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Review on new castle disease: A constant threat to poultry industry

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Abstract
Newcastle disease is an economically important highly contagious bird disease affecting many domestic and wild avian species worldwide. Newcastle disease remains a constant threat to the poultry industry and is a limiting disease for poultry producers worldwide. It is caused by virulent strains of Avian Paramyxovirus-1, which is a single strand non segmented negative sense RNA virus. Virulent ND virus strains are endemic in poultry in most of Asia, Africa, and some countries of North and South America. The transmission of ND infection occurs through direct and indirect modes. According to variation in strains of NDV, the rate of mortality and morbidity in a flock is variable. Gross and microscopic lesions as with clinical signs, the organs affected in birds infected with NDV are dependent on the strain and pathotype of the infecting virus, in addition to the host and all the other factors that may affect the severity of the disease. Newcastle disease has public health significance and causes conjunctivitis in humans. Clinical diagnosis based on history, signs and lesions in addition hemagglutination and hemagglutination inhibition test, virus neutralization test, Enzyme linked immune-sorbent assay, plaque neutralization test and reverse-transcriptase polymerase chain reaction (RT-PCR) can be used for confirmation of the ND virus.

Keywords: Poultry, Newcastle disease, paramyxovirus pathogenicity

Introduction
Poultry farming is one of the most important livestock of Indian farmers because its supply low cost animal protein. Poultry, the largest livestock group, account for more than 30% of all animal protein. However, this production is mainly based on commercial poultry, which accounts for only 20% of the total poultry population [32]. Poultry represents an important sector in animal production, with backyard flocks representing a huge majority, especially in the developing countries. In these countries, villagers raise poultry to meet household food demands and as additional sources of incomes. The main and high threat to this poultry industry has been the occurrence of diseases that decrease production. One of the most common and detrimental avian viral diseases affecting poultry production is Newcastle disease (ND). Newcastle disease is an important infectious disease affecting many domestic and wild avian species and an economically important disease and also a major threat to poultry industry [30].

This New castle disease also known as Ranikhet disease, caused by infections with virulent viruses from the genus Avulavirus and species avian avulavirus 1, commonly known as Newcastle disease virus (NDV) and abbreviated as avian paramyxovirus 1 (APMV 1) [27,2].

The Newcastle Disease (ND), is a highly contagious viral disease that affects domestic and wild bird species [6] and without an adequate control strategy, causes high morbidity and mortality as well as drops in egg production in layers [8,33,29]. The virus is capable of infecting at least 236 bird species, including the majority of wild and domestic bird species [24]. The disease was first described in 1926 from Newcastle–on–Tyne, England and Java, Indonesia [9]. Domestic poultry is considered highly susceptible to ND infection resulting in severe outbreaks worldwide. It represents major deplete in the economy of poultry rearing countries than any other viral disease [6] especially in developing countries including India.

According to the World Organization for Animal Health (OIE), ND is an OIE notifiable disease when it meets certain criteria of virulence. These high consequence strains can cause enormous economic impact.

NDV is zoonotic and has been reported in people with eye infections who are involved in activities related to NDV diagnosis and in poultry production [15].

The objective of this review is to understand the Newcastle disease causative agent, pathogenicity, clinical sign and how to prevent and control the Newcastle disease, which concerned with the currently published or reported research.

History of the disease

The first outbreaks to be recognized and termed Newcastle disease (ND) occurred in poultry in 1926, in Java, Indonesia, and in Newcastle-upon-Tyne, England. However, there are earlier reports of similar disease outbreaks in Central Europe before this date. The name "Newcastle disease", (after the geographical location of the first outbreaks in Great Britain), was coined by Doyle. The name has, however, continued to be used although when referring to the ND virus (NDV), the synonym 'avian Paramyxovirus type 1' (APMV-1) is now often employed [18].

Aetiology of the disease

Newcastle disease is caused by Avian Paramyxovirus-1, which is a single strand non-segmented negative sense single-stranded RNA virus [26].

This Avian Paramyxovirus-1 classified under order Mononegavirales, family Paramyxoviridae, subfamily Paramyxovirinae, and genus Avulavirus.

The viral genome of approximately 15 kb is composed of 6 genes encoding 6 structural proteins fusion (F), nucleoprotein (NP), matrix (M), phosphoprotein (P), RNA polymerase (L), and hemagglutinin-neuraminidase (HN). Two additional proteins also present namely proteins V and W. The determination of virus virulence depend on the cleavability of protein F however HN and V protein also influence pathogenicity of virus [13].

