



# **Newcastle disease virus**

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NDV-Pleomorphic, enveloped, non-segmented single stranded negative sense RNA virus, with helical capsid symmetry: genus *Avulavirus*, family *Paramyxoviridae*, order *Mononegavirales*

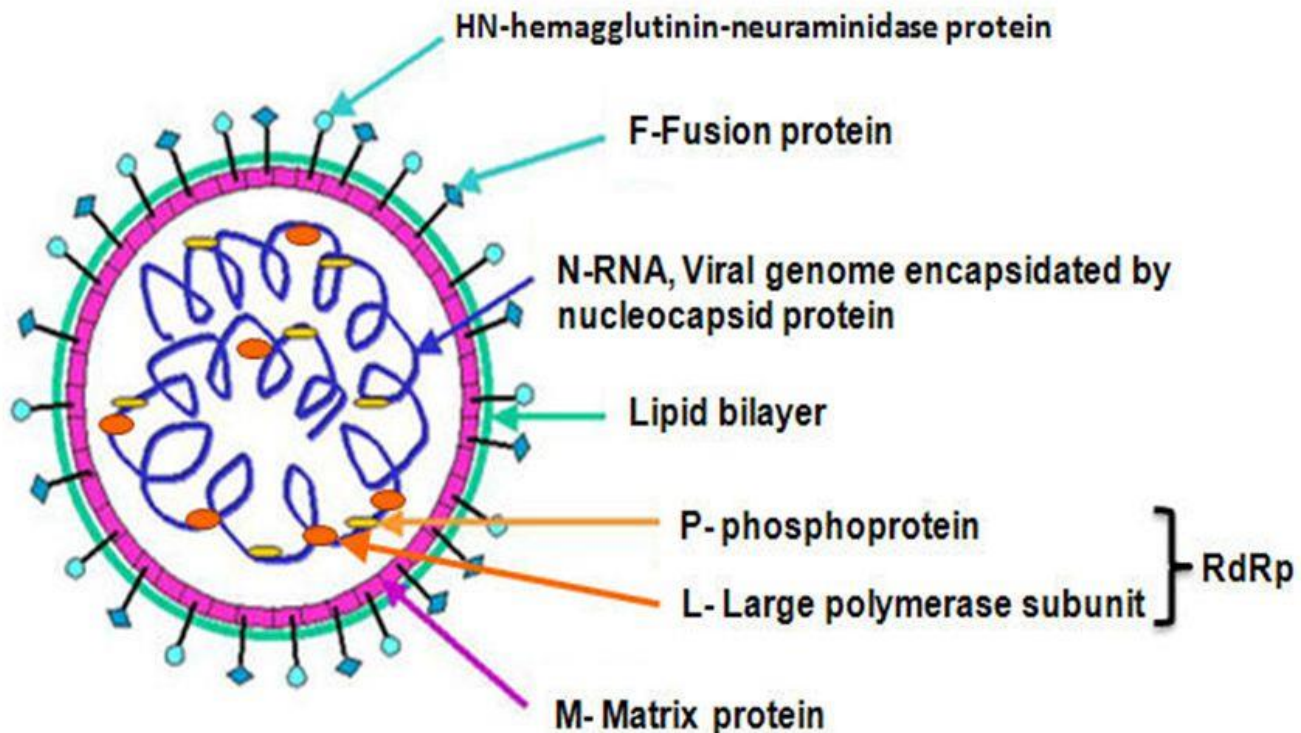


Fig1; Diagrammatic representation of Newcastle disease virus.

