Clinical Management of Diarrhea in Calves

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The raising of a large number of calves under intensified systems creates unusual disease problems, and the common diseases of the calf become more difficult to manage clinically than when only a few are raised together. Diseases of the alimentary tract in young calves, whether infectious or dietary in origin, account for the greatest cause of the economic losses incurred where large numbers of calves are raised in close confinement.

The clinical management of diarrhea in calves which are hand-fed milk or milk replacers should include the following:

a. *Determine the cause of the diarrhea if possible.* Feces must be examined for evidence of parasites and enteropathogenic bacteria. The formula of the milk replacer should be obtained to determine if any of the ingredients already discussed may be a contributing factor. The guaranteed crude analysis given on the label is of little use in assessing the nutritive quality of the milk replacer.

b. *Starve the calf from milk or milk replacer for 24-48 hours and give the calf a solution of water and electrolytes.* Several mixtures of electrolytes and glucose are available. A commercial powder preparation* contains electrolytes and glucose which, when added to water, makes up a multiple electrolyte solution containing glucose. This is an ideal solution for oral administration and while it is non-sterile, it has been used successfully parenterally. Dalton (3) has recently suggested the following mixture for preparation of solutions for oral use in calves: Sodium chloride 117 grams; Potassium chloride 130 grams; Sodium bicarbonate 168 grams; Potassium phosphate (Dibasic salt K_2HPO_4) 135 grams.

To prepare a liter of the solution, add 5.7 grams of the powder to a liter of water, to which may also be added 50 grams of glucose. For one gallon, add one ounce of powder and one-half pound of glucose to one gallon of water. The mixture of four salts is a dry powder which can be conveniently dispensed. Glucose should be added when the solution is used parenterally but the preparation cannot be sterilized by boiling. As an oral preparation it is a half-isotonic electrolyte solution supplying water and electrolytes and its hypotonicity results in diuresis aiding in the excretion of any excess electrolytes, acids and toxic catabolites.

c. *The antibacterial agent of choice should be added to the oral fluid preparation.* This may result in more effective distribution of the drug throughout the intestinal tract (9). This clinic uses nitrofurans because most of the *E. coli* isolated from affected calves are sensitive *in vitro* to the nitrofurans.

Whether or not antibiotics and chemotherapeutic agents given orally for neonatal diarrhea in calves is indicated is not really known. It has been generally assumed that oral antibacterials were a necessary part of the treatment but it is now clear that not all scouring calves should receive antibacterial agents orally. This clinic has successfully treated several scouring calves without antibacterials orally. The alterations in intestinal flora caused by these antimicrobial agents is not known in calves. There is an urgent need for some detailed clinico-bacteriologic studies in scouring calves, to determine what beneficial and detrimental effects orally administered antibacterial agents given at the usual therapeutic doses have on the intestinal flora. On the other hand, the widespread use of scour tablets and liquids containing one or more antibacterial agent with, or without, electrolytes, antispasmodics and intestinal protectants and their apparent success cannot be ignored. It seems that they are most successful in mild forms of neonatal diarrhea in calves and spontaneous recovery must be considered as a possibility.

d. *Fluid therapy is necessary if the calf is*

**Eltrad I.V. 4000, Haver-Lockhart Laboratories, Calgary, Alberta.*

dehydrated. The total daily amount, the rate and route of administration will vary depending upon the degree of dehydration and how rapidly it occurred. A calf weighing 50 kg. and affected with diarrhea for 24 hours may have lost five liters of body fluid (8 - 10 per cent dehydration) and will require four to five liters of electrolyte solution* to restore the fluid deficit. Phillips and Knox (11) have shown that calves with watery diarrhea have on the average a water space of 76% of body weight compared to 87% for normal calves, indicating that dehydration from the diarrhea is about 10% of body weight. In this example of a calf weighing 50 kg., an initial dose of 100 ml. per kg. of body weight (5000 ml.) is given as an intravenous drip via a polyethylene catheter inserted in a jugular vein over a period of four to six hours (2). If the fluid therapy is effective the calf will usually stand in about six hours and five to ten liters of the oral preparation are offered during the period of starvation (the next 24 hours) or until the calf has returned to normal. Butler (2) has recommended a maintenance level of fluids and electrolytes given at a rate of 70 ml. per lb. body weight intravenously for the next 20 hours following the initial hydration therapy.

