Technical Update

NEWCASTLE DISEASE

INTRODUCTION

Newcastle disease virus was first isolated from chickens in 1926 in Newcastle-upon-Tyne, a city in Northeast England. Newcastle disease virus (NDV) has become enzootic in many areas of Asia, South America, Africa, and the Middle East, causing significant economic losses and production challenges. The virulent Newcastle disease virus (vNDV), also referred to as exotic Newcastle disease in areas where it is not considered enzootic, is reportable to the World Organization for Animal Health (OIE). Clinical signs of Newcastle disease (ND) vary in severity and can include gastrointestinal, neurological, reproductive, and respiratory. Morbidity and mortality can reach up to 100% with vNDV strains. Effective control policies and on-farm management are required to prevent infection and spread of vNDV. Vaccination for Newcastle disease is common globally on commercial farms and generally provides good protection against most virulent strains. Vaccination is not as common in backyard and exhibition poultry, potentially contributing to outbreaks of vNDV in many parts of the world. Humans can be infected and develop conjunctivitis, usually from improper handling of ND vaccines.

Respiratory infections cause swelling of the eyelids, facial swelling and mucus discharge from the nostrils.

Neurogenic vNDV strains can cause birds to have signs of ataxia, tremors, torticollis and paralysis.

ETIOLOGY

Newcastle disease is caused by strains of avian paramyxovirus-1 (APMV-1) belonging to one seroytpe. Strains vary in virulence and are commonly classified from least to most virulent as asymptomatic enteric, lentogenic, mesogenic, or velogenic. These pathotypes differ in severity and type of disease, although there may be some overlap. Typically, vNDV refers to infection with velogenic strains.

Pathotype	Disease	Vaccine strains	Genotype
Asymptomatic	• Gastrointestinal tropism not causing disease	V4 VGGA Ulster	I II I
Lentogenic	• Mild or inapparent respiratory infection • Little to no mortality	B1 LaSota F	II II II
Mesogenic	• Respiratory infection, occasionally neurologic signs • Low mortality	Mukteshwar, R2B Komorov Roakin	III II II II

Velogenic	• Viscerotropic:
	  • Gastrointestinal signs, characteristic hemorrhages
	  • High mortality
	• Neurotropic:
	  • Respiratory and neurologic signs
	  • High mortality
		None	All

NDV strains are classified into 19 genotypes by sequencing the F and HN genes of the virus. Genotyping shows the phylogenetic relationship of different NDVs and is useful in the epidemiology of NDV outbreaks. Recently, Genotype VII isolates are the most important group of NDV reported since 2000 and have been identified in several economically important disease outbreaks in Asia, the Middle East, South America, and South Africa. They have shown increased virulence in birds vaccinated with traditional Genotype I and II vaccines, like B1 and LaSota. Research has shown that homologous vaccines can be more protective and as a result, genotype VII-specific NDV vaccines have been developed for use in affected areas.

TRANSMISSION

The primary modes of transmission for NDV are inhalation and ingestion. Birds demonstrating respiratory disease shed virus in droplets and aerosols that are inhaled by susceptible birds. Respiratory transmission can occur very rapidly among birds in modern production systems. Airborne spread of NDV over large distances is not thought to be of major importance but may occur under specific conditions. Birds demonstrating gastrointestinal disease excrete virus in feces that may be ingested by susceptible birds either directly or indirectly, through contaminated feed, water or litter. Fecal-oral transmission may spread more slowly, particularly if birds are housed in cages or otherwise not in direct contact with feces.

Wild birds contribute to the spread of disease either by infection or mechanical transmission. Wild bird reservoirs of NDV are known to exist with potential spillover into commercial poultry. Virulent NDV can be carried asymptomatically by waterfowl during migration and is thought to be endemic in cormorants, pigeons, doves, and psittacine (parrot) birds. Humans, however, play a much greater role in mechanical spread of NDV by the movement of poultry and poultry products, personnel, and other fomites, such as contaminated farm equipment. The ability of the virus to survive in dead birds or excretions likely contributes to mechanical spread by humans. NDV can survive for several weeks at cool temperatures or potentially for several years if frozen.

Asymptomatic wild birds can shed vNDV, causing infections in commercial poultry

Wild birds frequent commercial poultry farms in search for food in manure piles.

