Factors Predisposing to Urolithiasis in Feedlot Cattle

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Summary

Autoimmune Hemolytic Anemia (AIHA) is characterized by hemolytic anemia, a positive Coomb's test, and usually by thrombocytopenia. Affected dogs have a macrocytic anemia and a bone marrow response. Petechial hemorrhages are frequently present on mucous membranes and the urine may be blood-tinged.

Treatment consists of high doses of corticosteroids (prednisone is most often used), antibiotics, and blood if anemia becomes severe enough to warrant it. A splenectomy is sometimes performed in refractory cases with variable results. Relapses commonly occur and the prognosis is grave in all cases of this disease.

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Factors Predisposing to Urolithiasis in Feedlot Cattle

by Jerry R. Hardisty,* R. C. Dillman, D.V.M., Ph.D.†

The formation of stony precipitates anywhere in the urinary passages is called urolithiasis. The stone is called a urolith or urinary calculus. Urolithiasis is an important disease of castrated male ruminants because of the common occurrence of urethral obstruction. Although it occurs in all species, it is of greatest economic importance in feeder steers and lambs which are fed with heavy concentrate rations. Among feedlot cattle in the United States, obstructive urolithiasis is second in importance only to diseases of the respiratory tract.

There are three main groups of causes of urolithiasis. First, those which favor the development of a nidus. A nidus, usually in the form of a group of desquamated epithelial cells or necrotic tissue, favors the deposition of crystals about itself. Second, those which facilitate precipitation of solutes on the nidus. Third, those which favor concretion by cementing the precipitated salts to the developing calculus. It has been suggested that mucoprotein, particularly its mucopolysaccharide fraction, may act as a cementing

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agent; by acting as such, it favors the formation of calculi.\textsuperscript{22} In feedlot cattle the calculi are usually composed of calcium, magnesium and ammonium phosphates.\textsuperscript{1} The calculi are usually present as individual stones of varying size. The calculi may, however, form as a sludge or sandlike deposit. Many of these deposits seem to be purely inorganic in nature and without much of an organic matrix.\textsuperscript{14} Although the greatest field problem is that of obstructive urolithiasis caused by mineralized calculi or sediment, obstruction can also be caused by materials containing very little mineral. Marsh reported a 10\% incidence of obstructive urolithiasis in feedlot lambs being given fattening whole-ration pellets containing 0.5 mg. stilbestrol per pound. Urethral occlusions were found to be due to plugs of precipitated mucoprotein and no calculi were found\textsuperscript{10}. Lambs fed stilbestrol appear to have excessive production and precipitation of mucoprotein.\textsuperscript{10}

There have been many factors which have been incriminated as producers of urolithiasis in the feedlot ruminants (cattle and sheep). Apparently, there is not one specific factor leading to urinary calculi; most likely it is due to a combination of several factors. These factors are not always the same but vary with particular feeding and management practices. These factors must be dealt with as singular entities; however, it must be kept in mind that it is probably a combination of several separate factors which produce clinical obstructive urolithiasis.\textsuperscript{10}

One of the most commonly cited and possibly most important factor predisposing to urolithiasis is the nutrition of feedlot animals. The composition of the diet and mineral imbalance have assumed importance as major factors in ruminant urolithiasis. Calculus-provoking diets have been based on molasses, beet pulp, barley, oats, linseed meal, sorghum grain, sorghum silage, cottonseed meal, and hay.\textsuperscript{4,11,15,19} The ratio of concentrate: roughage in the ration seems to have an effect on urolith formation. The higher the ratio, the greater the incidence of urolithiasis.\textsuperscript{9} There is evidence that the concentration of the mucopolysaccharide portion of the mucoproteins of the urine can be directly correlated to the level of concentrates in the ration. This correlation is the result of the increased tissue turnover rate induced by an increased growth rate.\textsuperscript{20} The increased level of mucoproteins in the urine is thought to be important in the formation of calculi. In feedlot steers the predisposition to urolithiasis can be measured by the level of mucoprotein in the urine.\textsuperscript{22}

