CIR1080

UF UNIVERSITY of FLORIDA
IFAS Extension

Vaccines and Beef Cattle [1]

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Always remember: if the resistance level of an animal stays above the disease challenge, a healthy animal results (Figure 1).

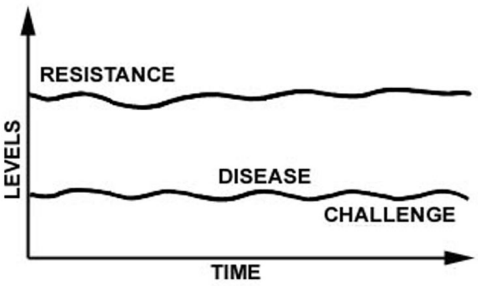

Figure 1. When the resistance level stays above the disease challenge, animals stay healthy.

It is to our advantage to keep a safe spread between the resistance level and the disease challenge level; the greater the spread, the safer it is for the animal. We use vaccines to increase that spread, by raising the resistance of an animal or herd of animals to selected disease challenges (Figure 2).

To properly immunize cattle against diseases, you must recall how each of the vaccines is formulated, what route of administration to use, how the body responds to the vaccine in the presence or absence of maternal antibodies, and how many doses

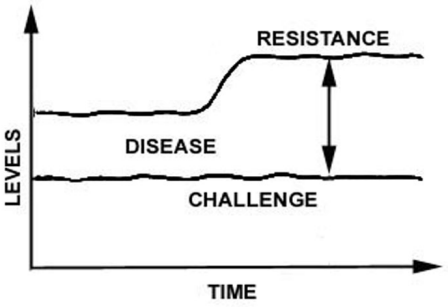

Figure 2. Vaccines raise the resistance level.

are required to stimulate the body to produce adequate levels of resistance against a particular disease. There are four vaccine forms.

- Replicating -- modified live (ML)
- Non-replicating -- modified live
- Inactivated non-replicating
- Intra-nasal

Replicating-ML vaccines. These vaccines must replicate (reproduce) in the animal's body before the resistance level is increased. Usually only one dose of replicating vaccine will stimulate high levels of long-lasting resistance in an animal. Failure of the

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vaccine organism to replicate will mean failure to stimulate a rise in the animal's resistance.

Examples of replicating-ML vaccines are listed.

- MLV-IBR
- MLV-BVD
- MLV-PI3
- Strain 19-Brucellosis

Non-replicating-ML vaccines. Even though these vaccines are live, they do not replicate in the body. Because of this, the animal will require at least two doses of the vaccine to stimulate adequate levels of resistance. The first dose will usually only trigger the memory mechanism in the body; a second dose, no sooner than 21 days, will stimulate the production of high levels of resistance.

How long the resistance remains high depends upon the animal's ability to respond and the quality and quantity of the vaccine. Most non-replicating ML-vaccines require at least one booster each year to maintain the high resistance level in the animal.

Examples of non-replicating-ML vaccines include:

- Chemically altered IBR/PI3
- MLV-BRSV

Inactivated non-replicating vaccines. These vaccines have been inactivated or "killed" during the manufacturing process; they can not replicate in the body. As with the non-replicating-ML vaccines, the animal will require at least two doses of the inactivated non-replicating vaccine to stimulate adequate levels of resistance. The first dose will usually only trigger the memory mechanism in the body; a second dose, no sooner than 21 days, will stimulate the production of high levels of resistance.

How long the resistance remains high depends upon the animal's ability to respond and the quality and quantity of the vaccine. Most inactivated non-replicating vaccines will require at least one booster each year to maintain the high resistance level in the animal.

Examples of inactivated non-replicating vaccines include the following list.

- Killed virus vaccines
- Bacterins
- Leptospira
- Clostridia
- Haemophilus somnus
- Vibriosis
- Pinkeye

Intra-nasal vaccines. These vaccines will usually replicate only in surface cells of the upper respiratory tract. They stimulate localized resistance for the areas in which they replicate. In general, these types of vaccines provide a quick, short-lived rise in resistance, and will trigger the "memory" cells in the body. Because of the triggering mechanism, boostering the animal at a later date with a replicating or a non-replicating vaccine containing the same organisms will stimulate a high level of resistance for a longer period.

