

Clinical, Pathological and Serological Identification of Newcastle Disease in Chicken in Kintamani and Susut District of Bangli, Bali

(IDENTIFIKASI KLINIS, PATOLOGIS DAN SEROLOGIS
PENYAKIT TETELO PADA AYAM DI KECAMATAN
KINTAMANI DAN SUSUT, BANGLI, BALI)

**Inda Sabrina Latifah^{1*}, Gusti Ayu Yuniati Kencana²,
Ida Bagus Kade Suardana², Tjokorda Sari Nindhia³,
Romy Muhammad Dary Mufa⁴, I Made Kardena⁵**

¹Undergraduate Student of Veterinary Medicine,

² Laboratory of Veterinary Virology,

³Biostatistics Laboratory,

⁴Laboratory of Veterinary Public Health,

⁵Laboratory of Veterinary Pathology,

Faculty of Veterinary Medicine, Udayana University,
Jl. Sudirman, Sanglah, Denpasar, Bali, Indonesia, 80234
imadekardena@unud.ac.id; [*indasabrina.16@gmail.com](mailto:indasabrina.16@gmail.com)

ABSTRACT

Newcastle Disease (ND), caused by Avian Paramyxovirus serotype 1 (APMV-1), remains endemic in Indonesia and continues to threaten poultry production due to its high transmissibility and economic impact. This study aimed to identify ND through an integrated clinical, pathological, and serological approach in commercial and indigenous chickens from Susut and Kintamani Districts, Bangli Regency, Bali. A total of 32 clinically suspected chickens (16 per district) were examined by necropsy, virus isolation in embryonated chicken eggs, and confirmation using hemagglutination (HA) and hemagglutination inhibition (HI) tests. Fifteen samples (46.88%) were confirmed ND-positive, comprising 7 (43.75%) from Susut and 8 (50%) from Kintamani. Digestive disorders were the predominant clinical sign (86.66%), and characteristic lesions were most consistently observed in the lungs (100%), intestines, and cecal tonsils (93.33%). Chickens from Kintamani had a 1.29-fold higher risk of ND infection compared to Susut (OR 1.29; 95% CI: 0.3–5.4). The study demonstrates active ND circulation in Bangli Regency and reveals variability in clinical expression potentially influenced by management systems and biosecurity practices. By integrating field-based clinical assessment with pathological and HA/HI confirmation, this research strengthens practical diagnostic reliability in resource-limited settings and provides region-specific epidemiological evidence to support targeted

vaccination strategies, enhanced biosecurity implementation, and sustainable poultry health management in endemic areas.

Keywords: avian virus, HA/HI test, Newcastle Disease, poultry

ABSTRAK

Newcastle Disease (ND) yang disebabkan oleh Avian Paramyxovirus serotipe 1 (APMV-1) masih bersifat endemik di Indonesia dan terus mengancam produksi unggas karena tingkat penularan serta dampak ekonominya yang tinggi. Penelitian ini bertujuan mengidentifikasi ND melalui pendekatan terintegrasi secara klinis, patologis, dan serologis pada ayam ras dan buras di Kecamatan Susut dan Kintamani, Kabupaten Bangli, Bali. Sebanyak 32 ekor ayam dengan dugaan klinis ND (16 ekor per kecamatan) diperiksa melalui nekropsi, isolasi virus menggunakan telur ayam berembrio, serta konfirmasi dengan uji hemaglutinasi (HA) dan hemaglutinasi inhibisi (HI). Sebanyak 15 sampel (46,88%) terkonfirmasi positif ND, terdiri atas 7 ekor (43,75%) dari Susut dan 8 ekor (50%) dari Kintamani. Gangguan pencernaan merupakan tanda klinis dominan (86,66%), dengan lesi khas paling konsisten ditemukan pada paru-paru (100%), usus, dan tonsil sekum (93,33%). Ayam di Kintamani memiliki risiko 1,29 kali lebih tinggi terinfeksi ND dibandingkan Susut (OR 1,29; 95% CI: 0,3–5,4). Penelitian ini menunjukkan adanya sirkulasi aktif ND di Kabupaten Bangli serta variasi manifestasi klinis yang kemungkinan dipengaruhi oleh sistem pemeliharaan dan penerapan biosekuriti. Integrasi pemeriksaan klinis lapangan dengan konfirmasi patologis dan HA/HI memperkuat keandalan diagnosis di kondisi sumber daya terbatas serta menyediakan bukti epidemiologis spesifik wilayah untuk mendukung strategi vaksinasi yang lebih terarah, penguatan biosekuriti, dan pengelolaan kesehatan unggas yang berkelanjutan di daerah endemik.

