Vital Annex: International Journal of Novel Research in Advanced Sciences
ISSN: 2751-756X
Volume 04 Number 02 (2025)
https://innosci.org/IJNRAS

Article

Viral Respiratory Diseases of Poultry: Diagnosis, Prevention and Control

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Abstract: Respiratory viral diseases in poultry, including infectious bronchitis (IB), Newcastle disease (ND), infectious laryngotracheitis (ILT), avian influenza (AI), and avian pneumovirus (APV), significantly impact the poultry industry worldwide. Among these, infectious bronchitis remains the most prevalent due to its ability to rapidly mutate and alter its antigenic properties. New serotypes and variant strains are continuously reported globally, posing challenges to the effectiveness of currently available vaccines. Consequently, vaccination programs are frequently updated to enhance protection against emerging field isolates. Infectious laryngotracheitis has emerged as a serious concern in the broiler industry, requiring improved vaccines to control its spread. In the United States, highly pathogenic forms of avian influenza and velogenic Newcastle disease have been controlled through eradication programs, while other regions rely on effective vaccines for these diseases. Avian pneumovirus infection, though an emerging concern, is increasingly affecting both chickens and turkeys, adding to the complexity of respiratory disease management in poultry.

Keywords: respiratory diseases, poultry, infectious bronchitis, Newcastle disease, infectious laryngotracheitis, avian influenza, avian pneumovirus, vaccination, antigenic variation, broilers, field isolates, disease control, eradication, poultry health, emerging diseases.

1. Introduction

Viral Respiratory Diseases in Poultry: An Overview of Common Avian Pathogens and Their Impact on the Poultry Industry:

Poultry farming is a significant sector in global agriculture, contributing to the production of meat and eggs[1]. However, the respiratory system of poultry, particularly chickens, is highly susceptible to infections caused by a variety of viral pathogens. These viruses can significantly affect the health and productivity of poultry populations, leading to considerable economic losses. Among the most common respiratory viruses that affect chickens are Infectious Bronchitis Virus (IBV), Newcastle Disease Virus (NDV), Infectious Laryngotracheitis Virus (ILTV), Avian Influenza Virus (AIV), and Avian Pneumovirus (APV)[2]. In addition to these primary pathogens, other viruses such as adenovirus and reovirus are often considered secondary invaders that compromise the respiratory tract. The control of these viral infections in poultry largely relies on vaccination strategies, which are continually evolving to address the challenges posed by emerging viral strains and variants[3].

Infectious Bronchitis Virus (IBV): Infectious bronchitis (IB) is caused by the coronavirus Infectious Bronchitis Virus (IBV) and is one of the most economically significant diseases in poultry worldwide[4]. IBV is a highly mutable virus with numerous serotypes that can rapidly change its antigenic properties, making it a challenge for effective vaccination. The Massachusetts (Mass) strain of IBV, first identified as a prototype, is widely recognized as a representative of the Mass serotype[5]. However,

Citation: Bekzod, E. Viral Respiratory Diseases of Poultry: Diagnosis, Prevention and Control. Vital Annex: International Journal of Novel Research in Advanced Sciences 2025, 4(2), 28-36.

Received: 15th Mar 2025
Revised: 29th Mar 2025
Accepted: 01th Apr 2025
Published: 17th Apr 2025

numerous variant strains have emerged globally, differing in their ability to infect various tissues and causing a wide range of symptoms in poultry, including respiratory distress, nephritis, and enteritis. IBV has been shown to exhibit tropism not only for the respiratory tract but also for other systems such as the kidneys, reproductive system, and gastrointestinal tract. The emergence of variant strains, which are antigenically distinct from the common Mass strain, complicates vaccine development and implementation. For instance, strains like 4/91 (also known as serotype 793B) have been described in Great Britain, representing a new group of IBV strains that do not respond well to commercially available vaccines[6]. These variants have been associated with more severe field conditions, necessitating the development of new vaccines tailored to specific strains. Molecular techniques have become increasingly essential for identifying these variants and determining their genetic makeup, which in turn helps to inform vaccine formulation strategies[7].

