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Transmissible Viral Proventriculitis in Broilers: An Updated Review of Studies from 2015 to 2024

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A B S T R A C T

The objective of this review is to analyze transmissible viral proventriculitis (TVP) in poultry, focusing on its etiology, pathogenesis, transmission dynamics, clinical signs, diagnostic approaches, and the economic impact it has on poultry production. A comprehensive review was conducted using scientific literature from multiple sources to examine the various aspects of TVP in broiler poultry. The causative agents of TVP are primarily viruses that lead to significant pathological changes in the proventriculus, with subsequent effects on digestion, growth, and overall poultry health. Transmissible viral proventriculitis causes symptoms such as loss of appetite, lethargy, and digestive disturbances, often leading to reduced productivity, weight gain, and increased mortality rates. Early diagnosis remains challenging due to the similarity of its symptoms to other diseases, and conventional diagnostic tools like PCR, serology, and histopathology are critical for accurate identification. Transmission occurs through horizontal and vertical routes, with environmental factors such as humidity, temperature, and poor biosecurity practices exacerbating the spread. The economic burden of TVP is considerable, encompassing direct costs (e.g., veterinary care, diagnostic testing) and indirect losses due to decreased productivity and higher mortality. Transmissible viral proventriculitis presents considerable challenges to the poultry industry. Although a specific vaccine remains unavailable, effective disease management, including enhanced farm conditions, stringent biosecurity measures, and ongoing research into novel preventive strategies, can help mitigate its economic and health impacts.

Keywords: *Transmissible viral proventriculitis (TVP), Broiler, Poultry*

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1 Introduction

Transmissible viral proventriculitis (TVP) in broilers has emerged as a significant concern in poultry health, due to its detrimental effects on bird welfare and its economic implications for the poultry industry. This disease, characterized by inflammation and necrosis of the proventriculus, compromises the organ's critical role in food processing and acid secretion. As a result, infected birds experience impaired digestion, decreased nutrient absorption, and poor growth performance, leading to suboptimal feed conversion rates and economic losses for producers. The transmissible nature of TVP further exacerbates its impact, allowing outbreaks to spread rapidly across densely populated farms, particularly where biosecurity measures are inadequate (1-3).

The viral etiology of TVP suggests that several different pathogens might be involved, complicating both diagnosis and control strategies. The disease has been associated with a variety of avian viruses, including some known to cause other poultry diseases such as infectious bronchitis (3, 4). Among these, the chicken proventricular necrosis virus (CPNV) has been identified as a key pathogen, capable of inducing the hallmark proventricular lesions under experimental conditions. Furthermore, emerging evidence suggests the involvement of novel pathogens such as cycloviruses, which have been detected at high prevalence in affected birds (5). These findings underscore the complex and evolving nature of TVP, necessitating advanced diagnostic tools and targeted interventions to manage the disease effectively (6, 7).

While viruses are central to TVP's pathogenesis, the contribution of secondary bacterial and parasitic infections is also noteworthy. Opportunistic bacterial pathogens such as *Escherichia coli*, *Clostridium perfringens*, *Pseudomonas aeruginosa*, *Proteus mirabilis*, *Citrobacter* spp., *Enterobacter aerogenes*, and *Klebsiella pneumoniae* can exacerbate the disease. Similarly, parasitic infections like *Ascaridia galli* and *Cryptosporidium galli* can further weaken the birds' immune system, creating a cascade of interactions that heighten disease severity and complicate treatment strategies (4, 8).

TVP presents a diverse clinical spectrum, from mild, subclinical cases to severe infections associated with high mortality rates. Its nonspecific clinical signs, including poor weight gain, lethargy, and reduced feed intake, make accurate diagnosis challenging. Histopathological examination of the proventriculus is the gold standard for confirming a diagnosis (1, 7, 9). However, the use of molecular techniques such as PCR-based assays is becoming increasingly common, enabling more rapid detection of the causative viral agents (1, 7, 9, 10).

This review provides an overview of the literatures from 2015 to 2024 on TVP, exploring its pathogenesis, transmission dynamics, clinical manifestations, and control measures. Special attention will be given to the viral agents implicated in TVP and their impact on poultry production.

2 Methods and Materials

This review is grounded in an extensive literature search aimed at gathering pertinent data on TVP in broilers. The study period for this review spans from 2015 to 2024, as this timeframe encompasses the most current and relevant research regarding the etiology, pathogenesis, transmission, diagnosis, and control measures associated with the disease. The review specifically includes studies published in peer-reviewed journals, industry reports, and relevant books. The methodology was carefully designed to ensure comprehensive coverage of the topic by selecting articles that provide robust data on clinical signs, epidemiology, and management strategies for TVP.

3 Literature Search Strategy

A comprehensive literature search was conducted through major scientific databases, including PubMed, Google Scholar, ScienceDirect, and Scopus. The search utilized specific terms such as "transmissible viral proventriculitis", "broiler viral diseases", "proventriculitis pathogenesis", "poultry viral infections", "TVP" and "viral proventriculitis transmission". Priority was given to studies encompassing experimental investigations, field studies, and case reports. In addition, the reference lists of these articles were manually examined to uncover any additional relevant studies that may not have been captured in the initial search.

3.1 Inclusion and Exclusion Criteria

The inclusion criteria for this review were as follows: (1) articles specifically focusing on TVP in broilers; (2) studies that provided data on the viral etiology, clinical symptoms, diagnostic methods, or epidemiology of the disease; (3) research detailing control and prevention strategies for viral proventriculitis; and (4) studies that included comprehensive data on the economic and production-related impacts of the disease within poultry farms.

Conversely, the exclusion criteria encompassed: (1) studies that did not specifically address broilers or TVP; (2) articles published in languages other than English or those lacking full-text access; and (3) research articles that did not present significant data on the topic or were based on non-peer-reviewed sources, such as dissertations or conference proceedings.