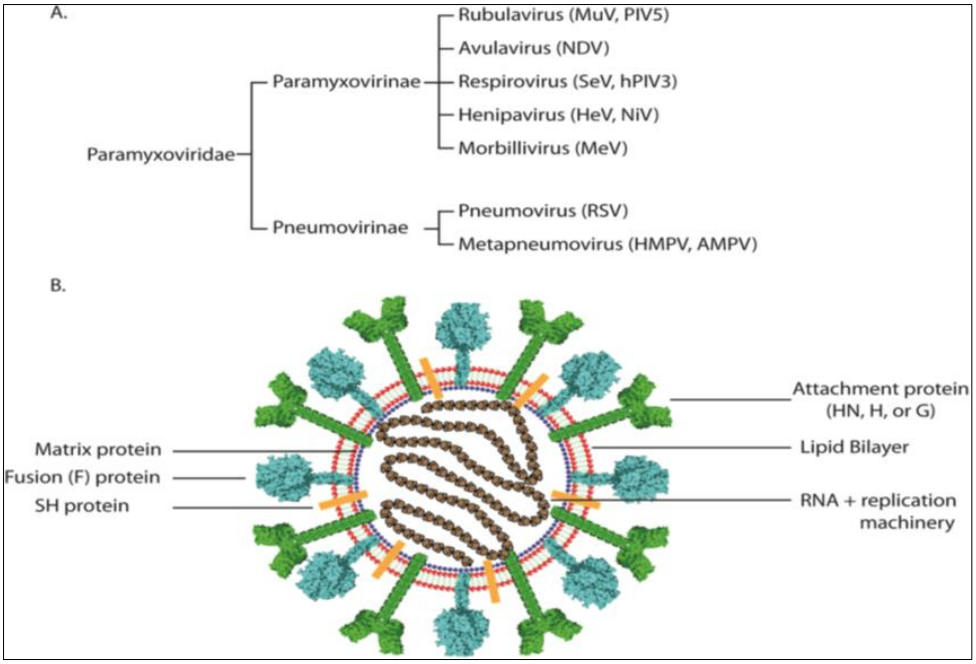

Fig 1: (A) Classification of representative members of the paramyxovirus family. (B) Schematic of a paramyxovirus [2]

Epidemiology

Many species of birds both domestic and wild Chickens are highly susceptible to disease. Game birds and parrots vary in susceptibility. Wild birds and waterfowl may harbour virus sub-clinically. Young cormorants have demonstrated disease associated with APMV-1. Disease has been recorded in ostriches and pigeons are known to be susceptible. Raptors are usually resistant to ND with exception of acute disease in bearded vulture, white-tailed sea eagle and some species of falcons. Other birds known to have been affected by NDV include: gulls fowls and pelicans. Passerine birds 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 have been recorded. Acute ND has been recorded in penguins. The morbidity and mortality rates vary among species, and with the strain of virus. Humans may become infected manifested by conjunctivitis and sub-conjunctival haemorrhage [18].

Pathogenicity of virus

The severity of the Newcastle disease in domestic and wild avian varies greatly, from peracute disease with almost 100% mortality to subclinical disease with no lesions. Such variability of the disease makes it impossible to target ND as a single clinicopathologic entity. Based on severity of disease, the New castle disease classified in to 4 pathotype known as Doyle, Beach, Beaudette, and Hitchner forms [4]. These pathotype categorised based on the pathogenicity from least pathogenic, asymptomatic enteric form, lentogenic, mesogenic, neurogenic to most severe velogenic form according to their ability to cause visceral or nervous involvement [6].

Transmission

Newcastle disease virus is highly contagious and easily spread from one bird to another through infected droppings and respiratory discharge between birds. Transmission of this infection takes place by directly and indirectly method both (Figure 02).

Direct transmission

The infection is usually transmitted by direct contact with sick birds or unaffected birds carrying the virus. Direct contact with secretions of infected birds principally via ingestion (faeco-oral route) and inhalation can transmit the virus.

The infection takes place by inhalation or ingestion of the virus or by contact with mucous membranes, specially the conjunctiva. Infected birds shed virus in aerosol, respiratory discharge and faeces. Virus is shed from the survival birds with faeces and soiled eggshell during the incubation period, during clinical stages [30].

Indirect transmission
Spread of virus between farms is by infected equipment, people, other animals, trucks, personnel, wild birds or air, contaminated poultry products, fomites, feed, water, implements, premises, human clothing, boots, sacks, egg trays/ crates feed and water is called indirect method of transmission. Fleas, rodent, insect and dog can also transmit ND virus mechanical from infected faeces.

