The Prevention and Control of Epidemics of Acute Undifferentiated Diarrhea of Beef Calves

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Introduction

Several different infectious agents may cause acute undifferentiated diarrhea in calves. The predominant clinical sign in all of these diseases is diarrhea; therefore, they are difficult to diagnose and differentiate from each other. Because calf diarrhea is a complex of diseases, it is difficult to control reliably. Improper management is one of the most important causes of herd problems. Thus, for prevention and control, the emphasis should be placed on management of the beef herd throughout the winter and especially at calving time.

In Western Canada, the management cycle of most beef herds follows a typical pattern. Cows with spring calves at foot are dispersed into summer pasture or range areas in April and May for breeding and remain there until calves are weaned, usually in October or November. Pregnant cows are fed winter roughage, usually mixed hay or straw plus some grain, or silage, for a variable length of time from November to May, depending on the amount of snowfall and the availability of feed. Calving begins as early as January in some herds and may continue into May and June; however, peak calving rates occur in March and April.

Many herd problems with calf diarrhea are initiated because cows are crowded or confined during the winter feeding or calving intervals. As the degree or duration of confinement in the winter feeding area increases, the risk of transmission of enteropathogens from carrier cows to other cows and heifers in the herd also increases. Hence, a large portion of cows may be shedding enteropathogens in their feces or have contaminated udders and underbellies when they are moved to the calving area. When this occurs, calving grounds which were relatively "clean" can become heavily contaminated very quickly. A similar pattern of events may occur even when cows are not confined during the winter period but are crowded into a relatively small area for calving. Even worse, winter feeding and calving may be done in the same area.

Newborn calves which are confined to the calving area further increase the population density which not only increases the transmission of infectious agents but also increases stress and reduces transfer of passive immunity. Calves born into a highly contaminated environment may become infected during or shortly after birth and remain clinically normal but shed enteropathogens, thereby contributing further to environmental contamination. Diarrheic calves become a primary source of infection not only for other calves, but also for adult animals and the environment. Hence, management of the beef herd throughout the winter and spring should be aimed at breaking the cycle of transmission of enteropathogens from carrier animals to the environment and eventually newborn calves. This can be done by increasing resistance and decreasing the risk of infection of both cows and newborn calves.

The management techniques used for prevention and control of epidemics of diarrhea are similar. However, preventive management provides many more options because it involves integrating and variety of procedures into the herd management program throughout the year. In contrast, when faced with trying to control an epidemic which is already underway, producers are restricted to using far fewer management procedures. They must deal with an immediate problem and therefore can use only those procedures which can be adapted and applied quickly. Alteration of management during spring calving is made even more difficult because resources such as labor, feed, and bedding are limited, or their application is restricted by inclement weather or shortage of facilities.

Proper management implies several things. It implies the ability to recognize a potentially dangerous situation and to adjust management procedures to remove the potential hazards. For example, a heavy snowfall, such as occurred in 1974, creates a potentially dangerous situation for several reasons. Herds are often confined which causes a build up of contamination in the wintering area and on the cows. When the snow starts to melt, usually after some calves are already on the ground, the ground surface becomes wet and muddy. This places a stress on the calves and helps to spread

infection. Under these conditions a potential exists for severe outbreaks. Steps should be taken before calving starts to decrease this potential. Cows should not be wintered and calved on the same ground. The proposed calving area should be kept relatively free of snow and the herd should be moved onto this area shortly before the onset of calving.

Proper management also implies the ability to recognize and correct those conditions which are causing a problem. No one can predict and avoid all of the potential dangers which will arise and epidemics will still occur in spite of apparent good management in some herds. However, the duration and severity of many outbreaks can be limited by altering or modifying management programs as soon as problems arise. For example, a farmer may have calved his herd of 100 cows in a 12 acre field for the past two years and not had any diarrheic calves. However, this year he has increased the number of calving cows to 120 and early spring storms have made the ground surface much wetter than it was during the past two years. About 50 percent of the calves have diarrhea. He should recognize that the transmission distance between animals is reduced since there are fewer square feet per cow-calf pair this year because more cows are calving within the same total area. Also, if the ground surface is wet, the level of contamination with infectious agents is likely to be higher. He should allow each cow-calf pair more space, perhaps by dividing the herd into two groups of 60 or by moving to a larger area. He should also supply more clean, dry bedding than in previous years.

