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Proposed Calfhood Immunization Program for the Commercial Dairy Herd

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ABSTRACT

Immunization programs never will usurp the central role of sound management practices and good nutrition in the disease prevention program of the commercial dairy operation. However, certain immunizations against diseases such as brucellosis, leptospirosis, and clostridial infections should be routine. Other diseases such as infectious bovine rhinotracheitis, bovine virus diarrhea, parainfluenza-3, colibacillosis, and pasteurellosis should be considered if it can be determined that the herd is infected chronically. The present knowledge of other disease conditions, vaccine effectiveness and safety makes the use of vaccines for other diseases of questionable value.

INTRODUCTION

The task of rearing healthy calves as milking-line replacements always has been a major problem of the dairyman. Little thought is required to realize that the death loss of potentially great producers due to scours and pneumonia in the baby calf is a major difference between a financially rewarding and a marginal or bankrupt operation. Management and nutrition are the keys to the door of successful disease prevention. Prophylaxis and treatment can be considered only, at best, a second line of defense against decimating diseases of the dairy calf. The prevention of disease by enhancing the immune mechanisms of the baby calf to increase its resistance to disease never should become more important in the dairyman's mind than the strict adherence to good management practices and sound nutritional programs. Such sound principles as the assurance by the dairyman that the neonatal calf receives adequate amounts of antibody-laden colostrum within the first few hours of life cannot be overemphasized. Even though this practice has a sound immunologic basis, it will not be considered in this discussion except as it applies to specific vaccination programs. The purpose of this report is to make an unbiased evaluation of the many vaccines available and try to develop recommendations1 for a reasonable vaccination program based upon scientific knowledge of the immunogenicity of the product, the resistance developed in the animal vaccinated, and the reasonable risk involved in not vaccinating the animal. The report is organized around bacterial and viral disease agents that may be expected in neonatal, young, and growing calves.

Diseases of the Neonatal Dairy Calf

The most prominent diseases in the neonatal dairy calf may be divided for convenience of discussion into septicemias and diarrhea-respiratory disease complexes.

Septicemias. Septicemic diseases usually occur in the first few hours of life. The syndrome is due to the growth and circulation of pathogenic bacteria and their toxigenic products within the blood stream. The clinical signs of fever, hemorrhages in the mucosal surface, lethargy, prostration, and hypoxia are indications of a grave prognosis. The disease can be caused by bacteria in virtually every genera of bacteria, but the most common ones, Streptococci, Escherichia, Salmonellae, Corynebacteria, Klebsiella, and Proteus, usually enter the blood stream through superficial wounds in the mucosal surfaces or severed naval cords. The value of colostrum to prevent such serious infections is unknown. Maternal antibody could

1 The recommendations are the opinions of the author and should not be construed to represent official positions of any organization or institution.
play an important role as a protective mechanism in light infections, but gross contamination always would overwhelm such protective mechanisms. No known vaccines to be used in the neonate have been effective nor would be expected to be developed against these bacterial agents. Viremias are in the same category as the above, but both conditions seem to be reasonably rare.

**Diarrhea-respiratory disease complex.** Bacterial and vital pneumoenteritis of the neonatal calf is perhaps the most prevalent cause of calf losses. A review of the literature indicates that many different agents are involved in the pathogenesis of diarrheal disease of the neonatal calf. These agents may be singularly causal or may serve as concert pathogens in combined infections. They may be divided conveniently into bacteria and viral agents. Bacterial causes include such well known agents as Escherichia coli (coli bacillosis), Salmonella typhimurium, S. Dublin, and other sp. (Salmonellosis) and, occasionally, other genera of bacteria. The viral agents associated with pneumoenteritis include bovine virus diarrhea—mucosal disease virus (BVD), reovirus, coronavirus, adenoviruses, infectious bovine rhinotracheitis (IBR), bovine parvoviruses, and probably enteroviruses.

**Bacterial Diseases of the Neonatal Calf**

*Colibacillosis.* It has been estimated that *E. coli* is responsible for 90% of the calf losses in early neonatal life. Colibacillosis may account for as many as 50% of the calf losses in a herd, and death rates of 10 to 20% are not uncommon. Because the disease strikes so early in life, it probably is not reasonable to believe that a vaccine could be developed that would immunize the individual effectively soon enough to prevent disease. Recent experimental data shows promise, however, in immunization of the dam with bacterins prepared from known pathogenic strains of the organism (31). Myers and his colleagues (30) have shown that effective resistance to experimentally induced colibacillosis is induced in calves nursing dams immunized with bacterins injected subcutaneously 1 yr previously and 1 wk before the expected beginning of calving within the herd. The practice of preparing autogenous bacterins from *E. coli* strains isolated from problem herds to vaccinate dams has been recommended by veterinarians for years, but these reports are sound scientific evidence that the procedure is effective. Though commercial vaccines are not now available, Myers (30) reports that “a commercial firm has prepared the vaccine for sale and will release it for marketing as soon as a license becomes available.” He recommends that the primary vaccination be administered 6 mo before and a secondary booster be given 1 mo before the expected calving date. The effectiveness of such a vaccination program on experimental infections with the homologous strain of *E. coli* provides hope for the dairyman, but the results of this and other investigations (8, 11) must be verified carefully against the efficacy of the procedure on a routine herd basis. The impact of strain differences in vaccine development and immunospecificity cannot be predicted with certainty.