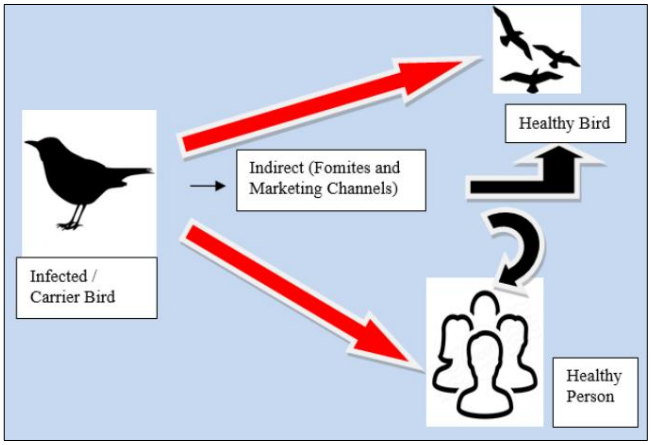

Fig 2: Transmission of NDV [30]

Incubation period
The incubation period of this disease is variable but usually about 3 to 6 days.

Pathogenicity of virus
The pathogenicity of the disease is determined by the strain of virus, dose, route of administration of virus, age of the chickens and environmental conditions. In general, the younger chickens are more susceptible with this disease. in field condition younger chickens experienced sudden death with virulent strain of virus whereas in older birds the disease may be more protracted and with characteristic clinical signs. Breeding or genetic purpose birds stock does not showed a significant effect on the susceptibility for this disease. This disease varies from mod to severe. A severe and contagious form is called exotic Newcastle disease (END), is so deadly that many birds die suddenly without showing any signs of disease

Clinical signs
The clinical signs of ND virus disease vary widely from very high morbidity to asymptomatic carriers. The severity of the infection dependent on various factors like the virus, virulence of the virus strain, pathotype, host species, age of host, immune status, co-infection with other organisms, environmental conditions [23].
Clinical signs alone do not present a reliable basis for diagnosis of ND. Morbidity and mortality depend on, degree of immunity, environmental conditions, and condition of the flock [8].
Clinical sign and course of infection categorised in to four different pathotypes based on the strain of the virus. These pathotype include the followings [3].

Viscerotropic velogenic
Highly pathogenic strains of ND cause high mortality up to 90%. In the initial stage of infection includes lethargy, in appetence, ruffled feathers and oedema of conjunctiva. As the disease progresses birds may develop greenish or white watery diarrhoea (Figure 03), dyspnoea and inflammation with cyanotic discoloration of the head and neck. In later stages of disease neurologic signs may be seen such as tremors, tonic or clonic spasms, wing or leg paresis or paralysis, torticollis, and aberrant circling behaviour also be seen (Figure 04). Sharp drop in egg production, eggs contain a watery albumin and appear misshapen with abnormally coloured, rough or thin shells. This strain results in sudden death, with few or no signs. Birds that survive in serious infection may develop neurologic and partial or complete cessation of egg production.

Fig 3: Chickens showing greenish colour diarrhoea

Fig 4: Chickens showing torticollis [18]

Neuroptopic velogenic: Acute signs from the nervous system dominate. Sudden depression, in appetence and drop in egg production are seen together with coughing and other signs from the respiratory tract. Mortality is usually around 10-20% for adult birds but can be higher for young birds.

Mesogenic: Mesogenic strains cause typical signs of respiratory distress. Labored breathing with wheezing and gurgling with other symptoms are depression, loss of weight and decreased egg production for up to three weeks. Mortality rate is usually low (10%).

Lentogenic: Usually associated with subclinical disease marked by mild respiratory disease; coughing, gasping, sneezing and rales and a small drop in egg production can be seen. No nervous signs and mortality is usually negligible.

Post mortem lesion
As with clinical signs, the gross lesions and the organs affected in birds infected with NDV are dependent on the strain and pathotype of the virus, in addition to the host and all the other factors that may affect the severity of the disease. The presence of hemorrhagic lesions in the intestine has been used to distinguish VVND viruses from NVND viruses [20]. These lesions are often particularly prominent in the mucosa of the proventriculus (Figure 04), caeca, and small and large intestine. They are markedly hemorrhagic and appear to result

from necrosis of the intestinal wall or lymphoid tissues such as cecal tonsils and Peyer's patches (Figure04). Gross pathologic changes of respiratory tract consist of mucosal hemorrhage and marked congestion of the trachea [7]. Air sacculitis may be present with relatively mild strains and thickening of the air sacs with catarrhal or caseous exudates is often observed in association with secondary bacterial infections [11].

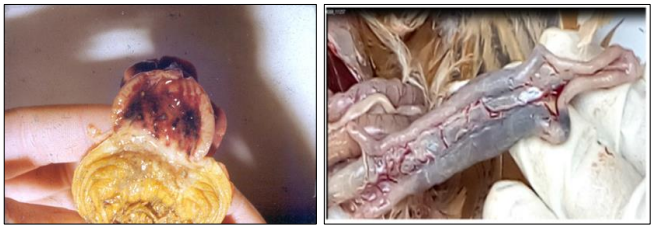

Fig 4: Hemorrhagic lesion in the proventriculus and intestine [18]

Diagnosis

Clinical diagnosis based on history, signs and lesions must be done. Laboratory diagnosis is used for confirmation of ND virus infection with different diagnostic tests like Hemagglutination and hemagglutination inhibition test, virus neutralization test, Enzyme linked immune-sorbent assay, plaque neutralization test and reverse-transcriptase polymerase chain reaction (RT-PCR) can be used.