It is not possible to outline one management system which is suitable for all herds under all circumstances. There are at least five basic management principles for the prevention and control of calf diarrhea, each of which can be adapted in individual herds to a greater or lesser degree. Most of the data used to illustrate these principles was obtained from the results of the CALF SCOURS QUESTIONNAIRE in Western Canada from 1973 to 1976.

The five principles are:

1. Remove the source of the infection from the calf's environment.
2. Remove the calf from the contaminated environment.
3. Increase the non-specific resistance of the calf.
4. Increase the specific immunity of the calf.
5. Reduce stress.

1. Remove the Source of the Infection from the Calf's Environment:

It is not possible to completely remove the infectious agents which cause diarrhea from the calf's environment. Some enteropathogens are carried by the cow and are transmitted to the calf during or shortly after calving. It is also likely that some bacterial and viral pathogens can survive for long periods in manure, contaminated bedding, and perhaps soil. Excess surface water, which is often a problem in calving grounds during the spring thaw, may be another source of contamination. Calving inside during the winter and spring can be particularly dangerous because contamination builds up quickly in poorly ventilated, damp areas not exposed to sunlight. After treating or handling diarrheic calves, people also become a primary source of contamination.

Prevention - The major objective is to keep the level of environmental contamination low so that the calf's natural defence mechanisms are not overwhelmed particularly before it ingests colostrum. The following recommendation will assist in reducing and controlling the level of contamination:

- Avoid confining the herd as much as possible during the winter feeding period. Rotate feeding and bedding areas so that cows and heifers are not forced to remain in a contaminated environment. This will help to reduce the number of infected "Carrier" cows which shed enteropathogens in their manure. Udders and underbellies will also be less contaminated which will reduce the risk that cows and heifers will be a primary source of contamination when they are moved into the calving area.
- Do not calve cows and heifers in the same location where they were held during the winter months.
- Move cows and heifers into the calving area one to two weeks prior to the onset of calving. This will prevent the excessive accumulation of manure and contaminated bedding in the calving area.
- Do not allow cows and heifers to become "over confined" during calving. The herd, particularly the heifers, must be observed during calving. However, they should not be restricted to small areas, particularly muddy corrals or small paddocks. Even animals calved on large areas can become confined by excessive snow or by restricting the placement of feed or bedding to the same areas.
- Allow animals plenty of space at calving. If the ground surface is muddy or wet, allow more square feet per cow-calf pair. If the calving herd cannot be turned out because of excessive snow, plow or bulldoze strips on sidehills and hilltops so they have room to disperse. This technique was used successfully to control outbreaks in several herds when record high snowfalls occurred in 1974. Change the location of feeding and bedding grounds every few days to encourage the herd to migrate within the calving area.
- Do not calve in the same location year after year, particularly if diarrhea has been a problem in that area previously. Attempt to rotate calving grounds from year to year.
- Locate calving grounds to take advantage of natural shelter and where the soil type and the contour of the land allows natural drainage away of surface water.

— Calving areas should be cleaned up and left vacant through the hot, dry, summer months. All manure and excess bedding should be removed so fresh, underlying soil is exposed.

Control - Once an outbreak has started, it is very difficult to remove the source of contamination from the calving area. Even if diarrheic calves are isolated, infectious agents may survive for a period of weeks or months in contaminated barns or sheds, in bedding, soil and ground surface water. Livestockmen who handle and treat sick calves also become a common and potent source of transfer of enteropathogens from calf to calf. If movement away from a contaminated calving area is not possible, provide as much clean, dry bedding as possible and attempt to disperse animals by spreading out bedding and loafing areas. If possible, the person treating sick calves should not have any direct contact with newborn healthy calves.

2. Remove Calves from the Contaminated Environment

Calves born on open range do not develop severe diarrhea as commonly as calves born and raised in confinement. This occurs because as the number of square feet available per cow-calf pair in the calving area decreases, several things happen:

1. The calving area becomes more contaminated.
2. The transmission distance between animals decreases thereby increasing the rate of passage of infectious agents from animal to animal.
3. The transfer of passive immunity from cow to calf may be impaired (8).
4. Stress may increase.

