IJPSR (2025), Volume 16, Issue 12 **(Review Article)**

INTERNATIONAL JOURNAL OF PHARMACEUTICAL SCIENCES AND RESEARCH

Received on 08 May 2025; received in revised form, 23 June 2025; accepted, 26 June 2025; published 01 December 2025

INNOVATIONS IN CANINE DISTEMPER MANAGEMENT: CURRENT TRENDS AND FUTURE DIRECTIONS

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Keywords:

Canine distemper, Morbillivirus, Proteins, Virus

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ABSTRACT: Canine distemper is a highly contagious and often fatal disease affecting domestic dogs and a wide range of wild carnivores. Caused by the canine distemper virus (CDV), a morbillivirus, it presents with diverse clinical signs that can complicate timely diagnosis and treatment. Over the past decades, significant progress has been made in understanding the pathogenesis, improving diagnostic techniques, and developing supportive care strategies. This review provides a comprehensive overview of current advancements in the management of canine distemper, including innovations in antiviral therapies, immunomodulatory treatments, and supportive interventions. Additionally, it highlights recent developments in vaccination protocols and the role of molecular diagnostics in early detection and prognosis. Emphasis is placed on a multidisciplinary approach to treatment and prevention, aiming to improve survival rates and reduce the global burden of the disease. The review also identifies emerging research areas that could shape future management strategies for canine distemper.

INTRODUCTION: Accurately recognizing and understanding how infectious diseases affect illness and death rates in wildlife is essential not only for guiding treatment approaches but also for supporting disease monitoring and outbreak risk evaluations. However, in most wildlife populations, detailed epidemiological data are lacking, making it difficult to determine how serious a disease threat may be. Moreover, the tools for quick and accurate identification of infectious agents are often unavailable. As a result, treatment frequently depends on preliminary or uncertain diagnoses. This issue becomes even more critical when the species affected are endangered [1].

QUICK RESPONSE CODE

DOI:
10.13040/IJPSR.0975-8232.16(12).3189-99

This article can be accessed online on
www.ijpsr.com

DOI link: https://doi.org/10.13040/IJPSR.0975-8232.16(12).3189-99

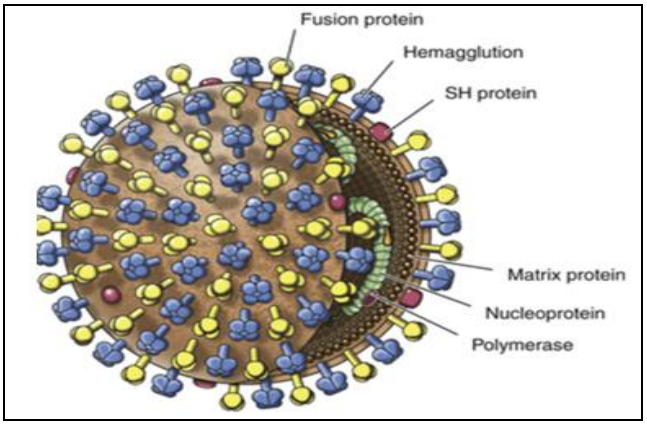

FIG. 1: CANINE DISTEMPER VIRUS

Although viral infections have been linked to significant population declines among carnivores, in-depth or long-term research on virus–carnivore dynamics in the wild is still scarce.

A prominent example is the canine distemper virus (CDV), a highly infectious pathogen responsible for canine distemper (CD) a severe and often fatal disease in carnivores around the globe. Initially detected in domestic dogs (*Canis familiaris*), CDV is now known to infect a diverse array of animals, including some non-human primates. Its ability to infect various hosts poses a serious conservation threat to both wild and captive populations of non-domestic carnivores. The virus's potential to jump between species has sparked concerns about its role in the potential extinction of vulnerable wildlife [2]. This review aims to summarize and analyze recent studies on CDV infections in wildlife, focusing on research published over the past decade since the last major review in 2001. It also highlights the latest discoveries regarding the factors influencing host range and the role of cellular receptors in the pathogenesis of canine distemper [3].

Viral Properties: Canine Distemper Virus (CDV) is a single-stranded RNA virus ranging in size from approximately 100 to 250 nanometers. It belongs to the genus *Morbillivirus* within the family *Paramyxoviridae*. Other well-known viruses within this genus include the measles virus in primates, rinderpest in hoofed animals, peste des petits ruminants in small ruminants, and distemper viruses affecting marine mammals such as seals and porpoises [4].

