

Bovine Veterinarian

February 1996

A supplement to Dairy Herd Management and Drovers Journal for bovine practitioners



CALF IMMUNOLOGY
Influencing the calf's immune system
Also: Hiring food animal associates

Vance
A VANCE PUBLICATION

A clean, dry environment during calving and after calving can help prevent immunosuppressive stress on the newborn calf.



Immunology Of The Calf

What happens to the calf's immune system at an early age can affect morbidity, mortality and later performance.

By Geni Wren

Editor's note: Fifth in an immunology series

We're learning more about the immune system of cattle every day, but in the quest to increase performance and production, it's easy to forget that we need to start with the young calf.

It may surprise you that by the third trimester a bovine fetus can recognize some antigens and produce its own antibodies. "In humans, antibodies can pass from the maternal side to the fetus," explains Louis Perino, DVM, PhD, Great Plains Veterinary Education Center, Clay Center, Neb. "But the cow's antibodies cannot move through placental barriers to the calf, so the only place the calf gets antibodies is from first milk and gut absorption."

For example, if during the third trimester a calf is exposed to an *in utero* infection such as BVD, usually it will be unaffected and produce antibod-

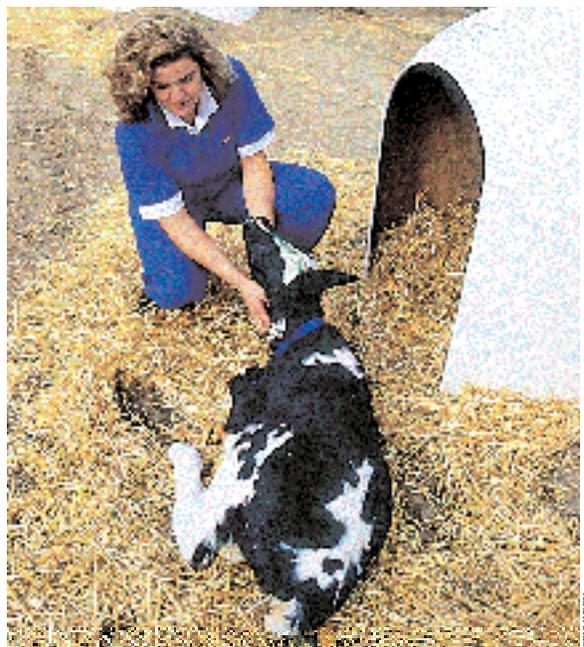
ies. "However, infections earlier in gestation can be detrimental," adds Victor Cortese, DVM, Pfizer, Inc. "Early non-cytopathic BVD can cause the developing immune system to not recognize the foreign BVD protein as foreign."

The newborn calf's immune system is functional but immature. Cortese says the complement level is about one-third of normal, B-cells aren't yet at an adult level, and neutrophil function and its ability to phagocytize are not complete. Perino adds that immune system development is a graded response that starts in the first trimester then begins to flatten out around puberty.

A calf that is deprived of colostrum does have the ability to mount an immune response and develop antibodies, says Sheila McGuirk, DVM, PhD, associate dean for clinical affairs and hospital director at the University of Wisconsin School of Veterinary Medicine. "However, if presented with an

overwhelming challenge, it's not able to mount a response that can save its life because its immune system hasn't reached the level of maturity it needs to prevent infections."

"Young calves have their immune system on one hand and pathogen levels on the other," says Tom Fuhrmann, DVM, Tempe, Ariz. "When these systems are in balance, the calf can survive. When the pathogen load gets higher, even a strong immune system isn't capable of handling it. Likewise, when the immune system become depressed for any reason — nutrient deficiency, lack of colostrum, vaccination and weather stress — a normal pathogen level can cause a sick calf."



Meg Cattell, DVM, says components other than antibodies in colostrum may affect immune response.

Start with the cow

Most of the focus of calf immunology is on colostrum, but we need to take a step back to the cow. Nutrition and vaccination of the pre-calving cow are critical to the calf's immune system.

"The cow's energy and protein levels affect calf vigor and survival," says Perino. "There will be more calves with scours from cows with deficient energy levels. This is clinically relevant."