Therefore, the potential for an outbreak of calf scours is higher when the entire pregnant herd is allowed to calve out in the same area and when the calves are allowed to accumulate in the same location until all the calves are born.

Prevention - A. Avoid calving in areas in which the level of contamination with infectious agents is likely to be high. These areas include:

1. Barns and sheds - The level of contamination builds up rapidly during the winter because effective cleaning and disinfection are difficult. In addition, ventilation and sunlight are restricted so that infectious agents survive for long periods. Therefore, avoid using barns or sheds which have been used to house or treat affected calves.
2. Corrals and paddocks in which there is an excess of mud and manure or in which the animal population density is high.
3. Local areas within the calving grounds such as restricted feeding, watering, and bedding areas and low-lying areas with poor drainage.
4. Areas which have been contaminated by diarrheic calves.

Attempt to calve in a clean, dry area where animals are not restricted in their movements. If calving has to be done in a confined area, try to remove the cow and calf to a new area as soon after birth as possible as described below.

B. Prevent crowding in the calving area.

A management system leased on the dual principles of 1) dividing the calving herd into smaller subgroups and, 2) dispersing newborn calves soon after birth will help prevent crowding and also increase the ease of providing surveillance and assistance to those cows which need attention.

Two such systems which have been used in Western Canada are outlined in Figures 1 and 2. The basic design was described by Dr. John Bradley[1] and used at the Canada Department of Agriculture Lacombe Research Station and similar systems are now used by many cow-calf producers.

In the Lacombe system, the main herd of several hundred cows is divided into smaller subgroups which are calved in separate areas. In addition, the cow and the calf are moved out of the main calving area into a nursery area within one day of birth of each calf. This system helps to overcome the problems of crowding, mismothering, failure of calves to suck colostrum early enough, and calf diarrhea. By moving the cow-calf pairs out of the main calving area as the calves are born, the job of observing the remaining calving cows is also made much easier.

The following recommendations were suggested for use of the divided calving areas:[1]

1) The calving area is sheltered by trees or windbreak fence (8 feet high, 20% porosity). A shelter and handling facilities may be included for difficult calvings. Nursing pastures each contain two calf shelters with windbreak fence at each end. Shelters at Lacombe are 24 feet long, 10 feet deep, and 8 feet high in front and easily moveable on skids. They are used primarily as creep areas, bedded for use of calves only.
2) Keep bedding in calf shelters fresh and clean. Move shelters when necessary.
3) The water supply to calving and nursing areas is provided by a winter water line and tank with an electric heater. If necessary, water troughs may be kept open by using propane or coal heaters, or water may be hauled by truck for short periods.
4) It is preferable to have an extra area (corral, barn) for chronically sick animals, weak calves that are sure to

[1] *Recommendations For The Management of The Beef Cow Herd During Calving Season, to Minimize Incidence and Severity of Acute Neonatal Diarrhea. J. A. Bradley. Presented at the Calf Scours Seminar, High River, Alberta, January 7, 1974.*

be a problem, and cows with no milk.

5) Move pregnant cows to the calving area approximately two weeks before calving. The bedding should be as clean and dry as possible, especially when calving starts.
6) Within one day after calving, move the cow and calf to one of the nursing areas. Do *NOT* calve and leave in calving area.
7) Fill nursing areas to maximum density of 35 to 40 cows for each 10 to 12 acre area. Then start in a new nursing area.
8) Do not leave cow and calf in smaller nursing pastures longer than four weeks. If weather permits, move each group out into larger summer pastures when the youngest is three weeks old. Otherwise problems with parasites and coccidiosis may occur.
9) In small herds it may be possible to calve in a corral, but it is not recommended. Again, cows and calves should be dispersed as soon as possible.
10) With herds larger than 150 cows the system can be duplicated. Alternately, older cows may be allowed to calve on the range and heifers and other cows of particular concern (exotics, purebreds, known problem calvers) managed as described.
11) Clean and harrow pastures thoroughly two or three times after use and leave vacant until grass is re-established. Graze over summer as required, harrow again in fall, and leave vacant for as long as possible over winter.