CDV has a lipid-based envelope that encases a non-segmented, negative-sense RNA genome about 15,690 nucleotides in length. This genome encodes six major structural and non-structural proteins:

- One membrane-associated protein: the matrix (M) protein,
- Two surface glycoproteins: the haemagglutinin (H) and fusion (F) proteins,
- Two proteins involved in transcription: the phosphoprotein (P) and the large polymerase protein (L), and
- One nucleocapsid protein (N) that wraps around the viral RNA [5].

The gene arrangement in the genome follows the order: 3′-N-P-M-F-H-L-5′, with untranslated regions (UTRs) between each gene. Two regulatory sequences flank the genome known as the leader (a 3′ non-coding region of around 52 nucleotides) and the trailer (a 5′ non-coding region of about 38 nucleotides) which are critical for the virus's replication and transcription processes [6]. Although CDV is recognized to have a single serotype, there are multiple co-circulating genotypes, particularly distinguished by differences in the H (haemagglutinin) protein. These genetic variations often correlate with geographic regions. Phylogenetic analyses of the H-gene have identified several genotype clusters, including [7]:

- America 1 (which contains nearly all current vaccine strains),
- America 2,
- Asia 1 and Asia 2,
- Europe/South America 1,
- Europe wildlife,
- South America 2 and 3,
- Arctic,
- Rockborn-like,
- Africa and Africa 2.

A genotype is defined when virus strains within a group exhibit more than 95% amino acid identity in the H-protein. Since the host immune defense against CDV largely targets the H-protein, it serves as an important molecular marker. Thus, the H-protein is especially useful for tracking genetic diversity in CDV strains and conducting molecular epidemiological studies [8].

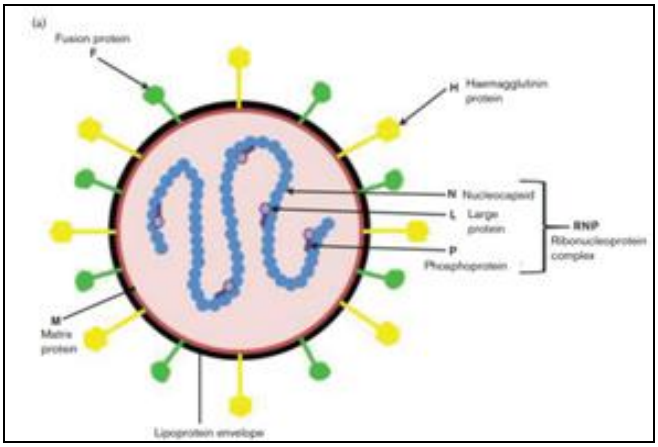

FIG. 2: CDV WITH A LIPOPROTEIN ENVELOPE (BLACK CIRCLE), CONTAINING A NON-SEGMENTED NEGATIVE-SENSE ssRNA GENOME, CONSISTING OF SIX GENES

Epidemiology: Originally identified as a disease affecting domestic dogs, Canine Distemper Virus (CDV) is now recognized as a globally distributed, multi-host pathogen. Over the years, it has been shown to affect a diverse array of carnivorous species. Its wide host range includes families such as Canidae, Felidae, Hyaenidae, Procyonidae, Ailuridae, Ursidae, Mustelidae, and Viverridae, among others. Major mortality events linked to CDV have occurred in various wildlife populations across these groups [9].

In addition to terrestrial species, CDV has also impacted aquatic mammals, with outbreaks reported among Baikal and Caspian seal populations. These marine cases are believed to have originated from transmission by infected land-dwelling carnivores [10].

In recent developments, CDV infections have been documented in non-human primates notably in rhesus monkeys (*Macaca mulatta*) and cynomolgus macaques (*Macaca fascicularis*) resulting in high mortality. These findings have raised alarms about a potential zoonotic threat, although no human cases of CDV infection have been confirmed to date. For those interested in the possibility of human susceptibility to CDV, further insights are available in a review by Cosby [11].

The notion that members of the Felidae family are resistant to CDV has been challenged by reported outbreaks in lions (*Panthera leo*), leopards (*Panthera pardus*), and tigers (*Panthera tigris*). Experimental exposure of domestic cats (*Felis catus*) to highly virulent CDV strains or tissue homogenates from infected leopards resulted in seropositivity, although clinical signs and viral shedding were absent [12].

