Mini Review

Canine and Feline Parvovirus: A Veterinary Review

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Abstract | Parvovirus is a highly contagious viral disease that primarily affects puppies and kittens, causing high mortality rates if not treated promptly. It is one of the most serious viral diseases affecting pets and is transmitted through contaminated feces or contaminated tools and surfaces. The causative agent is canine parvovirus (CPV) in dogs and feline panleukopenia virus (FPV) in cats, both of which belong to the Parvoviridae family. The virus is highly resistant to environmental factors and is resistant to long-term infection. Clinical signs include lethargy, loss of appetite, vomiting, watery or bloody diarrhea, high fever, and severe dehydration. In cats, leukopenia can also occur, leading to a weakened immune system. Diagnosis is made by clinical examination supported by stool analysis to detect the virus using tests such as ELISA, as well as a complete blood count, which shows a decreased white blood cell count. Treatment is primarily supportive and includes intravenous fluids to rehydrate, antibiotics to prevent secondary infection, and antiemetics. There is no specific treatment for the virus itself. Prevention relies on early and regular vaccination, isolation of infected animals, and regular environmental disinfection. Conclusion: Parvovirus is a serious disease, but it is easily preventable through adherence to vaccination and hygiene. Early diagnosis and treatment significantly improve the chances of survival.

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Introduction

Parvovirus is one of the most serious viral diseases affecting dogs and cats, characterized by its rapid spread and severe symptoms, especially among unvaccinated puppies and kittens (Abdelhameed *et al*., 2025). This virus belongs to the Parvoviridae family and includes two main types: canine parvovirus (CPV) and feline panleukopenia virus (FPV), also known as "feline distemper." Canine parvovirus first appeared in the late 1970s and is believed to have arisen as a result of genetic mutations in FPV that enabled it to infect dogs. Since then, the virus has evolved into several strains, such as CPV-2a, CPV-2b, and CPV-2c, which have also shown the ability to infect cats (Capozza *et al*., 2021). The virus targets rapidly dividing cells, such as those of the gastrointestinal tract and bone marrow, leading to severe symptoms including vomiting, bloody diarrhea, lethargy, loss of appetite, and severe dehydration. In cats, the virus causes a severe drop in white blood cell count, weakening the immune system and increasing

the risk of secondary infection (Abdelhameed *et al*., 2025). The disease is usually diagnosed through clinical examination supported by laboratory tests, such as the ELISA test to detect the virus in feces, and a complete blood count, which shows a drop in white blood cells (Tuteja *et al*., 2022). There is no specific treatment for the virus, so treatment focuses on supporting the infected animal by replacing lost fluids, administering antibiotics to prevent secondary infections, and antiemetics. Prevention is the first line of defense against this disease (Dos Santos *et al*., 2023). It includes regular vaccination, especially in the early stages of the animal's life, immediate isolation of infected animals, and regular environmental disinfection with effective disinfectants (Rehme *et al*., 2022). In conclusion, parvovirus is a serious threat to the health of dogs and cats, especially in environments lacking effective vaccination programs. Therefore, adherence to vaccination and hygiene are among the most important preventative measures to protect pets from this deadly disease.