McGuirk says colostrum quality is influenced by the dam's pre-calving levels of vitamin E, selenium, copper, manganese, zinc and others, all important for immune function.

Meg Cattell, DVM, Duo Dairy, Ltd., Loveland, Colo., says, "We've had groups of 600 calves from

purchased heifers of unknown vaccinal and nutritional status, with morbidity and mortality two-fold higher than calves from our own heifers."

"On a large commercial dairy you have control of the vaccination program in your dry cows and you can influence the immune system of the calf by paying attention to that," adds Fuhrmann.

Pre-calving vaccination timing influences the cow's immune response and colostral antibodies produced. "If you vaccinate 10 or fewer days pre-calving, you decrease her immune system's ability to respond for maximum passive transfer," says Cortese. "Vaccinating eight weeks or more pre-calving may cause the immune response to peak then fall to a lower level than we want."

"Vaccination of the dam in the 60 days pre-calving does change the colostral antibody content and may even change some of the colostrum's cellular components," adds McGuirk. "The dam needs at least two to four weeks to respond to a pre-calving vaccination in order for the calf to derive the benefits from the colostrum."

Colostrum

Good colostrum from a calf's dam is usually rich in antibodies, but there are other components of colostrum under study that may enhance the calf's immune system.

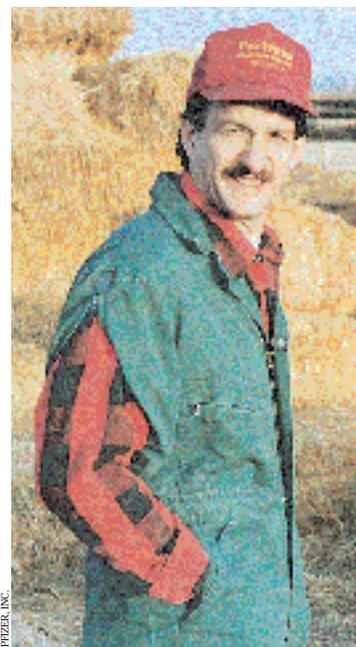
"We focus almost entirely on antibody transfer and that may be just one of the critical factors," Cattell notes. "Some data shows white blood cell transfer of cell-mediated immunity (CMI) may be important, but we don't have all the answers yet."

"There are neutrophils, macrophages, T and B cells in colostrum, and many are absorbed and functional in the very young calf," Cortese adds. "They may help regulate and enhance defense mechanisms."

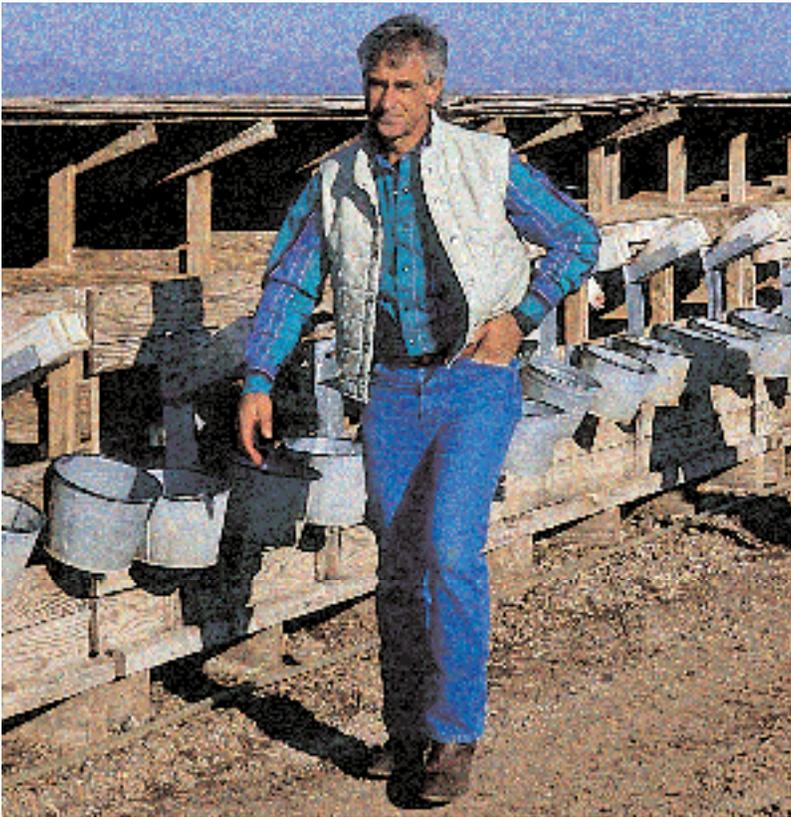
Because of these other factors, McGuirk says fresh colostrum is better than frozen. "Freezing will eliminate many of these other cellular components," she says. "Antibodies seem to be left intact, but we believe cellular components may not survive the freezing process."