Similarly, recent seroprevalence surveys in captive and wild cheetahs (*Acinonyx jubatus*) across Namibia indicate CDV exposure, though clinical disease is rarely observed mirroring responses seen in domestic cats [13].

Over the past decade, numerous CDV outbreaks have been reported across wildlife populations globally. Notable among these are infections in critically endangered species such as the Ethiopian wolf (*Canis simensis*) and the Amur tiger (*Panthera tigrisaltaica*). In China, concerns have arisen about the vulnerability of giant pandas (*Ailuropoda melanoleuca*), following CDV-related deaths in captive populations [14].

Despite these alarming occurrences, the true extent of CDV susceptibility in many wild species remains unclear, particularly in African ecosystems. Most available data from the continent stem from Tanzania, Kenya, and Botswana [15]. The 1994 CDV epidemic in Tanzania's Serengeti National Park remains one of the most devastating examples, resulting in the loss of one-third of the park's lion population and deaths among other carnivores such as bat-eared foxes (*Otocyon megalotis*), African wild dogs (*Lycaon pictus*), silver-backed jackals (*Canis mesomelas*), and spotted hyenas (*Crocuta crocuta*) [16].

More recently, outbreaks in South African reserves have underscored the continuing threat posed by CDV. A 2015 outbreak in the Waterberg region led to the death of 95% of a lion population on a private reserve, marking the first known case of CDV-related death in the endangered brown hyena (*Hyaena brunnea*). Just months later, two entire African wild dog packs (totaling 26 individuals) were wiped out in Kruger National Park and the Tswalu Kalahari Reserve [17].

These incidents highlight not only the broad host range of CDV but also the conservation risks it poses, particularly for endangered species already struggling with small population sizes and habitat loss [18].

Transmission and Stability: Canine Distemper (CD) is a highly contagious disease that spreads rapidly among vulnerable hosts. The primary modes of transmission include direct contact and exposure to aerosolized secretions such as saliva, respiratory droplets, and ocular discharge from infected animals [19]. During the acute phase of infection, additional bodily excretions, including urine, feces, and even skin, can serve as sources of viral particles. Notably, infected animals can shed the virus for up to 90 days, even if they show no outward signs of illness, making subclinical cases particularly dangerous for uncontrolled spread [20]. CDV is environmentally fragile, being highly susceptible to ultraviolet (UV) light, heat, drying out, detergents, oxidizing chemicals, and lipid

solvents. Under normal room conditions, the virus remains viable only for a short period typically between 20 minutes and 3 hours in organic materials like secretions or tissues. However, if shielded by organic matter and exposed to freezing temperatures, the virus can persist for several days. Despite this, successful transmission still relies heavily on close contact between infected and susceptible individuals [21].

For a CDV outbreak to be sustained, two conditions are typically necessary: dense populations of susceptible animals and the ongoing presence of a biological reservoir. Among these reservoirs, domestic dogs (*Canis familiaris*) play a pivotal role. Their widespread presence, particularly near wildlife conservation zones, poses a significant risk for disease spread. Often found in large numbers and with limited access to vaccination, dogs in rural or peri-urban communities can easily become a source of infection for nearby wildlife. These domestic animals frequently roam into protected or unfenced areas, coming into contact with wild carnivores, thereby facilitating viral transmission across species boundaries [22].

The threat is further compounded by a lack of systematic vaccination programs, especially in under resourced regions. Cross-species transmission amplifies this problem, as CDV is capable of infecting a wide range of carnivores. Encounters among animals such as jackals, hyenas, and lions at carcass sites create ideal conditions for interspecies spread, highlighting the complex and multi-host dynamics that sustain the virus in ecosystems [23].

Clinical Signs: The clinical symptoms of Canine Distemper Virus (CDV) in wild animals often mirror those observed in domestic dogs. However, the intensity and outcome of the disease can differ significantly between species. Factors influencing these differences include the virulence of the virus strain, the age of the infected animal, and its immune system status. Early signs of infection are usually mild and often go unnoticed, especially in free-ranging wildlife [24].