There are several electrolyte glucose solutions available. Most contain a mixture of sodium, chloride, calcium, potassium and glucose at an isotonic level. Some solutions contain lactate which in the normal animal is metabolized to bicarbonate and is thus used in the treatment of some cases of acidosis. Solutions containing potassium and lactate must be used with caution. If renal failure is present or imminent the administration of solutions containing potassium may cause a fatal hyperkalemia. Very often calves which have had severe diarrhea already have an abnormally high level of serum potassium and the additional load has a toxic effect on the myocardium. The use of lactate is not recommended in calves which are weak, unable to rise and in a state of collapse. These calves usually have a low blood pH ranging from 6.95 to 7.20, they are in a state of acidosis and the lactate is not metabolized normally because of poor liver perfusion and the acidosis becomes worse.

For the initial stages of the fluid therapy (hydration stage) this author is now using a mixture of 2000 ml. isotonic saline (0.85%) and 2000 ml. of isotonic sodium bicarbonate (1.30%). Solutions containing lactate or potassium are not used commonly. Usually two to three liters are offered to the calf every twelve hours and in most cases they will drink the solution readily.

e. *Broad spectrum antibiotics should be given parenterally to prevent bacteremia which could lead to coliform septicemia.* This author recommends chloramphenicol or oxytetracycline at a dose rate of 10 mg. per pound body weight given intravenously or intramuscularly. Usually no more than two successive injections of chloramphenicol eight hours apart are given. Parenteral antibiotics also aid in the prevention of bacterial polyarthritis and/or meningitis (1). Meningitis is a common sequel to colibacillosis in calves; a finding which is not generally appreciated (8).

f. *The calf should be reintroduced to milk in graduated amounts extended over a period of two to three days.* A very simple plan is to use a good quality milk substitute such as skimmilk powder with added fat (10 to 15%) which is easily digestible and allows for uniformity which can be used if cow's whole milk cannot be obtained. A satisfactory re-feeding schedule is as follows: 1) No milk or milk by-products for 24 hours but feed a mixture of electrolytes, glucose and water. 2) On the second and third days, feed twice daily 0.4 ounces milk substitute per 10 lb. body weight per feeding mixed with 8-10 parts water at 100°F, or feed whole milk at the rate of 3.5 ounces per 10 lb. body weight per feeding. 3) On the fourth and fifth days, feed twice daily 0.6 ounces milk substitute per 10 lb. body weight per feeding, or whole milk at the rate of 5 ounces per 10 lb. body weight. 4) On the sixth and seventh day, feed twice daily 0.8 ounces milk substitute per 10 lb. body weight per feeding, or whole milk at the rate of 7 ounces per 10 lb. body weight. 5) On the eighth day, switch to good quality milk replacer with some added fat (about 10% on a dry matter basis) or to cow's whole milk.

The milk substitute should be supplemented with an inexpensive mixture of vitamins containing vitamins A, D and E and the B-complex vitamins. This can be added to the reconstituted skimmilk at feeding time. Chronically ill calves require a dietary supplementation of vitamins, especially the B-complex vitamins during the convalescent period. Parenteral injections of mixtures of vitamins A, D and E may also be indicated.

The failure of calves to recover after treatment for diarrhea or relapses after an initial beneficial response is common and causes considerable confusion and frustration for the clinician. Some possible explanations for these failures are:

a. The presence of drug-resistant enteropathogens which can be determined only by a

*Ionalyte. Stevenson, Turner and Boyce, London, Ontario.

laboratory examination involving a drug sensitivity-spectrum test.

b. The continued intake of milk or milk replacers often in excessive quantities. This is a common cause of failure and the owner must be reminded of this hazard.

c. The presence of bacterial meningitis, which is more common than generally thought. Affected calves are depressed, usually will not suck or drink, they are usually weak and stand with a widebased stance if they can stand, but are usually recumbent and exhibit opisthotonus. The temperature is often normal or even subnormal although a fever may be present and blindness may or may not be evident. Most affected calves with meningitis due to *E. coli* die in spite of extensive treatment.

d. The failure to adequately treat the dehydration. Large quantities of fluids are necessary to rehydrate some affected calves. There has been a tendency for veterinarians to underdose dehydrated calves with fluids. If a calf weighing 45 kg. (100 lbs.) appears only slightly dehydrated, the degree of dehydration is an amount equivalent to from four to six per cent of its body weight and therefore it requires about 2.25 liters of fluid initially to merely replace the deficit which exists. This must be followed by maintenance fluid therapy given parenterally or orally.

