General Principles of Vaccination

The world of poultry production is rapidly changing. Poultry producers are faced with many issues that threaten their economic survival. However, these very issues are critical to ensure the growth and stability of our industry, we must face them and be progressive in our response to the public and to the perceptions of the consumer. Besides these on-going challenges, we are now coupled with disease syndromes with multifactorial etiologies (ascites, cellulits). The day of the single disease-causing agent is becoming a rarity, especially in broiler production.

One of the reasons for this effective management of single causing disease agents is the ***Art of Vaccination*** and the managerial techniques that synergize with its success. Vaccination is simply an art. The successful producers and/or companies of tomorrow are those who know their vaccines and the vaccination methods to optimize production results. Ensuring that the vaccines are properly administered at the proper time, utilizing the antigen combinations and antigen virulence to provide the titer needed to resist the challenge. These are the keys to immuno-competence in the bird. Vaccination is our biological means of providing that wall of protection to the bird. Vaccination stimulates the immune system to produce specific antibodies against viral, bacterial or protozoan diseases.

Determining the types of vaccines to be used, the route, the age and method of administration should be discussed and consulted with experts before vaccination begins. One should always consider the following criteria before embarking on a program of products and application.

- Diseases that are prevalent on your farm and in your area.
- Immune status of the breeders and the level of maternal antibodies as determined by serology or another diagnostic procedure.
- The need to provide the desired level of immunity for the bird/flock over the duration of grow-out time. Breeder stock and commercial layers require higher levels of immunity than broiler stock due to the length of the production cycle to protect against continual field challenge. Also, to maintain acceptable standards of egg production, hatchability and transfer of maternal antibody as in the case of breeders.
- Economics of vaccines. Can the cost of the vaccines, labour and equipment account for the cost of disease? Is it profitable?
- The general health status of the flock and the local pattern of disease.
- Vaccinate only healthy birds, avoid vaccination of flocks that are stressed or diseased at the time of vaccination.
- Consideration of the current management practices on the farm will dictate the desired vaccination route, method and frequency of vaccination.
- Other reasons for vaccination that should be considered:

    * To induce high maternal antibody for early protection.

    * To enhance egg production and quality.

    * To reduce the threat of condemnations.

    * To expose the bird before the risk of disease (IBD) or at time of least risk (AE).

In general vaccination programs should take into account the purpose of the flock. Does the flock contain

conventional broilers, Cornish hens, roasters, layers, breeders etc.? Each type of poultry requires a specific vaccination program modified by local or provincial factors. A successful vaccination program will result in immunization without harsh reaction and secondary infection. It should provide uniform titers, encourage consistent longevity of protection and promote cost beneficial results.

Avian Immune System

A basic understanding of the avian immune system is critical and essential to vaccination. The avian immune system is divided into two systems; the non-specific immune system and the specific immune system.

The non-specific immune system is largely **innate** (born with) in which the chickens resist disease. This system includes features such as;

- **Body temperature**. The high body temperature of the bird (107oF, 42oC) helps to preclude many diseases that affect other species (blackleg in cattle)
- **Body features (Skin)** are the largest body component providing an impermeable barrier to bacteria. Bacteria, which opportunize skin abrasions, reveal their effects (cellulitis).
- **Normal micro-flora,** the skin and gut normally maintain a dense stable bacterial population. This stable barrier prevents invading organisms from getting a foothold.
- **Respiratory tract (cilia and mucous**), tracheal (windpipe) cilia or hairs beat up and down projecting the caught dust or bacteria upwards and outwards. The mucous secretions of the tracheal cells aid the trapping of these particles.
- **Other factors** that are involved in the innate resistance include nutrition, environment, age, and acid pH of the gut and many more.

Management plays a critical role in this process, both directly and indirectly. Factors such as overuse of antibiotics or poor sanitation may lead to a disruption of the normal micro-flora. Poor nutrition could also lead to deficiencies that allow disease organisms to penetrate the protective body coverings. Hence, the bird is using its natural processes to defend it from insult. Good management and the minimization of stress potentiate this.

The specific immune system is the acquired immune process. This can be passive from the hen through the yolk to the chick/poult, or active through direct vaccination of the birds. The goal is to stimulate the immune cells that will instigate further cells to fight the infection. The system that activated the **B cells** to produce antibodies is derived from the bursa and is called the humoral immune system. These antibodies are produced when the bird is exposed to a vaccine and or wild organism.