Colostrum quality varies in that beef colostrum is more concentrated and takes relatively less volume to deliver the same number of grams of immunoglobulin. "We talk about the calf getting so many liters of colostrum," says Perino, "but we're after grams of immunoglobulin. Our goal is 200-400g, so how many liters we use depends on quality. This is why you need to assess colostrum quality if you're feeding exogenous colostrum or making colostrum banks."

Colostrum with specific herd antibodies is desirable. "A calf with adequate intake of specific antibody-negative colostrum can be challenged with a virulent BVD, for example, and die," Cortese ex-



It takes less disease to kill a calf with failure of passive transfer, says Vic Cortese, DVM.



With colostrum-deprived calves on a calf ranch, it's critical to alter the immune response, says Tom Furhmann, DVM.

plains. "Another calf with less colostrum intake but with specific antibodies to BVD will get sick but may not die."

For this reason, Perino says the best colostrum is from a calf's dam. Next is colostrum from another cow in the herd, then from another herd. He adds if using dairy colostrum for beef calves, to make sure the quality has been assessed.

Prevent FPT

Failure of passive transfer (FPT) occurs when a calf gets little or no colostrum in the short 0-24 hour window after birth. "It appears that gut closure is a time and event-driven process, so if we feed colostrum early and a lot of absorptive events occur, the gut will close quicker," Perino says. "It will be seriously compromised at 12 hours and it closes at 24 to 25 hours."

"There is a direct relationship between colostrum and mortality rates," Furhmann says. "It doesn't mean that every calf that has a low antibody level is going to die, it just means that statistically there's a big difference."

A calf that gets no colostrum at all has poor survivability. "Complete colostrum-deprivation can cause disease challenge to overwhelm the calf before the immune system responds," Cortese says. "It takes less disease to kill an FPT calf."

Perino says FPT calves are from three to 10 times more likely to have some sickness before weaning (see sidebar). "FPT calves get the 'disease of the week.' Baby calves have a higher rate of navel ill and bad joints. Then comes scours, pink eye and respiratory diseases. Whatever the population is getting, they'll get more of it."

And though six-to-eight-week-old FPT calves are comparatively similar to their counterparts that received colostrum, it's those first several weeks that are the most critical for their survival. "If the FPT calf develops a respiratory infection early on, it will have an impact on its growth and productivity, and later productivity probably will be reduced," says McGuirk.

Cattell says FPT calves can be managed with IV plasma treatments, but costs and risks must be evaluated. "The risk of dying or expensive disease like scours or septicemia is so much higher in the failure group that it might justify the cost of testing and administering plasma," she says. "But ask 'what's the attributable risk and how much can we change with treatment?'"

Perino suggests taking a "snapshot" of a herd with a lot of calf disease by sampling 20 calves, measuring immunoglobulin or protein, and noting the percent that have FPT. "If it isn't acceptable, we need to find the cause. While I'm concerned for the calves, my larger concern is what's broken in husbandry and management that these calves are not getting enough colostrum?"

Cortese adds, "We tend to try to find out what causes the scours instead of what's predisposing the scours, which is FPT."

Stress/nutrition

An early stress on a calf is dystocia. "Stress at birth will cause a little acidosis which affects passive transfer in the gut," Cortese says.

"With dystocia calves, we don't really know the effects not only of anoxia, but also of cortisol on immune function," Cattell notes. "We had a lot of embryo transfer calves that were induced with dexamethasone and we found them to be immunologically compromised with a higher scours incidence. We attributed it in part to the effects of cortisol on the immune system."

