influenza bovine rhinotracheitis virus, and IM injection of a parasiatrice. At the time of arrival, all steers were weighed, had the tips of their horns removed, and were branded, had the tips of their horns removed, and were branded.

Results

Respiratory tract disease in steers from Tennessee—On day 1, 2 steers vaccinated with bacterin-toxoid died, 1 of which had been medicated prophylactically with florfenicol. Both had gross lesions of pneumatic pasteurellosis, and MH serotype 1 was isolated from the lung lesions. Most treatments given to steers because of RTD were administered during the first week after arrival. Most prophylactically medicated steers that subsequently required treatment because of RTD were initially treated later than nonmedicated steers that subsequently required treatment because of RTD (Fig 1). Number of treatments for steers with RTD was significantly (P = 0.030) greater in nonmedicated steers. Significantly (P = 0.004) fewer prophylactically medicated steers were given treatments because of RTD, and significantly (P = 0.004) fewer were given >1 treatment (Table 1). Vaccination with MH bacterin-toxoid did not have a significant effect on the number of steers treated because of RTD. There were 77/121 steers treated because of RTD. Most prophylactically medicated steers were administered tilmicosin (10 mg/kg, SC) for the first treatment and florfenicol for the second treatment, when necessary. Steers that had not been medicated with florfenicol at the time of arrival were administered florfenicol for the first treatment and tilmicosin for the second treatment, when necessary. When necessary, third treatments consisted of the alternate antibiotic. After each treatment, steers were returned to their home pens. Steers with RTD were treated on days 1 to 15, 18, 21, and 25.

Collection of specimens—Swab specimens of nasal secretions were collected from all steers at the OBB (days –4 or –3) or ranch (day –3), at the time of arrival in the feedyard (day 0), and during their stay at the feedyard (days 4, 8, 15, 22, and 29). Sera were obtained from all steers on these same days, except for days 0 and 4. Swab specimens were obtained by inserting 1 cotton-tipped swab into each ventral nasal meatus. Each pair of swabs was placed into a dry tube, sealed, and stored on dry ice for transport to the National Animal Disease Center in Ames, Iowa. Samples then were stored at –70°C until analyzed.

Analysis of specimens—Swab specimens were streaked on blood-agar base plates containing 5% bovine blood, using a consistent procedure to form zones of decreasing growth. Cultures were incubated overnight at 37°C, and MH colonies were identified and serotyped. Serum antibody titers were determined by use of an indirect hemagglutination procedure.

Statistical analysis—Colonization status was compared among groups of steers, using a χ^{2} determination. The Yates correction for continuity was used in calculating results of the χ^{2} test. The Fisher exact test was used when numbers of steers were small. Serum titers were compared among groups, using paired t-tests. For all comparisons, a value of P < 0.05 was considered significant.

![Figure 1](https://example.com/figure1.png)

Figure 1—Time of first treatment administered because of respiratory tract disease to steers obtained from Tennessee (TN) or New Mexico (NM) and transported to a feedyard in New Mexico (day 0 = day of arrival at the feedyard). Half of the steers were prophylactically medicated, using florfenicol administered at time of arrival at the feedyard (PM +), and the remaining steers did not receive prophylactic medication (PM 0).
RTD in steers from Tennessee that received at least 1 treatment because of RTD. Incidence of RTD in the prophylactically medicated steers was 30/60 (50%), whereas incidence of RTD in nonmedicated steers was 47/61 (77%).

RTD in steers from New Mexico—None of the steers from New Mexico died. Most treatments because of RTD were given by 8 days after arrival (Fig 1). Number of treatments because of RTD was not significantly greater in nonmedicated steers (Table 1). Intranasal vaccination with modified-live MH did not have an effect on the number of steers treated because of RTD. There were 43/84 (51%) steers from New Mexico that received at least 1 treatment because of RTD. Incidence of RTD in the prophylactically medicated steers was 17/42 (40%), whereas incidence of RTD in nonmedicated steers was 26/42 (62%).

Serotype of MH isolates—Two serotypes of MH (ie, A1 and A2) were isolated from cultures grown from swab specimens of nasal secretions. Most serotype A2 isolates were in the OBB and ranch specimens (steers from Tennessee, 6 of 15 isolates; steers from New Mexico, 1 of 1 isolate). In the feedyard, serotype A1 accounted for 819/834 (98.2%) of the MH isolates. Isolates with the lktA-deficient MH serotype A1 were nonhemolytic. Wild-type MH serotype A1 were hemolytic, and all of them tested were resistant to kanamycin.