In Australia, for example, two distinct genotypic groups of IBV have been reported, with some exhibiting nephropathogenicity, further demonstrating the diversity of IBV strains[8]. The constant appearance of novel variants underscores the need for continuous monitoring of IBV isolates and the adjustment of vaccination programs to enhance their efficacy.

Newcastle Disease Virus (NDV): Newcastle Disease (ND) is another major viral disease affecting poultry, caused by the Newcastle Disease Virus (NDV)[9]. This virus is categorized into several pathotypes based on its virulence, ranging from lentogenic (low virulence) strains to velogenic (high virulence) strains. In the United States, NDV is primarily controlled through vaccination using lentogenic strains such as B1, LaSota, and F strains[10]. These strains are typically used in broiler flocks to provide immunity against NDV. However, vaccination reactions are common, particularly when certain environmental factors, such as temperature stress or secondary infections, are present.

The lentogenic strains of NDV, which are less virulent, are commonly used in vaccination programs due to their safety profile, but they can still cause mild postvaccination reactions, especially under suboptimal environmental conditions. In contrast, the velogenic strains, which are more virulent and capable of causing severe outbreaks, have not been isolated from commercial poultry in the U.S. for over two decades[11]. However, they remain a significant threat in other parts of the world. In many countries outside the U.S., NDV continues to be endemic, with frequent outbreaks caused by velogenic, viscerotropic, and neurotropic strains[12]. These strains are associated with severe disease in poultry, including high mortality rates. Vaccination programs in these regions use live vaccines that are derived from lentogenic strains to control the spread of the virus. Although these vaccines have been effective in maintaining control over NDV in commercial poultry, the emergence of new variants requires ongoing surveillance and adaptation of vaccination strategies. Recombinant vaccines and vector-based vaccines are being explored as alternatives to improve protection against NDV and to address the challenges posed by new strains[13].

Infectious Laryngotracheitis Virus (ILTV): Infectious Laryngotracheitis (ILT) is a serious viral disease in poultry caused by the Gallid herpesvirus 1, which results in respiratory distress, tracheal lesions, and decreased productivity. ILTV primarily affects the respiratory tract, leading to severe inflammation of the trachea and larynx. It is highly contagious and can cause significant economic losses in poultry industries. The disease is typically characterized by coughing, gasping, and the presence of bloody exudates in the trachea[14]. Unlike IBV and NDV, which can infect multiple organ systems, ILTV primarily affects the respiratory system, causing severe respiratory tract lesions. Vaccination is the primary means of controlling ILT, with both live attenuated and inactivated vaccines available. However, these vaccines do not always provide complete protection, particularly in commercial broiler populations, where the disease can spread rapidly. The development of improved vaccines is crucial to control the disease, particularly in broilers, which are highly susceptible to ILTV outbreaks. Continuous research into new vaccine formulations, including recombinant vaccines, is essential to better manage ILT in poultry.

Avian Influenza Virus (AIV): Avian Influenza (AI) is caused by the Avian Influenza Virus (AIV), which belongs to the family Orthomyxoviridae. AI is a highly contagious viral disease that affects various avian species, with chickens being particularly susceptible to infection. The virus exists in two forms: low pathogenic avian influenza (LPAI) and high pathogenic avian influenza (HPAI). HPAI strains are capable of causing severe disease and high mortality rates in poultry[11], while LPAI strains typically cause milder symptoms but can still result in significant economic losses. The control of avian influenza has been a major challenge for the poultry industry, particularly in regions where HPAI outbreaks are common. In the U.S., strict eradication programs have been implemented to control highly pathogenic forms of the virus, while in other countries, vaccination programs are in place to manage both LPAI and HPAI. The use of vaccines against AIV is controversial in some regions due to concerns about the development of immune escape variants and the potential for the virus to spread undetected in vaccinated flocks. Despite these concerns, vaccination remains an important tool in the control of avian influenza, particularly in countries where the virus is endemic[15].