Kata-kata kunci: virus unggas, uji HA/HI, penyakit Newcastle Disease, penyakit unggas

INTRODUCTION

Newcastle Disease (ND) is a highly contagious disease in poultry caused by virulent Avian Paramyxovirus type 1 (APMV-1) (Kencana *et al.*, 2017). The virus belongs to the genus *Avulavirus* within the family *Paramyxoviridae* (Hadi and Sulaxono, 2021). Based on pathogenicity, Newcastle Disease Virus (NDV) is classified into lentogenic, mesogenic and velogenic pathotypes, which are determined by clinical severity, intracerebral pathogenicity index (ICPI), intravenous pathogenicity index (IVPI), mean death time (MDT) in embryonated chicken eggs, and the amino acid motif at the fusion (F) protein cleavage site. Molecular

characterization of the F protein cleavage site has become an important method for determining viral pathotype and virulence level, particularly in identifying virulent field strains associated with severe outbreaks (Putri *et al.*, 2017). disease outbreaks pose a global threat, including in Indonesia, where the disease was first re-reported in 1926 (WOAH, 2021). In Bali, ND became endemic in 2007, with cases ranging from 1,500 to 8,000 chickens per month (Kurniangtyas *et al.*, 2017). In Indonesia, ND is commonly known as *penyakit tetelo*, while in Bali it is referred to as *gerubug* (Kencana *et al.*, 2019). Recent molecular studies reported that virulent NDV circulating in Bali belongs to genotype VIII, characterized by velogenic cleavage site

motifs and high homology among field isolates (Kencana *et al.*, 2025). The persistence of genotype VIIi indicates ongoing circulation of virulent strains in Bali, highlighting the importance of continuous surveillance at the regional level.

Bangli Regency comprises four districts, with Susut District having one of the largest broiler populations and playing a vital role in Bali's poultry sector (Sari *et al.*, 2024). Recurring ND outbreaks result in significant economic losses, particularly for small-scale farmers (Rell *et al.*, 2021). Although molecular characterization and genotyping of NDV have been reported in several regencies in Bali, including Tabanan and Gianyar (Kencana *et al.*, 2017; Kencana *et al.*, 2019), comprehensive data integrating clinical manifestations, pathological findings, and serological confirmation of ND cases in Bangli Regency remain limited. This represents a research gap, as field-level diagnosis combining clinical, pathological and serological approaches is essential to distinguish ND from other diseases with similar symptoms, such as avian influenza (AI) or infectious bronchitis (IB).

While molecular diagnostic methods such as Reverse Transcription Polymerase Chain Reaction (RT-PCR) and sequencing exhibit high sensitivity and specificity in detecting and pathotyping NDV, these techniques require relatively higher operational costs. In addition to molecular methods, other diagnostic approaches for detecting NDV include hemagglutination (HA) and hemagglutination inhibition (HI) tests, which are recommended as standard serological assays for NDV diagnosis due to their simple procedures, low cost and effectiveness in detecting hemagglutinating activity as well as specific antibodies (Mao *et al.*, 2022). Several studies have demonstrated that the HI test produces dependable results in confirming ND exposure under field conditions, making it particularly suitable for regional surveillance and routine diagnostic applications.

This important study was aimed to

analyze clinical signs and anatomical pathological changes in suspected ND cases in Susut and Kintamani Districts and to confirm ND infection using HA/HI tests. Identification was conducted through clinical, pathological, and serological approaches in Susut and Kintamani Districts, Bangli Regency. The findings of this study are expected to strengthen field-based diagnostic approaches and enhance regional disease surveillance strategies.

