Principles of Avian Disease Prevention, Diagnosis, and Control

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Background

- The goal of a poultry operation is to convert feed into food as economically as possible.
- Avian disease management has shifted from classically recognized acute diseases of individual animals to management of both clinical and subclinical disease in populations.
- Morbidity and mortality are no longer the primary metrics monitored, and the emphasis has shifted to economic performance through the entire production chain, product quality, and animal welfare.

Challenges of Disease Prevention, Diagnosis, and Control in Modern Poultry Production

Viral diseases

- Immunological protection against viral disease challenge is usually highly successful.
- Emergence of variant strains pose the biggest threat to the poultry industry.
- Increased population density and vaccination have likely enhanced the emergence of variant strain viruses.

Bacterial, protozoal, and parasitic diseases

- Protection through vaccination is much less successful than viral diseases.
- Antibiotics and chemotherapeutics have remained the primary means of control.
- Use of in-feed antibiotics in food animal agriculture are responsible for the proliferation of antibiotic resistant strains of bacteria, and for the increase in prevalence of antibiotic resistant infections in humans.

Disease prevention and control program

- **Eradication programs for three categories of diseases**
  - Significantly threaten public health
  - Devastating effect on bird performance
  - Severely compromise product quality
- **Control programs for the majority of diseases**
  - Limiting disease challenge to a tolerable level
  - Reducing the consequence or economic impact of the disease
  - Economic analysis is a critical step in biosecurity plan design.

Biosecurity

In poultry production, biosecurity includes all procedures implemented to reduce the risks and consequence of introducing an infectious disease into a flock. A comprehensive biosecurity program comprises three levels:

Conceptual Biosecurity

- Physical isolation is the most effective means of limiting disease risk.

Structural Biosecurity

- farm layout, perimeter fencing, drainage, change rooms, and housing Design.

Procedural Biosecurity

- Implementation and control of routine procedures intended to prevent the introduction (bioexclusion) and spread (biocontainment) of infection within a complex or enterprise.

Risk Assessment

$$\text{Risk of infection} = \frac{\text{challenge dose} \times \text{agent virulence} \times \text{challenge frequency}}{\text{host resistance}}$$

The probability of infection occurring can thus be reduced by

- improving host resistance through immunization and stress reduction
- reducing the challenge dose through biosecurity, cleaning, and disinfection
- reducing organism virulence by medication or

Epidemiology

For flock health management purposes,

- **First, each disease must be analyzed in terms of its relative risk, to determine whether it is necessary to implement control procedures.**
- **Second, in terms of its epidemiological characteristics, to ensure optimum resource allocation.**

Epidemiology

The important epidemiological characteristics for disease control purposes include:

- Source of infection
- Susceptible host
- Morbidity
- Transmission
- Predisposition
- Mortality
- Spread
- Prevalence
- Recovery

Principles

Disease prevention and control involves the three interrelated processes of

■ Disease prevention: Bioexclusion

➢systematic approach to eliminating or decreasing the number of disease causing organisms within the bird's environment.

■Diagnosis: Monitoring, Surveillance, and Confirmation

➢ongoing collection of data to describe the prevalence and severity of disease in a population.

■Disease control: Biocontainment

➢reduce the consequence of disease challenge by limiting challenge (bioexclusion), enhancing bird resistance (immunization), and preventing spread (quarantine).

Principle I

Disease prevention: Bioexclusion

Bioexclusion

Preventing or reducing disease challenge requires that there is a systematic approach to eliminating or decreasing the number of diseases.

Global Perspective: Top Down

- The poultry industry has become a global industry.

Country Perspective: Responsible Trade Through Risk Reduction and Disease Containment

- The movement of animals or animal products across country borders carries a risk of disease spread. So we need to concern the OIE listed diseases.

Region or State Perspective: Zoning and Compartmentalization

- Due to the difficulties in controlling the disease across the vast expanse, the Terrestrial Code makes allowance for zoning and Compartmentalization.

