Department of Animal Science

Disease Diagnosis in Poultry Flocks

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The poultry industry provides low-cost, high-quality protein products (meat and eggs) for human consumption, plays an increasingly important role in the global economy, and is the fastest-growing agricultural sub-sector (He et al., 2022). Controlling infectious diseases in commercial and backyard poultry flocks is vital for poultry health and well-being in Tennessee and across the U.S. Diagnostic methods are an invaluable tool to resolve disease etiologies and the impact of infectious agents on the host. Infectious diseases pose a constant risk to both commercial and backyard poultry health and production with substantial negative consequences on welfare and the economy. Consider the current U.S. avian influenza outbreak that has resulted in the loss of more than 208 million birds to date or the massive numbers of backyard birds that succumb to Marek's and Mycoplasma infections each year. Although the basic principles of disease diagnostics have not changed, the spectrum of poultry diseases is constantly expanding with the identification of new pathogens and improved knowledge on epidemiology and disease pathogenesis (Liebhart et al., 2023).

Many characteristics of commercial poultry production (closed housing systems, automatic feeding and drinking systems, environmental controllers, and large-scale integrations) provide a unique opportunity to adopt precision livestock farming (PLF) strategies to assess bird health and for early disease detection. While new technologies are being devised to identify and characterize infectious agents, classical methods remain crucial, especially the isolation of pathogens and their further characterization. The first successful example of combining pathogen detection with initial characterization followed by the implementation of a screening program was the control of Pullorum disease in the commercial poultry supply in the mid-1960s. The concentrated action of different stakeholders paved the way for the National Poultry Improvement Plan (NPIP) in the U.S. and is a role model for successful cooperation between scientists, government and industry as reviewed in detail by Schat et al. (2021). Poultry producers (commercial and backyard) should become familiar with the normal appearance of birds to recognize what is abnormal. Observing healthy birds can help you learn what to look for in sick birds. Even though backyard poultry are often not covered by the same rules and regulations as commercial poultry, diagnostic procedures should be performed to clarify disease etiology considering the importance of birds raised under somewhat loose biosecurity to pathogen spread (Whitehead and Roberts, 2014; Ayala et al., 2020)

Flock History

It is important to recognize and identify affected organs and tissues before determining a treatment program for disease-affected flocks. A treatment program cannot be successfully proposed without an accurate flock history and a list of symptoms and lesions. Poultry diseases are most often not considered as affecting individual birds but are generally considered as diseases of the entire flock rather than individual bird diseases. While initially a few individual birds may begin showing symptoms, this is usually an indication of a more serious flock-wide problem. It is critical to keep an accurate history on your flock. The source of many poultry diseases can be determined from an accurate flock history that includes:

- name and address of the flock owner
- name and address of anyone you may have recently gotten birds from
- when any new birds were added to the flock
- were new birds quarantined and isolated before adding to the current flock (if so, how far away and for how long?)
- breed, strain and age of all flock members

Management information will also be valuable:

- flock source (hatchery, feed store or CO-OP, friend, neighbor, poultry show, flea market, want ads, etc.)
- type of operation (commercial or backyard)
- confinement or free-range system
- feeding program
- flock vaccination history, including what was given (if anything), when, where, why and how

Details on the illness itself should include:

- date the illness was first observed
- severity and number of birds affected
- number of birds being lost
- medication or treatment history

It will be important to note if similar or different disease issues have occurred previously or if any unusual situations or weather conditions may have placed additional stress on the flock. Stress conditions can weaken the immune system, making the flock more susceptible to disease outbreaks.

External Examination

In the field, diagnostic procedures are often initiated as soon as flock health is compromised, using morbidity and mortality data as initial indicators. Investigations often start with the compilation of a case history pertaining to relevant flock management and disease characteristics (e.g., bird type and origin, age, routine medications, vaccination program, previous disease history, husbandry system, standard operation procedures such as feeding and watering systems, ventilation, lighting program, biosecurity practices, production parameters, morbidity and

mortality data, duration of symptoms and epidemiological links to other nearby production sites). On the farm, diagnostics start with the clinical examination of flocks, primarily individual birds in various stages of the disease.

Before examining the bird internally, observe and inspect the bird for external symptoms. Follow a systematic head-to-tail approach. Note the general appearance and fleshing (presence of meat on the bone) of the bird. Consider trauma and feather quality and check the condition of the skin and all natural body openings (nasal openings, mouth, ears, and vent). Examine the head, eyes, comb and wattles for color, swelling, lesions or unusual discharge. Look for signs of lameness, weakness or paralysis. Observe the affected areas for abnormalities or swelling that can be a clue to the cause. Note the position of the head if paralysis is observed. This can be an indicator of the cause of the disease. Check affected birds for external parasites such as lice, mites, ticks and fleas.

