Chapter 21

Newcastle Disease

Synonyms

ND, paramyxovirus-1, NDV, VVND, NVND

Newcastle Disease (ND) in domestic poultry is a focus for concern throughout much of the world's agricultural community because of severe economic losses that have occurred from illness, death, and reduced egg production following infection with pathogenic or disease causing strains. Prior to 1990, this disease had rarely been reported as a cause of mortality in the free-living native birds of the United States or Canada. Repeated large-scale losses of double-crested cormorants from ND in both countries has resulted in a need for enhanced awareness of ND as a disease of wild birds and, therefore, its inclusion within this Manual. Background information about ND in poultry is needed to provide a perspective for understanding the complexity of the disease agent, Newcastle disease virus (NDV). Some general information about ND in other avian species is also provided, but the primary focus for this chapter is the effect of NDV on double-crested cormorants.

Cause

Newcastle disease is caused by infection with an RNA virus within the avian paramyxovirus-1 group. NDV is highly contagious and there is great variation in the severity of disease caused by different strains of this virus. A classification system for the severity of disease has been established to guide disease control efforts in poultry because of the economic damage of ND.

The most virulent ND form causes an acute, lethal infection of chickens of all ages with mortality in affected flocks often reaching 100 percent. These strains produce hemorrhagic lesions of the digestive tract, thus resulting in the disease being referred to as viscerotropic or having an affinity for abdominal tissue, and velogenic or highly virulent Newcastle disease or VVND. This form of ND is rare in the United States, and it is primarily introduced when exotic species of birds are trafficked in the pet bird industry. Another acute, generally lethal infection of chickens of all ages affects respiratory and neurologic tissues and is referred to as neurotropic velogenic Newcastle disease or NVND. Morbidity or illness from NVND may affect 100 percent of a flock, but mortality is generally far less with extremes of 50 percent in adult birds and 90 percent in young chickens. The NVND form of ND was essentially eradicated from the United States in about 1970, but it has occasionally been reintroduced via pet birds and by other means. A less pathogenic form of ND causes neurologic signs, but usually only young birds die and, except for very young susceptible chicks, mortality is low. These strains are classified as mesogenic or moderately virulent. NDV strains that cause mild or inapparent respiratory infections in chickens are classified as lentogenic or low virulence. Lentogenic strains do not usually cause disease in adult chickens, but these forms can cause serious respiratory disease in young birds. Some strains of lentogenic NDV cause asymptomatic-enteric infections without visible disease (Table 21.1).

The virus classification standard applies to ND in poultry and the standard is not directly transferrable to wild birds. Experimental studies have demonstrated differences in bird response to the same strain of NDV. Thus, a highly pathogenic strain isolated from wild birds may be less hazardous for poultry and vice-versa. ND may be transmitted among birds by either inhalation of contaminated particulate matter or ingestion of contaminated material.

Species Affected

NDV is capable of infecting a wide variety of avian species. In addition to poultry, more than 230 species from more than one-half of the 50 orders of birds have been found to be susceptible to natural or experimental infections with avian paramyxoviruses. Experimental infections in mallard ducks exposed to large amounts of a highly virulent form of NDV for chickens disclosed that ducklings were more susceptible than adults, and that mortality of 6-day-old ducklings was higher than in 1-day-old and 3-day-old ducklings. Captive-reared gamebirds, such as pheasants and Hungarian partridge, have died of ND. However, large-scale illness and death from NDV in free-ranging wild birds has only occurred in double-crested cormorants in Canada and the United States. White pelicans, ring-billed gulls, and California gulls were also reported to have died from NDV in association with cormorant mortalities in Canada.

The 1990 epizootic of ND in Canada killed more than 10,000 birds, mostly double-crested cormorants. Mostly subadult cormorants died in these cormorant colonies. Losses in the United States have been primarily in nestlings and other young of the year. The total mortality attributed to ND during 1992 exceeded 20,000 birds. Mortality in Great Lakes cormorant colonies ranged from 2 to 30 percent, while that in Midwestern colonies was estimated to be 80 to 90 percent. In 1997, nesting failure of a cormorant colony at the Salton Sea in California was attributed to NDV. The total

mortality in 1997 was about 2,000 cormorants. During the 1992 epizootic, a domestic turkey flock in the Midwestern United States was infected at the same time NDV occurred in cormorants near that poultry flock.