Also, fattening rations are associated with mineral imbalance which is also an important cause of urinary calculi formation. Feedlot rations, comprised of protein supplements, grain and milling by products, produce a radical change in mineral intake from that on range where calcium intake is adequate. The phosphorus intake is greatly increased where as calcium intake is decreased. The calcium to phosphorus ratio is a critical factor in urolithiasis. High phosphorus and low calcium levels tend to predispose to urinary calculi.\textsuperscript{15} An elevated dietary phosphorus intake results in a concomitant increase in urinary phosphorus and urinary calcuri formation. One experiment of feeding of diets containing alfalfa hay showed an effect on urinary phosphorus levels. In this experiment Udall reported that alfalfa hay in the diet decreases protein bound hexosamine in the urine thus decreasing calculi formation.\textsuperscript{22} The average urinary phosphorus concentration in this experiment was:

<table>
<thead>
<tr>
<th>Diet</th>
<th>Urinary Phosphorus Concentration</th>
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<tbody>
<tr>
<td>All Concentrate Diet</td>
<td>19-99 mg./100ml.</td>
</tr>
<tr>
<td>15% Alfalfa Hay</td>
<td>0.8-24 mg./100ml.</td>
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The low urinary phosphorus values associated with the feeding of diets containing alfalfa hay may, however, have been a limiting factor in the lack of calculi formation.\textsuperscript{9} In a study using feedlot lambs it was found that urolithiasis free lambs had significantly lower urinary phosphorus concentrations than did those exhibiting urinary calculi.\textsuperscript{8}
Urolithiasis 7–162 mg./100ml.
Urolithiasis-free 3–20 mg./100ml.

By altering the Ca:P ratio in the ration the incidence of urinary calculi can be reduced. With a higher concentrate level, a lower amount of supplement phosphorus and a higher amount of calcium is required. Bushman recommended a Ca:P ration of 2:1 or higher for the prevention of phosphatic calculi. In an experiment by Hoar the greatest incidence of calculi (50–52%) was obtained by feeding 0.4% P and 0.31% Ca. However, by increasing dietary Ca to 1.06% with ground limestone (Ca:P of 2.3:1) calculi incidence was reduced to 29% vs. 50%.

Pelleting has increased the incidence of calculi when the ration is already urolithogenic but has had no effect on nonuro lithogenic rations.

Dietary potassium also seems to have an effect on the production of urinary calculi. When potassium is fed in conjunction with elevated levels of dietary phosphorus as 1% KCl, it promotes larger calculus formation. This could lead to an apparent increase in the number of obstructive cases.

Vitamin A deficiency has been incriminated as a factor in the development of urolithiasis; however, it does not appear to be a major factor. It has been theorized that a vitamin A deficiency would contribute to desquamation of epithelial cells around which calculi form. Some practitioners, however, like to include 20,000-30,000 units of vitamin A/head/day as part of the ration during the entire feeding period as a preventative measure.

Hormonal effects on the development of the urinary tract do not directly affect the production of urinary calculi but they may affect the occurrence of clinical obstructive urolithiasis. The highest incidence of occluding urolithiasis occurs in steer calves 8 to 12 months old. It has been found that deferring castration until calves are about 6 months old will reduce the incidence of clinical cases. Measurements of the diameter of the lumen of the urethra of 10 month old steer calves castrated at the age of 1 month, 7 months, and as bulls revealed differences in diameter. On the basis of average minimum diameter, a calf castrated at 7 months of age could pass a urolith 13% greater in diameter, and a bull could pass a urolith 44% greater in diameter, than a calf castrated when 1 month old. On occasion, mature breeding animals may develop clinical signs, but a 3 year study showed only a 7% incidence of urolithiasis in intact males. Although calculi formation is probably equal in both the male and the female animal, the short, relatively large urethra of the female affords little opportunity for blockage.

Although it has not been established as a problem in cattle, stilbestrol supplementation has increased the incidence of urethral blockage in feedlot lambs. This may be related to the increased production and precipitation of mucoprotein or may be related to the decreased diameter of the urinary passageway or both. In lambs fed with stilbestrol supplement the seminal vesicles and bulbourethral glands were enlarged.