- The envelope of the virion
  - derived from host cell plasma membrane
  - outer surface consisting of two viral glycoproteins : fusion (F) protein, and hemagglutinin-neuraminidase (HN) protein
  
- F protein functions for fusion of viral envelope with host cell membrane
  
- HN protein responsible for attachment of virion to host cell receptor
  
- F and HN proteins- immunogenic proteins of virion

- **Core :**

- consists of nucleocapsid (NP) proteins tightly bound to genomic RNA
- Phosphoprotein (P) and large polymerase (L) proteins are also attached

- **Matrix or M protein:**

- In between viral envelope and nucleocapsid
- acts as a driving force for the assembly of the virus particles

- The genome of ND virus consists of six genes which code for six different proteins
  - nucleocapsid protein (NP)
  - phosphoprotein (P)
  - matrix protein (M)
  - fusion protein (F)
  - hemagglutinin-neuraminidase protein (HN)
  - large polymerase protein (L)
- F protein, inactive precursor (F<sub>0</sub>), requires host cell proteolytic enzymes for cleavage
- cleavage yields two subunits F<sub>1</sub> and F<sub>2</sub> connected to each other by disulfide link
- HN protein binds with sialic acid, binding of virus to sialic acid containing receptor

# Newcastle disease virus

- Genus *Avulavirus*:
  - Avian paramyxovirus serotype I group
  - Avian paramyxoviruses (APMV) 2-12, (low-virulent )
- Newcastle disease:
  - important diseases of poultry worldwide
- Also called ranikhet disease, pseudofowl pest, and avian pneumoencephalitis
- Ist reported in Java in 1926, then in Newcastle, England in 1927 by Doyle
- In India, Ist reported by Edwards in 1927 at town ranikhet in Almora district
- APMV-2 and APMV-3: Respiratory disease in turkeys

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- ND reportable to the World Organization for Animal Health
- More than 241 bird species have been reported to be susceptible for NDV infection
- Susceptible avian sp.:
  - chickens, turkeys, pigeons, pheasants, ducks, geese
  - wide range of captive and free-ranging semi-domestic birds
  - free-living birds, including migratory waterfowl
- Signs of inf. vary depending on sp. of bird and strain of virus
- Most low-virulent or avirulent APMV serotype I strains are maintained in migratory waterfowl and other feral birds

## Classes I and II of NDV

- NDV strains into Classes I and II, based on genomic size and sequence analysis
- **Class I:**
  - mostly avirulent
  - frequently isolated from wild waterfowl
  - grouped into nine genotypes
- **Class II:**
  - most virulent, NDVs
  - at least 18 genotypes have been identified in this group



## Properties:

### Temperature:

Inactivated by 56°C/3 hours or 60°C/30 minutes

### pH:

Inactivated by acid pH  $\leq 2$

### Chemicals/Disinfectants:

-Ether sensitive

-Inactivated by formalin, phenolics, oxidising agents, chlorhexidine, sodium hypochlorite (6%)

### Survival:

for long periods at ambient temp., especially in faeces

## Avian paramyxovirus serotype I strain

- The disease is defined as an infection by avian paramyxovirus serotype I that meets one of the following criteria for virulence: (OIE Definition for Virulent Newcastle Disease)
- (1) the virus has an intracerebral pathogenicity index in day-old chicken of 0.7 or greater
- or (2) multiple basic amino acids (at least three arginine or lysine between residues 113 and 116) at the C terminus of F2 (fusion) protein) in the virus and phenylalanine at residue 117

Single basic amino acids at 113 and 116, along with leucine at 117, allows the fusion protein of avirulent NDV cleaved only by trypsin-like proteases

## ND virus strains

Five pathotypes:

(1) Viscerotropic velogenic: (Doyle's form)

- severe fatal disease, haemorrhagic intestinal lesions

(2) Neurotropic velogenic: (Beach's form)

- acute disease, nervous and respiratory signs, high mortality

(3) Mesogenic: (Beaudette's form)

- Respiratory and neurological signs, with low mortality
- mortality confined to young birds

(4) Lentogenic: (Hitchner's form)

- mild or inapparent infection

vaccines against ND

(5) Asymptomatic enteric

- avirulent infections, replication appears primarily in gut

## Transmission

- Virus is shed for up to 4 weeks in all secretions and excretions of birds that survive the infection
- by aerosols or ingestion of contaminated feed or water
- Mechanical transfer through movement of personnel and equipment
- can survive in carcasses for some weeks
- Virus in all organs of acutely affected birds & in eggs
- Captive and wild birds- spread of infection
- Pigeons are susceptible to all strains of NDV

