What to Do When You Encounter a New Disease: An Exercise in Problem Solving

H. John Barnes

Department of Population Health & Pathobiology
College of Veterinary Medicine
North Carolina State University
4700 Hillsborough
Raleigh, NC 27606
(919) 513-6273
john_barnes@ncsu.edu

New diseases are potential threats impacting the economy of the poultry industry and rural communities. Some come and go creating little impact while others have a significant effect. Most affect breeders, either directly by reducing productivity (decreased egg production, decreased fertility, increased mortality, increased costs, poor chick viability or productivity, etc.), or indirectly through genetics, inadequate immunity, or vertical transmission. New diseases occur with astonishing frequency – on average at least one new poultry disease is described each year. Following are some examples of new poultry diseases that have affected the industry during the past 25 years:

1. Turkey Coryza (Bordetellosis)
2. Avian Nephritis
3. Zoonotic Avian Influenza
4. Highly Virulent Infectious Bursal Disease
5. Variant Inf. Bursal Disease
6. Variant Infectious Bronchitis
7. *Ornithobacterium rhinotracheale* Infection
8. Angara (Hydropericardium) Disease
9. Runting Stunting Syndrome
10. Chicken Infectious Anemia
11. Transmissible Viral Proventriculitis
12. Variant MG and MS Infections
13. Dermal Squamous Cell Carcinoma
14. Myeloid Leukosis
15. Turkey Rhinotracheitis
16. Cryptosporidiosis
17. Spiking Mortality-Hypoglycemia Syndrome
18. Very Virulent Marek's Disease
19. Pulmonary Hypertension Syndrome
20. Big Liver and Spleen Disease
21. *Salmonella enteritidis* phage type 4
22. Equine Encephalitis Virus in Turkeys
23. Stunting Syndrome in Turkeys
24. Poult Enteritis Mortality Syndrome
25. Multicentric Histiocytosis
26. Hepatitis-Splenomegaly Syndrome
27. Turkey Osteomyelitis Complex

In this presentation, how to recognize a "new" disease, and what to do about it, will be discussed. It is vitally important to control new diseases as soon as possible to minimize their impact on the poultry industry. In addition, how one may get help or why help may be difficult to find or even obtain will be covered.

Recognizing a New Disease

New diseases will be most readily recognized when disease surveillance is already in place. We are fortunate in North Carolina to have an excellent and virtually no-cost diagnostic service available to the poultry industry, which makes disease surveillance readily available.

New diseases will be seen by the grower initially, service person, farm manager or other person who interacts on a continuous basis with the birds. Experience and training will help the individual to recognize that a new disease may have occurred.

New diseases will be different in some way from diseases that have occurred previously. They can be an emerging disease (truly new) or a re-emerging disease (a variation of a known disease). Recognizing how a disease is different from what is known is essential to identifying a new disease.

Steps to be Taken

In many ways, a disease investigation is like a criminal investigation. Three steps are essential: 1) Is the problem really a new disease or is it a known disease? Careful and complete diagnostic workups of affected flocks will help to determine this question. It is important to consider management and environment as well as search for infectious agents. 2) The new disease needs to be described, defined, and named to make communication possible. What are the salient features of the new disease that distinguish it from previously known diseases? 3) An epidemiologic study needs to be done. In most situations, something has been changed to permit the new disease to emerge or re-emerge. What is different now from when the disease was not occurring?

Types of "New" Diseases

a) *Well-known classical diseases in unusual situations.* Either a previously known disease occurs in a different class of poultry or in a geographic area where it has not occurred previously. This includes the introduction of foreign diseases such as exotic Newcastle disease or Highly Pathogenic Avian Influenza.
b) *Production diseases.* Most economic loss from disease in poultry flocks results from a failure of the bird to achieve its genetic potential, *i.e.,* morbidity, and not from outright death (mortality). Collectively these ill-defined diseases that adversely affect production are called production diseases to differentiate them from classical diseases with known causes (Table 1). Causes of production diseases cannot be defined by Koch's postulates; they are determined by considering a 'body of evidence' using Evans' postulates (Table 2).
c) *Polymicrobial diseases.* Few diseases result solely from the effects of a single agent. In most instances there is a primary pathogen, which initiates the disease process, and opportunistic microbes or non-infectious factors that complicate or intensify the clinical severity of the condition. Polymicrobial diseases require at least two infectious agents for the disease to occur.
d) *Emerging and reemerging diseases.* Infectious agents are constantly interacting with their host(s) in the process of adaptation and with each other to form new organisms through transfer of genetic material. Coinfection of a bird with two similar viruses can result in a recombinant virus with properties of both viruses, effectively resulting in a new virus. Variants also result from mutations during replication. In fact the mutation rate in coronaviruses is so high that it is unlikely that any two virus particles have completely identical genomes. "For virologists, evolution is a daily reality – not a theory," according to Dr. M. C. Horzinek (2000). Fortunately most genetic variants do not develop into unique pathogens or vary significantly from the original virus, however, the few that do behave

differently can be the cause of an emerging or reemerging disease.

e) *Diseases that 'jump' from another species.* Another means by which an infectious agent acquires new characteristics is when it adapts to a new host. Several pathogens spread between different avian species, most notably viruses such as avian adenovirus type 3, avian influenza viruses, avian metapneumoviruses, and Newcastle disease virus that commonly infect waterfowl with little or no effect, to poultry in which they cause clinical disease. Spread between mammals and poultry is less common although it is well recognized that influenza viruses common to pigs can cause egg-drops and mortality in turkeys and avian influenza viruses can infect people, occasionally with fatal results.

Getting Help?