FIG. 3: TEETH OF A BROWN HYENA (*HYAENA BRUNNEA*) THAT DIED OF CDV SHOWING ENAMEL HYPOPLASIA DUE TO PRESUMED PRIOR INFECTION AS A JUVENILE (PHOTO: A. K. LOOTS)

If the infected animal mounts a robust immune response, visible symptoms may not develop, and the disease remains subclinical. In domestic dogs, it's estimated that around 50–70% of infections do not result in clinical disease. On the other hand, animals with a weaker immune system might show vague, non-specific symptoms such as lethargy, reduced appetite, and fever. Even in cases where recovery occurs, the virus can persist in certain tissues for long periods, including the nervous system, uveal tract, urinary tract, and skin. In dogs, one notable skin-related sign is hyperkeratosis the thickening of paw pads or nasal skin. Additionally, if infection occurs in young animals before permanent teeth erupt, the virus may damage developing tooth structures, leading to enamel defects (enamel hypoplasia) [25].

Two distinct clinical forms of CDV can manifest in animals with little to no immune defense:

Acute Systemic Form: This develops roughly 2–3 weeks post-infection and involves widespread viral replication. Symptoms include:

- High fever
- Thick, yellowish discharge from eyes and nose
- Coughing and difficulty breathing
- General weakness and lack of appetite
- Gastrointestinal issues like vomiting and diarrhea

At this stage, the virus is present in all body fluids, making it highly contagious [26].

Chronic Neurological Form: Neurological symptoms may appear alongside or after the systemic phase, typically within 2–3 weeks. These signs vary depending on the brain regions involved and may include:

- ❖ Behavior changes and disorientation
- ❖ Seizures and jaw-chomping motions (chewing-gum fits)
- ❖ Vision loss
- ❖ Balance issues, tremors, and lack of coordination
- ❖ Partial or full paralysis
- ❖ Walking in circles (circling behavior)

The infection causes acute demyelination in the brain and spinal cord, often leading to death within two to four weeks after symptoms begin [27].

Due to its ability to suppress the immune system, CDV frequently leads to secondary infections, particularly of the skin and respiratory tract, further complicating the clinical picture [28].

Pathogenesis: To prevent Canine Distemper Virus (CDV) infection, it's crucial to understand the potential hosts that are susceptible and the pathways through which the virus enters the host cells, as well as its capacity to initiate viral shedding. In domestic dogs, CDV typically enters the body through the nasal or oral routes, where it initially comes into contact with the epithelium of the upper respiratory tract. The virus then multiplies within macrophages in the tissue. Within 24 hours, it spreads via the lymphatic system to the tonsils and respiratory lymph nodes, leading to severe immunosuppression [29].

In 2–4 days, CDV infects additional lymphoid tissues, and by day 6, the virus spreads to the gastrointestinal mucosa, Kupffer cells in the liver, and the spleen, triggering a systemic response characterized by fever and a decrease in white blood cell count (leukopenia). CDV continues to spread through cell-associated viremia, targeting epithelial cells and the central nervous system [30].

Viral shedding typically begins about one week after infection, with the virus being present in various excretions and secretions from the host.

Host Range Specificity: The specificity of a virus's host range is determined by several factors, including the mechanisms through which the virus enters host cells via specific cellular receptors and the host's ability to respond to the infection through its innate and/or adaptive immune responses [31].

Two major cellular receptors have been identified that are crucial for Canine Distemper Virus (CDV) pathogenesis: signaling lymphocyte activation molecule (SLAM, CD150) and nectin-4 (also known as poliovirus receptor-like-4). Both of these receptors have an immunoglobulin-like variable domain (V), which provides a binding surface for morbilliviruses.

SLAM functions as a receptor on immune cells and is expressed on activated T and B lymphocytes, dendritic cells, and macrophages. The second receptor, nectin-4, was only recently identified as the epithelial cell receptor for CDV. Nectin-4 plays a role in cell adhesion and is involved in organizing the junctions between epithelial and endothelial cells of the host. It is believed to act as an exit receptor, playing a role in the later stages of the infection when the virus is amplified and released from epithelial cells [32].

SLAM (CD150): Among the six structural proteins of Canine Distemper Virus (CDV), the H protein

exhibits the most significant genetic variation and plays a crucial role in the virus's attachment to host cell receptors. The interaction between CDV-H and SLAM, along with its potential as a key determinant of the virus's host range, has been extensively studied. Specific amino acid residues, such as Y525, D526, and R529, in CDV-H have been shown through site-directed mutagenesis to interact with SLAM. Additionally, amino acid residues 530 and 549 have been explored, and these are believed to be important factors in the virus's infectivity within carnivores. Both residues 530 and 549 are located in the receptor-binding domain on propeller b-sheet 5 of the CDV-H protein [33].