RESEARCH METHODS

Research Object

Chickens exhibiting clinical signs indicative of ND infection were collected from Susut and Kintamani Districts, Bangli Regency, Bali. The study population consisted of both commercial (layer/broiler-type) chickens and kampong or local indigenous chickens. Observed clinical signs included torticollis, respiratory distress, digestive disorders and anorexia. The kampong or local indigenous chickens were reared under a free-range or semi-scavenging system, without any history of ND vaccination or medical treatment. In contrast, the commercial chickens were raised under an intensive management system and had received routine ND vaccination. Necropsy was performed within a maximum of six hours post-mortem to prevent organ autolysis and tissue damage. Examined organs included the brain, lungs, proventriculus, cecal tonsils and intestines to identify gross pathological changes suspected of ND infection.

Research Materials

Suspected ND-infected organ tissues were homogenized and suspended in Phosphate Buffered Saline (PBS) to a concentration of 10-20%. The PBS used in this study had a neutral pH (approximately 7.2-7.4) to maintain viral stability and prevent protein degradation during the homogenization process. The suspension was centrifuged at 2,500 rpm for 10-15 minutes, and

the supernatant was collected. Penicillin (1,000–5,000 IU/mL) and streptomycin (1,000–5,000 µg/mL) were added to the supernatant, followed by incubation at 37°C for 30 minutes prior to inoculation into 8–12-day-old embryonated chicken eggs (ECE) (Mahardika *et al.*, 2016).

The selection of serological methods, namely the hemagglutination (HA) and hemagglutination inhibition (HI) tests, was based on WOAHA recommendations as standard assays for NDV detection and confirmation, as well as their simplicity, cost-effectiveness and suitability for field surveillance applications. In the HA and HI assays, an antigen control was included to verify haemagglutination activity and ensure assay validity. A known NDV antigen with established haemagglutinating activity was used to confirm proper test performance and the functionality of the assay system.

Isolation and Identification

According to WOAHA (2021), conventional isolation of NDV is performed through inoculation into specific pathogen free (SPF) or specific antibody negative (SAN) ECE. In this study, the allantoic cavity of 8-12-day-old ECE was used for virus inoculation. Prior to injection, the eggs were candled to determine air sac boundaries and embryo viability. After disinfection of the eggshell surface with 70% alcohol, 0.2 mL of clarified viral suspension supplemented with penicillin (1,000–5,000 IU/mL) and streptomycin (1,000–5,000 µg/mL) was inoculated into the allantoic cavity using a sterile needle and syringe, followed by sealing of the inoculation site. The inoculated eggs were incubated at 35–37°C and monitored daily for embryo mortality. Allantoic fluid from dead embryos or at the end of the incubation period was harvested and tested for haemagglutination (HA) activity, as recommended by WOAHA (2021).

The HA test was performed to detect the presence of NDV based on its ability to agglutinate red blood cells. Serial twofold dilutions of the harvested viral antigen were prepared in phosphate-buffered saline (PBS),

followed by the addition of a 1% red blood cell suspension. After incubation at room temperature for approximately one hour, visible agglutination indicated a positive HA reaction. The presence of HA activity in bacteriologically sterile allantoic fluid suggested infection with a haemagglutinating virus, including APMV-1.

Specific confirmation of NDV was subsequently performed using the haemagglutination inhibition (HI) test with NDV-specific antiserum. In this assay, f4 HA units (HAU) of NDV antigen were mixed with serially diluted serum samples and incubated for 30 minutes before the addition of 1% red blood cells. The absence of agglutination indicated a positive HI result, demonstrating the presence of ND-specific antibodies that inhibited haemagglutination (Mahardika *et al.*, 2016). While RT-PCR-based techniques are widely applied in modern diagnostic laboratories for NDV detection and typing, WOAHA (2021) also emphasizes that genetic variability among viral strains may result in potential false-negative findings in molecular assays if sufficient assay inclusivity is not ensured.