For lab diagnoses, RT-PCR is the most exclusively used method to detect ND Virus. RT-PCR assay is more sensitive, specific and less labour intensives as compare to other conventional methods such as virus isolation, Immuno-Fluorescence Staining, Neuraminidase Inhibition and ELISA. For identification and differentiation of NDV strains modern technologies and new diagnostic techniques are being developed. Other molecular diagnostic tests like real time PCR and nucleotide sequence analysis are also important in viral disease diagnosis [1].

Isolation and identification of causative agent

Direct detection of viral antigens: For the specific demonstration of the presence of virus or viral antigens in organs or tissues, Immuno histologic techniques are a rapid method. Immunofluorescence techniques for thin sections of trachea [22], or impression smears [28] and an immunoperoxidase technique for thin sections [19] [25] have been reported and used.

Isolation of virus

Culture system: ND viruses can be propagated in many cell culture systems. For this purpose different primary cell culture is used. The embryonated chicken egg represents an extremely sensitive and convenient vehicle for the propagation of NDV and is used almost universally in diagnosis. Embryonated chicken eggs should be obtained from a specific pathogen free (SPF) flock and incubated for 9-10 days at 37 °C before use.

Serologic tests for virus antibodies

Different serological tests such as single radial immune diffusion [14] single radial hemolysis [21] agar gel precipitin test [17], Virus Neutralization test in chick embryos [10] and plaque neutralization [11] extensively used to detect the antibodies of ND virus [12].

Differential diagnosis of Newcastle disease

Differential diagnosis is the process of differentiating the Newcastle disease with other disease which share similar signs or symptoms. The disease which have similar clinical sign with Newcastle disease are Fowl cholera, Highly pathogenic avian influenza, Laryngotracheitis, Fowl pox (diphtheritic form), Psittacosis, Mycoplasmosis, Infectious bronchitis, Aspergillosis [1].

Treatment: There is no specific treatment for ND disease.

Prevention and control

Good biosecurity measures are essential to prevent the Newcastle disease in poultry flocks. Biosecurity measures include bird-proof houses, feed and water supplies, minimizing travel on and off the facility, disinfecting vehicles and equipments that enter the farm. Pests such as insects and mice should also be controlled. The general approaches to the control of the disease are proper hygiene and regular vaccination. Hygiene includes measures such as cleaning, disinfection, limiting access to birds, and personal hygiene of the farm staff.

The effective way to control ND is vaccination in combination with appropriate hygiene measures.

Vaccination against ND would result in immunity against infection and replication of the virus. Currently, many live and inactivated killed ND vaccines are available around the world. ND vaccines available in either live or dead (killed) form. Live vaccines are fragile and require a cold chain up to the point of application. The immune response increases as the pathogenicity of the live vaccine increases. Live virus vaccines are administered by variety of routes and schedules from hatching till grow-out. Killed vaccines give good immunity but require priming with a live vaccine for best results, unless a natural infection has already served this purpose. Killed virus oil emulsion vaccines are administered parentally prior to the onset of egg production.

To obtain the desired level of protection without serious reaction, vaccination programs are needed that involve sequential use of progressively more virulent viruses or live virus followed by inactivated virus vaccine [1].

Public health importance

Humans are among the many species that can be infected by NDV in addition to avian species. NDV may cause conjunctivitis in humans, when a person has been exposed to large quantities of the virus [31]. Mostly, Laboratory workers and vaccinators are affected. The use of personnel protective equipment and biological safety cabinet has reduced the exposure of laboratory workers. Infection is rarely seen in the workers of a farm; moreover, persons handling or consuming poultry products do not appear to be at risk [16]. The conjunctivitis usually resolves rapidly, but the virus will be shed in the ocular discharges from 4 to 7 days. In some cases, mild, self-limiting influenza like disease with fever and headache has also been reported in humans [5]. There is no evidence found to support human to human transmission but the potential for human to bird transmission exists [31].

Conclusion

New castle disease is highly contagious poultry disease causes huge economic losses in the poultry industry worldwide. It has public health significant and affects humans may causes

conjunctivitis. Current efficient accurate and reliable detection and confirmation of ND is important to limit economic losses and contain the disease. According to the concluding remark, it is important to enhance the awareness especially poultry farm industry as well as utilizing the most efficient and accurate laboratory testing procedures and regular vaccination programme and proper hygiene measure should be adopted for prevention and control this infection and minimise the huge economic loss due to the disease.

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