History

Parvovirus is considered one of the most important and dangerous viral diseases affecting dogs and cats throughout modern history. This virus has only been known in the past few decades, yet it has left a significant mark on the field of veterinary medicine, not only because of the severity of its symptoms and the high mortality rates it causes, but also because of its rapid mutation, widespread spread, and genetic evolution, which make its control a constant challenge. The importance of studying this virus lies in understanding its evolutionary history and transmission between species, in addition to its significant impact on veterinary public health, and the history of its response through vaccination and containment (Decaro and Buonavoglia, 2012). The story of parvovirus actually begins with cats, not dogs. Before the discovery of canine parvovirus (CPV) in the 1970s, its feline counterpart, feline panleukopenia virus (FPV), had been known since the early 20th century. This virus, believed to be a direct or very close ancestor of CPV, caused fatal epidemics among cats in shelters, farms, and even wild cats. The disease caused by this virus was initially called "cat plague" due to its rapid and fatal nature, resulting in mass deaths of cats, especially young ones, within days of the onset of symptoms (Ybañez *et al*, 2026). During the first decades of the 20th century, scientific understanding of the disease was limited. Infection was often attributed to unknown causes, due to the similarities between the symptoms caused by FPV and other diseases. With the development of virology after World War II, the picture began to clear, and researchers were able to isolate the virus responsible and classify it as a member of the Parvoviridae family. This step paved the way for the development of targeted vaccines, which were achieved in the 1950s and 1960s, when the first effective vaccines against FPV were introduced, significantly reducing morbidity and mortality rates in domestic cats (Weidinger *et al*., 2024). With such progress in controlling the disease in cats, no one expected that a similar, more virulent virus would emerge, threatening dogs worldwide. In 1978, veterinarians in various parts of the world, including Australia, Europe, and the United States, began reporting a new disease affecting dogs, characterized by severe bloody diarrhea, vomiting, rapid weight loss, and a drop in white blood cell count. This was surprising, as the virus had not previously been known, and its spread was explosive. Within less than two years, the disease had become endemic on nearly every continent, an unprecedented epidemiological phenomenon that surprised and worried scientists (Miranda and Thompson, 2021). Analysis of samples revealed that the new virus belonged to the same family as FPV and had a genetic structure very similar to it, up to 98%. This led scientists to believe that the new canine virus, dubbed Canine Parvovirus Type 2 (CPV-2), had recently evolved from a virus that infects cats or related wild animals, such as foxes or raccoons. Indeed, some molecular studies support the hypothesis that CPV-2 arose as a result of one or more mutations in the VP2 protein, enabling it to recognize receptors on canine cells rather than those on feline cells (Pérez *et al*., 2020). From the moment of its emergence, CPV-2 was a highly contagious and rapidly progressive pathogen. Young dogs, especially those that were not vaccinated, were most susceptible to infection. Intensive breeding conditions on farms and shelters, and the lack of effective vaccines at the time, contributed to the spread of the virus. Biologically, CPV-2 targeted rapidly dividing cells, particularly in the intestinal mucosa and bone marrow. This cytopathic orientation explains the severe clinical symptoms, which include vomiting, bloody diarrhea, fluid loss, and a severe drop in white blood cell count, making infected animals susceptible to secondary infection (Batista *et al*., 2022). It was only a few years before new strains of the virus began to emerge. In the

early 1980s, new mutations emerged, dubbed CPV-2a and then CPV-2b. These strains were also capable of infecting cats, an unexpected development that raised concerns that the virus could become a dual threat to both cats and dogs. Another strain, known as CPV-2c, emerged in the late 1990s. It was first discovered in Italy but later spread to other regions, such as South America, Asia, and North Africa. This strain, although similar in symptoms, showed partial resistance to some older vaccines, necessitating the development of updated and comprehensive vaccines (Miranda and Thompson, 2021). Over the following decades, scientists continued to monitor the evolution of the virus. With the advancement of genetic sequencing techniques, researchers were able to track mutations occurring in the VP2 gene, responsible for the surface protein that determines the immune system's response (Müller and Cattaneo, 2020). It became clear that these mutations may be responsible for differences in virulence, incubation period, and even response to treatment and medical support. Studies have also revealed that the virus can remain active in the environment for several months, especially in cold and humid locations, making it one of the most challenging veterinary viruses to control environmentally (Yuan *et al*., 2021). On the other hand, the widespread spread of the virus has raised other environmental concerns. Cases of infection in wildlife have been documented, raising questions about the role of wildlife as reservoirs of the virus and the possibility of new strains emerging through cross-breeding between different viruses in multiple hosts. Cross-infection between cats and dogs has also become possible in some cases, particularly with CPV-2a and CPV-2b strains, further complicating the epidemiological landscape (López and González, 2022). Despite these challenges, vaccination programs have played a significant role in containing the spread of the virus, especially in countries with strict dog and cat vaccination policies. However, the challenge remains in developing countries, where organized prevention programs are sometimes absent, and many shelters and shelters lack adequate facilities.