As illustrated in Figure 1, our search identified a total of 155 articles focusing on the factors associated with TVP in world. After eliminating 59 duplicate entries, we were left with 96 studies. From these, 16 articles were excluded based solely on their titles, while another 20 were rejected after reviewing their abstracts. This process led us to a final selection of 23 studies, which were thoroughly evaluated against our inclusion and exclusion criteria. These evaluations considered factors such as the relevance of the articles' titles and abstracts to our research objectives and the limitations present in related studies. Ultimately, 37 articles met our eligibility criteria and were included in the final systematic review.

3.2 Data Extraction and Analysis

Data from the selected studies were extracted using a standardized form that included key elements such as study objectives, methods, results, and conclusions. The extracted data were analyzed qualitatively, emphasizing the identification of trends, common findings, and significant gaps in the current literature regarding the disease. A descriptive analysis was employed to provide an overview of the key findings from various studies and to synthesize the available evidence on the subject.

3.3 Critical Appraisal of the Literature

Each study included in the review was critically appraised for methodological quality and relevance. For experimental studies, the robustness of the experimental design, the validity of the diagnostic methods, and the sample size were considered. Field studies and case reports were evaluated based on the quality of data, the representativeness of the sample, and the applicability of the findings to broader poultry farming practices. The risk of bias was also assessed, with particular attention given to potential conflicts of interest or industry affiliations that could influence the outcomes. In synthesizing the findings, priority was given to studies that provided clear evidence of cause-and-effect relationships or offered strong statistical support for their conclusions.

3.4 Synthesis of Evidence

The evidence gathered from the reviewed studies was synthesized descriptively, aiming to provide an overview of the current understanding of TVP in broilers. Trends in viral etiology, clinical symptoms, and transmission dynamics were identified, and the most effective diagnostic and control strategies were summarized. In instances where conflicting results were noted, potential reasons for these discrepancies—including variations in study design, geographical differences, and variations in viral strains—were discussed. This review seeks to provide a balanced perspective on the state of research and highlight areas where further studies are needed to enhance our understanding of the disease and its impact on poultry farming.

4 Etiology and Pathogenesis

Transmissible viral proventriculitis in broilers is caused by several avian viruses that specifically target the proventriculus, an essential organ in the digestive system. Key viral agents associated with this disease belong to various families, including Coronaviridae, Birnaviridae, Astroviridae, Anelloviridae (2, 11-17), Adenoviridae (18), Circoviridae (5), and Picornaviridae. More details on viral agents of the TVP are listed in Table 1 and Figures 2 and 3. One significant contributor to TVP is the Chicken Proventricular Necrosis Virus (CPNV), a recently identified birnavirus first detected in 2011 in both field cases and experimentally reproduced instances of the disease (19). CPNV is classified within the Birnaviridae family alongside the Infectious Bursal Disease virus (20). Additionally, the Infectious Bronchitis Virus (IBV) is linked to Runting-Stunting Syndrome (RSS) and leads to severe proventricular lesions. IBV is one of the most prominent members of the Coronaviridae family (2, 21). Other notable viruses implicated in TVP include subtypes of Gyrovirus (11-15) and Cyclovirus (5), which are classified under Anelloviridae and Circoviridae, respectively. These viruses can act independently or synergistically, complicating both diagnosis and clinical outcomes. Other significant viral agents include Fowl Adenovirus (20), Megrivirus (22), Picornavirus (4), and Chicken Astrovirus (23), all of which are recognized as contributing factors to the development of TVP. The avian coronavirus induces inflammation, necrosis, and disrupts normal digestive processes in the proventriculus. It enters proventricular cells via specific receptors, causing cellular damage and triggering immune

responses that exacerbate disease progression. The infection can spread to the ventriculus and small intestine, impairing digestion and nutrient absorption (18, 24-26). Additionally, IBDV subtypes can cause significant proventricular damage, often leading to secondary bacterial infections that worsen the disease's severity. Higher viral loads correlate with more severe lesions and poorer clinical outcomes (7, 9).

Table 1. Summary of viral agents associated with TVP based on data from 24 published articles (2015-2024) worldwide.

Family	Genus	Country	Sample size and /or Prevalence	Sample type	Age	Syptoms / Extra	Method	Mortality rate	Reference
Circoviridae	Cyclovirus	China	30	Proventriculus	30 d*	Death, poor growth, retarded feathering and diarrhea with undigested food	Inverse PCR*	47%	(12)
Birnaviridae	CPNV*	California	330	-	-	Enlarged or dilated proventriculi followed by thickened walls in 71 cases and pale or mottled appearance in 54 cases	Histopathology		(27)
		UK	44	Proventriculus	-	Dilation of pro-ventriculus and/or evidence of white spots visible through the proventricular serosa	Histopathology Rt-PCR* Sequencing		(9)
		Poland	55%	Proventriculus	4 W*	Decreased body weight gains, reduced uniformity of birds, increased death rate	Histopathology	Below 5%	(28)
		Iraq	26	Proventriculus	11-31 d	-	RT-PCR Histopathology		(29)
		Thailand	14 (14.28%)	Proventriculus	2-4 W	Proventriculitis, growth retardation (Isolated from the amniotic sacs of embryonic eggs)	Histopathology RT-PCR Sequencing	-	(30)
		UK	452	Proventriculus	28-30 d	Necrosis of xynticopeptic cells	RT-PCR Histopathology		(7)
		Poland	-	Proventriculus	28 d	Enlargement, thickening and discoloration of pro-ventriculus -section	RT-PCR Histopathology		(24)
		Poland	12	Proventriculus Serum	24 d	Enlargement, thickening and discoloration of pro-ventriculus (Experimental study; TVP was from a naturally infected Ross 308)	Histopathology ELISA RT-PCR		(18)
		Brazil	73	Proventriculus	25–36 d	Reduced growth (Histopathology: 48%; RT-PCR: 36%)	RT-PCR Histopathology		(6)
	IBD*	India	33			-	IHC-fluorescent Histopathology	3%-18%	(20)
Adenoviridae	FAdV*	Poland	12	Spleen Liver Serum	24 d	Enlargement, thickening and discoloration of pro-ventriculus / Exxperimental study; TVP was from a naturally infected Ross 308	Histopathology ELISA RT-PCR		(18)
Coronaviridae	IBV*	California	60000	Proventriculus pancreas Intestine	14 d	Proventriculitis / Isolated from the intestine of chicken embryos	Histopathology IHC* RT-PCR Sequencing		(2)
		Egypt	-	Allantoic fluid and proventriculus	14 d	- / Virus isolation on SPF ECEs	Isolation RT-PCR		(21)
Picornaviridae	Picornavirus	South Korea	5 flocks	Proventriculus		Proventriculitis	Metagenomics		(4)
	Megriviruses	Netherlands	8 pooled	Fecal samples	-	No clinical signs	Conventional RT-PCR Metagenomics		(22)
Anelloviridae	GyV3*	China	336 cases	Proventriculus		Small intestinal enteritis, proventriculitis	PCR		(15)
	GyH1*	China	30 (83.37%)	Proventriculus	10-35 d old	Stunted growth, slightly enlarged proventriculus	Sequencing		(12)
	GyH1*	China	172 (9.88%)	Liver, kidney	-	-	PCR Sequencing		(11)
	GyH1*	China	1868 (8.99%)	Serum	-	Apparently healthy	Serology		(14)

