

NEWCASTLE DISEASE

Aetiology Epidemiology Diagnosis Prevention and Control References

AETIOLOGY

Classification of the causative agent

Newcastle disease (ND) is a member of the family Paramyxoviridae in the genus *Avulavirus*. There are ten serotypes of avian paramyxoviruses designated APMV-1 to APMV-10 and ND virus (NDV) has been designated APMV-1. NDV has also been categorised into five pathotypes based on clinical signs in infected chickens, designated: a) viscerotropic velogenic, b) neurotropic velogenic, c) mesogenic, d) lentogenic or respiratory and e) subclinical enteric. Pathotype groupings are rarely clear-cut.

Temperature:	Inactivated by 56°C/3 hours or 60°C/30 minutes.
pH:	Inactivated by acid pH ≤ 2.
Chemicals/Disinfectants:	Ether sensitive; inactivated by formalin, phenolics and oxidising agents (e.g. Virkon®); chlorhexidine, sodium hypochlorite (6%).
Survival:	Survives for long periods at ambient temperature, especially in faeces.

EPIDEMIOLOGY

Hosts

- Many species of birds both domestic and wild
 - Chickens are highly susceptible to disease; turkeys do not tend to develop severe signs
 - Game birds (pheasants, partridges, quail and guinea fowl) and parrots (order Psittaciformes) vary in susceptibility; cockatiels are susceptible
 - Wild birds and waterfowl (order Anseriformes) may harbour virus subclinically; some isolates within certain genotypes have caused epizootics within these species
 - Young cormorants (*Phalacrocorax* spp.) have demonstrated disease associated with APMV-1
 - Disease has been recorded in ostriches (order Struthioniformes) and pigeons (order Columbiformes) are known to be susceptible
 - Raptors are usually resistant to ND; except reports of acute disease in bearded vulture (*Gypaetus barbatus*), white-tailed sea eagle (*Haliaeetus albicilla*), a wild osprey (*Pandion haliaetus*) and some species of falcons
 - Other birds known to have been affected by NDV include: gulls (order Charadriiformes), owls (order Strigiformes), and pelicans (order Pelecaniformes).
 - Passerine birds (order Passeriformes) are variable in their susceptibility; some species show no signs of disease but excrete NDV while others may develop severe disease
 - Reports of deaths in crows and ravens (genus *Corvus*) have been recorded
 - Acute ND has been recorded in penguins (order Sphenisciformes)
- The morbidity and mortality rates vary among species, and with the strain of virus
- Humans may become infected; manifested by unilateral or bilateral reddening, excessive lachrymation, oedema of the eyelids, conjunctivitis and sub-conjunctival haemorrhage

Transmission

- Direct contact with secretions of infected birds; principally via ingestion (faecal/oral route) and inhalation
- Fomites: feed, water, implements, premises, human clothing, boots, sacks, egg trays/crates, etc.
 - Survival of agent is prolonged by presence of faeces; as in soiled egg shells
- Hatching chicks may be infected through egg for some NDV strains; transmission of highly virulent isolates is uncommon
- No clear evidence of role of flies in mechanical transmission

Sources of virus

- Respiratory secretions/discharges and faeces of infected birds
- All parts of the carcass
- Virus is shed during the incubation period, during clinical stages and for a limited period during convalescence
- Wild birds and waterfowl may act as reservoir hosts for lentogenic pathotypes of ND; subsequently, these viruses could become virulent following mutation upon establishment in domestic poultry
- Some psittacine birds have been demonstrated to shed ND virus intermittently for over 1 year and been associated with introduction into poultry

Occurrence

Velogenic NDV is endemic in areas of Mexico, Central and South America, widely spread in Asia, the Middle East and Africa, and in double-crested wild cormorants in the US and Canada. Lentogenic strains of NDV are worldwide in their distribution while widespread mesogenic pathotypes with a special adaptation to pigeons (i.e. pigeon paramyxovirus) do not appear to infect other poultry readily.

For more recent, detailed information on the occurrence of this disease worldwide, see the *OIE World Animal Health Information Database (WAHID)* interface [<http://www.oie.int/wahis/public.php?page=home>] or refer to the latest issues of the *World Animal Health* and the *OIE Bulletin*.

DIAGNOSIS

Incubation period is 2–15 days with an average of 5–6 days; some species may be over 20 days

Clinical diagnosis

Clinical signs seen in birds infected with NDV vary widely and are dependent on factors such as: the virus/pathotype, host species, age of host, co-infection with other organisms, environmental stress and immune status. Clinical signs alone do not present a reliable basis for diagnosis of ND. Morbidity and mortality depend on virulence of the virus strain, degree of vaccinal immunity, environmental conditions, and condition of the flock.