Epidemiology

Infection typically begins when an animal ingests viral agents orally, through contact with contaminated feces, contaminated surfaces, shared eating utensils, or even through indirect contact such as transmission via hands or shoes. After entering the mouth, the virus passes through the pharynx to the gastrointestinal tract, temporarily residing in the pharyngeal lymph nodes, the first sites where it begins to replicate. Parvovirus has a particular preference for rapidly dividing cells, which is why it initially selects lymphocytes (Pérez and Hernández, 2021). It uses the cell's own mechanisms to replicate within their nuclei, since it lacks its own replication enzymes. The virus begins replicating in these cells, causing necrosis and cell death that triggers initial immune responses. New viral particles then enter the bloodstream, causing viral viremia, which allows the virus to reach other organs. As the virus spreads in the blood, it begins targeting other tissues containing rapidly dividing cells. The virus's primary target is the small intestine, specifically the intestinal villi, which contain epithelial cells that undergo rapid division to compensate for daily damage (Parrish and Connell, 2022). The virus enters these cells and begins to destroy them, resulting in the sloughing off of the mucous layer and the loss of the protective barrier between the intestinal lumen and the bloodstream, opening the way for intestinal bacteria to penetrate the body. This damage leads to severe gastroenteritis accompanied by severe bloody diarrhea and massive loss of fluids and proteins, leading to severe dehydration and circulatory collapse. In addition, the immune cells present in Peyers' plaques, which form part of the intestinal immune system, are damaged, further exacerbating the weakened immune system (Xu *et al*., 2022). The virus also targets the bone marrow, where hematopoietic stem cells are located. The destruction of these cells leads to a sharp drop in the number of white blood cells, particularly neutrophils, leaving the body without an effective defense against bacterial invasion. This immune deficiency is a major cause of mortality because it makes the infected animal vulnerable to secondary infections that enter through the damaged intestinal lining. The result is a generalized toxic state, which can rapidly lead to circulatory shock and sudden death if immediate medical intervention is not provided. In very young puppies, especially those infected during the first weeks of life, the virus can target the heart muscle, causing inflammation and necrosis of myocardial cells (Dines *et al*., 2023). This rare but extremely serious condition often leads to sudden death without significant gastrointestinal signs. Although this cardiac form of the disease has become rare thanks to early vaccination programs, it still persists in some unvaccinated animal populations. In cats, panleukopenia virus follows a very similar course, initially infecting lymphocytes and then

moving to the intestine and bone marrow, causing a severe clinical picture accompanied by severe leukopenia, diarrhea, vomiting, and high fever. But the key difference between cats and dogs is that the virus can infect fetuses if the mother is infected during pregnancy, leading to failure of the cerebellum to form, a permanent neurological condition known as cerebellar hypoplasia that results in permanent ataxia in the newborn kitten's movements.