Disease Status: Classification of Diseases for Biosecurity Purposes

Classification of Diseases for Biosecurity Purposes

For biosecurity purposes, diseases should initially be grouped into those that are exotic and those that are endemic to the region as this helps to optimize resource allocation to biosecurity.

Exotic disease

- In the case of foreign diseases the emphasis is on reducing the risk of disease through prevention and eradication.

Endemic disease

- In the case of endemic diseases the emphasis is on limiting the consequence of the disease.

OIE Listed Diseases

The following 12 avian diseases are included in the OIE List:

- avian chlamydiosis
- avian infectious bronchitis
- avian infectious laryngotracheitis
- avian mycoplasmosis (*Mycoplasma gallisepticum),* avian mycoplasmosis (*M. synoviae)*
- duck virus hepatitis
- fowl typhoid
- highly pathogenic avian influenza and H5 and H7 low pathogenic avian influenza in poultry
- infectious bursal disease (Gumboro disease)
- Newcastle disease
- pullorum disease
- turkey rhinotracheitis
- West Nile fever.

Zoning and Compartmentalization

Due to the difficulties in controlling the disease status and management practices of poultry flocks across the vast expanse, the Terrestrial Code makes allowance for zoning and Compartmentalization.

Zoning

- applies to a subpopulation separated on a geographical basis.

Compartmentalization

- applies to a subpopulation separated by biosecurity procedures.

Control Zoning

Primary Control Zone: Poultry House and Hatchery

- Bioexclusion begins at the boundary of the smallest epidemiological unit.

Secondary Control Zone: Farm or Site

- The company farms or sites constitute the next logical zone or compartment for disease control.

Tertiary Control Zone: Complex

- An epidemiological unit may also refer to groups of birds that share a communal animal handling facility.

Primary Control Zone - The Poultry House

Management of the House Environment

- The process of risk reduction begins with an all-in all-out placement strategy, so that decontamination of the house environment by thorough physical cleaning followed by chemical disinfection and/or “downtime” is possible between successive placements.

Turnaround-time and Downtime

- The longer the bird-free period, the greater the reduction in disease challenge.

Decontamination: Clean-out and Disinfection

- Decontamination involves five steps: removal of debris, detergent application, washing with water, drying, and disinfecting.

Primary Control Zone - The Poultry House

Built-Up Litter and Uncleaned Buildings

- Place the healthy new flocks in cleaned and disinfected buildings with fresh clean litter.

Culling and Mortality

- Injured, diseased, poor performers or dead birds should be removed at least daily and categorized per house according to the likely cause.

Nest and Egg Hygiene

- The most important consideration in hatching egg sanitation is to manage the flock so that eggs are clean when gathered.

Feed and Drinking Water

- The potential for feed or waterborne challenge occurs every time the birds eat or drink.

Primary Control Zone - The Poultry House

House Access: People and Equipment

- People and especially visitors pose the greatest biosecurity risk to any poultry operation. The easiest and most effective means of reducing this risk is to reduce the frequency of visits to the poultry house.

House Access: Animals

- No animals should be allowed into the poultry house.

House Access: Insect, Mite, and Tick Control

- Insect, mite, and tick act as transmitters of disease.

Primary Control Zone - The Hatchery

Design and Location

- A hatchery should be located away from sources of poultry pathogens such as poultry farms, processing plants, necropsy laboratories, rendering plants, and feed mills.
- A good hatchery design has a one-way traffic flow from the egg-entry room through egg-traying, incubation, hatching, and holding rooms to chick-loading area.

Importance of Good Sanitation

- The cleaner the air and environment the less likely the navel is to become infected.

Surgical Procedures

- Proper beak trimming promotes maximum performance.

Secondary Control Zone

One Age of Fowl per Farm – All-in All-out production

- The best way to prevent infection from carrier birds is to remove the entire flock from the farm before any new replacements are added and to rear young stock in complete isolation from older recovered birds on a separated farm segment or preferably on another farm and in an isolated area.