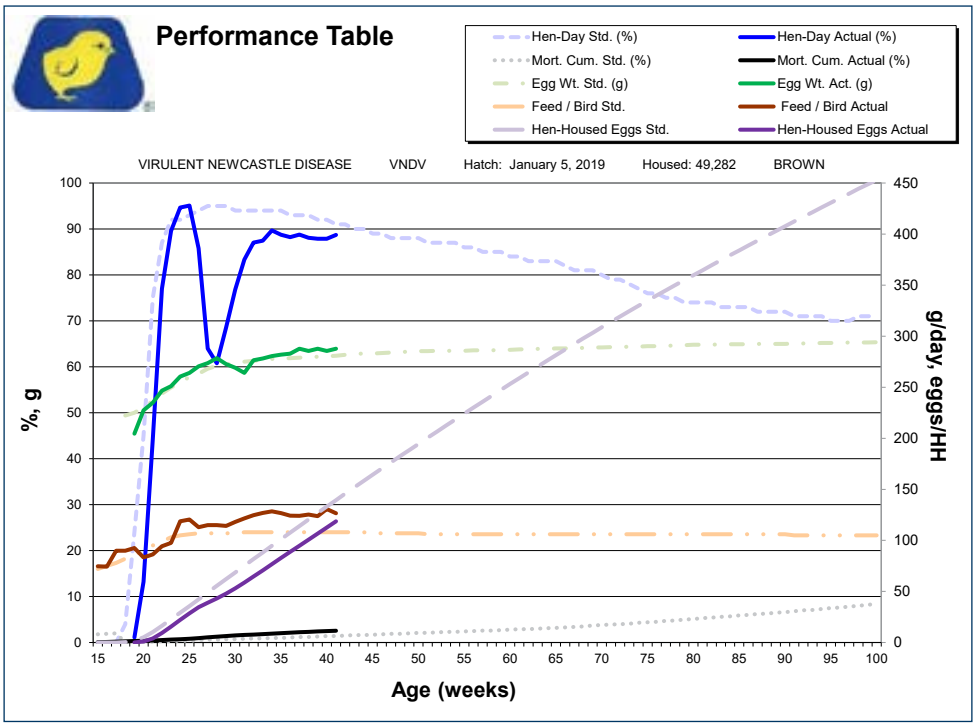
Pigeon houses are common in some parts of the world.

CLINICAL SIGNS

Infected birds typically begin to demonstrate clinical signs within 2–15 days of exposure. Incubation period and severity of disease depends on several factors, including virus strain and dose, bird age, immune status, level of environmental contamination, and route of exposure.

The clinical signs of NDV infection depend on the pathotype of the strain. Virulent Newcastle (vNDV) infection causes high mortality in the absence of clinical signs. Viscerotropic vNDV often begins with listlessness, increased respiration, and weakness, leading to prostration and eventually death. Green diarrhea is commonly observed in birds that do not die early on. Prior to death, some birds may demonstrate torticollis (twisting or tilting of the head), muscular tremors, limb paralysis, and opisthotonos (head arched backwards). Birds may move in circles, show ataxia or walk backwards, while at other times appearing normal. Mortality can reach 100% in fully susceptible flocks. Neurotropic vNDV is characterized by sudden and severe onset of respiratory disease, followed by neurologic signs and a dramatic decrease in egg production.

Panzootics of Newcastle Disease	Location	Genotypes Involved
1920s	Southeast Asia, spreading to England	II, III, IV
1960s	Middle East spreading to several other countries from imported psittacine birds	V
1970s	North Africa, Middle East with worldwide spread	Pigeon Paramyxovirus (an APVM-1 variant found in pigeons)
1980s–present	Southeast Asia with spread to Africa, Europe and South America	VII



Production of a well-NC vaccinated laying flock which was challenged with vNDV.

Hens may produce eggs having a characteristic shell defect described as a "mango egg." Morbidity can reach 100% while mortality is dependent on bird age and immune status. Younger birds can have mortality of up to 90% and older birds up to 50%. In flocks that are well immunized, few clinical signs other than severe drops in egg production may be observed. Drops in egg production can also be due to the particular strain of NDV.