Data Analysis

Data analysis was based on clinical signs, anatomical pathological changes and serological test results (HA/HI). Clinical signs were evaluated based on Rozi *et al.* (2020), who reported that the disease can cause disorders of the respiratory, digestive and central nervous systems in infected chickens. While pathological changes such as petechiae in the proventriculus, hemorrhages in the ventriculus, intestines, cecal tonsils, and lungs, as well as congestion and edema in the brain, were analyzed based on findings by Angreini *et al.* (2023), Sari *et al.* (2024), and Purnasari *et al.* (2017). The HA test detected the presence of ND antigen, while the HI test identified ND-specific antibodies, as described by Mahardika *et al.* (2016).

The results were presented as percentages of positive and negative samples for each diagnostic method. The prevalence differences between chicken samples from

Susut and Kintamani Districts were analyzed using the Odds Ratio (OR) with a 95% confidence interval and a p-value of < 0.05 to determine the relationship between clinical signs, anatomical pathological changes and HA/HI test results with ND infection.

RESULTS AND DISCUSSIONS

Clinical signs observed in chickens suspected of ND infection in District of Susut and Kintamani included respiratory, digestive, and neurological disorders (Figure 1). As shown in Table 1, the most frequently observed signs were digestive disorders (90.63%), followed by neurological (56.25%) and respiratory disorders (40.63%). Additionally, Table 2 demonstrates that

Table 1. Total sample of Newcastle Disease-infected chicken from District of Kintamani and Susut, of Bangli Regency, Bali

Parameters	Positive (%)	Negative (%)
Clinical symptom		
Respiratory	40.63	59.37
Digestive	90.63	9.37
Neurological	56.25	43.75
Anatomical pathology		
Respiratory	100.00	0,00
Digestive	93.75	6.25
Neurological	87.50	12.50
Serological Test		
HA	81.25	18.75
HI	46.88	53.12

86.66% of ND-positive individuals exhibited digestive disturbances. This high occurrence may be associated with the virulence characteristics of ND virus strains circulating in the region. These findings are consistent with Susanti *et al.* (2021), who reported that ND

Table 2. Comparison of Clinical Symptoms and Anatomical Pathological Changes in ND Positive Samples from Kintamani and Susut of Bangli, Bali Based on HA/HI Test

Parameters	Positive (%)	Negative (%)
Respiratory	53.33	46.67
Digestive	86.66	13.34
Neurological	40.00	60.00
Anatomical pathology		
Respiratory	100.00	0.00
Digestive	93.33	6.67
Neurological	93.33	6.67

affects the digestive, respiratory, and nervous systems. Other clinical manifestations of ND are dyspnea, greenish-white diarrhea, tremors and torticollis due to central nervous system involvement. Velogenic strains generally cause high mortality, whereas mesogenic strains induce milder symptoms (Elfatah *et al.*, 2021). Thus, the variation in clinical presentation observed in this study suggests possible differences in infecting ND strains and host immune responses across locations.

Gross pathological examination revealed characteristic ND lesions, including petechiae in the proventriculus, brain congestion and hemorrhages in the cecal tonsils, intestines and lungs (Figure 2). Respiratory lesions were observed in 100% of cases, consistent with the pneumotropic velogenic nature of ND (Angreini *et al.*, 2023). Digestive lesions were present in 93.75% of samples, aligning with findings by Sari *et al.* (2024) and the viscerotropic velogenic characteristics described by Kabiraj (2020). Neurological lesions occurred in 87.5% of samples, similar to Rahmaniar *et al.* (2024) observations and Purnasari *et al.* (2017) regarding neurotropic ND strains. Among the 15 ND positive samples confirmed by HA/HI (Table 2), digestive and neurological lesions showed equal prevalence (93.33%),

Table 3. Total chicken samples by district fro Bangli regency, Bali

District	HA/HI Test (birds)		Percentage (%)		Total Sampels
	Positive	Negative	Positive	Negative	
Susut	7	9	43.75%	56.25%	16
Kintamani	8	8	50%	50%	16
Total	15	17			32