Euthanasia

Starting a flock treatment plan at the first indication of disease may often save more birds than delaying treatment until the first birds die. However, you must know what you are treating to provide appropriate care. For disease diagnosis, it is often best to euthanize a sick bird showing symptoms for a complete necropsy. A necropsy on a healthy bird from a sick flock will be of no value in determining the cause of the problem. Cervical dislocation of the head from the cervical vertebrae is the most humane method of euthanizing a bird. Cervical dislocation is the most practiced method of euthanizing birds for examination.

To dislocate the head from the vertebrae, direct the bird's head toward you. Grasp the bird's head in a handshake grip. Place your thumb behind the head at the base of the bird's skull and allow the remaining fingers to extend under the throat. Hold the bird's feet with your other hand and gently stretch the bird until you feel the head separate from the neck vertebrae. You may find it useful to bend the head back slightly while stretching the bird. Apply gentle but constant stretching pressure until you feel the head separate from the neck vertebrae and be careful to stop pulling when the spine separates as to not pull the head off. For large chickens (commercial broiler breeders) and turkeys, a Koechner Euthanizing Device (KED) (Fig. 1) may be useful to perform the same task. It is important that you are familiar with poultry anatomy and can recognize the organs that you will see during a necropsy. Become familiar with the following anatomy before necropsing sick birds so that you will recognize what you are seeing.



Fig, 1. *Koechner Euthanizing Device (KED) used for euthanizing poultry.* Source: Clear View Enterprises. Tontitown, AR.

Poultry Anatomy

Respiratory System
Each nasal opening leads to a nasal cavity that is connected to sinus cavities around each eye. A split in the roof of the mouth provides air passage between the nasal cavities and the lower respiratory system. The nasal cavities filter air before it enters the lungs. The larynx is located at the rear of the mouth. It is the structure connecting the trachea (windpipe) and the esophagus. The trachea is a tube that separates into two bronchial tubes with each tube attached to a lung. The trachea and bronchial tubes are supported by rings of cartilage that prevent the tubes from collapsing.

The lungs are located near the vertebrae against the ribs. They resemble two bright red sponges because of the abundant blood supply. Bird lungs are smaller in proportion to body size than other animals. Though smaller in birds, the lungs are aided by an extensive system of air sacs found only in birds. The air sacs are thin membrane sacs that surround the internal organs. They are used as reserve air space to increase lung capacity. When the bird's body is opened, the air sacs in a healthy bird appear as clear, thin membranes among the body organs. They are among the first sites affected by respiratory diseases.

Digestive System
The mouth is connected to the rest of the digestive system by a thin-walled tube called the esophagus (or gullet). The lower portion of the esophagus forms a pouch called the crop. It functions as a temporary storage site for food. The lower end of the esophagus is attached to the bird's stomach. The stomach in birds is divided into two parts: 1) the proventriculus and 2) the gizzard. The proventriculus is the slightly enlarged area between the esophagus and gizzard. When opened, it has a deeply textured appearance. The gizzard has a tough membrane inner lining firmly attached to the muscular outer part. The gizzard is attached to the upper end of the small intestine. The first portion of the small intestine is the duodenum. It is held in a loop-like position by the pancreas. The pancreas is located between and attached to the portions of the intestine forming the loop. The lower portion of the small intestine is attached to a membrane called the mesentery. The mesentery is laced with many blood vessels that enter and exit the small intestine. When opened, the small intestine has a soft, velvety texture.

Two large, closed pouches called ceca are attached at the lower end of the small intestine. Bacterial action in the ceca helps break down some of the undigested food passing through the intestine. The ceca in adult chickens are usually about 4 to 6 inches long. When opened, in healthy chickens they contain a darker brown liquid waste material than seen in the intestines. Following the ceca, the small intestine transitions to the large intestine. The large intestine empties into the cloaca, or the chamber where the digestive, urinary and reproductive systems meet. The external opening of the cloaca is called the vent.

The liver is a large, dark brown organ located in the front portion of the body cavity below the heart. It is the largest organ in the body. It has two large lobes separated by a thin membrane. Its function is to produce digestive fluids and filter toxic wastes from the blood. A digestive fluid produced in the liver (bile) is stored in the gall bladder. The gall bladder is a small, greenish pouch attached to the liver. A bile duct between the liver and small intestine directs the bile into the intestine.