Lentogenic strains

- Usually associated with subclinical disease marked by mild respiratory disease; coughing, gasping, sneezing and rales
- If other co-infectious agents circulating, can result in severe signs
- Mortality is negligible

Mesogenic strains

- May produce cause acute respiratory disease and neurologic signs in some species
- Mortality rate is usually low (<10%)
- If other co-infectious agents circulating, can result in severe signs

Velogenic strains

- Most commonly cause severe disease in chickens with mortality; signs principally respiratory and/or nervous
- Initial clinical signs vary but include: lethargy, inappetence, ruffled feathers, oedema and injection of conjunctiva.
- As the disease progresses birds may develop: greenish or white watery diarrhoea, dyspnoea and inflammation of the head and neck often with cyanotic discoloration
- In later stages of disease neurologic signs may be manifested as: tremors, tonic/clonic spasms, wing/leg paresis or paralysis, torticollis, and aberrant circling behaviour; also be seen

- Sharp drop in egg production; eggs contain a watery albumin and appear misshapen with abnormally coloured, rough or thin shells
- These strains often result in sudden death, with few or no signs
- Birds that survive serious infection may develop neurologic and partial or complete cessation of egg production
- Morbidity and mortality rates may approach 100% in unvaccinated chickens

Lesions

There are no pathognomonic gross lesions; several birds must be examined to determine a tentative diagnosis and final diagnosis must await virus isolation and identification.

- Only velogenic strains produce significant gross lesions
- Lesions that may be found include:
 - swelling of periorbital area or entire head
 - oedema of the interstitial or peritracheal tissue of the neck; especially at the thoracic inlet
 - congestion and sometimes haemorrhages in the caudal pharynx and tracheal mucosa; diphtheritic membranes may be evident in the oropharynx, trachea and oesophagus
 - petechiae and small ecchymoses on the mucosa of the proventriculus, concentrated around the orifices of the mucous glands
 - oedema, haemorrhages, necrosis or ulcerations of respiratory/digestive lymphoid tissue, including cecal tonsils and Peyer's patches;
 - though not pathognomonic, ulceration/necrosis of Peyer's patches is suggestive of Newcastle disease
 - oedema, haemorrhages or degeneration of ovaries
 - although less evident in older birds, haemorrhages of the thymus and bursa of Fabricius may occur
 - spleen may appear enlarged, friable and dark red or mottled
 - some cases may present pulmonary oedema and pancreatic necrosis

Differential diagnosis

- Fowl cholera
- Highly pathogenic avian influenza
- Laryngotracheitis
- Fowl pox (diphtheritic form)
- Psittacosis (psittacine birds)
- Mycoplasmosis
- Infectious bronchitis
- Aspergillosis
- Also management errors such as deprivation of water, lack of or nutritionally deficient feed and poor ventilation
- In pet birds: Pacheco's parrot disease (psittacine birds), salmonellosis, adenovirus, and other paramyxoviruses
- In cormorants and other wild waterfowl: botulism, fowl cholera and conformational abnormalities

Laboratory diagnosis

Any laboratory processing samples or undertaking diagnosis from samples should meet the requirements for the appropriate Containment Group as determined by the risk assessment and as outlined in Chapter 1.1.2 Biosafety and biosecurity in the veterinary microbiology laboratory and animal facilities. Countries lacking access to such a specialised national or regional laboratory should send specimens to an OIE Reference Laboratory.

Samples

Samples should be collected from recently dead birds or moribund birds that have been killed humanely.

Identification of the agent

- Dead birds: oro-nasal swabs; lung, kidneys, intestine (including contents), spleen, brain, liver and heart tissues, separately or as a pool

- Live birds: tracheal and cloacal swabs (visibly coated with faecal material) from live birds or from pools of organs and faeces from dead birds
 - small delicate birds may be harmed by swabbing, but the collection of fresh faeces may serve as an adequate alternative
- Special attention should be given to appropriate types of media for shipping

Serological tests

- Clotted blood samples or serum

Procedures

Identification of the agent

- Virus culture: inoculation of embryonated specified pathogen free (SPF) eggs and tested for haemagglutination (HA) activity
- Virus identification: use of specific antiserum in a haemagglutination inhibition (HI) test
 - cross-reactions can be resolved by use of suitable antigen and antiserum controls
- Pathogenicity index determined by intracerebral methodology
- Pathogenicity index determined by molecular basis
- Definition of Newcastle disease:
 - a) criteria based on either intracerebral pathogenicity index (ICPI) in day-old chicks or
 - b) correlation of multiple basic amino acids
- Monoclonal antibodies: for rapid identification of NDV (avoiding cross-reactions with other APMV serotypes) and a valuable method for grouping and differentiating isolates of NDV
- Phylogenetic studies: allows for the rapid epidemiological assessment of the origins and spread of the viruses responsible for ND outbreaks
- Molecular techniques in diagnosis: advantage of extremely rapid demonstration of the presence of virus

Serological tests

- Haemagglutination and haemagglutination inhibition tests: most widely used and detects antibody response to virus glycoprotein (predictor of protection against disease)
- Enzyme-linked immunosorbent assay (ELISA): as whole virus is used as antigen, detects antibody to all of the virus proteins
 - commercial ELISA kits available to assess post-vaccination antibody levels

For more detailed information regarding laboratory diagnostic methodologies, please refer to Chapter 2.3.14 Newcastle disease in the latest edition of the OIE *Manual of Diagnostic Tests and Vaccines for Terrestrial Animals* under the heading “Diagnostic Techniques”.