Examples of intra-nasal vaccines are included below.

- Nasal IBR
- Nasal PI3

How an animal responds to a particular vaccine is greatly dependent upon the amount of maternal antibodies remaining in the calf at the time of vaccination. Before a maternal antibody can interfere with a vaccine, the antibody must be specific against that particular disease (i.e., anti-IBR antibodies, anti-BVD antibodies, anti-H somnus antibodies).

The animal's response to vaccines relative to the absence or presence of maternal antibodies must be understood to properly select a vaccine form.

Calves are born with very limited resistance against infectious diseases. The calves receive temporary resistance by a transfer of antibodies from the cow to the calf in the colostrum or first milk.

These antibodies are referred to as maternal antibodies (Figure 3).

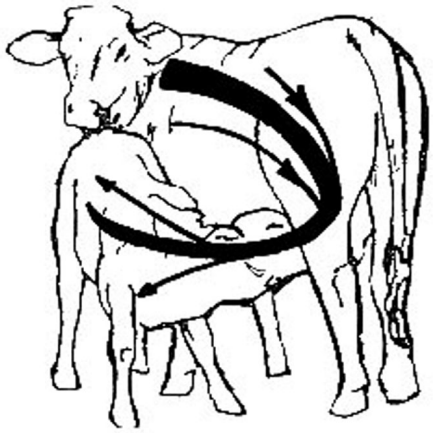

Figure 3. Maternal antibodies are transferred from the cows to the newborn calf via colostrum.

The calf gets two types of resistance from its mother: non-specific resistance, which acts against low-level infection in general; and specific resistance, which acts against particular infectious agents. Regardless of the type, the newborn calf's resistance to disease challenge is raised only after receiving the maternal antibodies found in the colostrum milk.

Since the maternal antibodies contained in colostrum are readily absorbed by the newborn only during the first 24 hours of life, it is important that the newborn calf receives colostrum immediately after birth. Excellent, non-specific resistance can be provided by properly feeding pregnant cows; adequate nutrition enhances the production of non-specific antibodies as well as the health and vigor of the calves at birth.

However, in addition to receiving adequate nutrition, a cow can develop specific resistance against specific infectious diseases only by being vaccinated against the disease or by surviving the disease itself. The cow produces antibodies against the disease and passes these antibodies to the calf through the colostrum.

Maternal antibodies passed to the calf via the colostrum are expected to be present in effective amounts as long as 4 to 5 months after birth. The length of time the maternal antibody remains in the calf also depends upon the amount produced by the cow and the amount absorbed through the calf's gut.

When Maternal Antibodies Are Present

In the presence of high levels of maternal antibodies, the MLV vaccines (replicating-MLV and non-replicating-MLV) can be neutralized in the body. They will not trigger the memory cells, nor will they stimulate the production of antibodies; hence, we see no rise in resistance (Figure 4).

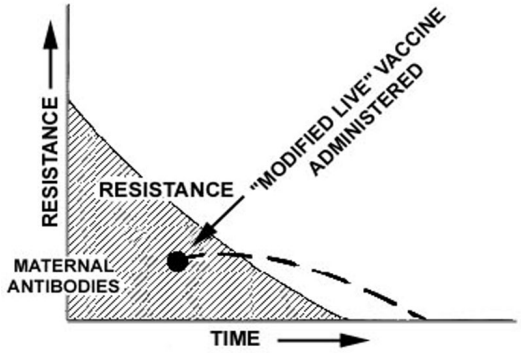

Figure 4. Response to modified live vaccines (includes both replicating-ML and non-replicating-ML vaccines) in the presence of maternal antibodies.

When maternal antibodies are present, the first dose of the inactivated non-replicating vaccines will trigger the "memory" cells. A second dose, called the protective dose, given later, will stimulate a high level of antibodies. (Figure 5).

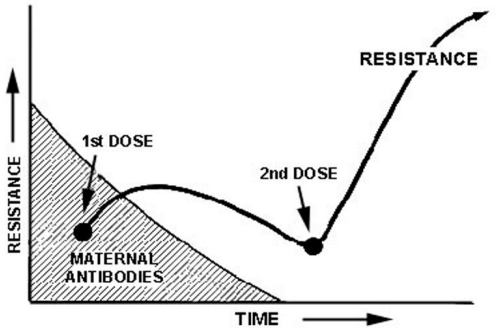

Figure 5. Response to "inactivated" vaccines in the presence of maternal antibodies.