# Pathogenesis

- Viral replication occurs initially in epithelia of respiratory and intestinal tracts
- followed by haematogenous spread to spleen and bone marrow
- Secondary viraemia- infection of other organs including lungs, intestine and CNS
- The extent of spread within the body relates to strain virulence -determined by the amino acid sequence of F glycoprotein
- Fusion (F) glycoprotein of NDV is synthesized in an infected cell as precursor molecule (Fo)- cleaved by host cell proteases to F1 and F2 subunits

- If cleavage fails to occur, non-infectious particles are produced
- For molecules of virulent strains of NDV possess basic amino acids at critical positions
  - cleavage by proteases in a wide range of host tissues
- The replication of lentogenic strains is confined to the respiratory and intestinal epithelia where suitable proteases are produced

# Clinical signs

- ❑ depends on:
  - Age, immune status of host
  - virulence and tropism of virus strain
  
- ❑ I.P. - 2 to 15 days, with an average of 5-6 days
  
- Respiratory, gastrointestinal and nervous signs occur in chickens
  
- Velogenic strains- high mortality—close to 100%—without clinical signs
  
- When present, signs in these flocks include listlessness, weakness and a decrease in egg production
  
- Viscerotropic strains- respiratory signs such as gasping and rales, oedema of the head and neck and greenish diarrhoea
  
- Birds surviving acute phase may develop neurological signs

- Neurotropic velogenic strains
  - results in respiratory disease
  - followed by nervous signs (wing paralysis, leg paralysis, torticollis, muscle spasm)



- Mesogenic strains:
  - usually cause respiratory and neurological signs
  - with low mortality



- Lentogenic strains:
  - No disease in adult birds
  - may produce respiratory signs in young birds



## Gross lesions

- Ecchymotic hemorrhages in larynx, trachea, esophagus, and throughout the intestine
- Foci of necrosis in intestinal mucosa, especially Peyer's patches and cecal tonsil, lymphoid tissues
- Generalized vascular congestion in most organs, including the brain
- Virulent velogenic strains- marked hemorrhage, in particular at junctions of esophagus and proventriculus, and proventriculus and gizzard, and in posterior half of small intestine
- In severe cases, hemorrhages in s/c tissues, muscles, larynx, trachea, esophagus, lungs, airsacs, pericardium, and myocardium, ovarian follicles of adult hens
- In CNS- encephalomyelitis with neuronal necrosis

# Lesions in ND

(Image source-google)



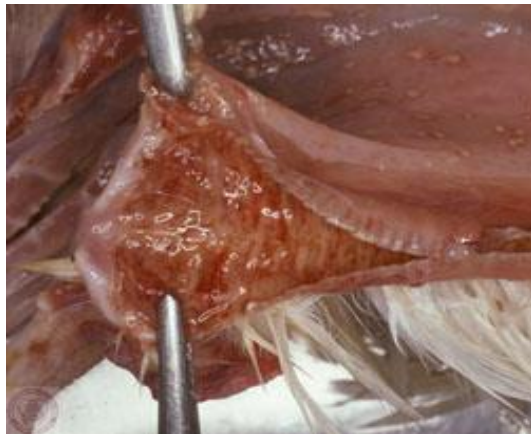
comb edematous and contains multiple foci of hemorrhage



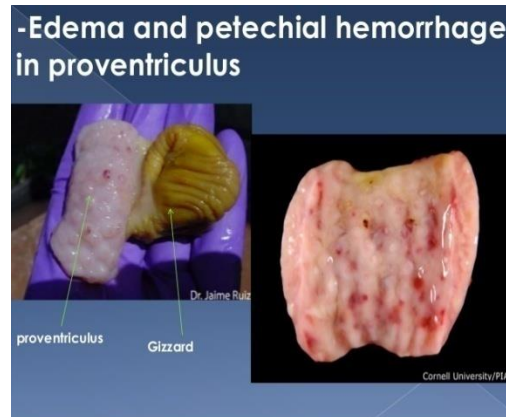
marked hemorrhage of the comb, wattle, and adjacent skin