Functional Units

- divided into separate quarantinable units or areas for different groups of birds.

Farm Access Control

- The site should ideally be completely fenced with sufficient deterrents to access.

People, vehicle, equipment

- Farm/site personnel should ideally be the only people permitted on site; all vehicles and equipments entering the site should be suitably disinfected prior to entry.

Tertiary Control Zone

Complex Environment

- Although a complex can be a large expanse of land, the same principles to housekeeping on the site are applicable.

Complex Access

- The transit facility is the entrance to the complex and serves as a biosecurity critical control point to reduce the risk of disease.
- Procedures for people, vehicle, and equipment access to a complex are the same as those for a farm.

Principle II

Diagnosis:

Monitoring, Surveillance, and Confirmation

Monitoring and Surveillance

Monitoring program

- designed to accumulate statistically reliable disease prevalence data over time, to indicate a change in the incidence or severity of a disease.

Surveillance program

- designed to collect prevalence data from a readily available sector of the population (potential sample bias) with the primary purpose of implementing timely corrective action when there is a perceived increase in incidence of a disease.

Diagnostic Procedures

Case History

- Knowledge of management factors such as ventilation; feeding and watering systems; accurate records of egg production, feed consumption, feed formulation, and body weight; lighting program; beak trimming practices; brooding and rearing procedures; routine medication and vaccination used; age; previous history of disease; farm location; and unusual weather or farm events. Duration of the signs, the number of sick and dead, and when and where they were found dead.

External Examination

- Examination should be made for tumors, abscesses, skin changes, beak condition, evidence of cannibalism, injuries, diarrhea, nasal and respiratory discharges, conjunctival exudates, feather and comb conditions, dehydration, and body condition.

Diagnostic Procedures

Blood Samples

➢Venipuncture of the brachial vein is usually the simplest and best method for obtaining blood from turkeys, chickens, and most fowl under field conditions.

Killing Birds for Necropsy

➢Cervical dislocation and decapitation are considered humane methods of poultry euthanasia.

➢If there is reason to suspect that birds to be necropsied are infected with disease that may be contagious for humans, stringent health precautions are essential.

Laboratory Procedures

➢Bacterial Cultures；Respiratory Virus Isolation；Gross Necropsy；Tissues for Histopathologic Examination；Disposing of the Specimen.

Principle III

Disease control: Biocontainment

Disease control strategies

Chemoprophylaxis

- Prophylactic medication in the form of in-feed medication and, in specific cases, water medication may be used to reduce the risk of disease.

Immunization

- Immunization through vaccination is a commonly used method of reducing the risk.
- The primary purpose of immunization is to raise the ID50 of the flock in order to prevent clinical disease following subsequent challenge.
- A second reason for the vaccination of poultry flocks is to hyperimmunize hens to maximize maternally derived antibody passed through the egg to the progeny.
- The success of vaccination depends on the manufacturing or research of vaccines, the maintenance of the cold chain, protection of the vaccine from the elements, and the correct application of the vaccine to the bird.

Types of Vaccines

Live vaccine

- Live vaccines are available for numerous viral, bacterial, and coccidial organisms. effective when mass applied; relatively economical; must be stored, mixed, dosed, and applied appropriately.

Inactivated vaccine

- generally whole bacteria or virus preparations combined with an adjuvant that are designed for subcutaneous or intramuscular injection.

Genetically engineered live vectored vaccine

- Commercially licensed live virus vectored vaccines currently available and widely used. The problem is differentiation of vaccine from virulent field challenge.

DNA vaccine

- DNA vaccines have both technological and economical challenges to overcome before they are commercially viable.

Vaccine Delivery Systems

In Ovo Vaccination

- Mainly for Marek's disease vaccine; IBD vaccine, reovirus vaccine, and the various Marek's-vectored vaccines.