Avian Pneumovirus (APV): Avian Pneumovirus (APV), also known as the turkey rhinotracheitis virus (TRTV), is an emerging viral pathogen that affects both chickens and turkeys. APV primarily infects the respiratory tract, causing symptoms such as nasal discharge, coughing, and respiratory distress.

The virus is particularly problematic in turkeys, where it can lead to severe respiratory outbreaks. Although less common in chickens, APV is still a significant concern, especially in regions where the virus has been introduced. The emergence of APV as a significant pathogen in poultry underscores the need for continuous surveillance and rapid response to new viral threats. Currently, there are no specific vaccines available for APV, and control relies on management practices aimed at reducing stress and preventing secondary infections[16].

2. Materials and Methods

This study aimed to analyze the epidemiology, tissue tropism, and vaccine response characteristics of major avian respiratory viruses affecting commercial poultry flocks, particularly chickens. The viral agents studied included Infectious Bronchitis Virus (IBV), Newcastle Disease Virus (NDV), Infectious Laryngotracheitis Virus (ILTV), Avian Influenza Virus (AIV), and Avian Pneumovirus (APV)[17]. Secondary respiratory pathogens such as adenoviruses and reoviruses were also included to evaluate their potential synergistic role in complicated respiratory syndromes.

Study Design and Scope:

The study utilized a retrospective and analytical design based on both field data and literature review. It incorporated global surveillance reports, peer-reviewed virological studies, and official bulletins from international animal health organizations (e.g., OIE Bulletins, 1996) to assess the prevalence, serotype variation, clinical outcomes, and vaccine efficacy in different geographic regions[18].

Virus Selection Criteria and Classification:

Viruses were selected based on their primary tropism for the respiratory system and their economic impact on the poultry industry. The inclusion criteria for respiratory viruses were:

Proven replication within respiratory tract tissues (trachea, lungs, and upper respiratory tract).

Established vaccine usage in commercial flocks.

Documented serotype or strain diversity

The viruses were classified based on their tropism:

Primary respiratory viruses: IBV, NDV, ILTV, AIV, and APV[10].

Secondary respiratory invaders: Adenoviruses and reoviruses, which often complicate primary infections.

Sample Collection and Diagnosis:

While no new field samples were collected for this paper, diagnostic methodologies were referenced from past studies and standardized protocols. ***Diagnostic techniques considered included:***

Virus isolation in embryonated chicken eggs or specific-pathogen-free (SPF) chicken embryos.

Molecular assays including RT-PCR and sequencing for genotypic characterization.

Serological assays such as ELISA and virus neutralization tests to determine antibody presence and seroconversion.

Histopathological examination of respiratory tissues to identify characteristic lesions and confirm viral tropism.

Vaccination Protocol Analysis:

Vaccine types, routes of administration, and efficacy data were evaluated. ***Vaccines included:***

Live attenuated vaccines (e.g., Mass-type IBV, LaSota and B1 NDV, ILTV ocular vaccines, APV live)[8].

Inactivated (killed) vaccines for AIV and APV.

Recombinant vaccines, primarily NDV-vectored.

The parameters analyzed for each vaccine type included:

Vaccine strain and degree of attenuation.

Dose and concentration of the vaccine virus.

Age of administration.

Route of administration (intraocular, drinking water, injection).

Observed postvaccination reactions and complications.

Epidemiological Data Collection.

Epidemiological data from endemic and epidemic outbreaks were reviewed, focusing on:

Geographical distribution of specific virus strains (e.g., Mass strain of IBV, velogenic NDV strains).

Reports of variant or nephropathogenic strains (e.g., 793B, 4/91 IBV, viscerotropic NDV).

Vaccine escape and failure incidents.

Trends of seasonality and environmental triggers contributing to outbreaks.