Note: Positive (+) = HA+HI+; Negative (-) = HA+, HI- / HA-, HI-

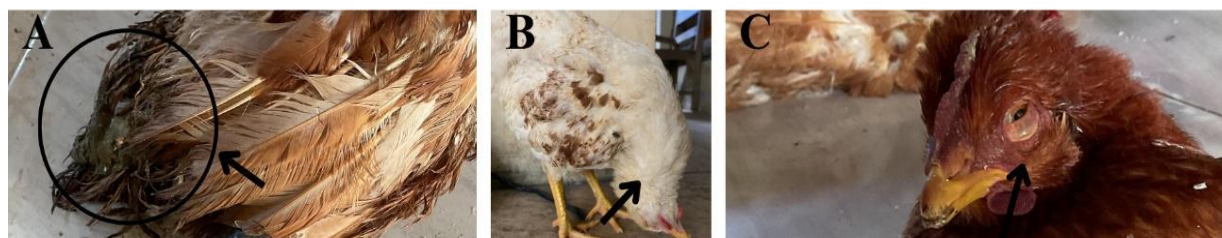


Figure 1. Condition of Chicken Samples Before Necropsy. A) digestive disorder, presence of dried feces; B) neurological disorder, torticollis; C) respiratory disorder, swelling in the infraorbital sinus.



Figure 2. Anatomical Pathology Examination Results. A) congestion in the brain; B) hemorrhage in the lungs; C) petechiae in the proventriculus; D) hemorrhage in the cecal tonsils; E) hemorrhage in the intestines.

reinforcing the systemic nature of ND infection.

The ND diagnosis was confirmed through Hemagglutination (HA) and Hemagglutination Inhibition (HI) tests. Of the 32 total samples, 26 (81.25%) were HA-positive, yet only 15 (46.88%) were confirmed ND-positive by HA/HI. According to Mahardika *et al.* (2016), HA detects viral antigen based on its ability to agglutinate red blood cells, while HI identifies ND specific antibodies. The HI test in this study was performed using a rapid qualitative method without antibody titer calculation. The discrepancy between HA and HI results may indicate that not all HA-positive samples contained sufficient ND specific antibodies for confirmation and HA positivity alone

cannot definitively confirm ND, as other hemagglutinating viruses such as Avian Influenza may produce similar reactions (Sari *et al.*, 2024).

Differences in findings between Susut and Kintamani districts indicate variations in clinical manifestations and lesion severity. Of the 16 samples collected from each district, eight chickens in Kintamani (50%) were confirmed ND-positive, whereas seven chickens in Susut (43.75%) tested positive by HA/HI. In Susut, three positive chickens exhibited respiratory and digestive disorders, two showed digestive and neurological disorders, and two presented only digestive disturbances. In contrast, in Kintamani, two positive chickens showed combined respiratory, digestive, and neurological

disorders; two had respiratory and digestive disorders; one had digestive and neurological disorders and three exhibited only a single type of disorder. These findings demonstrate that not all clinically suspected cases were serologically confirmed, and conversely, some seropositive birds did not present fully characteristic ND clinical signs. This pattern suggests the possibility of subclinical or early stage infections, particularly in Kintamani, where infection prevalence was slightly higher.

The variation in infection rates between districts may be influenced not only by environmental conditions, poultry density and differences in biosecurity implementation (Dharmayanti *et al.*, 2024), but also by diagnostic and epidemiological factors. Higher poultry density in District of Kintamani may have facilitated viral transmission through direct contact and potential involvement of wild birds as vectors (Henriques *et al.*, 2023). Variations in HA/HI results may additionally be affected by virus titer, coinfections or host immune status, as both tests may show reduced sensitivity when antigen levels are low (Ali *et al.*, 2022). Furthermore, similarity of clinical signs between ND and AI may lead to diagnostic bias if assessment is based solely on clinical observation (Ekaningtias *et al.*, 2017). Therefore, integration of clinical examination, pathological assessment and serological testing is essential to improve diagnostic accuracy. Biosecurity remains a critical determinant of ND transmission dynamics. Farms with inadequate biosecurity practices face significantly higher infection risks (Absalon *et al.*, 2019). Effective preventive measures including routine disinfection, hygiene maintenance, restricted farm access and traffic control are fundamental to disease prevention (Moustapha *et al.*, 2023; Indrawan *et al.*, 2020; Getabalew *et al.*, 2019). Poor personnel management and lack of sanitation procedures increase infection risk and poultry mortality (Haqiqi *et al.*, 2021). Strengthened biosecurity not only reduces disease spread but also lowers economic