Subcutaneous or Intramuscular Injection at Day of Hatch

- Marek's disease vaccine

Spray in the Hatchery

- deliver Newcastle disease virus, infectious bronchitis virus, or coccidiosis vaccine, attempt to mimic eye drop vaccination.

Spray Vaccination on the Farm

- spray vaccination of respiratory vaccines, such as Newcastle disease virus and infectious bronchitis virus, has become increasingly popular.

Vaccine Delivery Systems

Intraocular or Nasal Drop in the Hatchery or on the Farm

- a highly effective but labor-intensive method used to deliver respiratory disease vaccines.

Drinking Water Vaccination on the Farm

- A very common and useful technique in commercial poultry; a process that creates a mild degree of thirst by eliminating access to drinking water for approximately two hours prior to the vaccination.

Wing Web Stab

- most often used for fowl pox or fowl cholera

Subcutaneous or Intramuscular Injection on the Farm

- Frequently used in breeder pullets and commercial egg-laying pullets prior to egg production.

Vaccine Failure

■One of the most common causes of vaccine failure is the inappropriate administration of the vaccine.

- ➢failure to follow the manufacturer's recommended handling practices
- ➢mishandled or if water sanitizers have not been removed from the water prior to the addition of the vaccine.
- ➢not deliver the vaccine to the appropriate vaccination site.

■Management conditions play an important role in the prevention of vaccine failures.

■Certain infectious disease agents (IBDV、MDV、CIAV) and mycotoxins are immunosuppressive and may result in vaccine failure.

Handling Disease Outbreaks

- **Good poultry producers watch feed and water consumption and egg production at all times, but more important, they observe normal sounds and actions of the flock.**
- **Take precautions against tracking an infectious disease that may be present, but investigate management errors immediately.**
- **A high percentage of so-called disease problems referred to laboratories for diagnosis are noninfectious conditions related to management such as** beak trimming errors; consumption of litter and trash; feed and water deprivation; chilling of chicks; overcrowding; etc.

Quarantine the Flock

Submit Specimens or Call a Veterinarian

- Submit typical specimens to a diagnostic laboratory or call a veterinarian to visit the farm and establish the diagnosis.

Special Precautions

- In addition to causing serious losses in poultry, some diseases (chlamydiosis, salmonellosis) are especially hazardous for humans.

Nursing Care

- Nursing care plays an important role in the outcome of a disease outbreak.

Drugs

- Therapeutic medication, if appropriate, should be prescribed by the veterinarian after the problem has been diagnosed.

Disposition of the Flock

- The flock should not be moved or handled until it has recovered, unless the move is to a more favorable environment as part of the therapy or for emergency slaughter.

Antimicrobial Therapy

- **Judicious antimicrobial therapy includes proper diagnosis, knowledge of antibiotic properties, dosage, spectrum, interactions, and early initiation of treatment.**
- **The limited arsenal of drugs available for poultry makes it imperative to combine an accurate diagnosis with antimicrobial knowledge to result in the most efficacious and cost-effective approach to disease treatment with minimal potential risk of antimicrobial resistance development and selection.**
- **Successfully treating a bacterial infection without any adverse effects involves many important factors, including the choice of antimicrobial, the route of administration, and the dose and duration of treatment.**

Antimicrobial Therapy

- **Treatment of commercial poultry can be divided into three broad categories:**
  - **prevention of infection:** Disease prevention antibiotics are commonly given in the feed of broilers and turkeys.
  - **treatment of subclinical bacterial disease**
  - **treatment of clinically affected birds**: based on the observation of birds in the flock exhibiting clinical signs of a bacterial infection.

Routes of Medication

- Feed-grade antimicrobials are usually less expensive than the same drug in a water-soluble formulation.
- Early in the infection, water medication may be more effective than by the feed.
- Another consideration in selecting a water route of administration is the ambient temperature.
- Flock treatment is almost always the preferred route, and thus mass methods of administering antimicrobials are generally used.