	GyG1*	China	30 (0.34%)	Proventriculus	10-35 d	Stunted growth, slightly enlarged roventriculus	Sequencing		(12)
	CAV*	China	30 (15.10%)	Proventriculus	10-35 d	Stunted growth, slightly enlarged proventriculus	Sequencing		(12)
	Gyroviruses	China (6 provinces)	1197 (11.02%)	Serums, feces, feather shafts, and visceral tissues	-	Clinically healthy	PCR Sequencing	Slaughter house samples	(13)
Astroviridae	CAstV*	China	12000	Proventriculu, duodenu, pancreas	-	Growth retardation, hemorrhage in the proventriculus, duodenum and pancreas	Histopathology Quantitative real-time PCR Sequencing		(23)

d*: days old, PCR* Polymerase Chain Reaction: ,W*: Weeks old, CPNV*:Chicken proventriculitis necrosis virus , Rt-PCR*: Reverse Transcriptase Polymerase Chain Reaction, IBD*: Infectious Bursal Disease , FAdV*: Fowl Adenovirus, IHC*: Immunohistochemistry, IBV*: Infectious Bronchitis Virus, GyV3*: Gyrovirus 3, GyH1*Gyrovirus Hamsa 1: , GyG1* Gyrovirus Gala 1: , CAV*: Chicken Infectious Anemia, CAstV*: Chicken Astrovirus

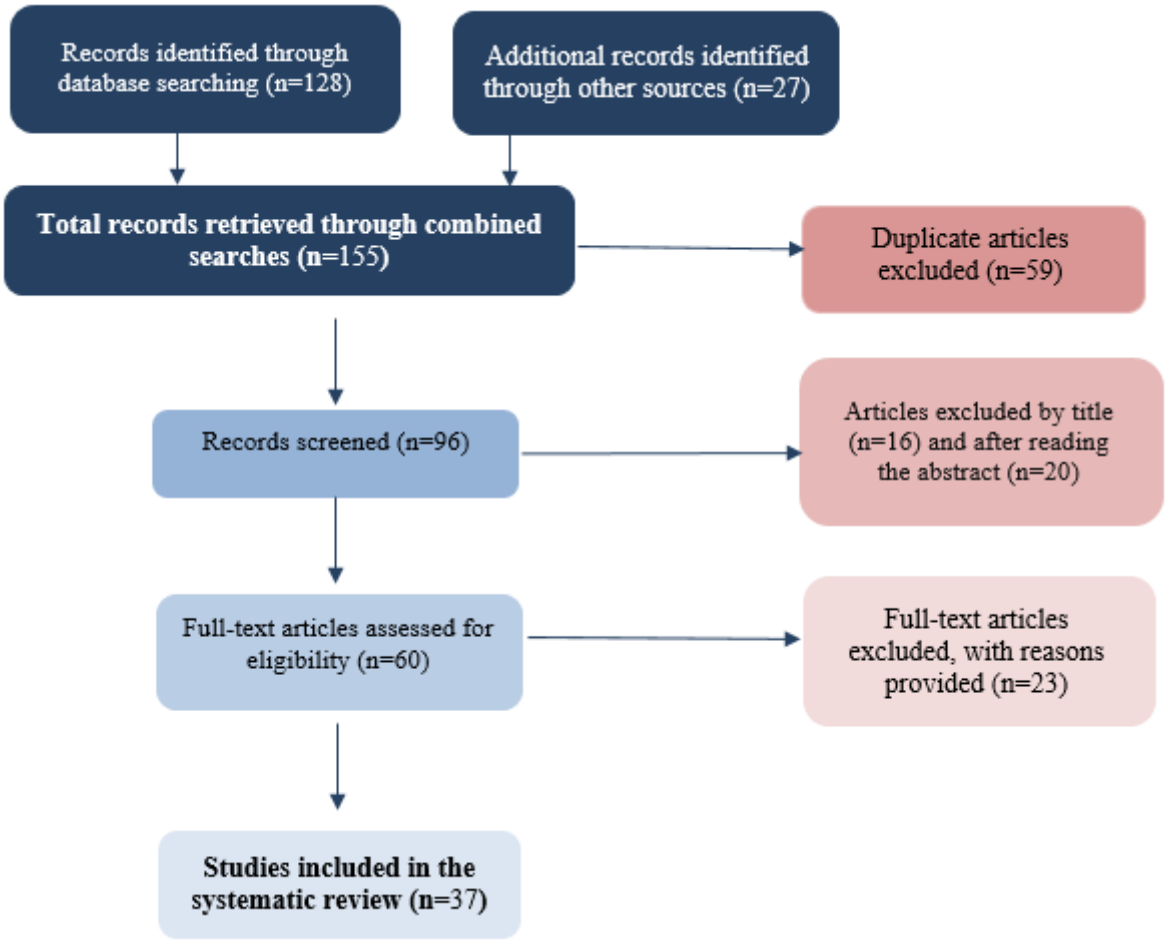

Figure 1. Study selection flow chart for a systematic review of the agents and factors associated with transmissible viral proventriculitis (TVP) worldwide.