losses and healthcare costs (Mappanganro *et al.*, 2018) and supports sustainable poultry production (Utami and Samudra, 2021). Without strict implementation of biosecurity principles, disease control efforts may fail (Sandriya *et al.*, 2023). Consequently, enhanced prevention strategies, including improved sanitation, movement control and monitoring of vaccination effectiveness, are essential for effective ND control in both Susut and Kintamani districts.

The difference in seropositivity rates between Susut and Kintamani district may therefore also be associated with vaccination status, management systems and biosecurity practices implemented in each area. The ND outbreaks commonly occur in flocks with low immunity due to the absence of vaccination or failure of vaccination programs (Susanti *et al.*, 2021). In traditional or semi-scavenging production systems, as reported in backyard chickens in Barru District of South Sulawesi Province free-range management increases direct contact between birds and makes environmental disinfection difficult, thereby accelerating viral transmission (Susanti *et al.*, 2021). Similar management conditions could contribute to sustained virus circulation in the present study areas. In addition, incomplete vaccination coverage, absence of booster administration and lack of vaccination records may impair the establishment of adequate herd immunity, potentially explaining the persistence of seropositive cases. Compared with reports from Aceh, where ND prevalence was identified in necropsied birds submitted to laboratory examination representing mostly clinically severe cases (Maulina *et al.*, 2024), the present findings demonstrate more varied clinical manifestations and suggest the possibility of subclinical or early-stage infections in field conditions. This comparison highlights that differences in sample origin, management systems and biosecurity implementation across regions in Indonesia may significantly influence ND epidemiology and observed seropositivity levels.

CONCLUSION

This study confirms the presence of ND cases in Susut and Kintamani Districts, Bangli Regency, with a high level of viral circulation in the areas. Clinical findings included brain congestion, petechiae in the proventriculus and hemorrhages in the lungs, intestines and cecal tonsils. The ND prevalence was 43.8% (95% CI: 19.8–70.1) in Susut and 50% (95% CI: 24.7–75.3) in Kintamani, indicating that chickens in Kintamani had a 1.29 times higher risk of ND infection compared to those in Susut (OR 1.29; 95% CI: 0.3–5.4). These findings highlight the multifactorial nature of ND epidemiology, involving interactions between viral virulence, host immunity, vaccination status, and biosecurity practices. Practically, the relatively high prevalence observed underscores the need to strengthen biosecurity implementation, including isolation, sanitation, and traffic control, alongside consistent vaccination programs and regular health monitoring. Improved and integrated prevention strategies are essential to reduce ND transmission and mortality, enhance poultry production sustainability, and ensure food safety standards.

SUGGESTION

Future research should include molecular characterization of NDv strains circulating in Susut and Kintamani Districts to confirm virulence levels and genetic variation. Additional investigations involving a larger sample size and different poultry types are recommended to improve diagnostic accuracy. Strengthening farm-level biosecurity evaluations and assessing the effectiveness of vaccination programs will also be essential for better ND prevention and control in the region.

ACKNOWLEDGEMENT

The authors would like to acknowledge the farmers in Susut and Kintamani Districts, Bangli Regency, for granting per-

mission to collect chicken samples from their farms. We also recognize the Biomedical and Molecular Biology Laboratory, Faculty of Veterinary Medicine, Udayana University, for providing us with research facilities.