Mesogenic NDVs may cause mild to moderate respiratory disease and a marked decrease in egg production. Occasionally, nervous signs may occur. Mortality is typically low in adult birds but can be exacerbated by concurrent disease or other stressful conditions. Lentogenic NDVs usually do not cause disease in adults but can cause potentially serious respiratory disease in young birds. Infection with lentogenic strains can cause serum antibody titer levels to increase mildly to dramatically with no accompanying clinical signs.

Characteristic "mango" shaped egg shell sometimes seen in affected layers. Photo: Diseases of Poultry, 13th Edition, AAAP.

PATHOLOGY

Gross Lesions

Gross lesions vary with the strain and pathotype of virus, as well as host and other factors. Virulent ND outbreaks causing rapid mortality may not show gross lesions.

Viscerotropic vNDV commonly presents with hemorrhagic lesions in local lymphoid tissues of the gastrointestinal tract, particularly found in the cecal tonsils, Peyer's patches, and at the junction between the proventriculus and the gizzard (ventriculus). Hemorrhages are also often noted in the spleen and thymus, and the spleen may appear enlarged and mottled. Mucosal hemorrhage and congestion of the eyelids and trachea may occur. Airsacculitis may be observed, but is typically associated with secondary bacterial infections (usually *E.coli*). Edematous ovaries, hemorrhagic ovarian follicles, egg yolk peritonitis, and hemorrhagic lesions in the oviduct may be observed in layers. Neurotropic vNDV typically has no gross lesions observed in the brain.

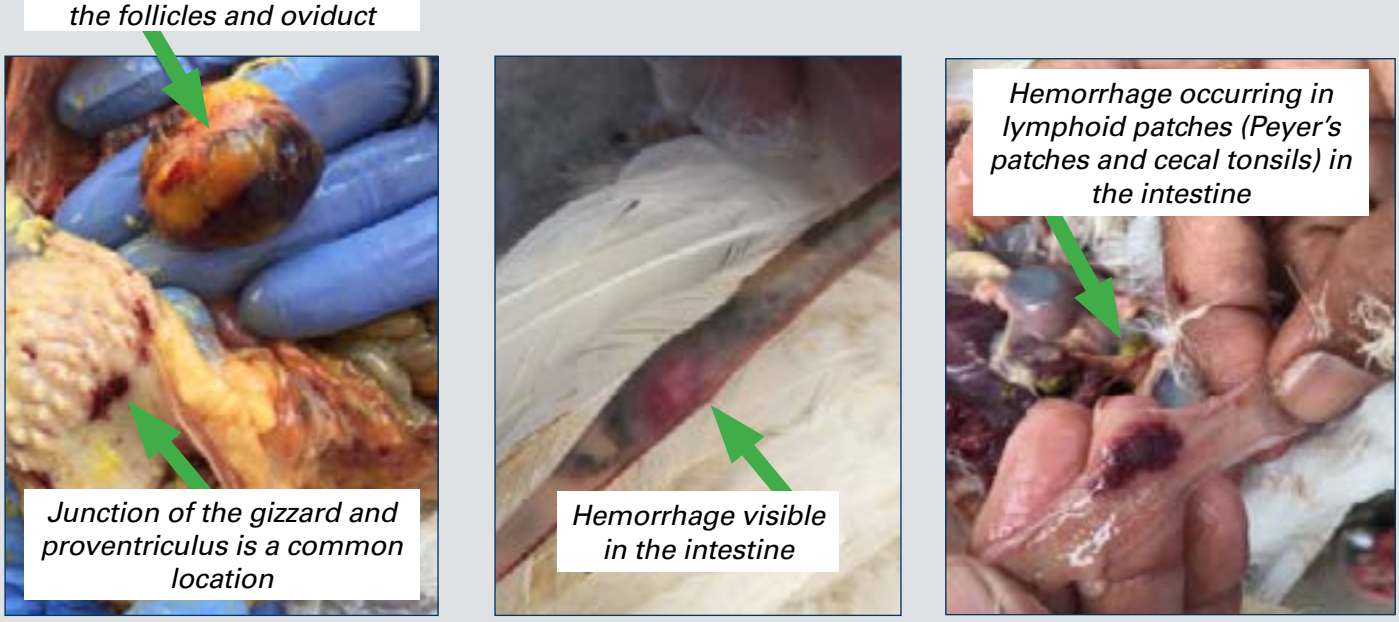
Microscopic Lesions

Grossly affected tissues may be collected for histopathology but will likely be of limited diagnostic utility. Microscopic lesions are not specific to Newcastle disease. Affected tissues generally have a lymphocytic inflammation common to other viral diseases.