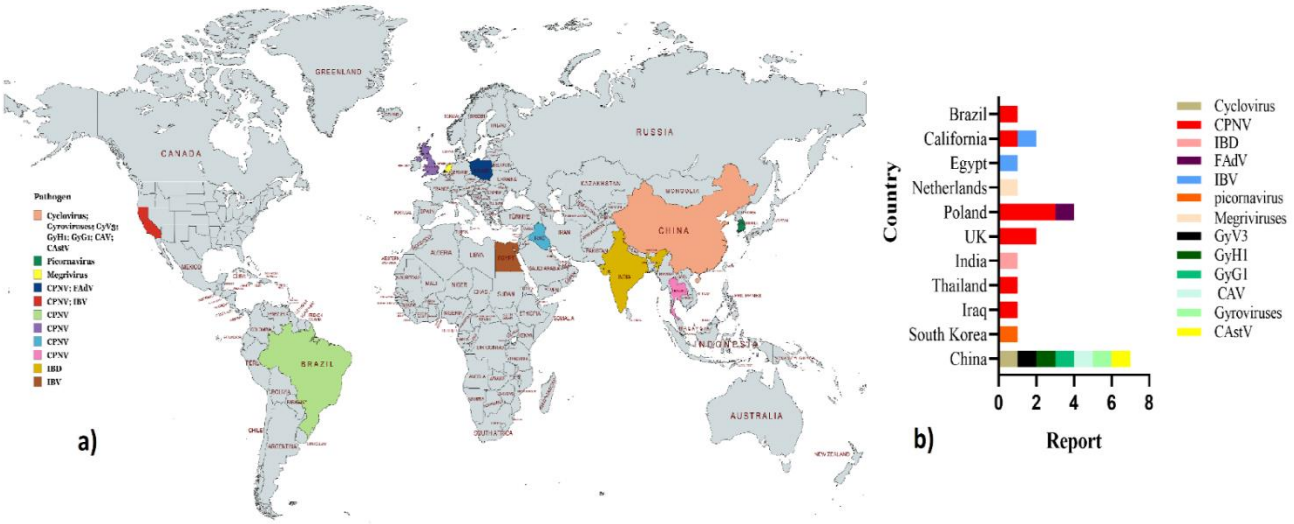

Figure 2. Global Distribution of Pathogens Associated with Transmissible Viral Proventriculitis (TVP) in Poultry (2015-2024)

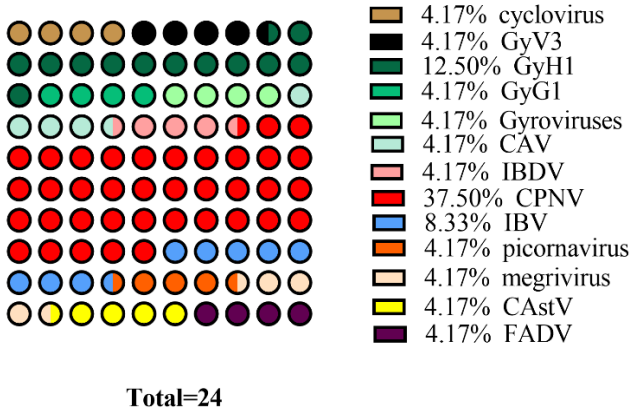

Figure 3. Percentage of repetition of viral agents in published articles (2015-2024).

The global distribution of pathogens associated with transmissible viral proventriculitis map (Figure 1a) was created using the Mapchart.net website, with countries reporting the viral agents of the disease highlighted in color. The summary data diagram (Figure 1b) showing the association of TVP viral agents and the corresponding reporting countries was created using GraphPad Prism 9.5.1 software, citing published articles from 2015 to 2024 (n=24). As illustrated in Figure 1b, China and Poland have conducted the most studies. Reports from China (n=7) identified seven viruses: Gyrovirus 3, Gyrovirus Hamsa 1, Gyrovirus galgala 1, Cyclovirus, unspecified Gyroviruses, Chicken Infectious Anemia and Chicken Astrovirus. In Poland (n=4), three cases of CPNV and one case of FADV were reported. Overall, CPNV is the most frequently reported viral agent associated with TVP in the last decade, with more reports published in Asia than in any other region of the world (Figure 2). Figure 3 illustrates the frequency of viral agents associated with TVP in reports published over the last decade (n=24), as a 10 10 dot plot using GraphPad Prism 9.5.1 software. The most frequently reported viral agents were CPNV (37.5%), GyH1 (12.5%), and IBV (8.33%). Other viruses, including Cyclovirus, GyV3, GyG1, Gyroviruses, CAV, IBDV, New Picornavirus, Megrivirus, CAstV, and FADV, were reported only once worldwide.

The pathogenesis of TVP involves multiple stages of viral replication and host response, resulting in significant structural and functional alterations of the proventriculus. Viral replication destroys the epithelial lining and disrupts glandular function, leading to the loss of mucosa responsible for digestive enzyme secretion. An inflammatory response, characterized by immune cell infiltration, further damages tissues, potentially resulting in severe proventriculitis (10, 31).

Beyond direct effects on the proventriculus, viral infections associated with TVP disrupt the entire digestive system. Lesions from the avian coronavirus can extend to the ventriculus and small intestine, impairing nutrient digestion and absorption. This disruption leads to reduced feed efficiency and suboptimal growth, resulting in poor weight gain and increased susceptibility to secondary infections (1, 7, 9). Malabsorption of essential nutrients contributes to a decline in overall health, impacting energy balance and nutritional status (7).

