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Newcastle Disease Virus in Poultry: Pathogenicity, Zoonotic Perspective and Clinical Application in Medicine

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ABSTRACT

Newcastle disease virus (NDV) is a part of the avulaviridae family. It is a significant avian pathogen, including lentogenic (low pathogenicity), mesogenic (moderate), and velogenic (high pathogenicity) strains. Velogenic strains pose an extreme danger to poultry due to systemic infection and a high mortality rate and cause mild conjunctivitis or flu-like symptoms among poultry workers. In poultry, both live attenuated (LaSota strain) and inactivated NDV vaccines are widely used. NDV has been used in human medicine as an oncolytic virus due to its selective replicative property and breakdown of cancer cells while stimulating antitumor immunity. Rapid and accurate diagnosis is important for disease control, utilizing techniques including virus isolation, hemagglutination inhibition assays, ELISA, and RT-PCR to differentiate and control outbreak management. Emerging advancements in recombinant NDV vaccines and viral vector technologies offer promising platforms for the improvement of vaccine efficacy and expanding applications in both veterinary and human health.

Keywords: Newcastle Disease Virus, Pathogenicity, strains, Zoonotic Transmission, Oncolytic Virotherapy, Poultry Vaccination

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Introduction

In 1926, on Java Island, Indonesia, and Newcastle-upon-Tyne (England city), the first outbreak of Newcastle disease (ND) was observed. It is a highly infectious and can cause disturbance in the economy, which is listed in category A by the Office International des Epizooties (OIE) [1]. Paramyxovirus 1 (APMV-1) is another name for it, and may give rise to acute, virulent, and highly contagious epidemic diseases of fowl, marked by destruction of the digestive tract and central nervous system [2]. It can bind with sialic acid-containing compounds such as N-glycoproteins by surface glycoproteins, and gangliosides [3]. The P protein allows the dissolvability of the NP by engaging in viral RNA synthesis, and the M protein is the core structure of the virus and is very important for the release of virus particles. The genome of NDV contains a single-stranded, anti-sense RNA with six structural (NP, P, M, F, HN, L) and two non-structural (V and W) proteins [4]. The splitting position of the F protein primarily determines the pathogenicity of NDV [3]. Any contact with infectious material and/or affected birds can pose a threat of zoonosis and highlight the public health concerns. As a mutant RNA virus, NDV has the potential to cross the interspecies barrier by mutating itself [5, 6]. The main and major reservoirs and vectors of a wide range of pathogens include zoonotic pathogens, which can be transmitted from wildlife to humans [7]. The most reported incidence of ND in humans so far is through accidental inoculation of high-tier NDV-adulterated egg fluid or touching NDV-adulterated fingers into the eyes after careless handling of infectious chicken samples [5].

Strains

NDV attributes a high evolutionary rate, just as any other RNA virus. Two classes, class I and class II, with twenty genotypes. As I to XXI, except XV, which contains genetically engineered viruses [8, 9]. Newcastle disease virus (NDV) can cause infection in more than 200 species of birds, especially poultry [8]. Its genotype VII (NDV-GVII) is a tremendously contagious pathogen, causing extreme financial repercussions for the poultry industry [9]. Velogenic, Mesogenic, and Lentogenic strains are the three important pathotypes of NDV, clinically [10]. Its class II genotype VI strains are the cause of clinical disease in the Columbidae family (includes pigeons and doves) [8]. Nowadays, study focuses on finding out the cytotoxicity of genetically engineered NDV strain R2B, which expresses GFP protein in two rodent cancer cell lines, rodent melanoma B16-F10, and rodent mammary adenocarcinoma 4T1 [11].

Pathogenicity

The virus virulence, virus tropism, immune system, age, and susceptibility of the host are the factors for the severity of infection [12]. Certain pathological differences were observed in the lungs, thymus, spleen, and bursa, along with obvious neuronal lesions in the brains of affected poultry, including hyperplasia of glial cells and degeneration of neurons [5]. The velogenic strains mainly affect serious neurological and respiratory indications with greater deaths, while the mesogenic strains with low mortality rates. Lentogenic strains cause subclinical diseases with mild respiratory and enteric diseases and are considered low-virulence strains [13]. Among the NDV proteins, the polymerase-associated proteins (N, P, and L) are found inside virions, as envelope-associated (M, F, AND HN) surround the inner and outer surface of the viral envelope [3]. The structure of the NDV is shown in Fig. 1.

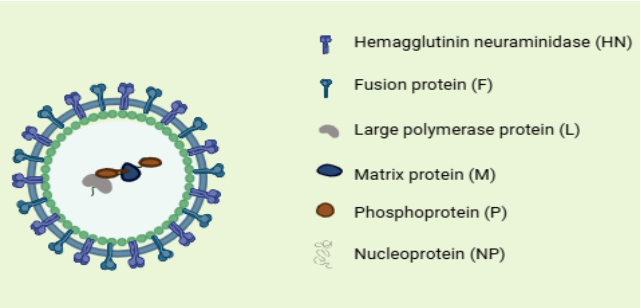

Fig. 1: It shows the structure of Newcastle Disease Virus

Safety and Clinical Use

The selective killing of the malignant cells without altering the normal cells and leaving them intact is the ideal cancer therapeutic policy [14]. NDV serves as a promising oncolytic virus; it is best known for its productive infection of tumor cells and initiation of intensive apoptotic response [15]. It performs a direct oncolytic role and can promote the activation of the immune system and employ the antitumor activity [16]. In the present day, scientists are keen on NDV because it can reproduce 10000 times more in human cancer cells than in most normal human cells and cause oncolytic effects [14]. It is also a captivating vaccine vector contender for both human and animal use, especially the lentogenic strains of NDV [16].

Diagnosis and treatment

NDV exhibits a broad spectrum of virulence that ranges from fatal to subclinical disease [17]. The conventional steps of virus identification include isolation, neutralization, and hemagglutination inhibition assays of the virus [18]. Nowadays, progress in DNA analysis, for example RT-PCR, has improved the detection and demarcation of NDV strains, improving pandemic governance [19]. ELISA is another robust and influential test used in NDV serology [17]. Streptomyces having streptothricin and Hygromycin B active compounds inhibits viral replication and interferes with viral transcription in the chicken and layer host is an antiviral compound produced by an actinomycete for NDV [12, 20].

Conclusion

NDV is a highly infectious virus that primarily affects birds, and rarely humans, but has zoonotic characteristics. The virulence of Newcastle disease virus (NDV) varies significantly, ranging from low-pathogenic (lentogenic) to highly pathogenic (velogenic) forms. Inactivated vaccines offer higher safety compared to live attenuated vaccines. NDV shows

promise as an oncolytic virus in cancer therapy due to its selective replication in tumor cells and ability to stimulate an immune response. Clinical trials have demonstrated its safety and potential efficacy. Advances in genetic engineering and molecular genetics have enabled the development of recombinant NDV vaccines that express heterologous antigens which enhancing their utility in both human and veterinary medicine. However, further research is needed to effectively deliver and minimize off-target effects.

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