Viscerotropic vNDV can cause necrosis, ulceration, and hemorrhage in many organs, commonly in the intestine, pancreas, spleen, and ovary. Microscopic lesions may occasionally be observed in the liver and gallbladder. Changes in the lymphatic system may be evident, including hemorrhages in intestinal lymphoid patches and lymphoid depletion in the thymus, bursa, and spleen.

Although gross lesions are absent with neurotropic vNDV, microscopic lesions may be observed in the central nervous system including lymphocytic perivascular cuffing, gliosis, and neuronal degeneration.

Viscerotropic strains of vNDV can produce hemorrhages in the lymphoid tissues of the gastrointestinal tract



DIAGNOSIS

Newcastle disease viruses vary widely in virulence and are classified into four different pathotypes based on intracerebral pathogenicity index or by finding basic amino acids in the F2 protein.

Due to the non-specific nature of gross and microscopic lesions, final diagnosis typically relies on virus detection and isolation from oropharyngeal and/or cloacal swabs. When collecting oral swabs, for best chance of virus detection, the entire oral cavity must be swabbed, particularly the choanal cleft. Swabs must be placed into viral transport medium and kept cold during transportation to a diagnostic laboratory. The most commonly used transport medium is brain heart infusion (BHI) broth. Dry swabs cannot be used for diagnosis because heat and desiccation can inactivate NDV within 24 hours.

RT-PCR of oropharyngeal or cloacal swabs is used for routine monitoring and surveillance for NDV and has become the most commonly used screening test, particularly in areas where flocks are vaccinated for NDV. RT-PCR has a fast turnaround time, often with same-day results, allowing for timely decision-making and confirmatory testing. With the use of certain primers and probes, RT-PCR is able to differentiate vaccinated from infected animals (DIVA). PCR probes can recognize specific sites on the NDV genome, allowing for characterization and differentiation of avirulent (vaccine) and virulent (field) strains of NDV. Virus isolation and gene sequencing are typically performed on PCR-positive samples to determine the origin of the virus strain and the pathotype.

Serology is also a commonly used monitoring tool for Newcastle disease but has limited diagnostic capability. Virulent Newcastle disease will typically kill birds before they are able to produce antibodies for detection by serology. Additionally, most commercially available serology kits (ELISA) cannot distinguish between antibodies due to natural exposure and those due to vaccination. Commercial kits may provide suspicion that a mesogenic or lentogenic strain are circulating through a flock, but these strains are not usually of major concern unless clinical signs are evident. More commonly, commercial kits are used to examine bird response to Newcastle vaccination strategies.

INTERVENTION STRATEGIES

Many countries have legislation in place to prevent the introduction and spread of vNDV due to the risks associated with international trade. For countries free of vNDV, legislation commonly imposes trade restrictions on countries where vNDV is considered enzootic or countries that are currently experiencing a vNDV outbreak. Legislation is variable from country to country, and an understanding of the legislation in both the importing and exporting country are required for successful trade.

In the USA and other countries where vNDV outbreaks are not enzootic, the primary control and eradication strategy for vNDV is “stamping out." Should a premise become infected, all birds on the premises and within a certain distance of the infected premises must be euthanized immediately to prevent further spread. The affected zone is placed under a prescribed surveillance program and movement of poultry is restricted until the area is officially declared virus-free.

There is no available treatment for Newcastle disease; therefore, preventing introduction of the virus onto a farm is key. Perhaps the most important on-farm interventions are excellent biosecurity and sanitation practices along with effective vaccination programs.

Vaccination

Vaccination is a commonly used intervention strategy for Newcastle disease. There are four types of commercially available vaccines: live lentogenic, live mesogenic, inactivated, and vectored vaccines. Mesogenic vaccine use is typically restricted to countries that are considered enzootic for vNDV.

Immunity acquired from NDV vaccination can protect birds from clinical Newcastle disease, but does not protect against infection, virus replication, or virus shedding of vNDVs. As such, vaccination may interfere with timely detection and eradication of vNDV strains.