It is difficult to define the maximum allowable population density in each area because it will vary depending on weather and ground surface conditions, the level of environmental contamination, and herd immunity. As a general rule, provide as much space per cow as possible. The Lacombe system was originally designed so that 70 cows would calve in 16 acre pastures; however, the entire area was not always available to the cows because of heavy snowfall. Following calving, 35 cow-calf pairs were dispersed onto 12 acre nursing areas. At the University of Saskatchewan Termeunde farm near Lanigan, Saskatchewan, use of a similar system successfully minimized scours when cows were allowed 1,000 square feet (50 cows in 50,000 square

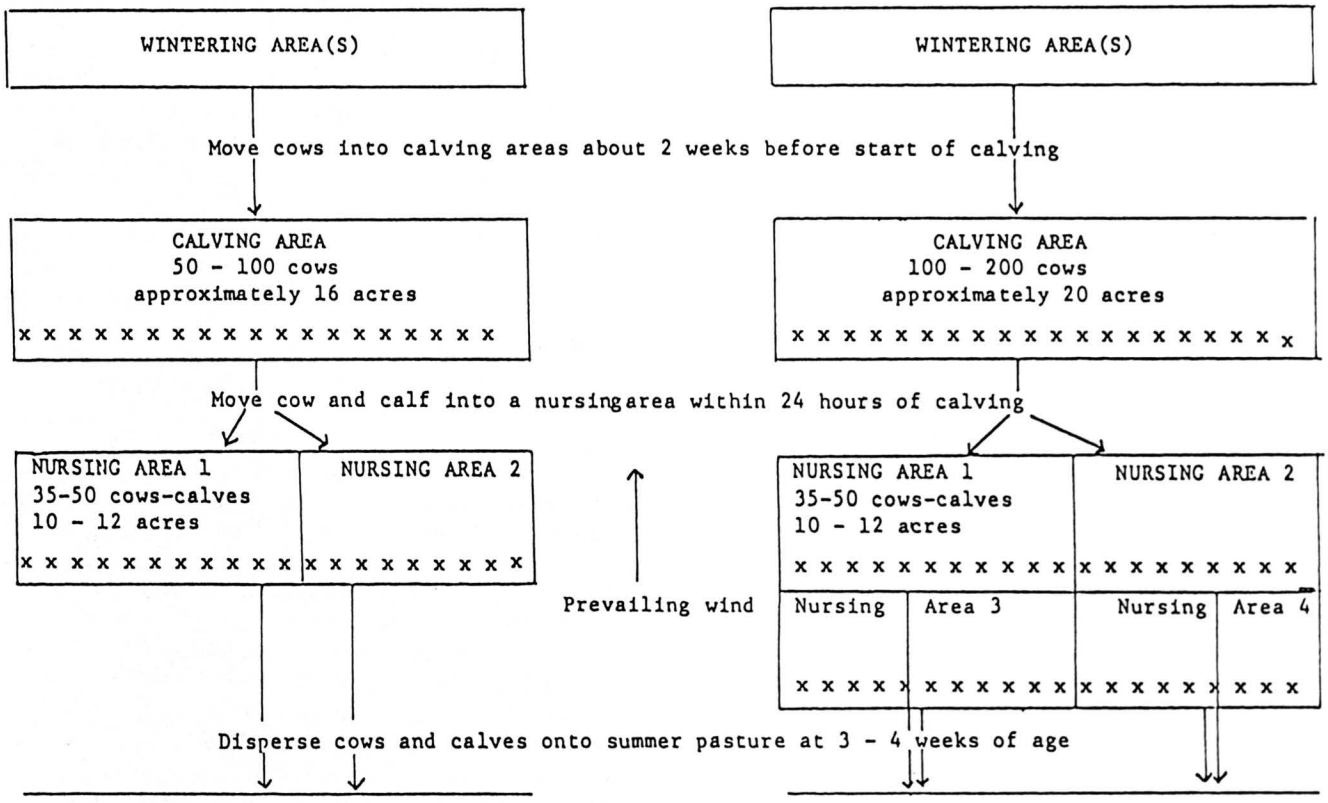

Figure 1 - Lacombe-type management system for groups of 50-100 cows. Larger herds may duplicate this system or use a design similar to Figure 2.