Preferential to the bird and production would be the vaccine first. Vaccine induced immunity provides cells and cells with memory to block infection and stop the disease agent.

Cell mediated immunity is characterized by another form of cells called **T cells**. These cells are derived from the thymus and instigate destruction of the invading organism, through digestion and acidification. The effective use of vaccines takes advantage of both humoral (B cell) and cell mediated immunity (T cell).

In summary, a conscientious effort must be made to stimulate the specific immune system of the bird. This specific immune system targets on the diseases that the bird has been exposed to. Vaccines, which can be qualified and qantified is the active approach towards disease control.

Maternal Antibody Immunity

Another name is passive immunity. As cows pass on immunity to their calves through milk, the component called colostrum, so do hens pass on antibody through the yolk. These transmitted antibodies are a collection of vaccines and or wild microorganisms that the hen was exposed too during her pullet and production phase. The most critical maternal antibody in the poultry industry and very familiar to our industry is **Gumboro**. The principle objectives of breeder vaccination programs is to immunize as close to 100% of the flock as possible without incurring excessive stress and cost. However, these antibodies do not last forever in a young chick or poult. All good things come to an end, therefore the need to take over actively through the process of vaccination.

The half-life of chicken antibodies from the hen range from 3 to 5 days, with protective immunity levels persisting for up to 3 weeks. Initial antibody level is proportional to protection. The higher and more uniform the titer the better for the progeny. Monitoring the antibody titer of the parent flock will provide an estimate as to when the level of maternal antibody has waned to permit active immunization of the young flock.

Administration of Vaccines

Vaccine quality is critical especially when used for the prevention and reduction of disease. In our country the importation and registration of live and killed vaccines is highly regulated by our government. It is safe to say that the acceptance and registration of vaccines have to meet three important requirements. Vaccines must be safe, efficacious and pure. Without these parameters being met the vaccine will not be registered. Also, critical to the efficacy of a vaccine are the safe transport, handling, and storage conditions. These criteria should be met to conform to the acceptable practices that ensure potency at the time of administration.

The attenuated live vaccines in our poultry industry contain a modified live disease-causing agent or antigen, usually adapted from the field, for administration either to individual birds (SQ/Marek's) or by mass application (Spray/Gumboro). Since these vaccines are live vaccines there must be special precautions to preserve viability by practicing stable storage (Temp) and transport (Dark). Killed vaccines or inactivated products contain the disease-causing agent in a killed form and usually in a carrier such as an oil emulsion. These vaccines are injected into the bird. Generally, killed vaccines stimulate high uniform titers after administration of a live vaccine. Live vaccines boost killed vaccines.

General procedures should be incorporated into a vaccination program; these are,

- The planning, administration and monitoring of the vaccination should be clearly established beforehand.
- Record all vaccination procedures. Write down what you do, do what you write down and prove it. This includes serial numbers and expiration dates.
- Timing of vaccination is critical. Make sure the appropriate doses and types are available when the time of vaccination arrives.
- All inventory of vaccine should be held at 4oC for live vaccines, -80oC for cell associated Marek's. Follow manufactures recommendations.
- Vaccination equipment should be regularly cleaned, maintained, calibrated and tested before the vaccination procedure.
- Read directions, indications and cautions/warnings.

- All used and unused vaccines should be properly disposed of (incineration).

Vaccination Procedures

HATCHERY

In ovo

Administration of the majority of the Marek's vaccines is given this way. 18-day embryonated eggs using special expensive equipment is now a common practice. Personnel must be trained to operate the equipment in a professional hygienic manner to maximize efficacy, safety and purity to optimize chick health.

Spray Vaccination

Spray cabinets, whether located on-line or independently off to one side of the room, are widely used for the administration of mild bronchitis vaccines in Canada and Bronchitis/Newcastle in the USA. This method requires mechanical input for the application, hence high hygienic standards must be in place to avoid accidental cross contamination to the young birds

Subcutaneous Vaccination

The method commonly used in our layer industry for the administration of the live cell mediated Marek's vaccines. Critical to the success of this vaccination is the storage of the vaccines and handling and dilution of the product at the time of vaccination.