*Salmonellosis.* Acute enteritis in neonatal dairy calves caused by salmonella infection are not rare, but the incidence is much lower than *E. coli* infections. The same type of general conditions apply as in the colibacillosis situation. Vaccination programs designed to immunize the dam and thereby provide antibodies via the colostrum offer hope. Since salmonella infections are more prone to be a serious disease in later life, it would be more feasible to suggest the possibility of developing a bacterin to be used in early calfhood to protect from Salmonellosis. The availability of effective vaccines for commercial use is unknown to the author. The procedures for development and potency testing of Salmonella vaccines have been reported (2).

**Viral Diseases of the Neonatal Calf**

Bovine virus diarrhea (BVD) causes serious disease in calves (35). Experiments by Lambert et al. (23) indicated that deaths due to acute enteritis may occur within 18 to 96 h of birth and that chronic diarrhea could exist for weeks. Widespread use of attenuated live viral diarrhea (BVD) virus vaccines has been reported (22). Their use in dairy calves has been recommended in conjunction with concentrated anti-BVD bovine serum (20). However, the seriousness of side reactions and the chronic nature of BVD infections has prompted caution and has promoted the investigation of killed virus vaccine development (21). Experimental evidence indi-
cated that such inactivated vaccines can be prepared (9, 10) but currently are not available commercially.

Infectious bovine rhinotracheitis (IBR) virus has caused intestinal disease in young and neonatal calves (12, 34). The wide range of symptoms recorded (12, 16) exemplifies the complex nature of the disease in chronically infected herds. The agent is apparently widespread in dairy herds (16), but each of these reports indicates that the widespread use of modified live virus vaccines may be responsible for some of the evidence for the existence of chronic infections. The intranasal type vaccine to prevent disease is recommended by workers actively pursuing research in this area (17). The primary vaccination should be given at 4 to 6 days of age, a secondary booster vaccination should be given at 6 mo of age and again at one yr and annually thereafter. The dangers of a modified live virus vaccine causing overt disease in immunodeficient calves or of reverting to the virulent form at present cannot be evaluated properly. Our own research indicates that few passages in bovine tissue culture cells and an increase in the viral titer of the inoculum will cause similar lesions to the field strain when inoculated by the same routes and that recrudescence of the vaccine virus by chemical immunosuppression causes overt disease. The use and effectiveness of an attenuated non-abortigenic temperature sensitive mutant of IBR has been reported (41). The theory behind such an effort is intriguing, but the vaccine must still be considered experimental.

Adenovirus infections have caused diarrheal disease in newborn calves in Europe (3) and North America (5, 24). Bovine adenovirus type 5 has been implicated as being one of the causal agents in the so-called "weak-calf syndrome" and has produced mild diarrhea when inoculated into neonatal calves (25). Adenovirus vaccines have been used widely in Europe (6), but their effectiveness is questionable. A limited field trial is underway in this country, but recommendations for their use in a herd health program must be withheld until such time as a proven potent, safe vaccine is available and the extent and importance of the disease condition in this country is known.

Bovine reoviruses have caused diarrheal disease in young calves (26, 39), and it has caused high incidence of herd epizootics in beef herds (40). The use of a modified live virus has been reported and, its use recommended to control outbreaks of the disease when a definite diagnosis has been made in a herd (27). Since adequate nonvaccinated controls were not used, it has been difficult to evaluate the effectiveness of the vaccine in controlling natural outbreaks of diarrhea. Expanded studies were reported later (28), but the evidence for the necessity for routine vaccination programs and efficacy of the vaccine in preventing diarrhea is not convincing.

Coronaviruses have caused diarrheal disease in neonatal calves. Their morphology and pathogenicity in neonatal gnotobiotic calves were described (36). The infections were in 12 of 19 beef herds examined. Though commercial vaccines are available, the scientific data are insufficient to determine the efficacy, potency, safety, and necessity of vaccination as a routine procedure.

