

Disease Prevention in Commercial Poultry ¹

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Prevention of disease in commercial poultry requires the producer to actively enforce an effective/comprehensive biosecurity program and to maintain an intact and functional immune system in the chicken.

Biosecurity for Disease Control/Prevention

Biosecurity is a commonly used poultry industry term that can be defined simply as “informed common sense.” That is, one develops a basic understanding of the principles of disease transmission and combines this knowledge with good old “common sense”. The objective would be to have a program design such that the diseases are not brought onto the poultry farm and poultry are not brought to diseases. An effective biosecurity program allows one to keep diseases off poultry farms; or if disease organisms are present, such a program would eliminate them or at least reduce them to a level of little or no significance.

Poultry veterinarians have been attempting to control diseases by improving biosecurity practices. This emphasis on controlling diseases by biosecurity practices rather than relying on vaccines and/or antibiotics has resulted from changes in the industry itself. As poultry farms became larger and more intensive, disease outbreaks became more costly; as the lifespan of broilers decreased because of improved genetics and feedings, birds did not have sufficient time to recover from diseases and make it to processing.

Veterinarians often find it difficult to convince many farm managers of the importance of biosecurity programs. The lack of support for these disease PREVENTION programs, which many farm managers may see as costly, time consuming, and just more unnecessary work, is probably due to the failure of previous programs. However, the failure of previous efforts was likely due to poor design and improper implementation of the programs. A comprehensive biosecurity program cannot eliminate the possibility of disease, but it can reduce the probability. In addition, often it is not possible to demonstrate direct benefits from a biosecurity program from just one flock. Improved production usually occurs gradually over several flocks.

Disease Transmission

Understanding how diseases are transmitted is an important factor in developing a biosecurity program. Studies have consistently demonstrated that approximately 90 percent of the time poultry diseases spread from one farm to another by contaminated people, poultry equipment, and farm vehicles. Exceptions to this include direct ovarian transmission (example: *Mycoplasma gallisepticum*), eggshell penetration (example: *Salmonella*) and hatcher contamination (example: *Aspergillus* sp.). Airborne transmission of poultry diseases is not considered to be an important means of disease transmission. For example, *Mycoplasma gallisepticum* is horizontally transmitted by direct contact between carriers and susceptible chickens, and by airborne dust or over droplets very short distances (such as between

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cage rows or pens within a house, but not between houses or farms).

M. gallisepticum is spread from one house to another, or from one farm to another by contaminated equipment, vehicles, and people. Studies with other poultry diseases have further demonstrated that airborne transmission is not a significant means of disease transmission between poultry farms.

Lifespan of Disease Organisms

Another important factor in developing a biosecurity program is determining the stability of poultry disease organisms in the environment. Table 1 includes the common poultry diseases and the time period for which they remain viable in the poultry house environment following the removal of chickens.

Down time, which includes the period of time between successive flocks when no chickens are present on the premises, has been used as a means to reduce the level of disease organisms in poultry farms. Increasing down time, however, may be of only limited value in reducing/eliminating specific diseases. As Table 1 illustrates, fragile organisms such as *M. gallisepticum* or *Hemophilus paragallinarum* (infectious coryza) remain viable for approximately 3 days outside the chicken. In these cases, a 1-week down period would be very effective in eliminating these diseases prior to bringing new chickens onto the premises.

However, for disease organisms such as infectious bursal disease virus or the coccidia, which are very resistant to environmental factors, increasing down time would be of limited value. In these cases thoroughly cleaning and disinfecting the premises would be necessary to reduce the level of these disease organisms.

Understanding the Immune System

The objective of any poultry management program should be disease PREVENTION through effective biosecurity practices. If there is a breakdown in biosecurity, and a disease outbreak occurs, be sure the chickens are immunologically competent. This will limit the resulting losses. Poultry producers need to understand the function of the immune system to assure that its integrity is maintained and that full advantage of its protective capability is utilized. The avian immune system is divided into nonspecific and specific immune mechanisms.

Nonspecific Immune Mechanisms

Nonspecific immune mechanisms include the innate or inherent ways in which the chicken resists disease. This protective system is often not considered when designing a poultry health program. Many programs tend to rely primarily on vaccinations and/or antibiotics to maintain flock health. The importance of nonspecific immune mechanisms should be realized. Examples have been included.