However, in the presence of extremely high levels of maternal antibodies, even the inactivated non-replicating vaccines may be neutralized by the antibodies to the extent that even the memory cells may not be triggered. Thus a second dose at a later date would not be a "protective" dose; it would only serve as a "triggering" dose.

In the presence of maternal antibodies, the IBR and PI3 intranasal vaccines can multiply in the surface cells of the nose and lungs, triggering the memory cells, and stimulating the production of short lived, local antibodies in the cells of the upper respiratory tract; hence, short-lived, elevated resistance results (Figure 6).

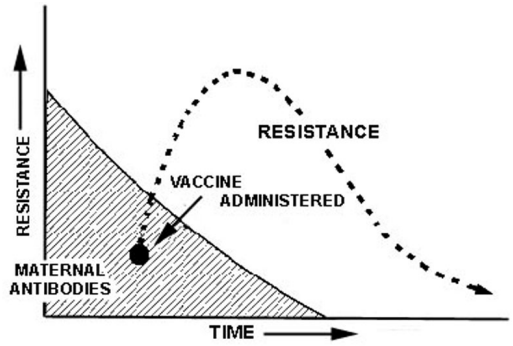

Figure 6. Response to "intra-nasal" vaccines in the presence of maternal antibodies.

If we look at a composite of the animal's response to the various vaccine forms, we can readily identify the vaccine forms needed to raise the resistance in animals when management requires the vaccination program to begin while the animals still possess maternal antibodies (Figure 7).

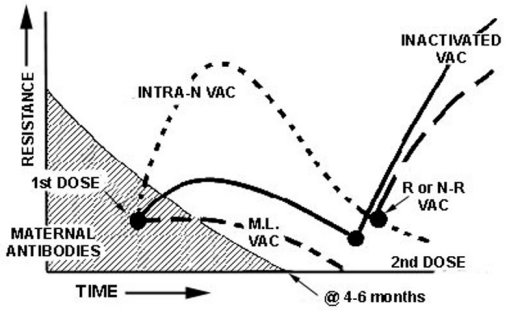

Figure 7. Response to various vaccine forms when administration begins during the presence of maternal antibodies.

In the Absence of Maternal Antibodies

In the absence of maternal antibodies, replicating-ML vaccines will multiply in the body to stimulate a high antibody response and trigger the memory cells and, hence, a high level of resistance. A second dose of these vaccines is usually not required for the animal to produce adequate levels of resistance (Figure 8).

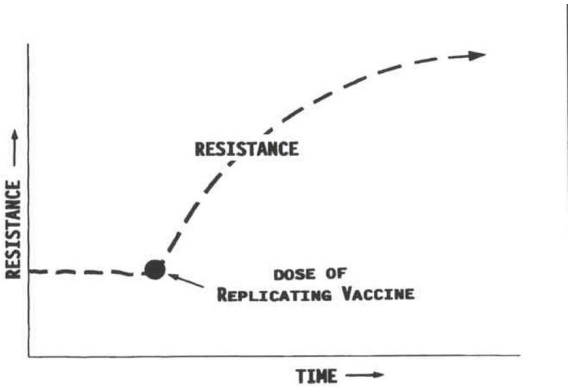

Figure 8. Animal response to a replicating-ML vaccine in the absence of maternal antibodies.

In the absence of maternal antibodies, the animal's responses to both non-replicating-ML and inactivated non-replicating vaccines are essentially the same. Hence, in the absence of maternal antibodies, we will refer to both forms of vaccine as non-replicating. Even though a single dose of non-replicating vaccine will trigger the memory cells in the absence of maternal antibodies, most non-replicating vaccines will require a second dose after 21 days to stimulate the production of a high level of resistance (Figure 9).