Enteroviruses and paroviruses have been associated with diarrheal disease of the young calf (1, 37). They are apparently widespread infections, and diagnosticians and other investigators often isolate one or both from calves with diarrhea. These viruses frequently are isolated from calves that are apparently healthy. The knowledge of the pathogenicity of

| Disease                  | Age of animal | Type of product | Revaccinate   |
|--------------------------|---------------|-----------------|---------------|
| Brucellosis              | 4 mo          | B. abortus strain 19 | No            |
| Clostridial infections   |               |                 |               |
| Black leg                | 3 mo          | Bacterin        | 10–12 mo      |
| Malignant edema          | 6 mo          | Bacterin        | 1 yr and annually |
| Leptospirosis            |               |                 |               |

TABLE 1. Routine immunization procedures.
TABLE 2. Immunization practice if the viral disease diagnosis has been made within the herd or if addition of animals from other herds is frequent.

| Disease                             | Age of animal | Type of product         | Revaccinate               |
|-------------------------------------|---------------|-------------------------|---------------------------|
| Infectious bovine rhinotracheitis   | at birth      | MLV-intranasal          | 6 mo & annually           |
| Parainfluenza-3                     | at birth      | MLV-intranasal          | 6 mo & annually           |
| Bovine virus diarrhea\(^a\)         | 4 to 6 mo     | MLV-intramuscular       | annually 1 mo prior to breeding |
| Reovirus infection\(^b\)            | at birth      | orally                  | no                        |
| Adenovirus infection\(^b\)         | at birth      | intramuscular           | no                        |
| Coronavirus infection\(^b\)         | at birth      | orally                  | no                        |

\(^a\) If commercial inactivated vaccines become available, this one should become routine.

\(^b\) Present vaccines are of questionable value, further information is needed.

these two groups of viruses is not complete. Our studies indicate that massive doses of bovine enterovirus inoculated orally in neonatal colostrum-deprived calves even when immunosuppressed with corticosteroids did not cause serious enteric disease.

Diseases of the Juvenile and Young Adult Cattle

Consideration of routine immunization of calves against several well known diseases should be incorporated into recommendations for a vaccination program for herd replacements.

*Brucellosis.* The vaccination of dairy calves with *Brucella abortus* strain 19 is a well accepted and scientifically sound principle (18). The vaccine is recommended for calves, except bulls (19), at 4 mo of age. However, the establishment of persistent infections with shedding of live organisms in the milk following standard vaccination procedures (29) is one of several undesirable features of the vaccine. Probably all vaccines used in animals could be improved, and current research (13, 33) in development of Brucellosis vaccines with *Brucella abortus* strain 45/20 prepared as a killed vaccine offers hope for those of us who desire an effective killed brucella vaccine.

*Leptospirosis.* A brief review of the *Leptospira* serotypes causing disease in cattle throughout the United States has been presented (38). The author's recommendation for the use of a polyvalent bacterin containing *L. pomona*, *L. grippotyphosa*, and *L. hardjo* seems practical.

*Clostridial infections.* Black leg and malignant edema can cause serious losses in dairy cattle. The use of *C. chauvei-C. septicum* bacterin as a routine practice is established.

TABLE 3. Bacterins which could be used if conditions warrant and effective vaccines are available.

| Disease                | Age of animal                  | Type of product | Revaccinate                    |
|------------------------|--------------------------------|-----------------|--------------------------------|
| Colibacillosis         | Dam at 6 mo stage of pregnancy | Bacterin\(^a\)  | 1 mo before calving and annually|
| Vibriosis              | Dam 1 mo before breeding       | Bacterin\(^b\)  | 1 to 2 wk before breeding & annually|
| Pasteurellosis         | 6 mo                           | Bacterin        | no                             |
| Salmonellosis          | 4 mo                           | Bacterin\(^c\)  | no                             |
| Infectious kerato-     | 4 to 6 mo                      | Bacterin\(^a\)  | 1 mo later                      |
| conjunctivitis         |                                |                 |                                |

\(^a\) Not available commercially.

\(^b\) Rare circumstance if disease is diagnosed as herd problem and A.I. program not desirable.

\(^c\) Probably could be controlled better by sound management.
Recommendations to utilize this type of bacterin in a herd health program should meet with little opposition.

Infectious bovine keratoconjunctivitis. Efforts to develop effective vaccines to prevent infectious bovine keratoconjunctivitis (Pinkeye) caused by Moraxella bovis are underway at the National Animal Disease Center (32) and elsewhere (14). The outlook is promising, but commercial vaccines are not available.

Vibriosis. General infections with Campylobacter (Vibrio) fetus virtually has been eliminated in the modern dairy industry principally through artificial insemination procedures (4). However, in infected herds, vaccination of adult cows (15) and bulls (7) can prevent and eliminate the problem.

Recommended Vaccination Program

The following recommendations are based upon the author's personal judgment and predicated upon personal ownership of an imaginary average commercial herd operation. Several routine immunization practices can be recommended as outlined in Table 1.

Diagnosis of a specific disease condition within a herd would indicate that other vaccination programs should become routine, and in those conditions listed in Table 2 should be continued in a routine. In each situation I believe the determination of the herd status by serologic or other accepted diagnostic techniques should receive high priority to enable one to make specific recommendations for the herd immunization program.

Immunization against bacterial diseases listed in Table 3 should become routine when the disease condition has been diagnosed or vaccines have been proven efficacious and are available for commercial use.

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