ON-FARM

Water Vaccination

Drinking water vaccination has been around for as long as we have had vaccines. This is an appropriate method for mass vaccination for most live vaccines, particularly for enteric diseases such as bursal disease. Due to the anatomy of the mouth, cloanal cleft, the water administration technique can be effective for the respiratory disease as well (IBV, NCD). As easy as it is to say water vaccination it is probably the most abused method in our vaccination methods today. The major concerns of water vaccination are proper distribution in the barn and prevention of inactivation by impurities (organic waste) or residue (chlorine) in the water lines. Care of preparation must be taken before active water vaccination. A standard procedure calls for the following steps towards water line preparation.

- No disinfectants, chlorine, or medication should be used 48 hours before vaccination and 24 hours after vaccination.
- Water medication tanks, (drinkers) bell founts or cups should be cleaned, use a mild soap and "elbow grease".

- 24 hours before vaccination flush the water lines with skim milk powder (1 cup/200 liters or 1 cup per 2 liters stock solution).
- Filters should be bypassed or removed during vaccination

The amount of water for vaccination can be assessed with the use of a water meter. It is assumed that the amount of water to be used should be 40% of their daily intake. For birds of broiler ages, the normal daily needs are approximated by a formula 5.25 milliliters times the age in days. Approximately 40% of this amount, on a per-bird basis, is needed for vaccination.

It must be remembered that the live vaccines are susceptible to anti-viral agents, hence refrain from the use or exposure to chlorine and compounds of this nature while vaccinating. The addition of skim milk powder to all water, which will come into contact with vaccine, is a simple and effective way to aid in the neutralization of some of the water impurities.

Remember that the milk protein that coats the vaccine viral particle acts like a raincoat on rainy days. It keeps the vaccine healthy. The addition of 10 grams per 4 liters or 1 kilo per 400 liters is mixed with the water at least 20 minutes prior to the vaccine being added.

Before vaccinating, the birds should be water starved 1 to 3 hours, enough to get them thirsty, but not crazy for a water source. For all drinkers it is critical that water means "off" when water is not present in the drinker. At this time water withdrawal is documented. The key is to create the thirst needed to optimize consumption. Industry input states that even with the best water vaccination methods only 70% of the birds actually take a drink in that critical period after vaccination (<2 hours).

To increase the success of vaccination, once the vaccine is presented to the birds; the manager must walk the birds and increase the light to stimulate activity. Operating feeders can also aid in stimulating the activity to drink.

Above all, the manager must be conscientious to recognize that good vaccination means respecting that the product is "live" and that immunity will not be stimulated if the birds do not consume the product.

Spray Vaccination

Considered the mass eye drop due to its delivery method and the response of the bird when receiving that droplet of water/vaccine mixture. A popular route of vaccination and gaining acceptance. This method does not need water starvation, hence any stress of water deprivation. This method alleviated the inconsistency and variability of water quality from farm to farm, district to district or province to province. However, spray vaccination has its challenges. Particle size is critical. Utilizing coarse spray (>100 microns), fine spray (50 – 100 microns) or aerosol (<50 microns) is a critical component in deciding what vaccine and the time of vaccination. You must strive to boost the birds by stimulating their immune system in a stair-step approach. Using hotter vaccines or utilizing finer and finer sprays to drive the vaccine into the deep respiratory tissue can do this. Full coverage is critical; one must assume responsibility to completely cover the birds on the floor or the birds in their cages. Be confident that an adequate volume of diluent is used for the size, age and location of the birds in the barn. Be conscious of obstacles in the barn and that complete coverage is achieved. It is critical to direct the spray to the target tissue that stimulates immunity. This is the upper respiratory tract of the head region. To vaccinate all the birds using a coarse spray, direct the nozzle 50cm to 100cm over every bird in the group. There are a number of applicators on the market today. Follow the manufactures recommendations and indications on their use. The sprayer should only be used for vaccination and not for other barn functions (disinfection, insect control etc.) Again it is important to resort to the manufactures indications to follow details on water-vaccine dilutions, mixing restrictions, sprayer-cleansing etc.

Eye Drop Vaccination

No doubt the most effective and accurate way to apply a live respiratory vaccine to a bird. However, it is very labor intensive and is only selected for the vaccines in this country that require precision via this route (ILT). Each bird is individually handled and receives one full dose (drop) of vaccine. The preferred target site is the surface of the eye. With proper application, the droplet will disappear into the eye cavity. Unlike mammals, the bird has a gland called the harderian gland which is stimulated by the vaccines to produce necessary local immune antibodies. Any excess vaccine runs into and down the nasal-lachrymal duct into the mouth cavity of the bird. Swallowed or inhaled the vaccine can further stimulate more respiratory immune cells and tissue. To verify vaccine coverage a blue dye is mixed into the diluent. This blue dye stains the surface of the tongue. Inspection of 2% of the flock gives the management a record of vaccination success. Care should be taken to make sure that vaccine does not roll off the eyelid, hence handle the birds carefully and do not release them until the droplet disappears with the blink of the birds eye.