Distribution

Different strains of NDV exist as infections of domestic poultry and within other species of birds throughout much of the world. Highly pathogenic strains of NDV have spread throughout the world via three panzootics or global epizootics since ND first appeared in 1926. The first of these highly pathogenic strains appears to have arisen in Southeast Asia; it took more than 30 years to spread to chickens worldwide, and it was primarily spread through infected poultry, domestic birds, and products from these species. The virus responsible for the second panzootic involving poultry appears to have arisen in the Middle East in the late 1960s; it reached most countries by 1973, and it was associated with the importation and movement of caged psittacine species. The most recent panzootic also appears to have its origin in the Middle East, and it began in the late 1970s. This panzootic differs in that pigeons and doves kept by bird fanciers and raised for food are the primary species involved. This NDV spread worldwide primarily through contact between birds at pigeon races, bird shows, and through international trade in these species. It has spread to chickens in some countries. A current question is whether or not the ND outbreaks that have occurred in double-crested cormorants are the beginning of a fourth panzootic.

In North America, NDV has caused disease in double-crested cormorants from Quebec to the West Coast (Fig. 21.1). Most cormorant mortality has occurred in the Upper Midwest and the Canadian prairie provinces, although smaller outbreaks have occurred at Great Salt Lake, in southern Cali-

Table 21.1 *Disease impacts on chickens resulting from exposure to different strains of Newcastle disease virus. [Pathotype refers to the severity of disease in susceptible, immunologically naive chickens. Velogenic is the most severe; lentogenic is the least severe.]*

Pathotype	Disease impacts
Velogenic	
Viscerotrophic velogenic ND (VVND)	Acutely lethal, kills chickens of all ages, often with lesions in the digestive tract. Flock mortality approaches 100 percent.
Neurotrophic velogenic ND (NVND)	Acutely lethal, kills chickens of all ages, often with signs of neurological disease. Flock mortality approaches 50 percent in adults and 90 percent in young birds. Sharp decrease in egg production.
Mesogenic	Moderate infection rates as indicated by clinical signs. Mortality generally only in young birds, but for very young chicks the death rate is low. Sharp and persistent decrease in egg production by adults.
Lentogenic	Mild or inapparent respiratory infections occur. Disease seldom seen in adults, but serious illness (generally nonlethal) can occur in young chickens.
Asymptomatic lentogenic	Infects the intestine but causes no forms of visible disease in chickens of any age.

fornia, and on the Columbia River between Washington and Oregon. Cormorants, the closely related shag, and gannets, which are another species of marine bird that has close associations with cormorants, were believed to be an important source of NDV for the poultry outbreaks along the coast of Britain during the 1949–51 epizootic in that country.

Seasonality

All of the North American cormorant die-offs from ND have occurred in breeding colonies. Mortality has occurred during the months of March through September.

Field Signs

Clinical signs, observed only in sick juvenile double-crested cormorants, include torticollis or twisting of the head and neck, ataxia or lack of muscular coordination, tremors, paresis or incomplete paralysis including unilateral or bilateral weakness of the legs and wings, and clenched toes (Fig. 21.2). Paralysis of one wing is commonly observed in birds surviving NVD infection at the Salton Sea in southern California (Fig. 21.3).

Experimental inoculations in adult mallard ducks with a highly virulent form of NDV from chickens resulted in onset of clinical signs 2 days after inoculation. Initially, mallards would lie on their sternum with their legs slightly extended to the side. As the disease progressed, they were unable to rise when approached and they laid on their sides and exhibited a swimming motion with both legs in vain attempts to escape. Breathing in these birds was both rapid and deep. Other mallards were unable to hold their heads erect. By day 4, torticollis and wing droop began to appear, followed by paralysis of one or both legs (Fig. 21.4). Muscular tremors also became increasingly noticeable at this time.

Figure 21.1 *Locations in North America where Newcastle disease has caused mortality in double-crested cormorants.*

Photo by Greg Kidd

Photo by Linda Glaser

Figure 21.2 *Clinical signs of Newcastle disease in cormorants include* ***(A)*** *torticollis or twisting of head and neck in these two nestlings, and* ***(B)*** *wing droop and abnormal posture in this subadult.*

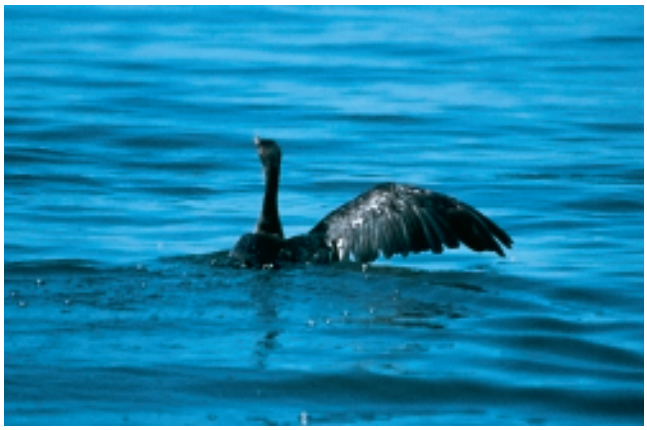

Photo by Milton Friend

Figure 21.3 *A double-crested cormorant fleeing from observers during the Newcastle disease outbreak at the Salton Sea, California. Note that only the right wing is functional. This bird is typical of juvenile birds surviving infection. The same condition was also observed in adults prior to the breeding season; these birds were presumably survivors from a previous Newcastle disease outbreak.*

