*New Perspectives on the Epidemiology of Bovine Virus Diarrhea - Mucosal Disease (BVD)

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Much has been written on the subject of bovine virus diarrhea - mucosal disease (BVD) since the syndromes were first described in 1946 and 1953. However, in the light of recent studies, field experiences, and diagnostic laboratory evidence the epizootiology, significance and economic impact of BVD virus infection deserve re-examination (1,2,3,4,5).

The originally described acute contagious clinical disease of the alimentary tract appears to occur only sporadically. More often the disease is inapparent or misdiagnosed, and what is clinically diagnosed as BVD is only the "tip of the iceberg." Serologic evidence suggests that there is a widespread prevalence of BVD antibody in cattle throughout the country. One might ask, then, what is the significance of this agent if the classical syndrome is relatively infrequently seen?

Perhaps what has been underestimated is the most significant pathogenetic effect of BVD virus. Its most constant feature is its predilection to replicate in and damage lymphoreticular tissues (6,7). This can result in a significant suppression of the animal's nonspecific and specific defense mechanisms against other organisms to which it may be concurrently exposed. Organisms which are otherwise mildly pathogenic or nonpathogenic, might under these circumstances become quite pathogenic. Such synergism between BVD virus and other agents can thus cause a more severe disease than would result from either agent alone. Clinical signs seen in such cases may more commonly be referable to the accompanying agents than to BVD virus, as evidenced by the frequent involvement of BVD virus in the bovine respiratory disease (BRD) complex. Here its association with *Pasteurella sp.*, *Corynebacteriam sp.*, *Mycoplasma sp.*, *Hemophilus somnus*, and a variety of viruses such as IBR, PI3, respiratory syncytial virus, rhinovirus, and adenoviruses, may be responsible for more severe BRD due to its modifying effect on the immune system. Animals with chronic BRD and the so-called "poor doers" are often the result of combinations of infections of BVD virus and some of the above mentioned agents.

*Paper presented at the 94th Annual Meeting, Ohio Veterinary Medical Association, Feb. 4, 1978, Columbus, OH; and at the meeting of the Iowa Veterinary Medical Association, Bovine Practitioners, May 4, 1978, Des Moines, IA.

Another disease entity in which accumulating evidence indicates that BVD virus has a role, in accompaniment with adenoviruses (8), is the so-called "weak calf syndrome," characterized by tendo-synovitis, diarrhea, weakness and depression in calves 18 to 96 hours old. This disease appears to be one of several possible consequences of perinatal or *in utero* infection of the fetus with BVD virus.

Fetal infection with BVD virus may lead to fetal death and resorption or abortion, cerebellar hypoplasia, necrotic dermatitis and alopecia, pulmonary aplasia, or it may result in the birth of an apparently normal calf, particularly if fetal infection occurs after 180 days gestation. The above manifestations are dependent upon the stage of gestation during which fetal infection occurs (9,10).

Data recently reported by Smithies and Modderman (11) suggest that BVD virus isolated from an aborted bovine fetus may not necessarily have been the cause of abortion. They reported the presence of BVD virus in kidneys used for cell culture from about 10% of presumably normal late-term bovine fetuses collected at abattoirs. By comparison, BVD virus was isolated from 7.5% of 1,033 aborted bovine fetuses examined over a period of 4 years. It would thus appear that BVD virus is less abortigenic in the last trimester of pregnancy than has been previously believed. Studies by Kendrick (10) also support this view. He found that bovine fetuses infected *in utero* after 180 days gestation developed BVD antibodies and were normal at birth.

A question remains, however. Might some of such calves be latently-infected carriers of BVD virus which might exacerbate under suitable conditions of stress, etc.? Might neonatal pneumoenteritis, so common in calves 2 to 3 weeks old be in part attributable to such a circumstance?