Examples:

- Genetic factors—birds may not have complementary receptors to allow many disease organisms to infect them. For example, some strains of chickens are genetically resistant to the lymphoid leukosis virus.
- Anatomic features—many disease organisms cannot penetrate intact body coverings (skin and mucous membranes) or are trapped in the mucus secretions. Some nutritional deficiencies (biotin deficiency) or infectious diseases compromise the integrity of the body coverings, allowing penetration of disease organisms.
- Normal microflora—the skin and gut normally maintain a dense, stable microbial population. This stable microflora prevents invading disease organisms from gaining a foothold. Improper use of antibiotics or poor sanitation can disrupt the balance of the microflora.
- Respiratory tract cilia—parts of the respiratory system are lined with cilia, which remove disease organisms and debris. If the air in the poultry house is of poor quality due to high levels of dust or ammonia, the ciliary system may be overwhelmed and become ineffective. Other factors involved in innate resistance include nutrition, environment (avoid heat/cold stress), age (young/old animals are more susceptible to disease), inflammatory processes, metabolic factors, complement and interferon.

The reason that good management practices are important in maintaining poultry health is better understood when the nonspecific immune mechanisms are defined. For example, poor sanitation or the overuse of antibiotics may lead to a disruption of the normal microflora; poor nutrition may lead to deficiencies that allow disease organisms to penetrate the protective body coverings; selection of disease resistant strains of chickens may preclude or lessen the effects of certain diseases.

Specific Immune Mechanisms

In contrast, specific immune mechanisms (acquired system) are characterized by specificity, heterogeneity and memory. This system is divided into noncellular (humoral) and cellular components.

NONCELLULAR IMMUNE MECHANISMS

The noncellular components include immunoglobulins (antibodies) and the cells that produce them. Antibodies are specific (specificity) for the foreign matter (antigen) to which they attach. For example, the antibody against Newcastle disease virus will attach only to the Newcastle virus, not to the infectious bronchitis virus (heterogeneity). There are three classes of antibodies that are produced in the chicken after exposure to a disease organism: Ig M, Ig G, and Ig A.

Ig M appears 4 to 5 days following exposure to a disease organism and will disappear in 10 to 12 days. Ig G is detectable 5 days following exposure, peaks at 3 to 3½ weeks and then slowly decreases. Ig G is the important protective antibody in the chicken and is measured by most serologic test systems. Thus, if you are interested in determining antibody titer levels following vaccination, you should collect sera after 3 to 3½ weeks. If sera is evaluated prior to this time, the antibody titer levels are still increasing, which makes interpretation of the vaccination program difficult. Ig A appears 5 days following exposure, peaks at 3 to 3½ weeks, and then slowly decreases. This antibody is found primarily in the mucus secretions of the eyes, gut, and respiratory tract, and provides “local” protection to these tissues.

The cells that produce antibodies are called B-lymphocytes. These cells are produced in the embryonic liver, yolk sac, and bone marrow. The cells move to the bursa of Fabricius (BF) at 15 days incubation and remain there through 10 weeks of age. The BF programs these cells, which then move to the blood, spleen, cecal tonsils, bone marrow, Harderian gland, and thymus. Destruction of the BF at a young age by Gumboro disease virus or Marek’s disease virus prevents the programming of B-cells. Thus, the chicken will not be able to respond as effectively to diseases or vaccinations by producing antibodies.

When a disease organism enters the body, it is engulfed by a phagocytic-type cell, the macrophage. The macrophage transports the disease organism and exposes it to the B-lymphocytes. The B-cells respond by producing antibodies 5 days following exposure. The lag period occurs because the B-cells must be programmed and undergo

clonal expansion to increase their numbers. If the chicken is exposed a second time to the same disease, the response is quicker, and a much higher level of antibody production occurs (memory). This is the basis for vaccinating.

Antibodies do not have the capability to kill viruses or bacteria directly. Antibodies perform their function by attaching to disease organisms and blocking their receptors. The disease organisms are then prevented from attaching to their target cell receptors in the chicken. For example, an infectious bronchitis virus that has its receptors covered with antibodies will not be able to attach to and penetrate its target cells, the cells lining the trachea. The attached antibodies also immobilize the disease organism that facilitates their destruction by macrophages.