Figure 2 - Lacombe-type management system for groups of 100-200 cows.

xxx = 20% porosity fence or natural windbreak

feet) but not when allowed 250 square feet (50 cows in 12,500 square feet) in the calving area (S. D. Acres, unpublished data). Newborn calves were moved to 8 acre nursing areas within two to three hours of birth.

Some advantages of a Lacombe-type system are:[1]

1. It is easier to examine the pregnant cows and heifers as a group and the cows which have already calved as another group.
2. Cows and calves are together with their own kind and find one another more readily. They are not disturbed by cows close to calving claiming another cow's calf.
3. There is a more relaxed environment for the calf, less movement in the herd and less likelihood of being trampled.
4. Calves of approximately the same age are grouped together which facilitates movement to large pastures according to age, and for branding and castrating schedules.
5. The herd is already divided if an outbreak of diarrhea develops.

Disadvantages include:

1. The initial cost of construction. This should be more than compensated for by reduced expenditures on medication and calf losses.
2. Increased time and labor for snow removal, feeding, bedding, and observing multiple groups. Reduced time spent on treating sick calves should compensate for these added inputs.

As mentioned above, there are additional risks associated with calving indoors because environmental contamination builds up rapidly. When indoor calving is practiced, a Lacombe-type system is still recommended for post-calving management.

Control - The above recommendations can also be applied during an outbreak. Cows which have not yet calved should be removed from the contaminated calving area to a "clean" location and one of the systems described above for reducing population density should be started. Most cases of *E. coli* diarrhea are initiated during the first 24 hours of life so handling of calves during the first day should be avoided if possible. In order to break the cycle of infection, it may be necessary for livestockmen to take special precaution to avoid contaminating their hands, clothing, and boots. In some cases it may be beneficial to wear disposable rubber gloves and clean coveralls if it is necessary to handle newborn calves when moving them from the calving grounds to holding areas or post-calving areas. Footbaths may also be used by workers moving from one pen to another. A fenceline is normally sufficient to control spread.

3. Increase the Non-Specific Resistance to the Calf

The newborn calf must ingest colostrum within a few hours after birth. The antibodies in the colostrum are absorbed into the blood circulation with maximum efficiency during the first six hours after birth and thereafter the efficiency of absorption is reduced quickly and almost no absorption occurs after 24 hours (13).

If calves ingest liberal quantities of colostrum within 12 hours after birth, they will usually attain serum gammaglobulin levels high enough to prevent bacteremia, septicemia, and death from diarrheal dehydration (4, 5). The minimum amount of colostrum which calves should ingest during the first 12 hours to attain satisfactory serum gammaglobulin levels is 50 ml per kg of body weight (5% body weight) (6). Therefore, a 40 kg calf should get about 2 L as soon as possible after birth.

The amount of colostrum ingested by the calf in the first six hours is dependent upon three factors:

1. *The amount of colostrum available from the dam.*

The amount of colostrum available will depend on the maturity of the cow and adequacy of the nutrition throughout the winter.

Based on a survey on one Hereford ranch, 50% of the two-year old heifers had only 500 ml or less of colostrum immediately after calving, 75% had only 750 ml or less and only 6% had between 1,000 and 2,000 ml. This suggests that under some conditions heifers may not have sufficient colostrum. This shortage of colostrum is due to a combination of inheritance, lack of maturity, and inadequate nutrition.

Calves which are born weak and cannot or do not want to suck should be offered one to two pints of warm colostrum by nipple bottle or force-fed the colostrum with a stomach tube. There is more than adequate absorption of immunoglobulins when colostrum is given by tube within minutes after birth (10).

2. *The maternal behaviour of the dam and whether or not she lets the calf suck.*

Mismothering occurs commonly in two-year old heifers (they make no effort to establish a dam-calf relationship) and abandon their calves or do not allow them to suck. Some of these heifers can be encouraged to accept their calves. The heifer is restrained in a head gate and her hind legs hobbled so she can't kick. The calf is held up to the teats and encouraged to suck. Confinement of the heifer with the calf in a small pen for a few days will often result in acceptance of the calf.

