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Causes of Vaccination-Immunization Failures in Livestock

This NebGuide discusses reasons why vaccinations fail to provide immunity against disease, and how to prevent this from happening.

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To comprehend the many reasons for vaccine failure, it is important to understand how animals and humans have the ability to resist infectious diseases. It is also important to know what a disease is and how it affects the animal.

According to *Stedman's Dictionary*, disease is an interruption, cessation or disorder of body functions, systems or organs. Diseases may be obvious even to the untrained eye, or detectable only by sophisticated testing procedures (subclinical disease). Serious irreversible damage may be done even at the subclinical level if therapeutic or preventive measures are not taken early.

The Causes of Disease

These may be categorized in two types:

1. *Nonliving*, such as chemical poisons (toxins), or excessive heat or cold.
2. *Living*, which includes infectious agents (pathogens), viruses, bacteria (which may themselves produce toxins), and large parasites such as lice and worms.

Resistance to Infectious Agents

Resistance can also be divided into two types:

1. *Nonspecific or innate resistance*--resistance that is present in the normal animal prior to infection.
2. *Specific immune resistance*--resistance that arises only after repeated exposure to the agent.

Innate Resistance

This type includes natural barriers such as the skin, the washing effect by secretions such as tears, and certain normal responses such as coughing. Each is a part of the individual from birth, but may be significantly affected by hereditary, nutritional, and environmental influences.

Specific "Immune" Resistance

This type usually arises following exposure of the animal (particularly the white blood cells in the animal) to the infectious agent (an antigen). This exposure can come about during an actual (natural) infection, or artificially by inoculation of the animal with the infectious agent, which has been killed or made nonpathogenic. This procedure is called *vaccination*. In most cases the animal will respond to the vaccine (antigen) by producing immune bodies called *antibodies*, and will stimulate production of *more* white blood cells that react *specifically* with the inciting agent (vaccine). Occasionally an animal does not respond sufficiently to provide protection. Such animals, in spite of vaccination, have failed to become immune--they are not *immunized*. Many factors can affect the development of immunity in the individual, and contribute to apparent failures in vaccine protection. The remainder of this NebGuide provides some reasons for such failure.

Factors Associated with the Animal

Age

The very young animal has not had time to develop a competent immune system. On the other hand, the very old animal may have various deficiencies in immunological capability.

Young animals that have received colostrum have also received large quantities of antibodies from their dam. High levels of these passively acquired antibodies can interfere with the development of the young animal's own immune response to vaccines for 1 to 2 months or longer.

Biological Variation

Some animals, due to heritable traits, respond less than the normal population does to antigens either through vaccination or natural infection. Even though they have been inoculated with the vaccine, they may not become immunized.

Nutrition Level

Animals deficient in nutrients may respond poorly to vaccines, as well as being below their genetic production potential.

Interference Due to Concurrent Disease

Certain diseases, if present at the time of vaccination, may prevent an adequate immune response to the vaccine.

Immunodeficiency

Protection against infection of newborn animals is best obtained by passive transfer of antibodies from the dam. Some vaccines are given to the dam in anticipation that she will transfer specific preformed antibodies to her young. These are passively acquired antibodies that are effective for only one to two months in the offspring. However, if she does not respond with adequate antibody levels, or if her offspring do not suckle adequately in the first 12 hours of life, there may be a *failure to transfer* antibodies to her young.

Antibody Interference

When the antibody level within an animal is present due to maternal or other passive immunity, the antigenic properties of vaccine can be neutralized and no immunity develops. As the passive antibody levels wane, the animal may then have no protection because the vaccine used earlier was inhibited by the very antibody that is now depleted.

Stress

Poor nutrition, shipping, crowding, and other stressful events may produce hormonal or chemical imbalances in the animal that suppress the immune system and its response to vaccines.

Factors Associated with the Antigen (Vaccine)

Wrong Serotype

The immune response is very specific. A vaccine may contain organisms of the same family as those involved in a disease outbreak, but if they are not of the same serotype (type within the family), the results may be disappointing.