CELLULAR IMMUNE MECHANISMS

The cellular component includes all the cells that react with specificity to antigens, except those associated with antibody production. The cells associated with this system, the T-lymphocytes, begin as the same stem cells as the B-cells. However, the T-lymphocytes are programmed in the thymus rather than the BF.

The T-lymphocytes include a more heterogeneous population than the B-cells. Some T-cells act by producing lymphokines (over 90 different ones have been identified); others directly destroy disease organisms. Some T-cells act to enhance the response of B-cells, macrophages, or other T-cells (helpers); others inhibit the activity of these cells (suppressors). The cellular system was identified when it was shown that chickens with damaged BF could still respond to and eliminate many disease organisms.

Active Immunity

A chicken may become immune to a disease organism by producing antibodies itself or by obtaining antibodies from another animal. When the chicken produces its own antibodies following exposure to a foreign material, the process is called active immunity. This occurs after the bird is exposed to a vaccine or a disease. Active immunity is harmed by anything that damages the cellular or humoral immune system.

PASSIVE IMMUNITY

When the chick receives pre-made antibodies from the hen through the egg, this is termed passive immunity. These antibodies are not produced by the chick. Maternal antibodies are present in the yolk albumin and fluids of the egg. If the hen has a high antibody titer level to a disease, the chick should also be immune for several weeks. However,

since the immune system of the chick is not stimulated, there will be no antibodies produced by the chick and no memory cells.

The flock manager must be aware of the maternal antibody levels in the chicks to schedule vaccinations. If chickens are vaccinated when maternal antibody titer levels are elevated, the vaccine may be buffered excessively, resulting in a reduced response. Conversely, if vaccinations are delayed and maternal titer levels are low, a severe vaccine reaction may result. Chickens may also be susceptible to diseases as maternal titer levels will be low, and approximately 12 days is required following vaccination before minimal protective antibody levels are produced.

In summary, the immune system of the chicken is very helpful in preventing disease and helping to ensuring that maximum productive potential is realized. We must learn how to take advantage of all parts of the system when designing health programs.

Serology

Routinely, serum samples are submitted to a poultry diagnostic laboratory to determine antibody titer levels as an aid in the diagnosis of disease or as part of a routine monitoring program. However, it is important to keep in mind that the ELISA serologic test system commonly used measures only Ig G levels in the blood. No determination is made of Ig A (local protection), Ig M (early protection), cell-mediated immunity, or the nonspecific immune system. Although serology can be very useful in a poultry health program it is important to understand its limitations. Table 2 lists common poultry diseases and the part of the immune system considered to be the primary protective mechanism in controlling the disease organism.

ELISA serology, commonly used in the poultry industry, has limitations. Some of these include the following:

- Measures Ig G response only, not Ig A, Ig M, CMI or the nonspecific immune mechanisms.
- Must have paired sera to make determinations (diagnostic).
- Must have an organized bleeding schedule (monitoring).
- Antigenic specificity may lead to inaccurate results.
- Serum samples must be properly selected (randomly, sufficient number).
- Selection of birds is critical (representative of the disease problem-diagnostic, or of the flock-monitoring). Lack of consistency of results between laboratories.

Development of Infectious Disease

The development of an infectious disease depends on three variables: 1) resistance of the chicken; 2) virulence of the disease organism; and 3) dosage of the organism to which birds are exposed. Through effective biosecurity practices, the dosage of the disease organism is reduced or even eliminated. Through proper vaccination practices, the resistance of the bird can be increased. The only factor over which there is little control is the virulence of the disease organism in the field.

Table 1. Diseases of chicken and lifespan of disease away from chicken.

Disease	Lifespan away from birds
Bursal disease	Months
Coccidiosis	Months
Fowl cholera	Weeks
Fowl coryza	Hours to days
Influenza	Days to weeks
Laryngotracheitis	Days
Marek's disease	Weeks
Newcastle	Days to weeks
Mycoplasmosis	Hours to days
Salmonellosis	Weeks

Table 2. Common poultry diseases and that part of the immune system mechanism that primarily controls the organism.

Primary Protective Mechanism/Disease			
	Ig A	Ig	CMI
Inf. Bursal Dis		x	
Newcastle Dis.	x	x	
Inf. Bronchitis	x		
Marek's Dis.			x
Fowl Pox			x
Coccidia			x