FIG. 4: AFRICAN WILD DOG (*LYCAON PICTUS*) AFFLICTED BY CDV SHOWING CLINICAL SIGNS OF MUCOPURULENT OCULONASAL DISCHARGE (A, B) AND WEIGHT LOSS (C) (PHOTOS: A. K. LOOTS)

Earlier studies suggested that residue 530 might represent an adaptation of CDV to non-domestic dog hosts. However, it has since been found that this residue is conserved across CDV lineages, regardless of the host species. On the other hand, positive selection at site 549 of CDV-H, along with the substitution of tyrosine (Y) with histidine (H) at this site, is thought to have facilitated the spread of CDV from domestic dogs to other non-dog species. CDV strains isolated from Canidae typically have Y at site 549, while strains from other carnivore families predominantly have H. Although studies on specific amino acid substitutions in the H protein are still speculative, other factors could also contribute to the spread of CDV [34].

Comparing the amino acid sequences of the H binding site in SLAM across various carnivore species reveals a high degree of similarity among Canidae species, suggesting a similar sensitivity to CDV within this group. In contrast, when comparing Felidae to Canidae, several differences in residues were identified, leading to changes in the electric charge at the SLAM interface in felids.

This suggests that CDV strains adapted to bind to dog SLAM receptors may not bind as efficiently to SLAM receptors from other non-canid hosts [35].

Nectin-4: Recent studies have shed light on the role of nectin-4, an epithelial receptor, in the pathogenesis of canine distemper virus (CDV) within domestic dogs. Following infection, typically between six to nine days, CDV targets epithelial cells across various systems in the body, including the respiratory, gastrointestinal, urinary, and endocrine systems. Nectin-4 serves as the key gateway facilitating the virus's entry into these cells. Once inside, the virus multiplies, leading to its release and the manifestation of severe symptoms affecting the respiratory tract, skin, and intestines.

In dogs with compromised immune defenses, the virus can progress to the central nervous system, triggering neurological complications. While nectin-4 has been implicated in promoting neurovirulence, it is possible that other unidentified receptors also play a role. Additionally, two variants of nectin-4 proteins have been identified, both of which are effective in enabling the virus to invade cells and spread between them [36].

Diagnosis: Due to the highly infectious nature of canine distemper virus (CDV), combined with its rapid progression and significant mortality rate, diagnosing the disease before death is strongly

preferred. Initial diagnosis largely relies on recognizing the clinical symptoms associated with CDV infection. However, this approach poses challenges because the disease presents with a wide variety of symptoms, making it difficult to distinguish from other illnesses that affect the respiratory, neurological, or gastrointestinal systems. These include rabies, feline panleukopenia, coronavirus, toxoplasmosis, bacterial enteritis, and parvovirus [37].

To address this, various serological and immunological diagnostic tests have been developed for detecting CDV in domestic dogs. Diagnosing CDV in wildlife populations, however, is more complex. Field conditions often make it difficult to collect and properly store samples for laboratory testing. For wildlife, confirmation of CDV infection is typically achieved post-mortem using histopathological analyses and immunological tissue staining techniques, although their accuracy in terms of specificity and sensitivity remains unclear for many species [38].

Molecular Assays: Advances in molecular techniques have introduced highly effective diagnostic tools known for their accuracy and precision in detecting pathogens like canine distemper virus (CDV). One such method is the reverse-transcription PCR (RT-PCR) assay, which targets the conserved N gene of the virus and has been widely used due to its sensitivity and speed compared to traditional culturing methods. However, RT-PCR remains a technically demanding process requiring several hours and additional steps for post-PCR analysis. Factors such as sample type, extraction procedures, and primer selection can influence the sensitivity of this technique [39].