5 Transmission Dynamics

Case studies and experimental evidence reveal that the transmission dynamics of TVP vary depending on the agent involved. The transmission of TVP in broilers primarily occurs through horizontal routes, with viruses spreading from infected birds to susceptible individuals within the same flock. Horizontal transmission typically involves direct contact between infected and healthy birds, as well as indirect transmission via contaminated feed, water, equipment, and other fomites. Droplet transmission, where the virus is expelled through respiratory secretions and inhaled by nearby birds, may also contribute to viral spread, particularly for viruses affecting multiple organs or with systemic effects (3).

While vertical transmission of TVP is less commonly reported, it may also contribute to the disease's spread. This type of transmission occurs when the virus is passed from an infected hen to her offspring via the egg. However, compared to other poultry diseases, vertical transmission plays a less defined role in TVP. Some studies suggest that while vertical transmission can occur for certain viral agents, it is not a significant route for the primary viruses involved in TVP. Therefore, horizontal transmission remains the dominant route, where infected birds shed the virus into their environment, leading to infection of susceptible birds within the same flock or even neighboring flocks on the same farm (7, 9).

Environmental factors significantly influence the transmission dynamics of TVP. Temperature and humidity affect the stability and survival of the viruses involved. Higher temperatures can degrade viral particles more quickly, reducing infection risks, while low temperatures and high humidity can prolong viral survival, increasing the likelihood of infection. This is particularly concerning in poorly ventilated, overcrowded poultry houses, where viral accumulation can sustain transmission within flocks (1, 7). In contrast, optimal farm management practices, including adequate ventilation, can mitigate the transmission of airborne viruses and help control outbreaks (6).

Farm management practices, especially biosecurity and flock density, play a critical role in the spread of TVP. Overcrowding, stress, and poor sanitation increase both direct and indirect contact between infected and healthy birds. Additionally, the reuse of contaminated equipment and improper carcass disposal further propagate the disease. Implementing stringent biosecurity measures, such as regular cleaning, disinfection, and restricted access, is essential for minimizing outbreaks of TVP (3). Moreover, the movement of personnel, vehicles, and equipment between farms, particularly in areas with high poultry density, contributes to the spread of viral agents among flocks (6).

The impact of environmental stressors on the transmission of TVP is also considerable. Stressful conditions, including high stocking densities, inadequate lighting, and poor air quality, can impair the immune responses of poultry, making them more susceptible to viral infections. Studies have shown that stressed birds are more likely to harbor viruses and transmit them to other flock members, particularly when multiple viral agents are present. Co-infections can exacerbate disease severity and increase transmission likelihood (4, 31). Furthermore, the presence of other disease agents, such as bacteria or parasites, can complicate transmission dynamics by creating a conducive environment for viral persistence and spread (32).

6 Clinical and pathological Signs and Diagnosis

Transmissible viral proventriculitis in broilers presents a range of nonspecific clinical signs, making early identification challenging without laboratory confirmation. Initial symptoms often include loss of appetite, lethargy, and reduced activity, leading to impaired growth rates. As the disease progresses, digestive disturbances become more pronounced, manifesting as diarrhea, dehydration, and noticeable weight loss due to nutrient malabsorption (3, 5, 26). Secondary complications, such as bacterial infections, can arise, particularly in younger birds, resulting in increased mortality and sudden death in severe cases (Figure 4) (1, 7, 9).

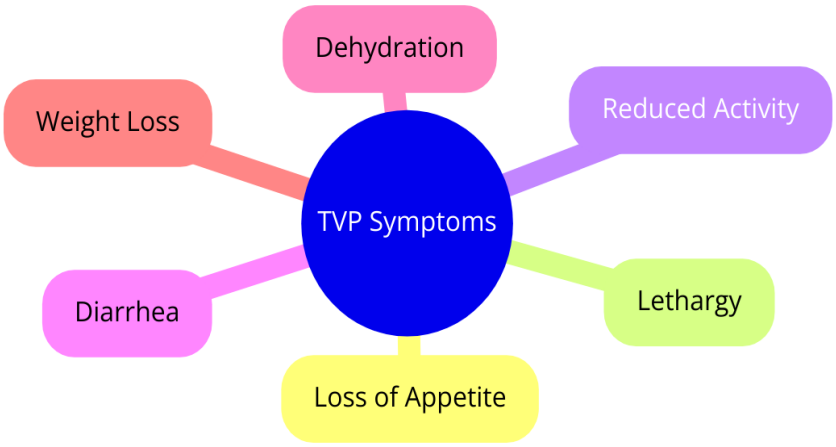

Figure 4. Clinical symptoms of transmissible viral proventriculitis (TVP) in broilers.

Transmissible viral proventriculitis is characterized by specific pathological lesions in the proventriculus that are critical for its diagnosis. Microscopic examination reveals key features such as necrosis of the epithelial glandular cells, which leads to the destruction of the normal glandular structure and impairs the proventriculus' ability to function properly. In addition to necrosis, there is often lymphocytic infiltration of the mucous membrane and within the proventricular glands. Another prominent feature observed is ductal epithelial hyperplasia, where the glandular epithelium undergoes metaplasia and transforms into ductal epithelium. This abnormal tissue growth contributes to thickening of the proventricular wall, a hallmark of the disease. These histopathological findings are not only indicative of the disease but also reflect the progression of the infection and the severity of tissue damage. The observed hypertrophy of the proventricular wall, combined with inflammatory and necrotic changes, underscores the role of infectious agents in exacerbating the pathological process, often amplifying pre-existing conditions rather than acting as the primary trigger. Understanding these lesions is vital for improving diagnostic precision and developing targeted strategies for managing TVP in poultry (2, 6, 18, 33).

The target organ for TVP appears to be the proventriculus, where the virus primarily causes damage to the glandular tissue, leading to inflammation, necrosis, and disrupted digestive function. Li et al. (2021) indicated that one notable pathogen involved in TVP is Gyrovirus 3 (GyV3), which has been shown to cause persistent infections in chickens and induce systemic inflammation, affecting organs such as the bone marrow, adrenal glands, and sciatic nerves. GyV3 viral loads peak in the bone marrow and adrenal glands, suggesting that these organs are critical sites of infection (31). Moreover, studies on the pathogenic agents of TVP have isolated various pathogens from organs beyond the proventriculus such as duodenum, pancreas, live (Table 1). These findings suggest that while the proventriculus remains the primary target for TVP, the disease also impacts multiple other organ systems, leading to a multifactorial pathogenesis (11, 13, 18, 21, 23).