Isolation of MH after arrival—Nasal secretions were examined for MH to determine the effect of prophylactic administration of florfenicol on colonization

Table 1—No. of steers treated with antibiotics because of respiratory tract disease (RTD) and No. of treatments administered to those steers

<table>
<thead>
<tr>
<th>Origin of steers</th>
<th>PM</th>
<th>Vacc</th>
<th>No. of times steers were treated</th>
<th>No. of treatments*</th>
<th>Total No. of treatments?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tennessee</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td>Yes</td>
<td>Vac</td>
<td>16 12 2 14</td>
<td>16 46</td>
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<tr>
<td></td>
<td>No</td>
<td></td>
<td>14 10 6 16</td>
<td>27 57</td>
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<tr>
<td>Total</td>
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<td></td>
<td>30 22 8 30</td>
<td>43 103</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>Yes</td>
<td></td>
<td>7 11 12 23</td>
<td>42 42</td>
<td></td>
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<td></td>
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<td></td>
<td>7 13 10 23</td>
<td>38 38</td>
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<td>80 80</td>
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</tr>
<tr>
<td>Total</td>
<td>Yes</td>
<td></td>
<td>16 23 3 28 30 30</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*No. of treatments administered because of RTD. Includes No. of treatments administered because of RTD and the 1-time prophylactic administration of medication on day of arrival at the feedyard. 1One steer in the group died 1 day after arrival at the feedyard.

Table 2—Effect of IM vaccination with Mannheimia haemolytica (MH) bacterin-toxoid (Vacc) and prophylactic medication in the form of administration of florfenicol at time of arrival in a feedyard (PM) on culture of wild-type MH from swab specimens of nasal secretions* obtained from steers from Tennessee in the feedyard

<table>
<thead>
<tr>
<th>Day after arrival at feedyard</th>
<th>0</th>
<th>1</th>
<th>4</th>
<th>8</th>
<th>15</th>
<th>22</th>
<th>29</th>
</tr>
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<tbody>
<tr>
<td>Vacc</td>
<td>+</td>
<td>0</td>
<td>+</td>
<td>0</td>
<td>+</td>
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<td>3</td>
<td>21</td>
<td>19</td>
<td>13</td>
<td>11</td>
<td>14</td>
</tr>
<tr>
<td>No</td>
<td>27</td>
<td>4</td>
<td>26</td>
<td>5</td>
<td>8</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>Total</td>
<td>54</td>
<td>7</td>
<td>35</td>
<td>26</td>
<td>15</td>
<td>22</td>
<td>20</td>
</tr>
</tbody>
</table>

| Yes                          | 28 | 2  | 16 | 13 | 7  | 14 | 7  |
| No                           | 28 | 2  | 29 | 10 | 1  | 12 | 17 |
| Total                        | 56 | 4  | 45 | 17 | 17 | 26 | 25 |

| Yes                          | 95 | 5  | 28 | 34 | 14 | 37 | 27 |
| No                           | 95 | 6  | 66 | 6  | 18 | 4  | 19 |
| Total-PM Yes                 | 95 | 6  | 66 | 6  | 18 | 4  | 19 |
| Total-PM No                  | 95 | 6  | 66 | 6  | 18 | 4  | 19 |

*Steers that developed RTD and were administered antibiotics within 7 days before collection of a specific sample were not included in the data for that sample. 1MH cultured. 0 = MH not cultured.
Within a specific sample collection day, No. is significantly (P < 0.05) different from No. of steers that did not receive PM. Within a specific sample collection day, No. is significantly (P < 0.05) different from No. of nonvaccinated steers.
of the nasopharynx. Tilmicosin treatment inhibits colonization by MH, and treatment with florfenicol in nonmedicated steers that developed RTD resulted in a change in nonmedicated status. Therefore, treatment of steers with RTD with either antibiotic changed the original status of those steers; therefore, steers with RTD that were given treatments within 7 days before collection of a specific sample were not included in the data for that sample.

Wild-type MH was isolated from 110 of 121 steers from Tennessee on day 0. Prophylactic administration of florfenicol at time of arrival significantly reduced the number of steers with positive results for bacterial culture for at least 4 days after arrival (Table 2). Significantly fewer vaccinated steers had positive results for bacterial culture on day 1 (ie, 3 to 4 days after vaccination), regardless of whether they were administered florfenicol at time of arrival. Vaccination did not have an effect on colonization after day 4. There was not a significant effect of prophylactic administration of florfenicol on MH colonization status of steers in samples collected on and after day 8. Most steers had positive results for culture of wild-type MH on and after day 8. The $lktA$-deficient MH were not isolated.