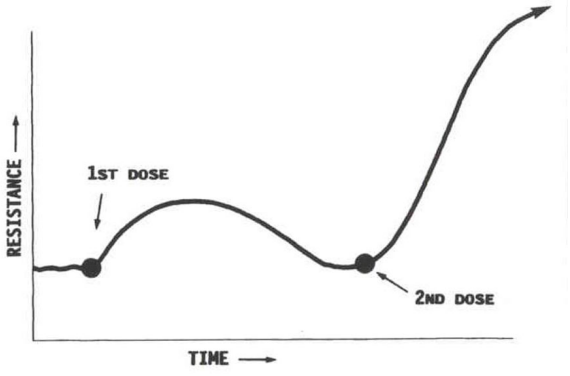

Figure 9. Response to non-replicating (both non-replicating-ML and inactivated non-replicating vaccines) vaccines in the absence of maternal antibodies.

In the absence of maternal antibodies, the intranasal vaccines will trigger the memory cells, multiply in the surface cells of the upper respiratory tract, and stimulate the production of localized antibodies in the cells of the upper respiratory tract; hence, the animals will achieve a high resistance level of short duration (Figure 10).

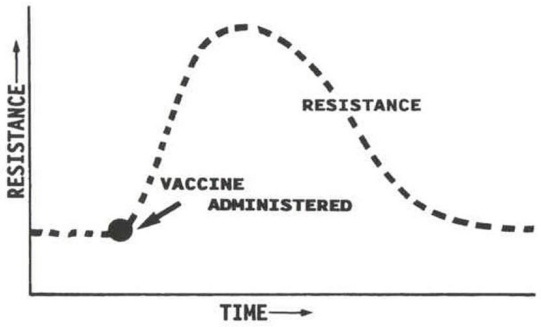

Figure 10. Response to intra-nasal vaccines in the absence of maternal antibodies.

In most beef herds the level of maternal antibodies in the calves is unknown and, if present, is expected to diminish to a non-effective level at 4 to 5 months of age. Thus, the vaccination schedules should begin after 4 months of age (Figure 11).

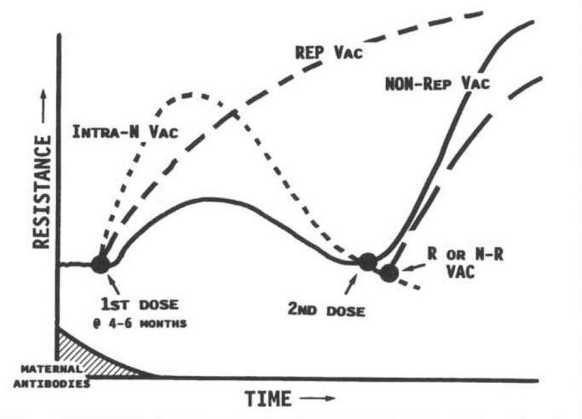

Figure 11. Response to various vaccine forms when administration begins after maternal antibodies have waned.

Generally, calves of this age are nursing pregnant cows, and the use of replicating MLV-IBR vaccines is not recommended. With the exception of replicating-ML PI3, strain-19 brucellosis, and live pasteurella vaccines, most vaccines available for use in calves nursing pregnant cows are of the non-replicating or intra-nasal forms, and animals will require at least two doses to achieve a high level of resistance.

When repeating or boostering vaccines, remember it is the type of vaccine that is important (i.e., IBR, BVD, lepto) not necessarily the form of the vaccine. For example, the first dose of IBR and PI3 could be in the intra-nasal form and the second dose given in the non-replicating form. Form is not important; repeating the vaccine type is!

The vaccinations (including boosters) should be timed so that peak resistance levels are achieved immediately before the disease challenge rises. For example, vibriosis is spread during mating; therefore, the ideal time to vaccinate (second dose or annual booster) would be 30 days before you turn the bulls out. Another example: to protect the calves against scour diseases via the colostrum, the best time to vaccinate the cow would be 30 days before calving. The disease challenges for both are predictable, and vaccinations can be scheduled accordingly (Figure 12).