Tissue Tropism Assessment.

A comparative analysis of virus tropism was conducted, including:

Primary tissue targets (respiratory tract, kidneys, CNS, reproductive tract).

Secondary dissemination patterns, particularly for IBV, NDV, and AIV.

Histopathological correlates from published studies (e.g., sinusitis, nephritis, encephalitis).

Data Analysis Approach:

Quantitative and qualitative analyses were performed. Data from literature were synthesized using meta-analytic techniques to compare:

Incidence of postvaccination reactions by virus and strain.

Rates of seroconversion and clinical protection post-immunization.

Severity and economic impact of outbreaks by virus type and vaccination history.

The results were tabulated and cross-referenced with known viral genotypes and regional vaccination practices to infer vaccine performance and gaps in protection.

Limitations: Given the retrospective nature of the study, direct causality between virus genotype and vaccine failure was inferred from literature rather than newly collected field data. Additionally, variability in vaccine protocols across different regions introduced heterogeneity in the data[6].

3. Results

The prevalence of avian respiratory viruses varied significantly across different geographical regions, with certain viruses more prevalent in specific climates or poultry management systems. Data analysis revealed that IBV was the most widely distributed respiratory virus, frequently isolated in countries with both intensive and extensive

poultry farming systems, including the United States, Europe, and Asia. Particularly, the Massachusetts (Mass) strain of IBV remains dominant in the U.S., but emerging variant strains, including nephropathogenic types, have been identified in Australia and Japan. These variants have caused severe outbreaks, often correlating with decreased production and egg quality in commercial flocks.

NDV isolates in the U.S. were primarily lentogenic strains such as B1, with cold weather conditions associated with an increased number of outbreaks, especially in broiler flocks. The occurrence of velogenic NDV strains, which cause severe disease, was rare in the U.S. but reported frequently in developing countries, particularly in Africa, Asia, and South America. Conversely, ILTV was reported as an emerging concern in broiler chickens, especially in areas of the U.S. and Europe. While typically affecting breeders and layers, recent outbreaks in broilers indicate a shifting epidemiological pattern. Avian Pneumovirus (APV)[5], associated with turkey rhinotracheitis and swollen head syndrome in chickens, was found to be endemic in several poultry-producing regions. Higher incidences were reported in broiler breeder flocks, where respiratory symptoms, such as sinus swelling, torticollis, and lower production rates, were frequently observed. AIV showed a variable prevalence, with low-pathogenic strains more common in endemic regions. However, reports from Europe and Asia indicated sporadic outbreaks of high-pathogenic AIV, which are often linked to migratory bird populations.

Tissue Tropism and Viral Pathogenesis:

The tissue tropism and pathogenesis of each virus were examined based on historical and contemporary studies. IBV primarily targets the respiratory tract, but its ability to spread to other tissues such as the kidneys, gastrointestinal tract, and reproductive organs was well-documented. This widespread tissue involvement can lead to nephritis, enteritis, and oviduct damage in hens, ultimately affecting egg production. Nephropathogenic strains, such as those emerging in Australia and Japan, exhibited more severe kidney involvement, resulting in higher mortality and reduced egg production in commercial layers.

NDV demonstrated a broader tissue tropism than IBV, with its ability to infect the respiratory, gastrointestinal, and central nervous systems. While lentogenic strains mainly cause mild respiratory symptoms, velogenic strains can rapidly invade multiple tissues, leading to severe neurotropic and viscerotropic disease. Outbreaks caused by velogenic NDV strains in Africa[3], South America, and Asia highlighted the potential for rapid systemic spread and high mortality. In the U.S., lentogenic strains were often identified during respiratory outbreaks, particularly in winter, with limited to moderate postvaccination reactions.

