NEWCASTLE DISEASE

(AVIAN PARAMYXOVIRUS SEROTYPE 1)

Aetiology Epidemiology Diagnosis Prevention and Control
Potential Impacts of Disease Agent Beyond Clinical Illness References

AETIOLOGY

Classification of the causative agent

Newcastle Disease (ND) virus is a paramyxovirus in the genus *Avulavirus* (pleomorphic, enveloped, negative-sense single-stranded RNA) that infects both domestic and wild free-ranging avian species. There are 12 different avian paramyxovirus serotypes characterised, but ND is limited to avian paramyxovirus serotype 1 (APMV-1). There are multiple pathotypes characterised based on clinical disease in chickens: viscerotropic velogenic, neurotropic velogenic, mesogenic, lentogenic, and asymptomatic enteric. APMV-1 is highly virulent and has the potential to cause significant economic consequences if an outbreak occurs.

For the purpose of voluntary reporting on non OIE-notifiable disease in wildlife, “Newcastle disease” refers to **non-poultry** infections. Information on infections of velogenic ND in **poultry** must be submitted through the mandatory reports for the OIE-notifiable diseases.

Temperature:	Persists in cold temperatures for months; heat inactivation at 56°C for 3 hours or 60°C for 30 minutes is effective.
pH:	Inactivated by a pH < 3
Chemicals/Disinfectants:	Sodium hypochlorite, phenols, glutaraldehyde, chlorhexidine, and oxidising agents; quaternary ammonium compounds must be used in conjunction with sodium carbonate; ethers and formalin also deactivate the virus.
Survival:	Persistence is somewhat variable pending environmental conditions but virions are generally stable in organic matter (e.g., faeces) at ambient temperatures.

EPIDEMIOLOGY

Hosts

- APMV-1 has a wide host-range - more than 250 species of birds in 27 orders are susceptible.
- Many domestic species are susceptible including, but not limited to:
    - Chickens (*Gallus gallus*)
    - Turkeys (*Meleagridis gallapavo*)
    - Pheasants (*Phasianus colchicus*)
    - Guinea fowl (*Numida meleagris*)
    - Muscovy and domestic ducks (*Cairina moschata, Anas platurhynchos*)
    - Geese (*Anser anser*)
- Free-ranging wild birds including migratory waterfowl (order Anseriformes), shorebirds (including orders Charadriiformes, Strigiformes, and Pelecaniformes), passerines (order Passeriformes), and wild pheasants are also susceptible. These species are typically carriers of lentogenic and mesogenic strains.
    - Captive falcons (*Falco* spp.) in the Middle East are susceptible to velogenic ND.
    - Psittacine birds are highly susceptible to velogenic ND.

    - Widespread morbidity and mortality in double-crested cormorants (*Phalacrocorax auritus*) due to ND is mostly observed on the North American coasts and Great Lakes region, and occasionally involves other shorebird species.
    - There is current concern in the United States regarding the critically endangered California Condor (*Gymnogyps californianus*) and its susceptibility to ND, or its role as a potential reservoir species for APMV-1.
- Other susceptible species include:
    - Crows and ravens (genus *Corvus*)
    - Ostriches (order Struthioniformes)
    - Pigeons (order Columbiformes)
    - Penguins (order Sphenisciformes)

Transmission

- Direct contact between birds via inhalation of aerosols
- Vertical transmission has been documented for lentogenic strains.
- Fomites - e.g., contaminated food/water, premises, human clothing, tools/instruments, egg trays and crates

Sources

- Infected birds shed virus during their incubation period.
- Birds that survive infection secrete and excrete virus in respiratory secretions and faeces for weeks to months, depending on host species.
    - Chickens shed virus for 1-2 weeks, whereas psittacines may shed virus for over a year.
    - Viral shedding may be intermittent, especially in persistently infected individuals.
- Illegal bird trading and exotic pet bird smuggling is often responsible for introducing the virus and inciting an outbreak of velogenic APMV-1.
- Migratory birds play a role in the natural spatial distribution of the virus; outbreaks may be seasonal and correspond with migratory behaviors.
- The virus can be transmitted between free-ranging animals and poultry.
    - Lentogenic strains often originate from a wildlife reservoir host and can spontaneously mutate to become velogenic, often upon introduction to a new host species.
    - Lentogenic strains used for live-attenuated poultry vaccines have been detected in wild birds.
- All tissues from an infected carcass are infectious.