For quicker diagnostics, real-time RT-PCR has gained prominence, serving purposes in both research and clinical settings. This approach is particularly effective for pathogen identification. Scagliarini et al. advanced the field by developing a rapid and sensitive real-time RT-PCR assay using TaqMan technology, which successfully detects and quantifies CDV in both clinical samples and cell cultures. This assay is based on a conserved region of the P gene and has demonstrated high sensitivity in one-step and two-step reaction formats, making it an excellent tool for research and diagnostics. In addition, nested PCR techniques have been employed for CDV detection. Shin et al. and Alcalde *et al.* utilized a nested PCR method built upon the product of a conventional one-step RT-PCR assay. Fischer *et al.* went further by designing a nested real-time PCR technique following reverse transcription. This innovative method, tested on various clinical samples, showed a sensitivity level significantly higher by two orders of magnitude than standard RT-PCR [40].

Serological Assays: Several serological tests are employed to detect and measure antibody levels against canine distemper virus (CDV), including the indirect fluorescent antibody test (IFAT), ELISA, and the serum-neutralization test. Both IFAT and ELISA are utilized to identify IgM and IgG antibodies targeting CDV in domestic dogs as well as other hosts. The presence of IgM not only confirms an active acute infection but can also retrospectively diagnose the disease by revealing seroconversion in paired serum samples collected during the acute phase and the recovery phase.

However, a challenge arises in wildlife cases, where conjugated antispecies antibodies compatible with IFAT or ELISA are not always available. A systematic review examining CDV hosts beyond domestic dogs revealed that ELISA was utilized in 13.8% of studies, whereas IFAT was employed in 7.7%. The serum-neutralization test, known for its high specificity and sensitivity, was used in 75.4% of cases, making it the preferred method for detecting antibodies and often considered the gold standard.

Nevertheless, serological testing alone is insufficient for differentiating between infections caused by naturally occurring CDV strains, attenuated vaccine strains (like those in the modified live vaccine or MLV), and immune responses from recombinant virus-vector vaccines. For improved accuracy, serological assays are best combined with techniques such as RT-PCR or viral antigen ELISA [41].

Virus Isolation: Virus isolation is commonly performed using pulmonary alveolar macrophages or through the co-culture of infected tissues with mitogen-stimulated lymphocytes from healthy dogs

or ferret blood lymphocytes. These approaches, while effective, are labour-intensive and require significant time often several days to weeks. A breakthrough occurred in 2003 with the development of Vero cells engineered to express canine SLAM, the main receptor for morbilliviruses in living organisms. These specialized Vero.DogSLAM cells exhibit remarkable sensitivity to virus isolation, showcasing cytopathic effects within just 24 hours of inoculation [42].

Pathological Examination: Post-mortem diagnosis of canine distemper virus (CDV) typically involves a thorough pathological examination of various organs, including the spleen, lymph nodes, stomach, lungs, small intestine, liver, pancreas, urinary bladder, kidneys along with the renal pelvis, and the brain. Diagnostic confirmation is achieved by identifying characteristic histopathological changes, such as viral inclusion bodies found in the lymphoid tissues, epithelium of the respiratory, gastrointestinal, and urinary tracts, as well as in the brain. Additional methods include observing distinct virions using electron microscopy with negatively stained preparations of fecal matter, as well as detecting viral antigens within tissues via immunofluorescence or immunohistochemistry.

While immunofluorescence is a commonly used diagnostic tool, it has limitations in sensitivity. It is only capable of detecting CDV antigens when the virus is actively present in epithelial cells, and certain clinical conditions may lead to false-negative results [43].

Management of Canine Distemper: Canine distemper is a widespread viral illness that affects various body systems in dogs, including the respiratory, gastrointestinal, and nervous systems. Due to the lack of a specific antiviral cure, treatment primarily focuses on relieving symptoms, supporting the immune system, and preventing complications like secondary bacterial infections. Early identification and consistent supportive care play a major role in improving the animal's recovery chances. Modern veterinary practices now incorporate a blend of traditional care and newer, research-based interventions to enhance treatment outcomes [44].

TABLE 1: KEY STRATEGIES FOR MANAGING CANINE DISTEMPER

Category	Strategies
Vaccination	Administer routine vaccinations to prevent infection.
Early Diagnosis	Look out for symptoms like fever, nasal discharge, coughing, and lethargy.
Quarantine	Isolate infected dogs to prevent the spread of the virus.
Hydration	Ensure the dog stays hydrated; provide intravenous fluids if needed.
Medications	Prescribe antiviral drugs and antibiotics to combat secondary infections.
Nutritional Support	Offer a nutritious diet and supplements to boost immunity.
Symptom Management	Use fever reducers and anti-seizure medications as advised by a veterinarian.
Hygiene Measures	Maintain a clean environment to reduce viral transmission.
Veterinary Support	Regularly consult a veterinarian for monitoring and treatment adjustments.
Post-Recovery Care	Provide ongoing care to manage any lasting effects like neurological issues.