Laboratory diagnostics are crucial for confirming TVP, with PCR being a common method for detecting viral pathogens in clinical samples. PCR is sensitive and can differentiate between viral strains, facilitating early diagnosis (3). Serology, through tests like enzyme-linked immunosorbent assays (ELISA), detects antibodies in the blood, providing insight into the immune response and prevalence of the virus, although it may not detect early infections. Histopathological examination of tissue samples can reveal characteristic changes, such as inflammation and necrosis of the proventriculus, aiding in diagnosis. Other diagnostic methods include viral culture, which allows for the identification of specific viral strains, though it is time-consuming (7).

7 Impact on Poultry Production and Economy

7.1 Direct Economic Impacts

Reduced Growth and Feed Conversion Efficiency: One of the immediate economic effects of TVP is the reduction in weight gain in infected birds, caused by impaired digestive function and nutrient absorption. This results in slower growth rates and reduced feed conversion efficiency. Consequently, production costs increase, especially when

feed prices are high, as more feed is required to achieve desired weight gains. Slower growth also leads to longer production cycles, delaying income generation and adversely affecting cash flow (12).

Increased Mortality Rates: TVP also results in higher mortality rates, particularly in younger birds, by weakening their immune systems and making them more susceptible to secondary infections (34). Also, Merad et al. (2024) reported that infected birds did not exhibit specific clinical signs but suddenly died, indicating the rapid and severe impact of the disease on bird health (33). This leads to significant losses before birds reach market weight, resulting in revenue loss. In cases of severe outbreaks, restocking flocks becomes necessary, disrupting production schedules and increasing operational costs.

Veterinary Costs*:* Effective management of TVP often requires diagnostic tests, such as PCR and serological assays, along with veterinary interventions to treat secondary infections. These procedures incur significant costs, placing additional financial pressure on farm operations. Furthermore, the time and resources dedicated to managing outbreaks, including labor for monitoring and caring for infected birds, add to the overall veterinary expenses (3).

7.2 Indirect Economic Impacts

Supply Chain Disruptions: TVP outbreaks can disrupt the poultry supply chain by reducing the availability of healthy birds for processing. This shortage leads to price fluctuations in the poultry market. In severe cases, farm closures may be imposed, exacerbating financial stress across the poultry industry. These disruptions have a cascading effect on poultry processors, distributors, and retailers (12).

Decreased Product Quality: Infected birds often exhibit poor muscle development and inferior carcass quality. As a result, the market value of poultry products declines, which impacts farmers' profitability. Moreover, consumer concerns regarding food safety and quality may lead to decreased demand for poultry products, particularly in regions with stringent food safety regulations and heightened consumer awareness of animal welfare (23).

Long-Term Sustainability Challenges: The chronic nature of TVP forces producers to adopt stricter biosecurity measures, necessitating investments in infrastructure, training, and enhanced farm management protocols. These additional costs can disrupt farm operations, lead to inefficiencies, and challenge the long-term sustainability of poultry farming (1, 9).

7.3 Mitigation Strategies

To alleviate the economic impacts of TVP, poultry producers must implement proactive disease control strategies. By minimizing the spread of the disease and mitigating its effects, producers can reduce the financial burden on their operations (2).

8 Prevention and Control Measures

The effective management of TVP in broiler poultry requires a multifaceted approach, including stringent biosecurity protocols, environmental control, and sound farm management practices. Despite the absence of specific vaccines, ongoing research focuses on understanding the immune response to TVP to develop potential vaccines. In the interim, robust biosecurity measures, such as strict protocols for visitors, vehicles, and equipment, along with regular health monitoring and isolation of symptomatic birds, are crucial in preventing outbreaks. Environmental control, including optimal temperature, humidity, and ventilation, is vital for reducing stress and supporting immune health. Farm workers must adhere to hygiene training and use disinfectants to maintain biosecurity. Effective farm management practices, such as health checks, symptom surveillance, and strict protocols for bird introduction and flock rotation, help prevent disease spread. Continued research into alternative control methods, such as probiotics and immunomodulatory compounds, may complement existing strategies. Ultimately, while the development of vaccines remains a priority, vigilant biosecurity, early detection, and comprehensive farm practices are essential for controlling TVP and safeguarding poultry health (1, 7, 9).

9 Future Research Directions and Recommendations

Transmissible viral proventriculitis presents significant challenges to poultry production, and while progress has been made in understanding its etiology and impacts, several research areas remain crucial to furthering control and prevention efforts. Future research should focus on the following key areas:

9.1 Development of Vaccines and Antiviral Treatments

The absence of a specific vaccine for TVP underscores the urgent need for vaccine development. Future research should focus on the identification of viral antigens and the genetic makeup of key pathogens involved, such as the chicken proventricular necrosis virus (CPNV) and emerging viruses like cycloviruses. Understanding the virus-host interactions and immune responses could pave the way for targeted vaccine development or antiviral treatments that could help control the disease more effectively.

9.2 Alternative Control Methods

In the absence of vaccines, alternative approaches, such as using immunomodulatory agents, probiotics, and prebiotics, should be investigated. These strategies could help strengthen the immune system of poultry and make them more resistant to infections. Investigating these alternatives, either as standalone treatments or in combination with biosecurity measures, will be vital for improving disease management, especially in regions where TVP is prevalent.

9.3 Environmental and Farm Management Factors

The role of environmental factors in the transmission and persistence of TVP warrants further investigation. Research should focus on understanding how temperature, humidity, and ventilation affect the stability and spread of the virus. Furthermore, exploring the effects of farm management practices, such as flock density and sanitation, on disease transmission will help improve biosecurity protocols and reduce the risk of outbreaks in commercial poultry farms.