Wild-type MH was not isolated from the steers from New Mexico, but $lktA$-deficient MH was isolated from 13 of 42 intranasally vaccinated steers on day 0. Prophylactic administration of florfenicol at time of arrival significantly reduced the number of steers that had positive results for bacterial culture of $lktA$-deficient MH for the first 4 days after arrival (Table 3). Three nonvaccinated nonmedicated steers had positive results for bacterial culture of $lktA$-deficient MH on day 4, and few steers had positive results of bacterial culture for $lktA$-deficient MH after day 8. Prophylactic administration of florfenicol did not significantly affect the $lktA$-deficient MH status of steers for samples obtained on or after day 8. Wild-type MH was isolated from 6 steers on day 1 (Table 4). Prophylactic administration of florfenicol at time of arrival significantly reduced the number of steers that had positive results for bacterial culture of wild-type MH on the sample obtained on day 4. We did not detect significant effects of intranasal vaccination or prophylactic administration of florfenicol on wild-type MH status of steers in samples obtained on or after day 8; most steers had positive results for bacterial culture of wild-type MH on and after day 8.

Effect of vaccination and prophylactic administration of florfenicol on development of serum titer to...
MH—Steers from Tennessee had low titers at the OBB before vaccination (geometric mean titer [GMT], 4.7). Vaccination with MH bacterin-toxoid elicited a significant increase in titer in medicated and nonmedicated steers within 3 to 4 days (GMT on day 1, 8.4). Titers of nonvaccinated steers reached similar values in 11 days, with titers of prophylactically medicated steers remaining lower than those of nonmedicated steers (Fig 2). Prophylactic administration of florfenicol to steers from Tennessee reduced the development of serum titers in nonvaccinated steers but not in vaccinated steers.

Steers from New Mexico had lower titers before vaccination at the ranch (GMT on day −2, 3.9), compared with titers for the steers from Tennessee at the OBB (days −4 and −3; GMT, 4.7). Intranasal vaccination with modified-live MH elicited significantly greater titers in prophylactically medicated and nonmedicated steers. Prophylactic administration of florfenicol reduced the development of serum titers in vaccinated and nonvaccinated steers from New Mexico (Fig 3).

**Discussion**

Acute RTD in the form of acute pneumonic pasteurellosis usually is evident in transported calves within the first week after arrival at a feedyard. Management practices to reduce the incidence of RTD include vaccination and prophylactic administration of medication. The opportunity to vaccinate calves often is limited to the assembly point immediately before transit or immediately after arrival at a feedyard. Using currently available vaccines, this does not allow sufficient time for an effective immune response to develop before the usual acute onset of RTD. Prophylactic administration of tilimicosin at the time of arrival is a common management procedure. It can reduce the incidence of acute RTD and inhibit colonization of the nasopharynx by MH for up to 6 days. Florfenicol is another antibiotic commonly used to treat cattle with RTD. In the study reported here, prophylactic SC administration of florfenicol at the time of arrival reduced the incidence of RTD and delayed the interval between arrival and time of detection of RTD. It also reduced the incidence of MH colonization of the nasopharynx for at least 4 days. Because the dramatic selective increase of the MH population in the nasopharynx is a prerequisite for the development of pneumonic pasteurellosis, inhibition of colonization of the nasopharynx by MH is a desirable goal when attempting to control the disease in calves. The delay in the onset of RTD afforded by prophylactic administration of medication may allow an effective immune response to develop after vaccination and could reduce the incidence and severity of RTD that develops later (ie, >7 days) during the period when calves are in the feedyard.

In the study reported here, vaccination did not have an effect on the number of steers treated because of RTD or on colonization of the nasopharynx by MH. Titers of steers vaccinated with the MH bacterin-toxoid were not inhibited during the period shortly after vaccination when those steers received prophylactic administration of florfenicol, but titers of prophylactically medicated steers were less during subsequent days, compared with those of nonmedicated steers. Prophylactic administration of florfenicol reduced the development of titers in vaccinated and nonvaccinated steers from New Mexico. Presumably, the reduction of titer development was a result of florfenicol suppression of natural MH infection.

Although prophylactic administration of florfenicol reduced the incidence of RTD, delayed the onset of RTD, and reduced the incidence of early colonization of the nasopharynx by MH, the number of treatments for steers that developed RTD plus the initial prophylactic administration of medication in the prophylactically medicated steers was more than the number of treatments required for nonmedicated steers that developed RTD. Field trials that provide data on feed consumption and weight gain would be necessary to determine the economic effect of prophylactic admin-
istration of medication. In the study reported here, measures to prevent RTD were directed against MH. Other agents that cause RTD may have been involved in the disease that developed later in these steers, even though most of the steers had positive results for bacterial culture of MH for an extended period.

References