Weather and animal density can add to stress on a newborn calf. "The environment in which the calf is born, in relation to stocking density and how many years they've been calving there, affects the disease level, so there may be overwhelming infections," says Perino. "Density of the calving environment many times is a management choice we can control."

McGuirk adds that cold or hot temperatures, overcrowding and poor ventilation, especially in veal barns, can be immunosuppressive.

And don't forget about the calf's nutritional needs. Cortese says calcium deficiencies can affect phagocytic ability of the macrophages and neutrophils, and selenium, copper and vitamins A and E all impact the immune system. "Nutrition has a tremendous impact on vaccine response and fighting disease. We need to look at that in herds that have a lot of calf disease."

"Good nutrition is not just for weight gain," McGuirk explains. "It's extremely important for the successful development and maturation of the immune system. Energy and protein are vital, but so are vitamins such as E, C and A and minerals such as copper, manganese, zinc and selenium for cellular immune function."

A large calf ranch Fuhrmann consults for supplements calves with daily oral vitamin E. "We believe there's a direct relationship between vitamin E and immune response. We also have more morbidity and mortality in selenium-deficient calves.

Vitamins and minerals definitely have an impact on the effectiveness of calf immunity."

"Mother Nature tapers off fat and other micronutrients in milk until the calf starts its dry feed intake," explains Cattell. "But we've disrupted that process by giving them colostrum for the first 24 hours then essentially starving them for two weeks. Protein intake may be inadequate during the period when calves are at risk of scours.

"At two weeks they're in a negative energy balance and not eating enough to support growth and maintenance. We're stressing them on a macro-nutrient level right when they need the most support." She says this stress can be manipulated by feeding the calves a high liquid protein diet at day one and encouraging them to begin eating dry feed as soon as possible.

Early vaccination

Conventional thinking about early calf vaccina-

FPT
calves get
the "disease
of the
week"

Early intervention impacts later performance

Does good management of the calf's immune system have an impact on subsequent performance? According to these veterinarians, the better start calves get in life the better they perform later.

Louis Perino, DVM, PhD, studied failure of passive transfer (FPT) in beef animals. "We looked at morbidity, mortality, weaning weight and average daily gain," Perino says. "It was a very clinically-oriented study. We found it wasn't FPT itself that predicted the weaning weight, it was sickness. FPT's effect is mediated through morbidity which affects growth performance."

Two of Perino's studies, published in the *American Journal of Veterinary Research*, September 1995, showed that:

- Calves of dams diagnosed with mastitis had lower mean plasma protein (PP) and IgG concentrations at 10 and 24 hours after birth.

- Calves that experienced morbidity or mortality prior to weaning had the lowest concentrations of serum IgG and PP.

- The risk of death prior to weaning was over five times greater for calves with inadequate passive transfer.

- Morbidity during the first 28 days of life was associated with a 16 kg. lower expected weaning weight and was indirectly associated with 24-hour passive immune status.

- Calves classified as having inadequate IgG concentration at 24 hours were at greater risk of preweaning mortality, neonatal morbidity and preweaning morbidity.



Louis Perino, DVM, PhD, says FPT's effect is mediated through morbidity which affects growth performance.

- Calves classified as having inadequate PP concentration at 24 hours were at a greater risk of feedlot morbidity and gained .09 pound/day less.

Dairy impact

FPT often manifests itself in scours cases on dairies. Meg Cattell, DVM, conducted a study on 500 dairy calves to see how scours affected morbidity, mortality, culling rates and freshening age.

"There was a five percent scours incidence and two percent incidence of pneumonia in calves born between December and June," she says. "Pneumonia made no difference in freshening age, but scours did."

In calves with scours that required treatment with antibiotics, the total removal rate due to death and culling was 38 percent preweaning through calving. The death plus culling rate for the non-scours group was five percent. "There was an eight-fold increase in death in the scours group," Cattell notes. "Scour calves also

peaked at a much lower level of milk production in the small data set we have," Cattell adds.

She notes that the cost of scours can be big and should be calculated in the same manner as mastitis costs. "There's not only the drug cost, but also withholding opportunity cost, immediate mortality, recurrence, long-term effect on health, feed conversion, age at which they go into milk production and others."