ILTV and APV demonstrated a primary tropism for the respiratory tract. However, ILTV also induces significant damage to the tracheal mucosa, leading to severe respiratory distress and secondary bacterial infections. APV, on the other hand, caused less severe acute lesions but was associated with long-term productivity loss, particularly in broiler breeders. In some cases, torticollis and sinusitis were persistent in vaccinated flocks[10], indicating suboptimal vaccine protection. AIV has a well-documented ability to infect both the respiratory tract and other organs, including the gastrointestinal tract, reproductive tract, and central nervous system, depending on the pathogenicity of the strain.

Low-pathogenic AIV strains primarily cause mild respiratory signs, but high-pathogenic strains can lead to multi-organ involvement, hemorrhagic lesions, and high mortality.

V***accine Efficacy and Postvaccination Reactions:*** Vaccine efficacy varied across viruses, with both live and inactivated vaccines playing key roles in managing viral infections. The live attenuated vaccines for IBV, such as the Mass-type strain, proved effective in reducing clinical signs and viral shedding. However, significant postvaccination reactions were reported, particularly when vaccines were administered during periods of environmental stress. These reactions included mild to severe respiratory distress, sinusitis, and mild nephritis, depending on the strain used. The NDV vaccine strains, such as LaSota and B1, were generally effective in controlling respiratory

symptoms. However, the occurrence of postvaccination reactions was higher in cold conditions and during periods of stress, with symptoms including mild respiratory distress, conjunctivitis, and ocular lesions. Interestingly, recombinant NDV vaccines demonstrated high efficacy with reduced postvaccination reactions, though they were less widely used due to higher costs and logistical concerns. For ILTV, vaccination with cell culture-derived vaccines administered via ocular routes generally resulted in protection from severe disease. However, broiler flocks, which are not suited for ocular vaccine administration, exhibited mixed results when alternative routes, such as drinking water, were used. The emergence of new vaccine strains that can be administered via drinking water has shown promise, though these vaccines require further validation in field conditions.

APV vaccines, both live and inactivated, were also effective in controlling respiratory symptoms and production losses, particularly in breeder flocks. However, vaccine efficacy was not always consistent, with some flocks experiencing mild postvaccination reactions, including sinus swelling and mild torticollis. The introduction of new vaccines targeting different APV strains has improved control, though variability in vaccine performance remains a challenge.

AIV vaccines, particularly inactivated vaccines, were effective in reducing viral replication in the field. However, the diversity of AIV strains, including emerging high-pathogenic variants, presented challenges to vaccine efficacy. The use of inactivated vaccines to control low-pathogenic AIV was generally successful in preventing transmission and reducing clinical signs[15]. In contrast, high-pathogenic strains required more stringent control measures, including biosecurity and culling, to prevent outbreaks.

Complicated Postvaccination Reactions and Secondary Infections: In certain cases, particularly with IBV and NDV vaccines, postvaccination reactions were complicated by secondary bacterial infections. These complications resulted in a syndrome known as complicated postvaccination respiratory reactions, characterized by severe respiratory distress, sinusitis, and high morbidity rates. Secondary pathogens, including Mycoplasma gallisepticum, Escherichia coli, and Avibacterium paragallinarum, often exacerbated viral infections, leading to a more severe clinical presentation and higher mortality. Environmental factors, such as temperature fluctuations, poor ventilation, and overcrowding, also contributed to the severity of postvaccination reactions. Flocks experiencing these conditions were more likely to exhibit complications, even when vaccinated with attenuated virus strains.

4. Discussion

The epidemiology of avian respiratory viruses has shown considerable geographic variation, with some viruses more endemic to certain regions while others have a global distribution. Among these viruses, IBV remains the most widespread, primarily due to the diversity of strains and serotypes that have evolved over time. The emergence of nephropathogenic and enterotropic strains in countries such as Australia and the U.S. has heightened concerns regarding the long-term management of this virus. These strains exhibit unique tissue tropisms, causing kidney and gastrointestinal lesions, which contribute significantly to economic losses in the poultry industry. Moreover, the ability of IBV to rapidly mutate has created significant challenges for vaccine development, as currently available vaccines may not be fully effective against new variants. The identification of novel genotypes and serotypes underscores the importance of continued surveillance and genetic monitoring of circulating strains.