Wing Web Vaccination

This route is used mostly for Fowl Pox vaccine virus and sometimes avian encephalomyelitis and fowl cholera vaccines. Again, this route is laborious. With the use of a special two-pronged needle the vaccine is directed into the skin of the wing web. The needle must pass through both skin tissue layers therefore releasing the vaccine into the lesion. Monitoring of the injection site 7 days post vaccination should reveal a bump or swelling, this indicates that there is a "vaccine take". Lumps with redness and discharge indicate bacterial contamination. No lumps or bumps mean a missed bird. Rule of thumb is to observe 2% of the flock for vaccination success.

Subcutaneous / Intramuscular Vaccination

Subcutaneous or intramuscular injection is the most common route of administration for the inactivated poultry vaccines. These vaccines contain high levels of killed viral or bacterial particles in an adjuvant. An adjuvant is simply a carrier for the vaccine design to stimulate the immune responses yet at the same time minimize tissue reaction. The most common adjuvant in our industry today is a water/oil adjuvant. The water fraction carrying the vaccine and the oil, usually a mineral oil, stimulating the immune cells. An injection of 0.5 mls. is designed to release the antigen over a long period of time! Slow release with frequent and consistent stimulation of the immune tissue. Vaccine is usually sold in 1000 dose bottles formulated for sterility and stability. The site of injection is most common in the breast and thigh for intramuscular or under the neck for subcutaneous. Alternate routes, depending on the bird and age can be the wing muscle or the tail. Accurate placement of the needle is critical. Most procedures call for an 18-gauge needle with a length of 6-mm (1/4 inch) or a 12-mm (1/2 inch). Care should be taken as to the handling of the bird, needle placement and follow up with respect to sanitation of the equipment. It is also a good policy to change the needle every 200 but not more than 500 birds. Frequent needle use can cause excessive bleeders, trauma and pain.

Vaccination Failure

Vaccination failure should be referred to as immunological failure (i.e. the vaccine did not stimulate the birds immune system), hence the bird did not receive the vaccine.

Failures can be grouped into key areas:

- Mechanical failures due to improper storage, adulteration, improper use or over-dilution.
- The bird may be incubating the disease that you are trying to protect against, or the vaccine may not contain the proper strains or serotypes of organisms required to stimulate protective immunity.
- Variation in immune responsiveness in the birds. Stress may reduce the chicken's ability to mount an immune response. Stress could include environmental extremes, inadequate nutrition, parasitism, or other diseases.
- A high level of maternal antibody in the young bird may interfere with the multiplication of the live vaccine, reducing the amount of immunity produced.
- Chickens may be immuno-suppressed due to infection with IBD, Marek's or consumption of feed with high levels of mycotoxins. Immuno-suppressed birds do not respond efficiently to active vaccination

It is important to realize, as a manager, that vaccines and the art of vaccination is not "the be all end all" in stopping disease. It is the management's responsibility to lower the insulting agents through optimum sanitation, disinfection and biosecurity measures. If infectious disease agents are allowed to build up on a farm over successive flocks without clean out and disinfection it is possible that the challenge dose will be too great and overwhelm vaccine capabilities.

Inadequate attention to balanced rations and adequate water supply can hinder growth and immuocompetence in our product, the bird. Knowing why we vaccinate and which vaccines we are going to have in our barns must be based on firm diagnostic testing, disease prevalence in the area and dedication to poultry management.

Conclusion

It is highly recommended that poultry producers and managers follow the guidelines indicated on vaccine vials and or bottles. The inserts that are provided are bullets of information on the use and application of their products**. Vaccination is simply an ART.** Take time to evaluate your procedure, and above all respect the birds that are to receive the vaccine. A vaccine that does not effectively stimulate the target tissue to maximize the immune response is a wasted vaccine. This is not only reducing the birds chance to fight the disease but also strips the profitability from the farm returns. A clear, conscientious effort must be made from start to finish. When in doubt ask, as the information available from the supporting industries is infinite in quality and quantity.

Acknowledgments

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