Gross Lesions

Dead cormorants examined at necropsy have had only nonspecific lesions. Mildly enlarged livers and spleens and mottled spleens have been noted, but these may be the result of other concurrent diseases, such as salmonellosis.

Diagnosis

Virus isolation and identification, supported by characteristic microscopic lesions in tissues, is necessary to diagnose ND as the cause of illness or death. Whole carcasses should be submitted, and the samples should be representative of all species and age-classes affected. Clinically ill birds should be collected, euthanized by acceptable methods (see Chapter 5, Euthanasia), and, if possible, a blood sample should be collected from euthanized birds and the sera submitted with the specimens. Contact with the diagnostic laboratory is recommended to obtain specific instructions on specimen collection, handling, and shipment. A good field history describing field observations is of great value (see Chapter 1) and should be included with the submission.

Control

An outbreak of ND is a serious event requiring immediate involvement of disease control specialists. NDV infections can be devastating for the domestic poultry industry and an immediate objective in the diagnosis is to determine if the strain of virus involved poses a high risk for poultry. As soon as ND is suspected, strict biosecurity procedures should be followed to contain the outbreak as much as possible and to prevent disease from spreading to other sites.

Photos by Milton Friend

Figure 21.4 *Clinical signs of Newcastle disease in adult mallards that were experimentally infected with a velogenic form of NDV:* ***(A)*** *leg paralysis and inability of two of the birds to hold their heads erect,* ***(B)*** *torticollis, and* ***(C)*** *wing droop.*

Large amounts of virus are often shed in the excrement of infected birds and these can contaminate the surrounding environment. Also, NDV is relatively heat-stable and, under the right conditions, it can remain infectious in a carcass for weeks.

The spread of ND in poultry epizootics has occurred via several means including human movement of live birds such as pet or exotic species or both, gamebirds, poultry and other types of birds; other animals; movement of people and equipment; movement of poultry products; airborne spread; contaminated poultry feed; water; and vaccines. Humans and their equipment have had the greatest role because contaminated surfaces provide mechanical transportation for the virus to new locations and to susceptible bird populations.

The critical points are to recognize the outbreak site as a contaminated area, regardless of whether or not poultry or wild birds are involved, to be sensitive to the wide variety of ways that NDV can be moved from that site, and to take all reasonable steps to combat the disease and minimize its spread to other sites and to additional birds at that site.

Control efforts can become complicated by wildlife rehabilitation interests, the presence of strains of NDV that are highly virulent for domestic poultry, and the proximity of the wildlife involved to domestic poultry operations. Collaboration involving all concerned parties is essential in these situations.

Human Health Considerations

NDV is capable of causing a self-limiting conjunctivitis or inflammation of the membrane covering the eyeball and a mild flu-like disease in humans. Most reported cases in humans have occurred among poultry slaughterhouse workers, laboratory personnel, and vaccinators applying live virus vaccines. Aerosols, rather than direct contact, are most often involved as the route for transmission to humans.

Douglas E. Docherty and Milton Friend

Supplementary Reading

Alexander, D.J., 1997, Newcastle disease and other paramyxovirus infections *in* Calnek, B.W., and others, eds., Diseases of Poultry, (10th ed.): Ames, Iowa, Iowa State University Press, p. 541–569.

Friend, M., and Trainer, D.O., 1972, Experimental Newcastle disease studies in the mallard: Avian Diseases, v. 16, no. 4, p. 700–713.

Meteyer, C.U., Docherty, D.E., Glaser, L.C., Franson, J.C.F., Senne, D.A., and Duncan, R., 1997, Diagnostic findings in the 1992 epornitic of neurotropic velogenic Newcastle disease in double-crested cormorants from the upper midwestern United States: Avian Diseases, v. 41, p. 171–180.

Wobeser, G.F., Leighton, F.A., Norman, R., Meyers, D.J., Onderka, D., Pybus, M.J., Neufeld, J.L., Fox, G.A., and Alexander, D.J., 1993, Newcastle disease in wild water birds in western Canada, 1990: Canada Veterinary Journal, v. 34, p. 353–359.