REFERENCES

- Absalon AE, Cortes-Espinosa DV, Lucio E, Miller PJ, Afonso CL. 2019. Epidemiology, Control, and Prevention of Newcastle Disease in Endemic Regions: Latin America. *Tropical Animal Health and Production* 51: 1033-1048.
- Ali AA, Abdallah F, Sameh K, Fathy S, Kotb G. 2022. Molecular Characterization of the Newcastle Disease Virus Currently Circulating Among Broiler Chicken Flocks During 2021 in Sharkia Province, Egypt. *Journal of Advanced Veterinary Research* 12(6): 773-778.
- Angreini M, Balqis U, Etriwati, Hasan DI, Aisyah S, Salim MN, Nazaruddin, Darmawi. 2023. Newcastle Disease Case in Broiler Chicken. *Jurnal Medika Veterinaria* 17(2): 57-61.
- Dharmayanti NLPI, Nurjanah D, Nuradji H, Suyatno T, Indriani R. 2024. Newcastle Disease Virus: The Past and Current Situation in Indonesia. *Journal of Veterinary Science* 25(1): e3.
- Ekaningtias M, Wuryastuty H, Wasito. 2017. Diagnosis Approach Avian Influenza Virus and Newcastle Disease Virus at Layer Field Case: Streptavidin Biotin Immunopatologis. *Jurnal Sain Veteriner* 35(1): 118-126.
- Elfatah KSA, Elabasy MA, El-Khyate F, Elmahallawy EK, Mosad SM, El-Gohary FA, Abdo W, Al-Brakati A, Seadawy MG, Tahoon AE, El-Gohary AE. 2021. Molecular Characterization of Velogenic Newcastle Disease Virus (Sub-Genotype VII.1.1) from Wild Birds, with Assessment of Its Pathogenicity in Susceptible Chickens. *Animals* 11(2): 505.

- Getabalew M, Alemneh T, Akebereg D, Getahun D, Zewdie D. 2019. Epidemiology, Diagnosis and Prevention of Newcastle Disease in Poultry. *American Journal of Biomedical Science and Research* 3(1).
- Hadi S, Sulaxono RL. 2021. Newcastle Disease (ND) Surveillance in Poultry in West Papua. In: *Proceeding National Seminar on Agricultural Development and Vocational Education: Creating Millennial Entrepreneurial Farmers in Facing the Industrial Revolution 4.0 and Society 5.0 Era by Manokwari Agricultural Development Polytechnic*. Presented at the Seminar Nasional PPVP 2021. 2(1): 134-139. DOI: <https://doi.org/10.47687/snppvp.v2i1.178>. [9 March 2025].
- Haqiqi M, Hertamawati RT, Rahmasari R. 2021. Level of Biosecurity Implementation in Egg-Laying Chicken Farming Businesses in Jember Regency. In: *Synergy Between Government, Universities and DUDI in Sustainable Local Livestock Development* by Department of Animal Science, Jember State Polytechnic. Presented at the The 2nd Conference of Applied Animal Science (CAAS) 2021. DOI: [10.25047/animpro.2021.7](https://doi.org/10.25047/animpro.2021.7). [9 March 2025].
- Henriques AM, Neto A, Fagulha T, Almeida V, Fevereiro M. 2023. Molecular Characterization and Phylogenetic Analysis of Newcastle Disease Viruses Isolated in Southern Angola, 2016-2018. *Infection, Genetics and Evolution* 113: 105481.
- Indrawan D, Cahyadi ER, Daryanto A, Hogeveen H. 2020. The Role of Farm Business Type on Biosecurity Practices in West Java Broiler Farms. *Preventive Veterinary Medicine* 176: 104910.
- Kabiraj CK, Mumu TT, Chowdhury EH, Islam MR, Nooruzzaman M. 2020. Sequential Pathology of a Genotype XIII Newcastle Disease Virus from Bangladesh in Chickens on Experimental Infection. *Pathogens* 9(7): 539.
- Kencana GAY, Suartha IN, Nainggolan DRB, Tobing ASL. 2017. Immune Response of Layer Against Newcastle Disease and Egg Drop Syndrome Vaccines. *Jurnal Sain Veteriner* 35(1): 81-90.
- Kencana GAY, Nirhayu, Suartini IGAA. 2019. Seroprevalence of Newcastle Disease on Domestic Chicken in Kerambitan District, Tabanan Regency, Bali. *Indonesia Medicus Veterinus* 8(4): 496-501.
- Kencana GAY, Astawa INM, Kendran AAS, Pratomo AA. 2025. Assessment of Active LaSota and Inactivated Newcastle Vaccines and Their Nucleotide Sequence Homology on the Virulence of Wild-type Newcastle Disease Genotype VIII Virus. *World's Veterinary Journal* 15(3): 678-687.
- Kurniangtyas E, Setiyaningsih S, Indrawati A. 2017. Molecular Pathotype Determination of Newcastle Disease Virus: Field Isolate in Three Districts of East Java. *Acta Veterinaria Indonesia* 5(1): 8-15.
- Mahardika IGNK, Astawa INM, Kencana GAY, Suardana IBK, Sari TK. 2016. *Virus Lab Techniques*. Denpasar. Udayana University Press.
- Mao Q, Ma S, Schrickel PL, Zhao P, Wang J, Zhang Y, Li S, Wang C. 2022. Review Detection of Newcastle Disease Virus. *Frontier in Veterinary Science* 9:936251.
- Mappanganro R, Syam J, Alim C. 2018. Level of Application of Biosecurity in Laying Farms in Panca Rijang Sub-district Sidrap Regency. *Jurnal Ilmu dan Industri Peternakan* 4(1): 60-73.
- Maulina SR, Etriwati E, Ferasyi TR. 2024. Prevalence of Newcastle Disease and Estimated Economic Losses in Necropsied Poultry at the Pathology