9.4 Co-infections and Their Impact on TVP

Co-infections with other viral, bacterial, and parasitic agents complicate the clinical presentation of TVP and can exacerbate its severity. Future research should investigate the interactions between TVP and other pathogens, particularly those that affect the gastrointestinal system. Understanding how these co-infections influence the course of the disease will aid in more accurate diagnosis and in the development of targeted treatments to address both primary and secondary infections.

9.5 Global Epidemiology and Surveillance

The geographic spread of TVP and the involvement of multiple pathogens across different regions call for enhanced global surveillance systems. Future studies should focus on the epidemiology of TVP in different poultry farming environments, particularly in areas with high-density farming practices. Understanding regional variations in pathogen prevalence and transmission dynamics will enable better-targeted disease control strategies and contribute to the development of preventive measures tailored to specific areas.

9.6 Collaboration and Industry-Wide Initiatives

The complexity of managing TVP highlights the need for collaboration across the poultry industry, including researchers, veterinarians, and farm managers. Establishing partnerships between academia, industry, and government bodies will foster the sharing of knowledge, tools, and resources to combat TVP. Collaborative initiatives aimed at improving farm biosecurity, enhancing diagnostic capabilities, and implementing effective management strategies are essential for reducing the disease's global impact.

10 Conclusion

Transmissible viral proventriculitis presents significant challenges to both poultry health and production, with far-reaching economic consequences for the industry. The complexity of its viral etiology, pathogenesis, and transmission dynamics calls for ongoing research to improve diagnostic tools, control strategies, and preventive measures. While the absence of a specific vaccine remains a key obstacle, the development of vaccines and alternative control methods, combined with improved farm management practices and biosecurity measures, is critical to mitigating the impact of TVP. Furthermore, enhancing the understanding of environmental factors and co-infections will be vital to improving disease management. Through a multi-faceted approach that integrates research, advanced diagnostics, and rigorous farm-level interventions, the poultry industry can reduce the spread and economic burden of TVP, ensuring the sustainability and resilience of poultry production systems worldwide.

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Conflict of Interest

The authors declared no conflicts of interest.

Author Contributions

Authors contributed equally to this article.

Data Availability Statement

Data are available from the first author upon reasonable request.

Ethical Considerations

As a review of existing literature, this study did not involve direct interaction with human participants or the collection of primary data. Ethical approval was therefore not required. However, care was taken to appropriately credit all sources and adhere to principles of academic integrity. The review also prioritized the inclusion of studies that had undergone ethical scrutiny, ensuring that the findings presented are based on ethically conducted research.

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References

1. Grau-Roma L, Marco A, Martinez J, Chaves A, Dolz R, Majo N. Infectious bursal disease-like virus in cases of transmissible viral proventriculitis. The Veterinary Record. 2010;167(21):836-. [PMID: 21262640]
2. Hauck R, Gallardo RA, Woolcock PR, Shivaprasad HL. A Coronavirus Associated with Runting Stunting Syndrome in Broiler Chickens. Avian Diseases. 2016;60(2):528-34. [PMID: 27309300] [DOI]
3. Hauck R, Stoute S, Senties-Cue CG, Guy JS, Shivaprasad HL. A Retrospective Study of Transmissible Viral Proventriculitis in Broiler Chickens in California: 2000–18. Avian Diseases. 2020;64(4):525-31. [DOI]
4. Kim H-R, Yoon S-J, Lee H-S, Kwon Y-K. Identification of a picornavirus from chickens with transmissible viral proventriculitis using metagenomic analysis. Archives of virology. 2015;160:701-9. [PMID: 25559673] [DOI]
5. Yan T, Li G, Zhou D, Yang X, Hu L, Cheng Z. Novel Cyclovirus Identified in Broiler Chickens With Transmissible Viral Proventriculitis in China. Frontiers in Veterinary Science. 2020;7(September):1-6. [PMID: 33134354] [PMCID: PMC7550471] [DOI]
6. Leão PA, Amaral CI, Santos WHM, Moreira MVL, de Oliveira LB, Costa EA, et al. Retrospective and prospective studies of transmissible viral proventriculitis in broiler chickens in Brazil. Journal of Veterinary Diagnostic Investigation. 2021;33(3):605-10. [PMID: 33769146] [PMCID: PMC8120089] [DOI]
7. Grau-Roma L, Schock A, Nofrarías M, Ali Wali N, de Fraga AP, Garcia-Rueda C, et al. Retrospective study on transmissible viral proventriculitis and chicken proventricular necrosis virus (CPNV) in the UK. Avian Pathology. 2020;49(1):99-105. [PMID: 31591909] [DOI]
8. A. Radwan I, A.E. Shehata A, H. Abed A, Reda Hosni A. Bacterial Species Associated with Broiler Proventriculitis and Antimicrobial Resistance of Clinical Important Species. Journal of Veterinary Medical Research. 2016;23(2):275-87. [DOI]
9. Grau-Roma L, Reid K, de Brot S, Jennison R, Barrow P, Sánchez R, et al. Detection of transmissible viral proventriculitis and chicken proventricular necrosis virus in the UK. Avian Pathology. 2017;46(1):68-75. [PMID: 27400318] [DOI]
10. Kubacki J, Qi W, Fraefel C. Differential Viral Genome Diversity of Healthy and RSS-Affected Broiler Flocks. Microorganisms. 2022;10(6):1-17. [PMID: 35744610] [PMCID: PMC9231120] [DOI]
11. Yan T, Zhao M, Sun Y, Zhang S, Zhang X, Liu Q, et al. Molecular evolution analysis of three species gyroviruses in China from 2018 to 2019. Virus Research. 2023;326(61):199058-. [PMID: 36731631] [PMCID: PMC10194384] [DOI]
12. Yan T, Li G, Zhou D, Hu L, Hao X, Li R, et al. Long read sequencing revealed proventricular virome of broiler chicken with transmission viral proventriculitis. BMC Veterinary Research. 2022;18(1):1-7. [PMID: 35768837] [PMCID: PMC9241223] [DOI]
13. Zhang F, Xie Q, Yang Q, Luo Y, Wan P, Wu C, et al. Prevalence and phylogenetic analysis of Gyrovirus galga 1 in southern China from 2020 to 2022. Poultry Science. 2024;103(3):103397-. [PMID: 38295496] [PMCID: PMC10846400] [DOI]
14. Zhang S, Yang J, Zhou D, Yan T, Li G, Hao X, et al. Development of a DAS–ELISA for Gyrovirus Homsa1 Prevalence Survey in Chickens and Wild Birds in China Shicheng. Veterinary Sciences. 2023;10(5). [PMID: 37235395] [PMCID: PMC10224540] [DOI]
15. Li G, Yuan S, He M, Zhao M, Hao X, Song M, et al. Emergence of gyrovirus 3 in commercial broiler chickens with transmissible viral proventriculitis. Transboundary and Emerging Diseases. 2018;65(5):1170-4. [PMID: 29923685] [DOI]
16. Bayry J. Emerging and Re-emerging Infectious Diseases of Livestock2017. 1-449 p[DOI]
17. Piryaei M, Bagheri S, Riahi A, Razmyar J. Astroviruses; Pathogenesis and Diagnosis: A Review. Journal of Poultry Sciences and Avian Diseases. 2023;1(3):1-17. [DOI]
18. Śmiałek M, Gesek M, Dziewulska D, Niczyporuk JS, Koncicki A. Transmissible viral proventriculitis caused by chicken proventricular necrosis virus displaying serological cross-reactivity with IBDV. Animals. 2021;11(1):1-11. [PMID: 33374720] [PMCID: PMC7822447] [DOI]
19. Guy JS, West MA, Fuller FJ, Marusak RA, Shivaprasad HL, Davis JL, et al. Detection of chicken proventricular necrosis virus (R11/3 virus) in experimental and naturally occurring cases of transmissible viral proventriculitis with the use of a reverse transcriptase-PCR procedure. Avian diseases. 2011;55(1):70-5. [PMID: 21500639] [DOI]
20. Singh J, Banga HS, Brar RS, Singh ND, Sodhi S, Leishangthem GD. Histopathological and immunohistochemical diagnosis of infectious bursal disease in poultry birds. Veterinary World. 2015;8(11):1331-9. [PMID: 27047039] [PMCID: PMC4774747] [DOI]

