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Newcastle Disease Virus Infection in Domestic Pigeons: Epidemiology, Pathogenesis, Diagnosis, and Vaccination Strategies with Emphasis on Chitosan Nanoparticles

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ABSTRACT

Newcastle disease virus (NDV), also known as avian paramyxovirus-1 (APMV-1), is a highly contagious pathogen that affects most avian species, including domestic pigeons (*Columba livia*), leading to Newcastle disease (ND). The ND in pigeons is attributed to pigeon-specific strains of NDV, predominantly characterized by the emergence of pigeon paramyxovirus-1 (PPMV-1). This viral strain is specifically adapted to affect avian species, particularly within the pigeon population, resulting in distinct pathological features associated with the disease. The ND was correlated with severe respiratory, neurological, and gastrointestinal manifestations, resulting in elevated morbidity and mortality rates, which may reach up to 80%. The present study provided an updated overview of the pathogenesis, clinical and pathological features, and diagnostic approaches related to NDV infection in domestic pigeons worldwide. Conventional and modern vaccination strategies were discussed in the present study, with a focus on mucosal immunization. Chitosan-based nanoparticles (CS-NPs) have emerged as a promising vaccine delivery platform due to their compatibility with biological systems, strong adhesion to mucosal surfaces, and ability to enhance antigen stability and stimulate the immune response. The CS-NPs improved antigen uptake at mucosal surfaces in poultry and stimulated both humoral and cellular immune responses, which included activating cytotoxic T cells, producing cytokines, and secreting immunoglobulins at mucosal sites. The present review may contribute to the advancement of more effective and targeted vaccine strategies against NDV in pigeons and other avian species.

Keywords: Chitosan, Live vaccine, Nanoparticle, Newcastle disease, Paramyxovirus, Pigeon

INTRODUCTION

Newcastle disease virus (NDV) is the causative agent of Newcastle disease (ND), a highly contagious infection affecting poultry. The economic impact of ND is significant, posing considerable challenges to the poultry industry worldwide (Mao et al., 2022). The ND was first reported in 1926 on Java Island, Indonesia, and in Newcastle-upon-Tyne, England; the disease later spread worldwide, causing substantial economic losses to the poultry industry (Mao et al., 2022; Dharmayanti et al., 2023). The ND is endemic in parts of Asia (Ansori and Kharisma, 2020), Africa (Ansori and Kharisma, 2020), the Middle East (Dzoghema et al., 2021), Central and South America, and Indonesia (Dharmayanti et al., 2023).

The NDV, recognized as avian paramyxovirus-1 (APMV-1), belongs to the family Paramyxoviridae, subfamily Avulavirinae, genus Orthoavulavirus, and species avian paramyxovirus 1 (Zerbini et al., 2024). The NDV possesses an envelope and carries a single-stranded, negative-sense RNA genome (Biswas et al., 2024). The RNA genome encodes six structural proteins, including nucleoproteins (NP), phosphoproteins (P), matrix protein (M), fusion protein (F), hemagglutinin-neuraminidase (HN), and large polymerase protein (L) (Moustapha et al., 2023). The complete nucleotide sequence of the *F* gene indicates that the virus is categorized into class I, which contains a single genotype, and class II, which comprises 20 genotypes (I-XXI) (da Silva et al., 2020). The classification of NDV pathogenicity encompasses