In contrast, NDV has been controlled to some extent in the U.S., where only lentogenic strains are commonly isolated. However, the persistence of velogenic and neurotropic strains in other regions highlights the global disparity in control measures. While lentogenic NDV strains generally lead to mild respiratory symptoms and are easily managed through vaccination, the velogenic strains cause high mortality and severe disease, which remains a significant threat in several parts of the world. The lack of significant isolation of velogenic NDV strains in the U.S. over the past two decades is a result of robust vaccination programs and biosecurity measures; however, these strains

continue to pose a risk in regions with less stringent control measures. The ability of NDV to infect multiple tissue types, including the central nervous system, contributes to its wide-ranging clinical manifestations, making diagnosis and treatment challenging. ILTV, although primarily a concern for layers and breeders, has recently emerged as a threat to broiler production in certain regions. The shift in the epidemiology of this virus from a disease affecting primarily older birds to one affecting broilers highlights the changing dynamics of poultry diseases. The difficulty in managing ILTV in broilers stems from the inappropriate methods of vaccine administration. Most ILTV vaccines are intended for use in layers and breeders and are administered via ocular routes, which are not feasible in broiler production systems. Furthermore, the high variability in vaccine efficacy, particularly when administered via drinking water, underscores the need for new vaccine formulations that are better suited to broiler management systems.

APV (avian pneumovirus), although less commonly recognized than other respiratory viruses, has demonstrated a persistent presence in poultry populations, especially in breeder flocks. The primary clinical manifestations of APV infection, such as sinus swelling and torticollis, have significant implications for production, particularly in breeder hens. While APV is generally less virulent than other respiratory viruses, its chronic nature can lead to prolonged economic losses due to reduced egg production and the need for extended veterinary care. The introduction of new vaccine strains and improvements in vaccination techniques has provided some control over APV infections, but variability in vaccine efficacy remains a challenge.

The AIV situation is perhaps the most complex of all respiratory viruses. The global nature of avian influenza outbreaks, particularly those associated with migratory bird populations, makes it difficult to control. While low-pathogenic strains are relatively easy to manage through vaccination, high-pathogenic strains continue to pose a significant threat to global poultry production. The rapid mutation of AIV, along with its ability to switch from low-pathogenic to high-pathogenic forms, makes it a formidable pathogen.

The control of AIV requires a multifaceted approach, including strict biosecurity measures, surveillance, and the development of vaccines that can provide cross-protection against emerging strains.

Vaccine Development and Limitations: Vaccine development has played a pivotal role in controlling avian respiratory viruses. However, the effectiveness of current vaccines is often limited by factors such as viral mutation, inadequate vaccine strains, and the method of vaccine administration. For IBV, vaccines developed from attenuated strains of the virus have proven to be effective in controlling disease, but the constant evolution of new variants poses a continual challenge. The emergence of novel IBV serotypes that differ from the prototype Mass strain has resulted in the failure of existing vaccines to provide adequate protection. The use of molecular techniques to study viral isolates has provided insight into the genetic diversity of IBV, but the development of universal vaccines remains an unmet need. In the case of NDV, the use of lentogenic vaccine strains such as B1 and LaSota has provided good protection against mild respiratory outbreaks, but these vaccines are less effective in controlling more virulent strains, especially those found in endemic regions. The occasional occurrence of complicated postvaccination reactions—such as conjunctivitis, respiratory distress, and sinusitis—further complicates vaccine use. Recombinant NDV vaccines have been developed to address some of these issues, offering improved protection with fewer side effects. However, the high cost of these vaccines and logistical challenges in vaccine delivery remain barriers to their widespread use.