PREVENTION AND CONTROL

No treatment.

Sanitary prophylaxis

- Bird-proofing houses, feed and water supplies
- Proper carcass disposal
- Pest control in flocks; insects and mice
- Avoidance of contact with birds of unknown health status; including newly acquired domesticated poultry, pet birds and wild or feral birds
- Control of human traffic; facility employees should not have contact with outside birds and consideration of a policy of shower-in with dedicated clothing
- Control of vehicular traffic; strict disinfection of conveyances and equipment
- One age group per farm ('all in-all out') breeding is recommended; disinfection between groups
- During outbreaks:

- effective quarantines and movement controls
- destruction of all infected and exposed birds; 21 days before restocking
- thorough cleaning and disinfection of the premises

Medical prophylaxis

- One of the most important considerations for any vaccination programme is the type of vaccine to be used, the immune and disease status of the birds to be vaccinated, the level of maternal immunity in young chickens and the level of protection required in relation to any possibility of infection with field virus under local conditions; various strategies exist and references, like the OIE Terrestrial Manual, should be consulted
- Vaccination with live and/or oil emulsion vaccines can markedly reduce the losses in poultry flocks but can not ensure the prevention of virus circulation (replication and shedding)
- Sentinel chickens have been employed to monitor vaccinated flocks
- In general, the more immunogenic live vaccines are more virulent, and are therefore more likely to cause adverse side-effects
- Conventional live virus vaccines: 2 groups
 - lentogenic vaccines (e.g. Hitchner-B1, La Sota, V4, NDW, I2 and F)
 - mesogenic vaccines (e.g. Roakin, Mukteswar and Komarov); infections these viruses would fall within the OIE definition of ND thus some countries have specified that only lentogenic NDV strains can be used as vaccines
 - most live virus vaccines grown in allantoic cavity of embryonated fowl eggs; some mesogenic strains have been adapted to a variety of tissue culture systems
 - live virus vaccines administered to birds by incorporation in the drinking water, delivered as a coarse spray, or by intranasal or conjunctival instillation; some mesogenic strains are given by wing-web intradermal inoculation
- Inactivated vaccines
 - tend to be more expensive than live vaccines
 - application entails handling and injecting individual birds
 - prepared from allantoic fluid that has had its infectivity inactivated by formaldehyde or beta-propiolactone
 - incorporated into an emulsion with mineral oil, and is administered intramuscularly or subcutaneously; each bird thus receives a standard dose
 - advantage of no subsequent spread of virus or adverse respiratory reactions
 - virulent and avirulent strains are used as seed virus; from a safety control perspective the use of the latter appears more suitable
 - much larger amount of antigen is required for immunisation than for live virus vaccination (no virus multiplication takes place after administration)
 - a high yield of virus to produce a potent vaccine is important; Ulster 2C strain is very suitable for this purpose.
- New recombinant vaccines: fowlpox virus, vaccinia virus, pigeonpox virus, turkey herpesvirus and avian cells in which the HN gene, the F gene, or both, of NDV are expressed

For more detailed information regarding vaccines, please refer to 2.3.14 Newcastle disease in the latest edition of the *OIE Manual of Diagnostic Tests and Vaccines for Terrestrial Animals* under the heading “Requirements for Vaccines and Diagnostic Biologicals”.

For more detailed information regarding safe international trade in terrestrial animals and their products, please refer to the latest edition of the *OIE Terrestrial Animal Health Code*.

REFERENCES AND OTHER INFORMATION

- Brown C. & Torres A., Eds. (2008). - USAHA Foreign Animal Diseases, Seventh Edition. Committee of Foreign and Emerging Diseases of the US Animal Health Association. Boca Publications Group, Inc.
- Coetzer J.A.W. & Tustin R.C. Eds. (2004). - Infectious Diseases of Livestock, 2nd Edition. Oxford University Press.

- Fauquet C., Fauquet M. & Mayo M.A. (2005). - Virus Taxonomy: VIII Report of the International Committee on Taxonomy of Viruses. Academic Press.
- Kahn C.M., Ed. (2005). - Merck Veterinary Manual. Merck & Co. Inc. and Merial Ltd.
- Spickler A.R. & Roth J.A. Iowa State University, College of Veterinary Medicine - <http://www.cfsph.iastate.edu/DiseaseInfo/factsheets.htm>
- World Organisation for Animal Health (2009). - Terrestrial Animal Health Code. OIE, Paris.
- World Organisation for Animal Health (2008). - Manual of Diagnostic Tests and Vaccines for Terrestrial Animals. OIE, Paris.

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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 October 2009.