Conjunctival hemorrhage



Tracheal and laryngeal mucosa with many foci of hemorrhage



Cecal tonsils: hemorrhages, necrosis

### Infection in turkeys:

- usually involves resp. system and CNS
- Airsacculitis most common lesion
- less severe than that in chickens

### Pigeons with 'pigeon' paramyxovirus 1:

- neurological signs and diarrhoea
- Mortality up to 10%

### Ducks and geese:

- inapparent, few cases of severe disease in domestic ducks

### Humans:

- Minor zoonosis
- Transitory conjunctivitis, generally very mild and self limiting

# Diagnosis

➤ **A presumptive clinical diagnosis:**

By characteristic signs and lesions assoc. with virulent strains

➤ **Laboratory confirmation:**

- Tracheal and cloacal swabs from live birds for virus isolation
  - Postmortem specimens- faeces, intestinal contents and portions of trachea, intestine, spleen, brain and lung
  - Samples may be stored at 4°C for up to four days
- **Isolation of the agent**
- by allantoic sac inoculation of 9-10day old embryonating eggs
  - Any hemagglutinating agents identified by hemagglutination-inhibition or RT-PCR assays

➤ **Virus identification:**

- use of specific antiserum in HI test

➤ **Virulence of NDV isolates assessed by in vivo test in SPF chicks:**

- Intracerebral pathogenicity index
- Intravenous pathogenicity index

➤ **Mean death time (MDT) using embryonated eggs:**

- Velogenic (embryonic death (ED) in less than 60 hours),
- Mesogenic (ED between 60 and 90 hours)
- Lentogenic (ED in more than 90 hours)

➤ **Demonstration of antibody to NDV**

- Diagnostic value only in unvaccinated flocks
- HI, ELISA

➤ **Demonstration of viral antigen**

- In tracheal sections or impression smears using immunofluorescence, less sensitive

# Prevention and control

## 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
- Control of human traffic, vehicular traffic; strict disinfection of conveyances and equipment
- One age group per farm ('all in-all out') breeding

## 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

# Prevention and Control

- Where the disease is enzootic:
- Control by good hygiene combined with immunization
- Either live-attenuated virus vaccines containing naturally occurring lentogenic virus strains
- Recombinant (vectored) vaccines based on turkey herpesvirus or fowl poxvirus with avian paramyxovirus I F and/or HN gene inserts
- Inactivated virus

These vaccines are effective and safe, even in chicks

# Vaccination

- Live virus-based vaccines-  
administered via drinking water or by aerosol, eye or nostril droplets, or beak dipping, some mesogenic strains by wing-web intra-dermal inoculation
- Inactivated vaccines are formulated as oil emulsions and injected
- Recombinant vaccines by injection of birds in the hatchery at 1 day of age
- Broiler chickens are vaccinated at least twice
- Long-lived birds, such as laying hens, are revaccinated several times throughout their lives with inactivated vaccines



## Vaccines

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)

Inactivated vaccines:

- prepared from allantoic fluid, inactivated by formaldehyde or beta-propiolactone

New recombinant vaccines:

- fowlpox virus, vaccinia virus, pigeonpox virus, turkey herpesvirus in which the HN gene, the F gene, or both, of NDV are expressed

- Birds vaccinated with live virus-based vaccines-
  - excretion of vaccine virus
  - movement restriction for 21 days after vaccination
  
- Advantages of vectored vaccines
  - lacking vaccine-induced respiratory disease as can occur with live avian paramyxovirus I vaccines
  
  - allow detection of field virus infections in vaccinated population through detection of antibodies to nucleoprotein, lacking in recombinant vaccines