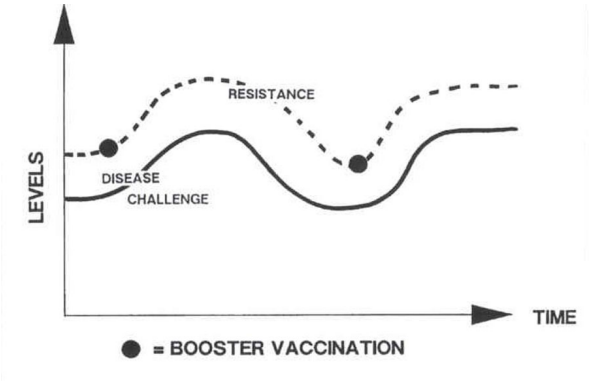

Figure 12. If disease challenge is predictable, administer booster vaccine before the disease challenge rises.

In contrast, the disease challenge by leptospirosis is quite often year round, and the resistance level stimulated by the vaccine is short lived. Therefore, to constantly keep the animal's resistance above the year-round disease challenge, it would be advisable to vaccinate for leptospirosis at least two to three times a year (Figure 13).

Fortunately, an alternative would be to select a vaccine with an adjuvant that provides a longer "depot effect," thus prolonging the antigenic stimulus to the body. This results in higher or prolonged blood antibody levels in the animal, thought to be indicative of higher/prolonged resistance levels. Vaccines of this type are not available for all diseases (Figure 14).

When a specific disease challenge is sporadic, or the vaccine is expensive, we may only booster every other year to keep the memory "primed" for that disease.

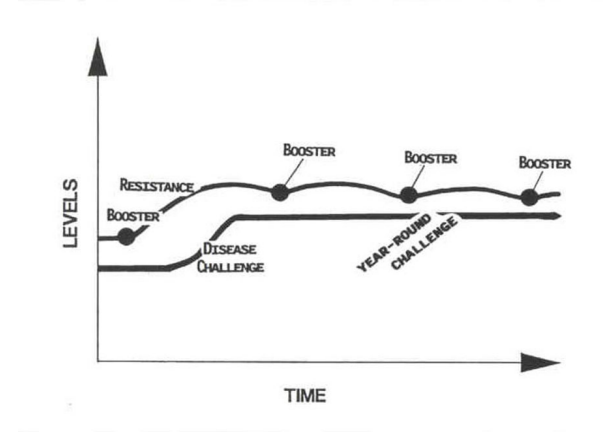

Figure 13. Multiple booster vaccines may be required if certain year-round disease challenges occur.

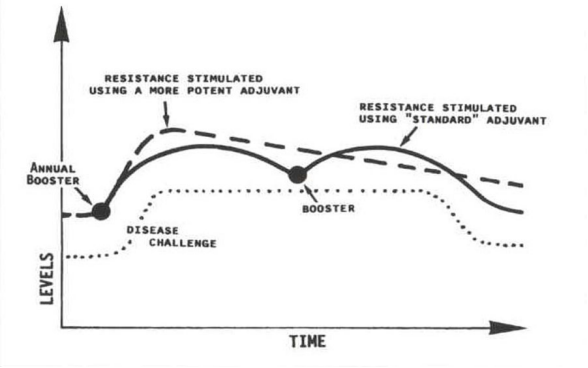

Figure 14. A more effective adjuvant may eliminate the need for additional boosters during a challenge period.

However, if a clinical case of the disease is detected, the entire herd must be boostered immediately to raise the resistance level in the herd (Figure 15).

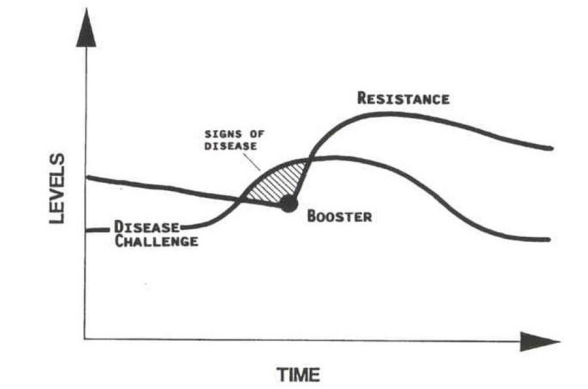

Figure 15. Periodic boostering keeps the trigger primed; re-boostering will raise the resistance if a challenge occurs.

Vaccinating the cow herd "by-the-book" would not fit most cattle operations. However, a vaccination program can be designed to provide adequate resistance for most beef cattle herds.

Just remember, vaccines are used to stimulate a rise in the resistance level against certain disease challenges.