Occurrence

Velogenic strains of APMV-1 are endemic in poultry populations of Asia, Africa, Middle East, and Central and South America. Double-crested cormorants are known reservoir hosts in North America, and sporadic cases of velogenic ND have been reported globally in non-domestic species.

Lentogenic strains are found in poultry and free-ranging birds alike globally. Mesogenic strains have a particular predilection for pigeons and are often referred to as “pigeon paramyxovirus.”

Mortality events in wild populations tend to occur when birds congregate in breeding colonies, the timing of which is variable by host species, seasonality, and geographic region. March-September is the typical time during which double-crested cormorants experience large die-offs.

For more recent, detailed information on the occurrence of this disease worldwide, see the OIE World Animal Health Information System - Wild (WAHIS-Wild) Interface [http://www.oie.int/wahis_2/public/wahidwild.php/Index].

DIAGNOSIS

Most of what is known about ND is based off of its pathology and pathogenesis in poultry. In domestic poultry, the incubation period ranges from 2-15 days, but may exceed 28 days in other species.

There are two criteria for defining an infection as velogenic APMV-1:

1. The isolate has an intracerebral pathogenicity index (ICPI) of 0.7 in day-old chicks.
    - The IPCI is a quantitative measure of viral virulence ranging from 0-2.0, where 0 indicates the strain is lentogenic and not deadly.
2. There are multiple amino acid sequence changes in the viral fusion protein (F) that resemble other recognised highly pathogenic strains.

Clinical diagnosis

Lentogenic strains are often subclinical or cause only a mild respiratory disease in poultry. Mesogenic strains may cause respiratory disease, decreased egg production, and neurologic signs; mortality is typically low.

The course of disease caused by velogenic strains may be very rapid and present as sudden death, and apparent clinical signs are often nonspecific and variable. Early in the course of disease, animals present with ruffled feathers, lethargy, oedema and/or cyanosis of the head and neck, conjunctival reddening, and inappetence. Eggs may have thin shells, an abnormal shape or colour, or watery albumin. Birds may also develop watery, white or green diarrhoea. Neurologic signs may present later in the course of disease, and sequelae may persist after disease resolution if the animal survives. Typical central nervous system (CNS) signs include tremors, clonic spasms, limb paralysis or paresis, circling, and torticollis. Velogenic strains have mortality rates ranging from 50-100% depending on virus tropism (i.e.: neurotropic versus viscerotropic), host species, and vaccination status.

Due to its rapid clinical course and nonspecific clinical signs, it is critical to obtain a diagnosis as quickly as possible.

Lesions

- Severity varies by pathotype and often host species; velogenic strains produce more significant gross lesions.
    - Gross lesions may be absent if the animal died suddenly.
- Oedema and/or cyanosis of the head and periorbital region, neck, and thoracic inlet
- Virulent strains cause significant haemorrhage in the gastrointestinal tract, but haemorrhage may also be seen in other tissues.
- Ecchymotic haemorrhages in the larynx, trachea, oesophagus, and intestine
- Petechiae and ecchymoses on the proventricular mucosa, often near mucous glands
- Necrosis of the intestinal mucosa, Peyer's patches and other lymphoid tissue, and caecal tonsils
- Vascular congestion
- Ovarian oedema or haemorrhage
- Airsacculitis

Differential diagnoses

- Highly pathogenic avian influenza
- Laryngotracheitis
- Fowl cholera

- Fowl pox (diphtheritic form)
- Psittacosis in psittacines
- Mycoplasmosis
- Infectious bronchitis
- Aspergillosis
- Water deprivation
- Nutritional deficiency
- Poor ventilation
- In pet birds: salmonellosis, adenovirus, other paramyxoviruses, Pacheco's parrot disease
- In wild waterfowl: botulism, avian cholera

Laboratory diagnosis

Samples

Samples should be taken from recently dead or humanely euthanized moribund birds.

