Newcastle Disease (ND)

- Highly contagious viral disease of chickens, turkeys, and most other species of birds. The most severe form of the disease in chickens is characterized by high mortality with hemorrhagic and necrotic lesions in the intestinal mucosa or neurologic disease.
- Zoonotic disease
- Nomenclature can be complicated. Only the more virulent strains of APMV-1 viruses are termed ND by OIE.
  - A more straightforward method is to use vND for virulent strains and LoND for low virulent strains
- ND, (vND, Exotic Newcastle Disease), is reportable to the World Organization for Animal Health.
Newcastle Disease

Family: Paramyxoviridae
Subfamily: Paramyxovirinae
Genus: Avulavirus

Virus serotype:
1. APMV-1 which are classified as velogenic, mesogenic or lentogenic based on virulence in chickens or other factors.
2. Other APMV serotypes: APMV-2 through APMV-9
Classic Key Lesions
ND Outbreaks Jan 2011 to Jan 2012
Multiyear Disease Distribution Map
Recent Isolations of vNDV in US

• 1992 turkeys (ND)
• 1998 game fowl (CA)
• 2002-03 chickens, wild birds, pet birds, game fowl
• Double crested cormorants (wild waterfowl) over multiple years in multiple states
• 2005-11 pigeon paramyxovirus type-1 in pigeons and/or doves in multiple states
• 2010 one lot of imported birds in CA quarantine facility
Pigeon Paramyxovirus Type 1 (PPMV-1)

- Host-specific variant of ND
- Neurologic disease
- Worldwide distribution
- Identified in wild pigeons in U.S.
- Not yet isolated from poultry in U.S.
- Distinguished by monoclonal antibodies.
General Features of the 2002-03 ND Outbreak in the United States

- High morbidity and mortality in backyard poultry (>90%)

- Mid-December 2002 – the virus spread to commercial layers with low morbidity and mortality (0.7 – 5%)
Disease Eradication in the City
2002/2003 ND Outbreak (Backyard - CA, NV, AZ, TX)

- 300,000 premises surveyed
- 2,671 premises positive or DC
- 149,247 birds depopulated
- 19,056 premises quarantined
2002/2003 ND Outbreak (Commercial - CA)

- 21 premises positive + 1 DC
- 3,021,815 birds depopulated
- >1.5 million spent hens destroyed
- 3/26/03 – last positive case
- Total cost - $167 M
Additional Setbacks

• January 16, 2003 – Nevada (2 counties)  
  – 138 (10 IP) premises depop (2,746 birds)  
  – Jan 29 – last positive case

• February 4, 2003 – Arizona (3 counties)  
  – 4 (1 IP) premises depop (269 birds)  
  – Feb 7 – last positive case

• April 9, 2003 – Texas (2 counties, 3 in NM)  
  – 40 (1 IP) premises (2,002 birds)
Newcastle Disease (ND)

*Host Range and Disease:*

- Most species of birds, both domestic and wild
- Chickens/turkeys – most susceptible
  - ducks least susceptible
- Mortality/morbidity influenced by species, strain of virus, environmental factors, and vaccination practices
- A carrier state can exist in psittacine birds.
Host Range includes Humans
Sources of Virus

- Poultry (backyard flocks)
- Pet birds (smuggled)
- Wild birds (cormorants)
- Humans (careless activities)
Methods of Spread: ND Infected Premises

- Infected Premises
- People
- Vehicles/Equipment
- Infected Birds
- Fecal/oral (bird-bird)
- Wind
- Wild Birds
- Insects
- Aerosol (bird-bird)
- Rodents
Incubation and Shedding of Virus

- Incubation period 2 to 15 days
  - Chickens typically 2-6 days
- Duration of virus shedding is highly variable, depending on species other factors
  - Chickens usually less than 2 week
  - Psittacine infected for very long time and clinically normal
- Shedding/circulation of virus within a vaccinated flock
Pathogenesis of ND
Replication at point of entry

Avirulent strains
F cleaved by trypsin
Limited viral replication
Few basic amino acids, /L (B-X-X-R/L)

Viremia
Systemic infection

Virulent strains
F cleaved by furin
Multiple basic amino acids, /F (B-X-B-R/F)
Newcastle Disease (ND)

Old terminology based on clinical signs and pathology:

- Velogenic (most virulent form) vND
  - Viscerotropic velogenic (VVND)
  - Neurotropic velogenic (NVND)

- Mesogenic (intermediate form) vND

- Lentogenic (mild form, vaccines) loND
  - Respiratory
  - Asymptomatic enteric
Newcastle Disease (ND)  

**OIE Definition**

- APMV-1 serotype and:
  - Intracerebral Pathogenicity Index of 0.7 or greater
    - Inoculate ten, 1-day-old chicks, and give a numerical value for the number ill and dead each day.