When the dam-calf relationship has been established (when the calf is sucking and is encouraged by the mother to

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suck), the cow and calf should be moved out of the main calving area to a nursery area or pasture. This will prevent overcrowding which is a common predisposing cause of calf diarrhea.

3. *The vigor of the calf and whether or not it can suck the cow.*

The vigor of the calf and its desire and ability to stand, "seek the teat," and suck the necessary amount of colostrum will depend on the health of the calf and the environment. Newborn calves may be weak at birth because of congenital defects and infection or because of a difficult and prolonged birth. The cause of the "weak calf syndrome" is still uncertain, but *in utero* infection of the fetus in late gestation is a possibility. Prolonged difficult dystocia may cause intrapartum hypoxia, edema of the soft tissues of the head including the tongue, and inability of the calf to suck early enough. All of these calves must be given colostrum as soon as possible either by nipple bottle or force feeding using a stomach tube. Calves which are born in deep snow or are exposed to very cold and windy weather may become hypothermic, weak, and unable to stand or suck within one hour. These calves must be detected early and fed adequate quantities of colostrum and placed in a dry, weather-protected area until they have regained their strength.

4. Increase the Specific Immunity of the Calf

The degree of immunity to specific enteropathogens in each animal (individual immunity) and within herds (herd immunity) varies depending on previous exposure to the infectious agents.

Most strains of *E. coli* known to cause diarrhea in calves possess the K99+antigen which helps the bacteria to colonize the calf's small intestine (3, 12). The K99+antigen is a filamentous structure found on the surface of most enterotoxigenic *E. coli* (ETEC) regardless of serotype (7, 11, 12). Colostral antibodies against the K99+antigen will prevent diarrhea caused by K99+ ETEC (2). Under natural conditions, the colostrum of less than 10% of beef cows contains K99+antibody, therefore many calves remain susceptible to *E. coli* diarrhea during the first few days of life even though they ingest colostrum soon after birth. Immunity to the K99+antigen can be induced by immunizing pregnant cows during the third trimester of gestation. A formalin-killed bacterin prepared from a K99+ strain of *E. coli* (VICOGEN - Connaught Laboratories) is available and should be administered subcutaneously to cows twice, the first time six to seven weeks before the onset of parturition and the second time about three weeks later. In the face of an outbreak, some beneficial immunity may develop within three weeks following the first injection. Cows which calve up to 45 to 60 days after the second injection have protective colostral antibody titres.

In contrast to the above, individual as well as herd immunity to rotavirus is high in beef herds in Western Canada. In a survey of ten cows from each of 20 herds, 146 cows (73%) and 19/20 (95%) herds were positive for rotavirus antibody (9). Therefore, over 70% of beef cows appear to have colostral levels of rotavirus antibody high enough to prevent diarrhea during the first five to seven days of life. However, colostral antibody levels decline rapidly after calving and many calves probably become susceptible to rotavirus diarrhea by one week of age because antibody levels in the milk reaching the lumen of the small intestine are not high enough to prevent infection and multiplication of the virus. Also because of this decline in antibody levels, outbreaks of rotavirus diarrhea can occur year after year inspite of the presence of colostral antibody in most of the cows at calving (1, 14). When herd immunity is low, outbreaks of rotavirus diarrhea can occur in younger calves but this appears to be the exception rather than the rule. Sporadic cases will also occur in younger calves if they do not ingest colostrum, or when the volume of colostrum ingested is low (i.e. heifers). Serum antibody to rotavirus does not prevent diarrhea (14).

A modified live virus vaccine (Calf Guard - Norden Laboratories), which contains both rota and coronaviruses, can be administered either to the cow prior to parturition or to the calf at birth. By vaccinating the dam, the expected rapid decline in colostral antibody levels is delayed so that antibody persists in the milk for longer than normal. There is not yet sufficient evidence available to allow a critical evaluation of the vaccine when administered to the dam. Alternatively, the same vaccine, previously marketed as Scourvax II, can be administered orally to newborn calves at birth. To be effective, the manufacturer recommends that all newborn calves in the herd be vaccined. This procedure is supposed to reduce environmental contamination resulting from passage of the viruses through clinically normal calves. In nursing calves, there is a danger that the vaccine virus will be neutralized in the intestine by colostral antibody thereby making it ineffective. Because of this problem, it could be counter-productive to administer the vaccine to both the dam and the calf. Initiation of oral calf vaccination in the face of an outbreak may not be effective.