Available evidence suggests BVD virus may be one of the most important causes of economic loss to the cattle industry. This would suggest that measures to control this disease are inadequately applied. In large part this is due to the fear by veterinary practitioners that BVD vaccines will cause severe post-vaccinal complications. This problem was reviewed most recently by Lambert (12). Available evidence indicates that the incidence of post-vaccinal BVD problems related directly to vaccine is less than 1% of

vaccinated animals, and that this is associated with failures or deficiencies in the immune mechanism of individual animals.

Undoubtedly many cattle also have been vaccinated while incubating virulent BVD virus and other infectious agents and thus vaccine was circumstantially associated with post-vaccinal disease (12,13,14,15). Animals receiving BVD vaccine following excessive stress (weaning, shipping, adverse weather, etc.) or in association with corticosteroid therapy may also fail to respond normally to an otherwise avirulent live-virus vaccine.

Recent studies and field experience with a porcine cell line modified live NADL strain BVD-MD vaccine have provided evidence that this vaccine does not cause leukopenia, viremia, is not shed in secretions or excretions, and is not spread to susceptible contact animals. Post-vaccinal problems attributable to this vaccine have not been reported. Protection against challenge has also been clearly demonstrated for this and other available BVD vaccines (16).

A big question with all available BVD vaccines is "what is the duration of immunity?" Kahrs (17) believes immunity to BVD following infection and recovery, or vaccination, to be lifelong. I believe there is too much evidence from the field to suggest that this is not the case. Indeed I have heard of several situations in which cows were annually vaccinated during their open period with BVD vaccines. Despite this program these operations were experiencing 20-50% mortality of neonatal calves, due to pneumoenteritis associated with confirmed BVD infections. It would appear in these situations that maternal immunity in terms of gbvd antibody was insufficient to confer passive colostral protection to the neonatal calves.

I have also heard of occasions of so-called BVD "vaccine breaks" occurring in feedlot calves 4 to 8 months after BVD vaccination.

There is a possible explanation for these occurrences. The traditional view has been that only one serotype of BVD virus exists, and therefore, that vaccine made with any strain will protect against all field strains. Several investigators have, however, demonstrated significant differences in antigenic and other characteristics among various strains of BVD virus (1,2,3,4,5). While immune serum antibodies developed in inoculated animals against one strain (e.g., the NADL strain) will neutralize that strain and other strains (e.g., Oregon C24V, New York 1), the neutralization index with the homologous virus strain may be 70 to 100 times greater than with heterologous strains. This suggests that minor antigenic variations among BVD virus strains may be responsible for shorter durations of protection conferred by vaccines containing a single virus strain. Protection conferred immediately after vaccination may be broad against all field strains, but may gradually become narrower and be effective only against the homologous strain by 6 to 8 months. Field evidence suggests this to be the case. Obviously research needs to be done to prove this, including research on possible polyvalent BVD vaccine containing several strains.

In some instances using two different BVD vaccines, respectively containing the NADL and Oregon C24V strains, has alleviated the problem of recurrent BVD infection in problem herds. Alternatively, BVD vaccination at 6-month intervals has also been effective in correcting such problem situations. In a few cases the use of an NADL-strain BVD vaccine in pregnant cows during the 7th to 8th month of gestation has been dramatically effective in reducing neonatal calf losses (18). This procedure was recommended for several operations where calf losses were 30-50% among calves 2 to 4 weeks old. Vaccinating cows during the open period and again at 7 to 8 months gestation virtually eliminated these losses (19).

Based on what is currently known about BVD, I would recommend BVD vaccine as a regular part of the preventive medical program for cattle. Vaccinate calves at 4 to 6 months of age (at 1 to 2 months in areas of high endemicity) and repeat vaccination at one year. Revaccination should be done at least annually. Greater effectiveness may be achieved by using one vaccine strain first (e.g., the NADL strain), then follow at 4 to 6 months with vaccine containing the Oregon C24V strain.

There is obviously a need for much more research on this disease to definitively answer the questions of duration of immunity, pathogenesis, significance of strain variations, and immune mechanisms. The availability of funds for such research has not been commensurate with the cost of this disease to the bovine industry. Our profession and livestock producers can assist by emphasizing the needs for more funding of research on this problem.

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