Failure to restore renal function is a common cause of failure when a beneficial response does not occur after the fluid therapy is begun. The renal failure may be irreversible because of a prolonged state of dehydration and circulatory failure. The renal failure results in decreased excretion of potassium which increases the levels of serum potassium to toxic and fatal levels.

e. The development of mycotic rumenitis and/or abomasitis due to prolonged oral antibiotic therapy has occurred frequently (7). Affected calves continue to scour in spite of extensive treatment and many die. The only rational treatment would be continued fluid therapy, withdrawal of the oral antibiotic and the use of fungistatic agents, economics permitting. Laboratory examination of the feces may reveal large numbers of fungal mycelia but their absence in feces does not rule out mycotic gastroenteritis.

f. The diarrhea may be nutritional in origin because of low quality milk replacers. However, it is extremely difficult, if not impossible, to incriminate the milk replacer when the only method available for evaluation of the product under practical conditions is to feed the milk replacer to several calves and observe the performance. A presumptive diagnosis of indigestion due to an inferior milk replacer is justified if the diarrhea stops and the calves respond favorably when they are changed to cow's whole milk.

g. The alimentary tract form of infectious bovine rhinotracheitis in young calves is characterized by a persistent diarrhea which does not respond permanently to therapy (16). A favourable clinical response may occur after the initial dose of fluids but several hours later or the next day, they relapse with severe diarrhea and dehydration and most die. Only few calves affected with the disease will respond and recover after continuous fluid therapy for several days. Some calves affected with the alimentary form of I.B.R. have visible foci of necrosis on the pharynx and rhinitis and conjunctivitis may be present but these are not constant in young calves and commonly the diagnosis is made only on post mortem.

h. "Villous atrophy" of "sprue gut" is a possible sequel to chronic enteritis in calves (12). The pathogenesis of this condition, which has been studied extensively in man, has not been studied in calves but is presumably related to enteric colibacillosis. The net effect is a malabsorption syndrome and affected calves are unthrifty and remain stunted for several weeks.

i. Chronic tissue potassium depletion due to the shift of potassium from the intracellular to extracellular space. Restoration of potassium into the cell occurs at a much slower rate than its loss and requires continuous infusion of the ion parenterally for a few days. This can be accomplished using the multiple electrolyte solutions containing potassium.

Raising Newborn Calves

Some guidelines are presented here for the successful management of newborn calves with particular emphasis on the raising of large numbers of calves under intensified systems.

a. Each calf must be housed and fed in an individual pen. A suitable inexpensive pen would measure 2' x 4' with 4' high solid walls on three sides, a head gate in front and a raised slatted or expanded metal floor with no bedding. These pens can be built in rows and should be in a separate part of the barn, preferably in a closed-off area (calf barn) which can be heated up to 90°F with an excellent ventilation system. The pens should be constructed of metal sheeting; wooden pens are satisfactory but they cannot be cleaned and disinfected as effectively as the metal ones.

b. After birth each calf is weighed, its navel is swabbed with 2% tincture of iodine, and then it is placed in an individual pen and not allowed to nurse its dam.

c. Colostrum should be fed within one to two hours after birth, the earlier the better, and then for two or three times daily for the next four days unti' the supply of colostrum from the dam is used up. Surplus colostrum can be stored frozen for occasions when the supply is limited. Newborn calves weighing 35 to 45 kg. should receive at least 2 kg. of colostrum within five hours after birth.

Recent work has shown that there are several factors which influence the absorption of immunoglobulin from colostrum. There is a direct correlation between the amount of colostrum ingested within a few hours after birth, the concentration of immunoglobulin in the colostrum of the first milking after parturition and the final amount of immunoglobulins absorbed (4,5,6). Heavier calves at birth absorb more immunoglobulin than lighter calves, calves which suckle within two to five hours after birth absorb more than calves which suckle later. The time between birth and when the calf first suckles its dam is dependent on the behaviour of both the dam and the calf. Observations have shown that several factors may be responsible for delayed suckling (14,15). Some calves did not suck for up to eight hours after birth, some calves had difficulty finding the teat because of the shape and contour of the udder and teats of some dams.

d. The daily amount of colostrum milk or liquid milk replacer fed should not exceed an amount equivalent to 10 per cent of the calf's body weight. The daily allowance for calves of the smaller dairy breeds should not exceed eight per cent for the first week of life.

e. When changing from colostrum to whole milk or milk replacer, reduce the daily allowance of the new ration by one-third and increase it gradually over a period of four days.