To minimize the impact of new diseases, early detection and control are essential. Unlike the situation with emerging human diseases, there exists no comprehensive systematic investigative approach (i.e. Center for Disease Control and Prevention, CDC) to quickly identify and combat new food animal diseases. The current approach is fragmented and dependent on individual production companies and individual researchers, which often results in an uncoordinated effort that can result in severe economic losses due to delays in recognition and control of the disease.

Health care for poultry can be thought of as a three-tier system that mirrors health care for people. Primary health care, provided at the flock or complex level, is analogous to that provided by the family physician. Individuals within the company, consultants, or extension personnel handle the day-to-day health issues including preventative health programs. Often this is a poultry veterinarian assisted by the service people who visit flocks and complex managers. Unfortunately, primary care for poultry, which is when a possible new disease would initially be recognized, continues to decrease. The number of poultry veterinarians working in production has decreased even though live production has increased. Poultry veterinarians also have increased responsibilities that may span breeders to processing plants or a number of complexes in different geographic areas, and regulatory or other governmental duties that can consume considerable time and prevent attention being given to bird health.

Medical specialists, following referral of a patient from the primary physician, provide secondary health care for people. Veterinary diagnosticians provide secondary health care for poultry following submission of affected birds to a diagnostic laboratory. Usually they are State or Federal labs, but some companies have their own facilities. The number of diagnostic labs, diagnosticians, and capabilities of the labs continues to decrease, even in areas where poultry production is significant. In North Carolina we are fortunate to have an excellent diagnostic lab system, even though some branch labs have had to be closed in recent years. Additionally, geographical information systems used by local governments may be needed to determine where the disease is and which flocks are at greatest risk.

When problems cannot be solved at the primary or secondary levels, they may be referred to the tertiary care level. Typically, this is some type of research facility such as a major medical center. Tertiary care for poultry typically is provided by an academic or governmental research center. Here, global issues of significant economic importance that tend to affect large segments of the industry, and not just individual farms or companies, are investigated. As with primary and secondary care of poultry, tertiary care continues to decline. Only few institutions still have poultry medicine training and research programs. Also, academia has changed and is not as receptive now to investigative clinical research as it has been in the past.

Poultry extension personnel play a key role in the identification of possible new diseases. They span all levels of health care and connect companies that have a potentially new disease problem with resources, secondary and/or tertiary, that can help solve the problem.

An important aspect for controlling new diseases is partnerships between local government, academia, and industry. No one group alone has the requisite resources needed to identify and control a new disease. These relationships are best established and maintained prior to a new disease problem occurring.

References

Horzinek MC. Emerging and re-emerging diseases. Proc. 51st North Central Avian Disease Conf, Columbus, OH, Oct 8-10, 2000, pgs. 1-2.

Table 1. Characteristics of production and classical diseases.

	Production Disease	**Classical Disease**
Cause	Complex, multifactorial, interactions between non-infectious & infectious factors	Simple, usually one, or les commonly, two agents; may b infectious or non-infectious
Clinical Signs	Not present or mild and not considered significant	Usually present and readily recognized
Mortality	Typically nil to low	Variable, but usually present
Pathology	Not present or mild and nonspecific	Typical lesions usually present
Diagnosis	Production below genetic potential; inductive (few findings lead to generalities about flock)	Signs, lesions recognized, ID of cause; deductive (many findings lead to specific cause)
Treatment	Rarely possible, often too late, usually of little value	Often possible, moderate to high success
Prevention/ Control	Requires high biosecurity, excellent management, very good nutrition	Vaccines and medications often useful
Experimental Reproduction	Difficult to impossible to experimentally reproduce and confirm; proven by Evan's postulates	Generally easy to experimentally reproduce; proven by Koch's postulates
Methods of Study	In flocks on farms, good records essential, emphasis on population medicine, epidemiology, etc.	Natural or experimental disease, emphasis on microbiology, pathology, toxicology, etc.

Table 2. Koch's and Evans' postulates for determining the cause(s) of classical and production diseases respectively.

Koch's Postulates

1. The agent must be present in every case of the disease and isolated in pure culture.
2. The agent must not be found in other diseases.
3. Once isolated, the agent must be capable of reproducing the disease experimentally.
4. The agent must be recovered from the experimentally induced disease.

Evans' Postulates

1. Prevalence of the disease should be significantly higher in those exposed to the putative cause than in case controls that are not exposed.[a]
2. Exposure to the putative cause should be present more commonly in those with the disease than in controls without the disease when all risk factors are held constant.
3. Incidence of the disease should be significantly higher in those exposed to the putative cause than in those not so exposed as shown in prospective studies.
4. Temporally, the disease should follow exposure to the putative agent with a distribution of incubation periods on a bell shaped curve.
5. A spectrum of host responses should follow exposure to the putative agent along a logical biologic gradient from mild to severe.
6. A measurable host response following exposure to the putative cause should regularly appear in those lacking this before exposure (i.e., antibody, cancer cells) or should increase in magnitude if present before exposure; this pattern should not occur in persons so exposed.
7. Experimental reproduction of the disease should occur in higher incidence in animals or man appropriately exposed to the putative cause than in those not so exposed; this exposure may be deliberate in volunteers, experimentally induced in the laboratory, or demonstrated in a controlled regulation of natural exposure.
8. Elimination or modification of the putative cause or of the vector carrying it should decrease the incidence of the disease (control of polluted water or smoke or removal of the specific agent).
9. Prevention or modification of the host's response on exposure to the putative cause should decrease or eliminate the disease (immunization, drug to lower cholesterol, specific lymphocyte transfer factor in cancer).
10. The whole thing should make biologic and epidemiologic sense.

[a] The putative cause may exist in the external environment or in a defect in host response.