Efficacy of vaccination strategies depends on the timing of application and the type of vaccine used. Maternal antibodies provide protection, but also interferes with Newcastle disease vaccination up to 3–4 weeks of age. To overcome this, birds are typically vaccinated with live vaccines suitable for 1-day-old chicks to provide local mucosal protection and revaccinated at 3–4 weeks of age. In areas where vNDV is not present, the first vaccination may occur at 3–4 weeks of age, utilizing milder vaccine strains of vaccine like VG/GA or B1. The combination of live vaccines and inactivated ND vaccines give the best protection from clinical disease in long-lived birds. In areas under challenge with vNDV, the stronger live Newcastle vaccine strains like LaSota are widely used. In areas with enzootic vNDV, the use of inactivated Newcastle vaccine in birds 0–3 weeks of age is common, along with live vaccine. In layers, to maintain immunity over a long lifespan, B1 or LaSota live vaccines are then given at regular intervals (6–10 weeks) and/or inactivated vaccines are used.

Comparison of Vaccine Strains and Vaccination Techniques

Commercial Vaccines		Vaccination Techniques	
Mild	V4	Mild	Very coarse spray (200-300 µ (microns)
	VGGA		Eyedrop / Nasal
	Ulster		Water
	B1, B1		Course spray (100 µ)
	Clone 30		Medium (70 µ)
	B1, LaSota		Fine (40 µ)
Stronger	Mesogenic strains	Stronger	

Route of administration of live Newcastle vaccines include eye drop, intranasal, drinking water, or spray. Coarse sprays are used in young birds to reduce the risk of adverse vaccine reaction. Medium and fine sprays may be used in subsequent vaccination in older birds. Inactivated vaccines are administered by intramuscular or subcutaneous injection.

Recently, the development of vaccines that are "antigenically matched" to the prevalent Genotype in a region are showing promise. Traditional commercial NDV vaccine strains are no longer similar antigenically to the challenge strain in many regions and this may reduce their effectiveness. Using a homologous vaccine strain matching the genotype of the field challenge may improve the protection from clinical disease and reduce the shedding of challenge vNDV. Commercial antigenically matched vaccines have been used in Asia and Mexico using Genotype V and VII strains.

Vector vaccines have been highly successful in many vNDV challenge areas. Commercial vHVT-ND vaccines given in the hatchery provide uniform dosage to all birds. Vector vaccines provide protection from clinical disease and no post-vaccination reactions. It takes about 4 weeks for significant immunity to occur from vHVT-ND vaccination. In areas with significant vNDV challenge, the vectored ND vaccines may require additional NDV vaccinations for adequate protection.

Vaccination technique is an important aspect of immunizing birds against NDV. Live vaccines are commonly applied by mass vaccination through the birds' drinking water or by spray. Mass application, while being convenient and fast, can leave significant numbers of birds unvaccinated if not done properly. It is thought that 85% of the individual birds must receive a protective dose of vaccine to achieve flock immunity. Individual bird vaccination methods like eyedrop or intranasal vaccination improve vaccine distribution but are labor-intensive.

The size of the spray droplet determines how deeply the vaccine penetrates down the respiratory tract. Smaller droplets penetrate more deeply into the respiratory tract, and by doing so are more immunogenic. Early vaccination in young birds should utilize larger spray droplets (100-300 µ) to avoid unwanted post-vaccination respiratory reactions, while in older, vaccinated birds, it is safer to utilize smaller spray droplet size (40-70µ).

When devising vaccination programs, consider the following:

- Current disease situation
- Disease control policies
- Vaccine availability
- Maternal immunity
- Use of other vaccines
- Presence of other disease
- Flock size
- Expected life of flock
- Labor
- Climate
- Economics

For more information on vaccination programs, see the Vaccination Recommendations technical update at www.hyline.com.

ZOONOSIS

NDV is considered a human pathogen, although reported infections are typically mild. The most commonly reported clinical signs in humans include eye infections, excessive tearing, swollen eyelids, conjunctivitis, and subconjunctival hemorrhage. Infections are usually transient with no permanent eye damage. Human infections are most likely to occur from direct contact with the virus, which usually requires direct bird or live vaccine contact. Although risk of infection is still small, diagnostic laboratory employees, veterinarians, processing plant employees, and vaccination crews have a more elevated risk.

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