Antimicrobial Resistance

- One possible side effect from antimicrobial therapy of any food animal is the potential for increasing the level of resistance in the bacterial population of those food animals.
- Antimicrobial resistance can lead to decreased effectiveness of future antimicrobial therapy in the food animal population, but can also pose a potential risk to human health.
- Antimicrobial resistance is a growing concern for human health because of the increasing incidence of bacterial infections that are refractory to antimicrobial therapy.

Public Health Significance of Poultry Diseases

- Several poultry diseases have the potential to impact human health, such as H5N1 and H7N9 avian influenza viruses, foodborne pathogens of *Salmonella* and *Campylobacter*.
- Common biosecurity practices including the use of gloves, eye and respiratory protection, and protective outerwear are all important elements of zoonotic disease prevention. Good hand hygiene and routine injury prevention are also essential.
- Agents of viral, bacterial, fungal, parasitic diseases are associated with the human diseases.

Viral Diseases

- **Arboviral Encephalitis:** viruses transmitted to vertebrates by the bite of arthropod vectors including mosquitos, ticks, and flies. Three main viruses: Eastern equine encephalitis virus (EEEV), Western equine encephalitis virus (WEEV), and West Nile virus (WNV).
- **Avian Influenza**: subtypes H5N1, H5N6 Gs/GD lineage and H7N9 avian influenza viruses.

Bacterial Diseases

- **Botulism:** Botulism is a paralytic intoxication caused by botulinum toxin, is produced by *Clostridium botulinum*. *Clostridium perfringens* causes two different types of foodborne disease as well as gas gangrene in humans.
- **Campylobacteriosis**: an enteric infection caused by members of the genus *Campylobacter*. Most human infections are caused by the thermophilic species *C. jejuni* or *C. coli*.
- **Chlamydiosis**: also known as ornithosis or parrot fever, is a respiratory disease of humans caused by *Chlamydophila* (or *Chlamydia*) *psittaci*.
- ***Erysipelothrix rhusiopathiae* Infection**: infection in humans is called erysipeloid.

Bacterial Diseases

- ***Escherichia coli* Infection:** only the enterohemorrhagic *E. coli* (EHEC) strains (e.g., O157:H7) are considered to be zoonotic pathogens.
- **Listeriosis**: is caused by *Listeria monocytogenes*. Three serotypes 1/2a, 1/2b, and 4b are most frequently associated with human disease.
- **Mycobacteriosis**: Members of the *Mycobacterium avium* complex (MAC) cause disease in humans worldwide.
- **Salmonellosis**: *Salmonella enterica* serotypes Enteritidis and Typhimurium have a broad host range and are two of the most common nontyphoidal serovars isolated from humans.
- ***Staphylococcus aureus* Infection and Foodborne Intoxication**: Staphylococcus aureus frequently colonizes the skin and mucous membranes of humans and animals, including poultry.

Fungal Diseases

- **Cryptococcosis:** Cryptococcosis is a fungal infection caused by members of the genus *Cryptococcus*.
- **Dermatophytosis (Favus)**: *Microsporum gallinae* is a contagious zoophilic fungus that is responsible for causing dermatophytosis in poultry and in humans.
- **Histoplasmosis**: Histoplasmosis is caused by the fungus *Histoplasma capsulatum*.

Parasitic Diseases

- **Avian Mite Dermatitis:** Avian mite dermatitis is most frequently caused by *Dermanyssus gallinae* (the poultry red mite or chicken mite) or *Ornithonyssus sylviarum*.
- **Cryptosporidiosis**: Cryptosporidiosis is caused by intracellular protozoan parasites belonging to the genus *Cryptosporidium*.
- **Toxoplasmosis**: Toxoplasmosis is caused by infection with the obligate intracellular protozoan *Toxoplasma gondii*.

Thank you for your attention!