Potency and Purity

Vaccines must have adequate antigenic mass to properly stimulate an immune response. Vaccines not made under strict controls may not have this capability. Purity is also an important factor as contamination may render the vaccine worthless by destroying antigenic properties. Other adverse effects may include abscess development at the site of inoculation, or the introduction of an entirely different disease problem.

Outdated Vaccine

Outdated vaccine may not contain the required antigenic properties due to deterioration or other factors. It is not worth taking a chance that it may work. The investment to obtain fresh, quality vaccine far outweighs the possibility of losing just one animal due to poor vaccine.

Vaccine Limitations

All vaccines have limitations. Some vaccines for certain diseases occasionally do not cause production of enough immunity at both the local and systemic levels to give adequate protection against that

disease. Alternate routes of administration and/or boosters are sometimes used to help alleviate this problem. We must not expect more than the vaccine manufacturer indicates.

Factors Associated with Handling Vaccine

Handling Procedures

It is imperative that vaccines be stored and used *exactly* as directed by the manufacturer. Exposure to sunlight, chemicals, drugs, and adverse temperatures may destroy the vaccine's effectiveness. Vaccine that requires mixing should always be used promptly. Sources of purchase of vaccine should be evaluated to help determine if proper care was provided before purchase.

Improper Mixing

Mixing vaccines properly is a "must" as the "antigenic mass," or dosage, is calibrated to produce antibody levels that are protective. Modified live virus (MLV) vaccines must be reconstituted properly, using the diluent supplied for that vaccine in the correct quantity. Administer vaccine only from sterile syringes that have been sterilized without the use of chemicals. Never mix other vaccine types together when *not* specifically recommended by the manufacturer, as chemical incompatibility is possible.

Timing of Vaccinations

The correct timing of vaccine administration is absolutely necessary to expect a reasonable immune response. Time to build protection, time in relation to animal age, and the time when most resistance to the disease is needed are some of the factors you must consider.

Waning of Immune Status

Immune status can wane to the point of susceptibility when exposure to antigenic material is minimal or absent. For this reason, some manufacturers recommend using a booster vaccination to build a higher antibody level. When the manufacturer's directions recommend a booster, *it is necessary that it be done at the recommended intervals*. Frequently the first dose only sensitizes the immune system; the second dose is necessary to develop a high protective level.

Other Factors

Overwhelming Challenge

This can occur when excessive animal stress combines with entrance of extremely large numbers of virulent disease-causing organisms. This overwhelming infection can overcome even a relatively strong immune protection.

Mechanics of Vaccination

At the time the vaccine is administered, strict attention to details is very important to prevent "misses." Animals can be missed at vaccination time when too many jobs are being done simultaneously. Organization is very important. Escape-proof pens or corrals and other methods to reduce the "missed ones" are also *very* important.

Route of Administration

Companies that produce vaccine will specifically label the route of administration and which site of inoculation is preferred. Research by the manufacturer has proven which route is best. If injection in the muscle is specified, the vaccine should not be given by any other route. Your veterinarian should be involved to ensure proper vaccine selection and use.

Animal Protection

Precautions should be taken to ensure the physical well-being of the animal. In addition to vaccine recommendations, precautions should be followed so as not to mechanically damage nerves, joints, or other body parts with the needle. This includes paying attention not only to the area of the animal injected, but also such things as length and gauge of the needle.

Vaccination in the Face of an Outbreak

All commercially manufactured vaccines are formulated and labelled to be used only on *healthy animals*. Vaccinating animals in the face of an outbreak would generally be unadvisable as relatively high numbers of these animals would be sick, under stress, and would not be "healthy" at that time. These conditions contribute to vaccine failure.

Summary

The causes of vaccine failure are numerous, but if precautions are taken as described in this NebGuide, the "vaccine failures" that occur can be greatly reduced and disappointing livestock losses can be avoided. The best procedure in using vaccines is to CONSULT YOUR VETERINARIAN AND FOLLOW THE MANUFACTURER'S INSTRUCTIONS.

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