Urinary, Reproductive and Vascular Systems
The urinary system in birds consists of kidneys and ureters. There are two kidneys in each bird, and each kidney has a ureter. The kidneys are small dark brown organs located in a pocket of the pelvic bones. The ureters are tubes that pass the urinary wastes from the kidneys to the cloaca.

The reproductive organs include the ovary and oviduct in the female and the testes in the male. The hen usually has only one functional ovary and oviduct (left). The right ovary usually regresses during embryonic development and remains nonfunctional in the adult bird. The ovary is a group of egg yolks in various stages of development and is located in the area of the kidneys. Some yolks may not be seen, while others in the adult laying hen may be the size of normal egg yolks. The oviduct in mature hens appears as a coiled tube extending from the area of the ovary to the cloaca. In immature hens the ovary and oviduct may be difficult to see.

The reproductive system of the male consists primarily of the testes. The testes are oval organs located between the lungs and kidneys. Ducts through which sperm pass (ductus deferens) extend from each testis to the cloaca. Vascular organs consist primarily of the heart and spleen. The four-chambered heart is located above the liver. The spleen is a spherical, reddish-brown organ located between the liver and gizzard. Its primary function is remove unhealthy blood cells, microorganisms, and debris from the blood system.

Necropsy Procedure

A necropsy is an examination of a dead animal. While the only necessary tool to perform a necropsy on poultry is a good sharp knife or cutting tool, several other quality tools such as surgical-type scissors, scalpels, or knives could prove useful. A sharp pair of surgical-type scissors and a scalpel, or knife, make it easier to cut certain tissues. Heavy duty shears are helpful when cutting through bones. While few poultry diseases can infect people, it is wise to wear disposable plastic gloves during any necropsy procedure. A complete necropsy procedure is described below:

1. Place the deceased bird on a flat surface (a table works well but pickup tailgates also will do) with the breast side up and the head directed away from you. The following steps are numbered in sequential order to make it easier to follow the necropsy procedure.
2. Remove the upper portion of the beak by cutting through the nasal cavities and turbinated bones. Turbinated bones are the membrane-covered plates on the walls of the nasal chambers. This allows you to observe the upper respiratory tract for the presence of infection. Squeeze the turbinate area and note if excessive matter oozes from the area that could indicate infection. Check the eyes for inflammation (unusual reddening), swelling, mucus or discoloration.
3. Insert a knife or one scissor blade into the mouth and cut through one corner of the mouth. Extend the cut down the neck so the interior of the gullet is exposed. Examine the mouth and larynx for abnormalities that could indicate fowl pox, mycosis, or other diseases. Scan the gullet for tiny nodules (bumps) or signs of injury by foreign materials.
4. Cut the larynx and trachea from the mouth and open the trachea lengthwise. Examine its interior for excessive mucus, blood or cheesy exudate material.
5. Make an incision in the abdominal skin just below the tip of the breast. Extend the cut around the body on each side. Grasp the upper edge of the cut skin and peel the skin back

over the breast to expose the breast muscles. Examine the breast for conditioning and the presence of hemorrhages (sites of prior bleeding in the muscle).

6. Cut the skin on the abdomen where the legs join the body. Place a hand on each leg and press down until the femoral joints dislocate and the legs lie flat on the surface of the table or tailgate. Examine the bone for signs of femoral head necrosis and tibial dyschondroplasia. Remove the skin from the legs and check for small pin-point hemorrhages.
7. Make an incision through the abdominal muscles just below the tip of the breast. Do not cut too deep to avoid damaging the internal organs. Extend the cut toward the back and then angle forward toward the point of the wing attachment on each side. Push the breast up and forward toward the head and dislocate the shoulder joints and remove the breast from the carcass.
8. Observe the condition of the air sacs. While air sacs are clear in healthy birds, diseased birds often have air sacs that are cloudy, contain soap-suds-looking bubbles (indicating a possible *E. coli* infection), or covered with cheesy yellow mucus, indicating a severe respiratory infection.
9. Examine the liver for unusual swelling, ulceration, bullseye-looking lesions, hemorrhages, or abnormal coloration. Make incisions into the liver and look for scar tissue or necrotic (dead) tissue. Check the spleen for hemorrhages, lesions and swelling. Check for a cloudy, cheesy or fluid-filled air sac around the heart.
10. Remove the liver, heart and spleen to expose the digestive system. Check the digestive system for abnormal nodules, tumors or hemorrhages. Cut the gullet near the mouth and remove the entire digestive system. Cut the lower intestine below the ceca for complete removal of the digestive system.
11. Cut into the crop, noting if the contents has a sour smell. Wash the contents from the crop and examine the lining for thickened, patch-like areas or necrotic ulcers. Wash the contents through a worm screen (Fig. 2) and check for capillary worms. Capillary worms will appear as small, hair-like fibers on the screen.
12. Open the proventriculus, the slightly enlarged area between the esophagus and gizzard, and note any hemorrhages or a white coating on the lining.
13. Open the gizzard and examine the lining for unusual roughness or lesions. Determine if the lining is separating from the underlying muscles.