GEN WREN

The cow's pre-calving energy and protein levels affect calf vigor and survival.

tions says maternal antibodies block vaccine response, but opinions are changing. "Traditional studies vaccinated the calf, then in three weeks measured antibody level and found no change," says Cortese. "We assumed the vaccine was blocked. But now we're assessing CMI response and find T-cell blastogenesis in response to an antigen, so other parts of the immune system are being affected." Vaccination also can decrease the severity of disease, depression and temperatures in calves even in the presence of maternal antibodies.

"Data supports that maternal antibodies interfere with antibody response to vaccines," Perino adds, "but a Canadian study of calves immunized at 84 and 196 days showed that calves at 84 days had high maternal antibody titers, but responded to the vaccine as evidenced by an anamnestic response at day 196. Some part of their immune system was able to respond."

But there is window of time the very young calf should not be immunized. Cortese says steroid release from calving is a significant stress that will compartmentalize T cells for three to five days after birth, so intramuscular vaccines should not be used at that time.

"When they're around seven days or older and T cells are available again, it can make a big differ-

ence. The dam's T cells disappear at three to five weeks so the first IM vaccine needs to go in when the maternal T cells are still available, up to about two and a half weeks of age." However, if the first vaccination is not given within that time, you should wait until at least five weeks of age.

In Fuhrmann's case, on the calf ranch many of the calves are colostrum-deprived so they are vaccinated at five to seven days of age (see sidebar). "We've seen clinical IBR and BRSV within five to seven days of arrival, and also hemorrhagic BVD by 21 days, so we know we have to do something," Fuhrmann says.

Cortese says vaccination will have a more dramatic effect in colostrum-deprived calves. It may not work better, but it's easier to measure in colostrum-deprived calves.

McGuirk says early vaccination can have adverse effects on calves stressed from shipping, crowding, heat or cold. "Early vaccination needs to be closely supervised by a veterinarian who can weigh the potential negative effects against the benefits," she says.

"We need to understand how competent the calf's immune system is and identify immune responses to different agents," Fuhrmann adds. "Then we'll be able to design programs that use products more specific to the problems." ■

Calf ranching poses its own calf health challenges

Ensuring that baby calves get adequate colostrum and protection from environmental stressors and disease is challenging enough, but on a large calf ranch with thousands of young calves, you have to have an excellent system in place.

Tom Fuhrmann, DVM, Tempe, Ariz., a consultant for a large calf ranch in Arizona, says managing these calves is entirely different than commercial dairy calves.

"The ranch receives excess male calves from three to five days of age, weighing 60 to 90 pounds," he says. "A significant 40 to 60 percent are colostrum-deprived. It's difficult to manage health programs for them as there is a direct relationship between inadequate colostrum and health problems."

Vaccination

Because of the significant colostrum deprivation, calves are vaccinated within a couple of days of arrival for IBR, BRSV and BVD. "Fifty percent of the new calves are antibody deficient and we're dealing with a highly susceptible population. We must try to alter their immune response."

Fuhrmann uses a modified live viral vaccine, then calves are revaccinated at 35 to 40 days of age for an anamnestic response. "We are convinced there's a window of time you don't want to vaccinate (see "Early vaccination", page 9). At first he was concerned that the MLV vaccines would stress

the calves and back them off feed, but he found the setback was minimal and the benefits of immunization in the colostrum-deprived calves was worth it.

"We're really trying to affect the cell-mediated immune response," he says. "Using MLV products at an early age on the calf ranch alleviated viral diseases that we had diagnosed and confirmed with laboratory tests."

Pathogens

A one to three percent death loss on a closed dairy can be obtained, but Fuhrmann says the standards of the calf ranching industry fluctuate around 10 percent. "We have been fortunate to experience losses lower than these," he says. "Pathogen exposure and weather at calving have an impact. We get California calves born in the muck and mud, and we'll get coliform bacterial diarrhea through 10 to 12 days of age. We diagnose *Salmonella typhimurium* between 8 and 15 days and *S. dublin* later lasting through three or four months of age.

"It's best to get colostrum in calves, but we have to manage all the calves we get, even the colostrum-deprived ones. On the calf ranch you need a well-planned immunization program, good nutrition with emphasis on adequate micronutrient levels, calf comfort, early detection and proper treatment programs and overall good management."