21. El-Nahas EM, El-Sayed HS, El-Basuni SS, El-Bagoury GF. A genotyping of a new avian infectious bronchitis virus isolated from chickens proventriculus in Egypt. Journal of Virological Sciences. 2017;1:54-66.
22. Kwok KTT, de Rooij MMT, Messink AB, Wouters IM, Koopmans MPG, Phan MVT. Genome Sequences of Seven Megrivirus Strains from Chickens in The Netherlands. Microbiology Resource Announcements. 2020;9(47):27-8. [PMID: 33214312] [PMCID: PMC7679105] [DOI]
23. Bi X, Song Z, Meng F, Sun S, Du X, Yang M, et al. Molecular characteristics and pathogenicity of a novel chicken astrovirus variant. Veterinary research. 2023;54(1):117-. [PMID: 38066626] [PMCID: PMC10709865] [DOI]
24. Śmiałek M, Gesek M, Dziwulska D, Samanta-Niczyporuk J, Koncicki A. Chicken proventricular necrosis virus related transmissible viral proventriculitis in broiler chickens in Poland. research Square. 2020. [DOI]
25. Yang M, Yang Q, Bi X, Shi H, Yang J, Cheng X, et al. The Synergy of Chicken Anemia Virus and Gyrovirus Homsa 1 in Chickens. Viruses. 2023;15(2):1-12. [PMID: 36851729] [PMCID: PMC9964263] [DOI]
26. Zhang S, Yuan S, Yan T, Li G, Hao X, Zhou D, et al. Serological investigation of Gyrovirus homsa1 infections in chickens in China. BMC Veterinary Research. 2022;18(1):1-8. [PMID: 35717195] [PMCID: PMC9206369] [DOI]
27. B. SchlegelA MB, OjkicB D. Proceedings of the sixty-fifth western poultry disease conference. Western Poultry Disease Conference 2016. 2016.
28. Śmiałek M, Gesek M, Śmiałek A, Koncicki A. Identification of Transmissible Viral Proventriculitis (TVP) in broiler chickens in Poland. Polish Journal of Veterinary Sciences. 2017;20(2):417-20. [PMID: 28865208] [DOI]
29. Allawe AB, Abbas AA, Taha ZH, Shony M. Detection of transmissible viral proventiculitis in Iraq. J Entomol Zool Stud. 2017;5(5):974-8.
30. Wandee, Lertwatchrasarakul P, Songserm T. Discovery of Chicken Proventricular Necrosis Virus from Transmissible Viral Proventriculitis Outbreak in Broilers, Thailand. The Thai Journal of Veterinary Medicine. 2024;53(1):63-71. [DOI]
31. Li G, Zhou D, Zhao M, Liu Q, Hao X, Yan T, et al. Kinetic analysis of pathogenicity and tissue tropism of gyrovirus 3 in experimentally infected chickens. Veterinary research. 2021;52(1):120-. [PMID: 34526128] [PMCID: PMC8442313] [DOI]
32. Marusak RA, West MA, Davis JF. Transmissible viral proventriculitis identified in broiler breeder and layer hens. Journal of Avian Medicine and Surgery. 2013;27(1):69-70. [PMID: 23397852] [DOI]
33. Merad D, Zeghdoudi M, Madi S, Bouzid R, Aoun L. Pathological, epidemiological features, and statistical study of histopathological changes in chicken transmissible viral proventriculitis. Veterinaria Mexico OA. 2024;11. [DOI]
34. Li G, Yuan S, Yan T, Shan H, Cheng Z. Identification and characterization of chicken circovirus from commercial broiler chickens in China. Transboundary and emerging diseases. 2020;67(1):6-10. [PMID: 31411792] [DOI]