***Fig. 2**. Worm screen*. Source: Tom Tabler

14. Slit the intestine lengthwise and examine the contents for the presence of roundworms, tapeworms, free blood and excess mucus. Check the lining for inflammation, ulcers or hemorrhagic areas. Make note of the thickness of the intestinal wall. If unusual conditions exist, note in which one-third portion of the intestine the conditions are located. Different strains of coccidiosis affect different parts of the intestinal tract.

15. Open the ceca and examine the contents. Look for hard cheesy cores and small, thread-like cecal worms. If you find blood, which could indicate coccidiosis, wash and examine the lining for scarring.
16. Check the reproductive organs (ovary and oviduct in females, testes and ductus deferens in males) for abnormalities before removing them from the body.
17. Examine the kidneys and ureters for unusual swelling or presence of whiteish salt deposits.
18. Check the sciatic nerve extending to each leg for swelling. Once you remove the kidneys, you will see this nerve as a small, white fiber stretching from the spinal cord along the femur into the lower leg. Also check the brachial nerve extending from the spine, along the humerus, to the wing tip.
19. Examine the lungs and bronchial tubes for lesions, spores, and unusual accumulation of mucus.

Be aware that many respiratory diseases show similar symptoms. You may be able to determine that the disease issue is respiratory, but it may likely require the assistance of a diagnostic lab to determine which respiratory disease is causing the problem.

Diagnosis and Treatment

If you are a backyard flock owner, help with a diagnosis and treatment may be available from your local county agent or a state Extension poultry specialist. In addition, the staff at the C. E. Kord Animal Health Diagnostic Laboratory in Nashville (615-837-5125) or the University of Tennessee College of Veterinary Medicine Immunology/Virology Laboratory in Knoxville (865-974-5880) can assist you with disease diagnosis. Once an accurate diagnosis is determined, access to medication often requires a prescription from a licensed veterinarian. Take care to administer any recommended medication using the proper dosage, method of application and recommended period of time. Becoming familiar with disease symptoms and lesions and following the proper diagnostic procedures will help eliminate the difficulty of diagnosing many poultry diseases.

If you are a commercial poultry producer, notify your field service technician at the first sign that you may have a disease issue with your flock. Often, a drop in water consumption is the first indication that something is wrong with the flock. Monitor daily water intake and make note of any unexplained drop in daily water consumption. Your service technician may recommend a treatment plan based on his or her necropsy of sick birds on your farm. Follow the recommendations of your service technician for a treatment program and for management of house temperature and environment. Maintain a strong biosecurity program. Do not allow unnecessary visitors on your farm, and do not visit other farms where live birds are present. Limit your contact with other poultry growers at such places as feed stores, co-ops, cafes, poultry supply houses, etc. If you go to town, change clothes when you get home and do not check your birds in the same clothes that you wore to town.

Summary

Diagnosing poultry diseases starts at the farm with precise recording and a detailed flock history. The sustainability of backyard and commercial poultry production depends on quick and accurate detection of a disease situation to plan interventions and adjust prophylactic strategies.

We have provided some first steps to on-farm diagnosis of disease in poultry flocks. However, be aware that many diseases show similar symptoms and cannot be accurately identified without the help of a diagnostic laboratory. The more history and information you can provide the diagnostic lab regarding the flock, the easier it will be for the lab to determine what the problem is and to recommend a treatment program. Keep in mind that not all poultry health problems are caused by disease agents. Always consider non-infectious conditions (management factors or FLAWSSS) first such as:

- **F**eed quality
- **L**ighting
- **A**ir quality and ventilation
- **W**ater quality
- **S**pace (overcrowding or inadequate feeder and drinker space)
- **S**anitation
- **S**ecurity (biosecurity and security from predators)

Currently, PLF tools for early detection and recognition of diseases on farm are not routinely available, as most PLF data have been acquired under experimental conditions and farm equipment will require updating. However, expect that with additional research leading to progress in technology and the validation of behavioral tracking and analyses of flock data collected in poultry house environments, PLF developments will offer huge potential for the future of disease diagnostics in poultry. In the future, the importance of linking human expertise with PLF technologies, both in the field and the lab, to develop a sustainable, holistic approach as a basic strategy to diagnose infectious diseases in poultry must not be overlooked.

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