There is not, nor is there likely to be in the near future, a vaccine which is effective against all enteropathogens. Multiple-component vaccines which provide protection against several enteropathogens appear to be technically feasible and may becom available within the foreseeable future. Although neither manufacturer of the above vaccines has recommended that both be administered together, there does not appear to be any reason at this time why they should not be administered at the same time but by separate injection. This type of approach should be most beneficial in herds where infection with K99+ ETEC and rota or coronavirus exists. Colostrum from vaccinated cows can also be stored frozen and fed to weak or neglected calves, or used for treatment of sick calves.

Apparent failure of the vaccines under field conditions may occur for a variety of reasons. Other enteropathogens, such as Cryptosporidia, Salmonella sp, and other viruses which are not related to the antigens in the vaccines, may be

present. There may be strains of ETEC which colonize the small intestine by some mechanism other than K99 antigen and against which K99 antibody will not be protective. Such strains have not yet been identified. There is also increasing evidence that there are different strains of bovine rotavirus which could be immunologically distinct. If so, a viral vaccine prepared from one strain of virus might not protect against all other strains of the virus which occur in the field. Also, in herds where animals are crowded within the calving area or where the level of environmental contamination is high, the protective level of colostrum may be overwhelmed by infection pressure. Individual calves may also fail to ingest colostrum for a variety of reasons.

5. The Reduction of Stress

Stress is the reaction by which the animal body adapts to environmental conditions. The ability of newborn animals to adapt to changes in the environment is limited and conditions which appear to have no effect on mature animals may be detrimental to the newborn calf. It has been recognized for many years that stress is a contributing factor in many individual cases and in outbreaks of calf diarrhea. However, because many different environmental conditions can cause stress and because stress is difficult to measure, it has not been possible to identify all of the factors which contribute to the problem. Also, some conditions such as "over-crowding" which cause psychological and physical stress, also lead to increased levels of contamination and exposure to infectious agents.

The results of the CALF SCOURS QUESTIONNAIRE sent to the ranchers in Alberta and Saskatchewan have helped to identify some of the factors which contribute to stress.

1. Inclement Weather - Many outbreaks occurred within 48 hours following snow storms when the weather was classified as cold and changeable. Later in the spring, rain will also precipitate epidemics.
2. Poor Ground Surface Conditions - Ground surface conditions preceding outbreaks were classified as "wet" by 81% of ranchers. Excess surface water and cold, wet bedding makes it difficult for calves to find a comfortable place to sleep and leads to the buildup and spread of contamination. Locate calving areas to take advantage of natural drainage away of surface water. Use clean, dry straw for bedding. Increase the amount and depth of bedding as ground surface conditions become wet or muddy.
3. Crowding - Crowding can cause stress and increase exposure to infectious agents. These two effects are difficult to separate, however, as the number of square feet per cow-calf pair decreases, the incidence of diarrhea increases.

   During the first two weeks of life calves spend most of their time sleeping or sucking. Under crowded conditions their resting and feeding patterns may be altered. This stress, added to increased exposure to infectious agents may result in a higher incidence of dairrhea. Every effort should be made to ensure that calves have a clean, dry, sheltered area in which nursing and resting are not disturbed.

Summary

It is frequently evident that outbreaks of diarrhea occur in spite of apparent "good management" and "good calving conditions". This observation underlies the fact that we still do not understand many of the epidemiological factors which contribute to calf diarrhea outbreaks. For example, we still lack biological criteria by which to judge the degree of crowding and the degree of stress. Nevertheless, application of the principles described above will prevent or decrease the severity of many annual epidemics. To be successful, a program of prevention and control should be discussed with producers long before the calving season, preferably during the preceding summer or fall. Implementation of a complete program may take several calving seasons and producers should be made aware that prevention by improved management is an on-going, evolutionary process. More and improved vaccines are becoming available; however, as is the case with most biologicals, their impact cannot be determined until after they have been used for several years. They should be recognized as only one of several management tools at the disposal of the veterinarian and livestock producer.

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