f. Use only high quality milk replacers formulated for the digestive ability of calves under 28 days of age. These should contain about 75 per cent by dry weight skimmilk or milk by-products and should not contain non-milk sources of protein or carbohydrates. Future technological advances may find economical methods of "predigesting" vegetable and animal and fish proteins and non-milk carbohydrates.

g. The dilution rates for preparation of the milk replacers must be consistent, and the water should be about 100°F and calves should be fed at regular intervals.

h. Provide a source of clean fresh drinking water for each calf. Calves will drink about two liters of water between feedings without adversely affecting their appetite for the next feeding of milk or milk replacer.

i. Constant vigilance and care are necessary when using automatic milk replacer dispensers or calf "nursettes." They must be checked at least twice daily for evidence of plugging and improper mixing of the water and milk replacer powder.

j. When raising large numbers of calves in a vealing unit, a vacant period for clean-out and disinfection is necessary. Effective cleaning can be accomplished using a low volume high pressure sprayer delivering water mixed with a disinfectant at a pressure of about 600 p.s.i. The incidence of diarrhea and the mortality from the common causes of diarrhea in calves will steadily increase as the occupation time of a calf barn increases (13). The occupation time is the length of time the calf barn has been occupied since the last vacant period (13). The calf barn should be cleaned out, disinfected and left vacant for several days at least once annually and preferably twice. A vacant period of two weeks during the summer months is usually possible without too much disruption in routine.

k. Scrupulous sanitation of pails is necessary. Ideally, each calf should be fed using the same marked pail each time; a practice which is economical when the relatively inexpensive cost and versatility of plastic pails are considered. The use of two-quart, square plastic bottles with a removable nipple is becoming popular. Calves can thus be fed individually; and with some organization at feeding time, large numbers of calves can be fed efficiently and labor is put to maximum use (19).

The raising and feeding of calves purchased from several different origins is difficult. The clinical effects and the high mortality from enteric diseases are the chief difficulties encountered.

The morbidity and mortality rates from the common infectious diseases of calves can be minimized if after arrival on the farm each calf is managed according to a strict routine.

a. Each calf should be housed in an individual pen for the first two weeks. If groups of calves are to be fed by automatic dispensers they should not be placed into groups unless they are clinically normal and thrifty. Placing several newly purchased calves together in a single large pen and expecting them to adjust quickly to being fed from an automatic milk replacer dispenser is extremely hazardous. Such a practice requires constant, almost hourly supervision which is not practical on most farms. Calves should not be placed in a

free-stall system until they are about two weeks of age.

b. A broad spectrum antibiotic should be given parenterally immediately after arrival. This reduces the incidence of bacteremia and the common sequelae such as meningitis and polyarthritis.

c. Each calf should recieve an injection of a mixture of vitamins A, D and E because of the unknown origin and nutritional history of some calves.

Table 1

Some Common Constituents of Commercial Milk Replacers

Milk or milk by-products	Added fats	Added carbo-hydrates	Added non-milk proteins	Added vitamins	Added anti-biotics	Added minerals
Skimmilk powder, spray dried or roller dried	Lard	Oat flour	Fish flour	Vitamin A	Oxytetracycline	Copper sulfate
	Tallow	Corn starch	Soy flour	Vitamin D_3		Cobalt sulfate
	Coconut oil	Wheat middlings	(crude or highly purified)	Vitamin E		Iodized salt
	Soybean oil	Molasses		B-complex vitamins		Iron sulfate
Whey powder	Margarine		Blood flour	(Brewer's yeast)		Zinc sulfate
			Meat Meal	Vitamin B_{12}		Dicalcium phosphate
Buttermilk powder						Magnesium sulfate

d. A satisfactory feeding schedule for starting purchased calves is as follows: 1) First feeding. Give a mixture of electrolytes, glucose and water. Offer five liters of 2.5 per cent glucose with or without a mixture of the multiple electrolytes described previously. There are many mixtures of electrolytes and glucose available. 2) Second, third and fourth feedings. Give one-half of the amount of the reconstituted milk replacer which is going to be fed to the calves. 3) After the fourth feeding, increase the allowance of milk replacer at each feeding according to the recommendations of the manufacturer and depending on how well the calf adjusts to the diet.

Summary

The clinical management of diarrhea in calves is discussed with some emphasis on the necessity for fluid therapy given both orally and parenterally.

The feeding, care and clinical management of newborn calves born and raised on the same farm or those purchased from many outside sources are discussed with the aim of reducing disease of the calf, especially enteric diseases, to a minimum.

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