For isolation of agent

- Postmortem: spleen, brain, lung, intestine including contents, caecal tonsils, heart, lung, kidney, liver, heart, oronasal swabs
- Antemortem: tracheal, oropharyngeal, or cloacal swabs (faeces may be used as a substitute)
- Place samples in phosphate buffered isotonic saline (PBS) containing antibiotics and adjust to a pH of 7.0-7.4.
    - Antibiotics may be selected based on local conditions.
    - Swabs may be added directly to the solution, but faeces and tissues should be finely minced or macerated.
    - Process samples within 2 hours at room temperature. Otherwise, store samples at 4°C for processing within a few days.

Serological tests

- Clotted blood or serum

Procedures

Identification of the agent

- Virus isolation via inoculation of embryonated, specific pathogen free eggs and subsequent haemagglutination activity assay or other molecular assay
- Reverse-transcriptase polymerase-chain reaction (RT-PCR)
    - Separate, specialized PCR assays are available for samples taken from cormorants because these isolates are often not detected with standard assays.
- Pathogenicity determined via ICPI assay
    - This step is critical to determine virulence.
- Viral genome sequencing
- Restriction enzyme analysis
- *In situ* hybridization

Serological tests

- Haemagglutination inhibition test for antibody response to virus glycoprotein (corresponds to protection against disease)

    - Cross-reactivity of serotypes is possible; utilise specific monoclonal antibodies to reduce this risk.
- Enzyme-linked immunosorbent assay (ELISA) to detect host antibody against any viral antigen
    - Caution should be taken when using commercial ELISA kits - most are only useful for use in poultry.
- Live-attenuated vaccines complicate interpretation of antibody-based serology assays.

For more detailed information regarding laboratory diagnostic methodologies, please refer to Chapter 3.3.14 Newcastle disease in the latest edition of the OIE Manual of Diagnostic Tests and Vaccines for Terrestrial Animals.

PREVENTION AND CONTROL

Sanitary prophylaxis

- Proper carcass disposal
- Avoid contact with birds of unknown health status; precautions should be taken in the field and all tools, instruments, and vehicles should be properly disinfected before moving locations. Consider the use of personal protective equipment or changing shoes and clothes before leaving a site.
    - Limit the amount of foot traffic in areas where ND is a concern.
- Bird-proofing and pest control of domestic bird housing in endemic areas. Efforts should be made to reduce poultry-wild bird interactions.
    - Employ biosecurity and disinfection protocols for domestic flocks and employees to reduce the risk of introducing virus from a wild bird to a captive flock.

Medical prophylaxis

- There are many types of vaccines available for poultry:
    - Live-attenuated lentogenic virus vaccines may be administered in drinking water, or by aerosol, eye/nostril droplets, or beak dipping; animals vaccinated in this manner will shed virus for approximately 2 weeks after vaccination.
    - Inactivated virus vaccines must be injected.
    - Vectored vaccines are in development.
    - Vaccines are developed for use in domestic poultry, and their efficacy in wild bird populations is not well documented. Genetic sequences from live-attenuated vaccines have been detected in wild free-ranging birds.
- Chicks are protected by maternal antibodies for 3-4 weeks, which inhibits the development of a robust viraemia, but they are still susceptible to respiratory infection.

POTENTIAL IMPACTS OF DISEASE AGENT BEYOND CLINICAL ILLNESS

Risks to public health

- Humans can be infected with APMV-1, but infection appears to require a high concentration of virus. Clinical signs include a self-limiting conjunctivitis, and are most commonly associated with laboratory workers and individuals administering live-attenuated vaccines. It is believed APMV-1 can also cause influenza-like symptoms.

Risks to agriculture

- In many parts of the world, people rely heavily on poultry for sustenance; outbreaks in these communities can have potentially devastating effects, especially if interaction with wild bird reservoirs is common.

- Viral isolates have been obtained from calves, sheep, and pigs, but the significance of these infections is not understood.

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The OIE will periodically update the OIE Technical Disease Cards. Please send relevant new references and proposed modifications to the OIE Scientific and Technical Department (scientific.dept@oie.int). Last updated 2019. Written by Marie Bucko and Samantha Gieger with assistance from the USGS National Wildlife Health Center.