- Laboratory of the Faculty of Veterinary Medicine, Syiah Kuala University. *Acta Veterinaria Indonesiana* 12(2): 154-159.
- Moustapha A, Talaki E, Akourki A, Ousseini M. 2023. Newcastle Disease Virus in Poultry: Current Status and Control Prospects. *World Veterinary Journal* 13(2): 240-249.
- Purnasari ME, Adi AAM, Winaya IBO. 2017. Effect of Newcastle Disease Virus Virulent Isolates to Brain Histopathologic and Chicken's Embryo Weight. *Indonesia Medicus Veterinus* 6(2): 101-108.
- Rahmaniar RP, Widhowati D, Nussa ORPA, Amelia J. 2024. Studi Kasus Newcastle Disease Velogenik pada Ayam Buras yang Tidak Diberi Vaksin. *Jurnal Sains Peternakan* 12(1): 63-69.
- Rell F, Adi AAAM, Mahardika IGNK. 2021. Phylogeny Analysis of Bali Isolates of Newcastle Disease Virus in 2013 to 2014 Based on Cleavage Site of the Fusion Protein. *Buletin Veteriner Udayana* 13(1): 67-74.
- Rozi F, Rahmahani J, Purnama TE, Hamid IS, Yudhana A, Praja RN. 2020. Seroprevalence of Newcastle Disease (ND) Antibodies on Ducks in Temuasri Village, Sempu, Banyuwangi. *Jurnal Medik Veteriner* 3(1): 108-113.
- Sandriya A, Sujoko H, Wibowo S, Silitonga L, Yuanita I, Aritonang N. 2023. The Level of Application of Biosecurity in Broiler Farms in the City of Palangka Raya. *Buletin Veteriner Udayana* 15(5): 905-914.
- Sari NPDS, Suardana IBK, Winaya IBO, Sudipa H, Suratma NA. 2024. Newcastle Disease and Avian Influenza in Broiler That Vaccinated on Day Old. *Veterinary Science and Medicine Journal* 6(04): 363-375.
- Susanti WG, Wicaksono A, Basri C. 2021. The Incidence of Newcastle Disease Amongst Backyard Chicken Farms in District of Barru. *Jurnal Ilmu Pertanian Indonesia* 26(3): 379-385.
- Utami K, Samudra F. 2021. E Evaluation of Biosecurity Implementation in Joper Chicken Farms in East Java. *valuasi Penerapan Biosekuriti di Peternakan Ayam Joper di Jawa Timur. Agriekstensia* 20(2): 183-190.
- [WOAH] World Organisation for Animal Health. 2021. Newcastle Disease (Infection With Newcastle Disease Virus). Terrestrial Manual 2021. https://www.woah.org/fileadmin/Ho/me/eng/Health_standards/tahm/3.03.14_NEWCASTLE_DIS.pdf. [17 February 2026].