Urolithiasis is caused by conditions that tax the precipitate-carrying capacity of the urinary system. Normally inorganic constituents of the renal filtrate interact to produce finely divided precipitates which are carried along by the water and are eliminated without injury to the animal. Blockage is prevented by adequate water volume and the presence of natural crystal-growth-inhibiting substances. A deficiency of water consumption by feedlot cattle is often followed by an increase in the incidence of urinary calculi. This may be due to several factors, both climatic and management. In the winter, when conditions are severe or when there is a cold snap, there may be a decreased water consumption. Also, if large numbers of cattle are confined together with only one water tank available, or if drinking water has been used for mass medications, water intake may be decreased.

Water from artesian wells in some areas may contribute to natural mineral intake variations. The total contribution of minerals from very hard water, however, may
be quantitatively little more than those from soft water.

Certain conditions that affect the urinary system in general may have a predisposing effect toward the formation of urinary calculi. Local infections may be incriminated as a contributory cause, but should not be considered as the sole influence. It is not uncommon to find secondary calculus formation, with production of a gravel-like material composed of magnesium ammonium phosphate as a sequelae to bacterial pyelonephritis in cattle. Infection of the urinary tract is closely related to rises in urine pH. Renal damage may permit large protein molecules to pass into the urine and these could result in mineralization. Anything that leads to urinary stasis may also encourage the formation of calculi.

The pH of urine affects the solubility of some solutes, mixed phosphates and carbonate calculi being more readily formed in alkaline urine than in acid. Increased urine acidity and hypercalciuria immediately after feeding may cause minerals of varying chemical stabilities to precipitate as urinary calculi. The alteration in acid-base balance is attributed to increases in urine acidity and hypercalciuria caused by the increase in flow of alkaline rich saliva, and the hypercalciuria to metabolic acidosis. Thus one ewe had alkaline urine and excreted calcium at 10 mg/min. before feeding, but 1/2 hour after feeding had started urine was acid and calcium excretion exceeded 100 mg/min. Rations of more alkaline character have been reported to produce more calculi than those of acid character. Feeding of sodium bicarbonate can cause urinary calculi, probably by the decrease in urine acidity.

The feeding of certain compounds to reduce the urine pH has been used with some success in the prevention of urolithiasis. Ammonium chloride, calcium chloride and phosphoric acid have been used to reduce urine alkalinity and thus aid in the prevention of urinary calculi.

Urolithiasis has been associated with unfavorable weather conditions and appears to be an interaction of cold and endocrine response, but there is little experimental evidence of the nature of this interaction and its effect on urine composition. Most authorities agree that urinary calculi consist of a mucoprotein matrix with layers of mineral elements. The concentration of the mucopolysaccharide portion of the protein is in direct ratio to the level of protein hydrophilic colloids in maintaining the urinary crystalloids in solution. Any decrease in these colloids from nutritional causes may increase the incidence of urinary calculi, since the stability of the crystalloid solution is impaired. In man the level of urinary hydrophilic colloids decreases during stress. In feedlot cattle, the stress of adaptation and inclement weather may possibly have similar results. During winter months, decreased water consumption by feedlot cattle is often followed by an increase in the incidence of urinary calculi. During dehydration the stability of the protective urinary colloids is decreased.

Summary

Among feedlot cattle in the United States, obstructive urolithiasis is second in importance only to diseases of the respiratory tract. With a disease of this magnitude prevention is much more economical than treatment of clinical cases. Predisposing factors to urolithiasis are many. The actual cause is probably due to a combination of several of these factors. Of these predisposing factors, fattening ration and minerals imbalance probably assume the most important role; but, hormonal effects, climatic conditions and urinary pH, among others, may also add to the problem.

REFERENCES

Some Aspects of Veterinary Medicine and Veterinary Services in Israel

by Zadok Ruben*

During the summer of 1970, while vacationing in Israel, I talked with several Israeli veterinarians from whom I learned about several aspects of the activities of the Government Veterinary Services. The purpose of this paper is to present a review of some aspects of veterinary medicine in Israel with an emphasis on the Government Veterinary Services.

Israel is located on the eastern shore of the Mediterranean Sea. Its area is 20,700 Km² and its population is 2,745,000. Also, the Golan Heights, the Western Bank, the Gaza Strip and the Sinai Desert are presently under Israeli control; as a result, all matters concerning veterinary medicine in these areas are under the supervision of the Israeli veterinary authorities. The permanent agricultural cultivated area is 4,410 Km², which is almost the maximum area suitable for agricultural cultivation. The main agricultural crops

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