**OR**

- Multiple basic amino acids at the C terminus of F2 (fusion) protein and phenylalanine at residue 117 (NH2 terminus of F1)
### Intracerebral Pathogenicity Index (ICPI)

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<th>Day</th>
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<th>2</th>
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ICPI = \( \frac{\text{Weighted Mean}}{\text{Number of Observations}} \) = \( \frac{3 + 54}{80} \) = 0.71
Cleavage site

Position | 113 | 114 | 115 | 116 | 117
Avirulent | R/K | Q  | G  | R  | L
Virulent  | R/K | Q  | R/K| R  | F
Clinical Signs in Poultry

• Sudden high mortality
• Anorexia, depression
• CNS disease
  – Paresis, paralysis, muscle tremors, torticollis
• Diarrhea
• Respiratory symptoms, due to secondary bacterial infections
• Drop in egg production, misshapen eggs
• Swollen head and conjunctivitis
Newcastle Disease (ND)

Clinical Signs

- Depression, fever and anorexia
- CNS signs
Poultry

• No pathognomonic gross lesions
• Viscerotropic strains – necrosis, hemorrhage, fibrin: oral cavity, pharynx, trachea, proventriculus, and cecal tonsil
• Peritracheal-head edema
• Neurotropic strains – mortality with no gross lesions
Newcastle Disease (ND)  
**Clinical Signs/lesion in Pet Birds:**

- **Respiratory system**  
  - Rapid/labored breathing  
  - No characteristic gross lesions

- **Central nervous system**  
  - Depression  
  - Paralysis (wing droop, leg weakness)  
  - Head shaking  
  - No gross lesions with CNS form
Newcastle Disease (ND)  
*Differential Diagnosis:*

- Acute fowl cholera
- Avian influenza
- Infectious laryngotracheitis
- Fowl pox (diptheritic form)
- Psittacine herpes virus (Pacheco’s disease)
- Chlamydiosis (psittacines)
Sample collection ND is the same as sample collection for AI

Why is sample collection the same?

1. Serology
   - When is serology useful for END?
Sample Collection

- Serum – 20-30/flock (95% CI – 10% prevalence)
- Swabs (2-4 ml BHI, Dacron, plastic shaft)
  - Vaccinated flocks – sample daily mortality
  - Waterfowl – cloacal swabs (individual)
  - Poultry – tracheal/oropharyngeal and cloacal swabs (pool up to 5/tube)
- Tissue (3-5 birds)
  - Spleen, lung
  - Pool different tissues from the same bird, but do not pool like tissue from different birds
- Storage/shipping
  - 4°C for 48-96 hrs
  - Ship with frozen gel packs
  - Long-term storage -70°C (do not store at -20°C)
• Clinical features are not diagnostic

• Virus isolation and characterization
  – Essential (especially index case)
  – 9-11 day embryonating chicken eggs (2-14 days)
  – Chicken pathogenicity testing (8 days)
  – Sequencing (1-2 days)

• RNA detection (swabs, tissues)
  – rRT-PCR (matrix, vND, IoND assays) – 3 hr

• Serology (not very useful because of vaccine use)
  – HI (2-3 hr)
Farm Biosecurity

- Protect poultry, feed and water from contact with other birds/feces
- Purchase birds from reputable and tested supplier
- Limit access to farm
- Provide clean clothing and boots to workers
- Clean and decontaminate all vehicles and equipment coming on to the farm
- Don’t bring in equipment from other farms
- Avoid visiting other farms and live bird markets
Disinfectants

- Peroxygens (Virkon-S)
- Iodophores
- Phenolics
- Quaternary ammoniums
- Ethanol
- Bleach
Newcastle Disease (ND)

*Prevention/Control:*

- **Vaccination:**
  - **Live virus**
    - Lentogenic strains (B1, La Sota)
    - Administered by spray or in water
    - Multiple exposures needed
  - **Killed virus**
    - Oil-emulsion, administered SQ
    - Used in layers, breeders (after live virus)
National Biosecurity

- Import restrictions on poultry and poultry products countries with Newcastle disease
- Heighten border surveillance
- Imported live birds
  - 30 day quarantine
  - END testing
Newcastle Disease

**Summary:**

- Probably the most important viral disease of poultry worldwide
- Numerous outbreaks recorded in U.S.
  - Illegal bird imports (pet and backyard fowl)
  - Wild birds - cormorants
- Virulent forms are reportable
  - Domestic poultry – high mortality, hemorrhagic gut lesions, CNS
  - Pet birds – respiratory, CNS
- Vaccination routinely practiced