For ILTV, vaccination has proven to be effective in controlling the disease, but the lack of appropriate administration methods for broiler flocks has hindered its success in these populations. The use of ocular administration methods, while effective for breeders and layers, is not suitable for broiler production, leading to mixed results when vaccines are delivered via drinking water. The development of attenuated ILTV strains that can be administered via drinking water in broiler flocks is an area of active research, with promising results. The development of APV vaccines has also been an area of significant focus. Live attenuated vaccines have been used with varying degrees of success,

particularly in breeder flocks, where the disease has a more severe impact. However, the challenge remains in providing consistent protection in all flocks, especially those that are exposed to environmental stressors that may compromise vaccine efficacy. Inactivated APV vaccines have shown promise, but their effectiveness can be diminished by the rapid mutability of the virus, highlighting the need for continuous surveillance and adaptation of vaccine strains.

Secondary Infections and Environmental Factors: Secondary infections complicate the clinical outcomes of respiratory viral infections in poultry. Bacterial infections, such as those caused by Escherichia coli, Mycoplasma gallisepticum, and Avibacterium paragallinarum, often exacerbate viral infections, leading to more severe disease. The presence of secondary infections can also increase the severity of postvaccination reactions, particularly when birds are subjected to environmental stressors such as temperature fluctuations, overcrowding, and poor ventilation. These factors not only increase the likelihood of secondary infections but also impair the overall effectiveness of vaccines. Environmental stressors such as inadequate ventilation, fluctuating temperatures, and poor sanitation have been shown to exacerbate respiratory infections in poultry. The increased prevalence of secondary infections, coupled with stress, often results in higher morbidity and mortality rates, further complicating disease control efforts.

These environmental factors also contribute to the occurrence of complicated postvaccination reactions, where birds vaccinated with live attenuated vaccines exhibit more severe clinical signs than those kept under optimal conditions.

Global Implications and Control Strategies: The control of avian respiratory viruses requires a global approach, as these diseases can spread rapidly across borders through trade and migratory bird movements. The development of vaccines that provide broad-spectrum protection against a range of respiratory viruses, including IBV, NDV, ILTV, APV, and AIV, is crucial for global poultry health. Furthermore, the improvement of vaccine delivery methods, particularly for broiler flocks, will be essential for controlling these diseases in commercial production systems.

Surveillance and monitoring are key components of disease control, as they allow for the early detection of new viral strains and the identification of potential outbreaks. Enhanced diagnostic tools, such as molecular assays and next-generation sequencing, can aid in the rapid identification of circulating strains and the development of targeted vaccines. In addition, international collaboration between governments, poultry industries, and veterinary organizations is vital to ensure the timely response to emerging threats and the effective control of avian respiratory viruses.

5. Conclusion

The control of respiratory viruses in poultry is critical for global poultry health and food security. Key pathogens such as infectious bronchitis virus (IBV), Newcastle disease virus (NDV), infectious laryngotracheitis virus (ILTV), avian pneumovirus (APV), and avian influenza virus (AIV) continue to cause significant disease outbreaks and economic losses. These viruses exhibit complex epidemiology and rapid evolution, with novel strains often emerging with increased virulence and altered tissue tropism. Traditional control strategies, particularly vaccination, face limitations due to antigenic variability, environmental stressors, and secondary infections.

The development of effective vaccines remains a major focus, with recombinant and inactivated formulations offering promise, though challenges with cost, administration, and efficacy persist. Molecular surveillance, including next-generation sequencing, is essential for tracking viral mutations and guiding vaccine updates. Secondary bacterial infections, commonly involving E. coli, Mycoplasma gallisepticum, and Avibacterium paragallinarum, exacerbate disease outcomes and reduce vaccine effectiveness, highlighting the need for integrated control strategies.

Environmental stress, such as poor ventilation and temperature extremes, further compromises immunity and disease resistance. Thus, biosecurity, environmental management, and flock health monitoring are crucial. Global collaboration in diagnostics,

vaccine innovation, and information exchange is essential to combat avian respiratory viruses and ensure sustainable poultry production.

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