FIG. 5: MANAGING DOGS FROM CANINE DISTEMPER

Treatment and Control: Managing and treating infectious viral diseases like canine distemper virus (CDV) is particularly challenging, especially in wildlife populations. Since there is no specific

antiviral drug available for treating CDV in any species, including domestic dogs, therapeutic efforts focus primarily on symptomatic and supportive care. Research continues into the use of antiviral compounds against CDV *in-vitro*, but additional studies are necessary to establish their safety and effectiveness across different species [45].

One promising advancement comes from Krumm *et al.,* who tested an orally administered, shelf-stable pan-morbillivirus inhibitor targeting viral polymerase. Their findings revealed that treating CDV-infected ferrets during the viraemia stage led to reduced viral loads, absence of symptoms, and full recovery. Another compound, fucoidan, derived from brown algae, demonstrated efficacy in vitro by suppressing syncytia formation and interfering with early stages of viral replication. Carvalho and colleagues investigated the antiviral properties of various flavonoids (quercetin, morin, rutin, hesperidin) and phenolic acids (cinnamic, trans-cinnamic, ferulic acids), all of which exhibited antiviral activity against CDV during different phases of its replication cycle. Additional experimental approaches include mesenchymal stem cell therapy and the use of veterinary pharmaceutical silver nanoparticle preparations [46].

Vaccination remains the most effective preventive strategy against CDV. The 1960s saw the development of two modified live vaccines (MLVs): the Onderstepoort vaccine, derived from natural isolates adapted through passage in ferrets and chicken cells; and the Rockborn strain vaccine, adapted to canine kidney cells. These MLVs have been effective in managing CDV in domestic dogs but, in rare cases, have caused vaccine-induced illnesses, including post-vaccination encephalitis. Cross-species responses to vaccination vary, with some species showing susceptibility to vaccine-related complications. For instance, an avian cell-adapted CDV vaccine proved fatal for European mink and ferrets but offered protection for maned wolves, fennec foxes, and red and grey foxes [47].

Concerns about MLV efficacy have led to the creation of recombinant vaccines like the canarypox-vectored vaccine. This vaccine, which cannot replicate in host cells, effectively triggers immune responses and has been tested in wildlife species, including European ferrets, fennec foxes, giant pandas, Siberian polecats, and meerkats. In tigers, studies comparing live attenuated vaccines and recombinant canarypox-vectored vaccines revealed that both were safe, but the live attenuated version produced more robust immune responses. Despite these advances, data on CDV vaccine efficacy in wildlife remain limited. Efforts to vaccinate domestic dogs near conservation areas, while beneficial, often fall short of achieving the 95% coverage necessary to control CDV, leaving wildlife at risk [48].

The question of vaccinating endangered wildlife is a complex one, with several challenges to consider: (1) evaluating vaccine safety and effectiveness for the target species, (2) selecting an appropriate delivery method whether during routine handling, via hypodermic dart, or through oral bait, all of which have limitations, (3) ensuring logistical feasibility of administering booster doses, and (4) accounting for the cost of establishing and maintaining wildlife vaccination programs [49].

CONCLUSION: Canine distemper virus (CDV) is a rising concern that poses a significant threat to the survival of both captive and free-ranging wildlife species. Its capacity to infect multiple host species complicates efforts to control and eliminate the disease. Historically, research on CDV has primarily focused on domestic dogs, leaving a substantial gap in studies related to wildlife. Understanding the factors that affect host vulnerability and the mechanisms of CDV pathogenesis across both known and potential hosts is crucial. Further exploration of the two established cellular receptors, SLAM and nectin-4, in diverse wildlife species could provide valuable insights into the virus's host specificity.

ACKNOWLEDGEMENTS: Nil

CONFLICTS OF INTEREST: Nil

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How to cite this article:
Pandey T, Sahu P, Sahu D, Shanikar S, Nayak Y, Sahu GK and Sharma H: Innovations in canine distemper management: current trends and future directions. Int J Pharm Sci & Res 2025; 16(12): 3189-99. doi: 10.13040/IJPSR.0975-8232.16(12).3189-99.

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