Pathogenesis

Infection typically begins when an animal ingests viral agents orally, through contact with contaminated feces, contaminated surfaces, shared eating utensils, or even through indirect contact such as transmission via hands or shoes. After entering the mouth, the virus passes through the pharynx to the gastrointestinal tract, temporarily residing in the pharyngeal lymph nodes, the first sites where it begins to replicate. Parvovirus has a particular preference for rapidly dividing cells, which is why it initially selects lymphocytes (Decaro and Buonavoglia, 2012). It uses the cell's own mechanisms to replicate within their nuclei, since it lacks its own replication enzymes. The virus begins replicating in these cells, causing necrosis and cell death that triggers initial immune responses. New viral particles then enter the bloodstream, causing viral viremia, which allows the virus to reach other organs. As the virus spreads in the blood, it begins targeting other tissues containing rapidly dividing cells. The virus's primary target is the small intestine, specifically the intestinal villi, which contain epithelial cells that undergo rapid division to compensate for daily damage (Liu and liao, 2021). The virus enters these cells and begins to destroy them, resulting in the sloughing off of the mucous layer and the loss of the protective barrier between the intestinal lumen and the bloodstream, opening the way for intestinal bacteria to penetrate the body. This damage leads to severe gastroenteritis accompanied by severe bloody diarrhea and massive loss of fluids and proteins, leading to severe dehydration and circulatory collapse. In addition, the immune cells present in Peyers' plaques, which form part of the intestinal immune system, are damaged, further exacerbating the weakened immune system. The virus also targets the bone marrow, where hematopoietic stem cells are located. The destruction of these cells leads to a sharp drop in the number of white blood cells, particularly neutrophils, leaving the body without an effective defense against bacterial invasion. This immune deficiency is a major cause of mortality because it makes the infected animal vulnerable to secondary infections that enter through the damaged intestinal lining (Nourbakhsh *et al*, 2026). The result is a generalized toxic state, which can rapidly lead to circulatory shock and sudden death if immediate medical intervention is not provided. In very young puppies, especially those infected during the first weeks of life, the virus can target the heart muscle, causing inflammation and necrosis of myocardial cells. This rare but extremely serious condition often leads to sudden death without significant gastrointestinal signs. Although this cardiac form of the disease has become rare thanks to early vaccination programs, it still persists in some unvaccinated animal populations. In cats, panleukopenia virus follows a very similar course, initially infecting lymphocytes and then moving to the intestine and bone marrow, causing a severe clinical picture accompanied by severe leukopenia, diarrhea, vomiting, and high fever (Decaro and Buonavoglia, 2012). But the key difference between cats and dogs is that the virus can infect fetuses if the mother is infected during pregnancy, leading to failure of the cerebellum to form, a permanent neurological condition known as cerebellar hypoplasia that results in permanent ataxia in the newborn kitten's movements.

Clinical symptoms

Parvovirus in cats and dogs is one of the most serious viral diseases affecting pets. It is considered a highly contagious disease that requires rapid intervention and a thorough understanding of clinical symptoms to avoid fatal complications. The virus belongs to the Parvoviridae family and is most prevalent among young puppies and unvaccinated cats. The severity of symptoms varies between cats and dogs, but many of the clinical manifestations overlap, which can be recognized and monitored by veterinarians or pet owners (Zhou *et al*., 2024). In dogs, the virus is known as Canine Parvovirus type 2 (CPV-2), while in cats, it is known as Feline Panleukopenia Virus (FPV). Both affect rapidly dividing cells, primarily attacking the gastrointestinal tract, bone marrow, and immune system. The clinical signs displayed by an infected animal reflect the true internal effects of the virus and are important in that they are the first step toward prompting a diagnosis and appropriate therapeutic action (Prittie, 2004; Mazzaferro, 2020). Clinical signs in dogs typically begin after a short incubation period of 3 to 7 days. One of the first noticeable signs is a sudden loss of appetite, with the puppy refusing to eat or drink. This is followed by general lethargy and

apathy, with the puppy appearing inactive, sleeping for long periods, and showing no desire to play or interact with its surroundings. This lethargy results from a general deterioration in the body's condition resulting from the virus's impact on immune cells and a decrease in white blood cells (Prittie, 2004). One of the most prominent clinical signs of parvo in dogs is recurrent vomiting, which is frothy or watery, and in some cases, takes on a dark yellow or brown color. Vomiting occurs as a result of gastritis and irritation of the intestinal lining caused by the virus. This symptom is accompanied by severe diarrhea, which is watery and has a very foul odor, and often contains blood from the erosion of the walls of the small intestine. This diarrhea leads to rapid fluid loss, causing severe dehydration, manifested by loss of skin elasticity, dry mucous membranes, sunken eyes, and decreased urination (Horecka *et al*., 2020; Umar *et al*., 2024).). Fever is also a primary symptom, and can be very high at the onset of the disease, reaching temperatures as high as 41˚C. As the condition progresses and circulation deteriorates, the temperature may drop sharply, a telltale sign of the onset of shock. These symptoms are accompanied by severe abdominal pain, which becomes more pronounced when touched or picked up. The dog expresses its pain by whining, arching its back, or attempting to evade any contact (Mazzaferro, 2020). Blood tests show a severe drop in white blood cells, a hallmark of this disease. The virus targets the bone marrow and inhibits the formation of defense cells, increasing the risk of secondary bacterial infection. At this stage, dogs often develop septicemia due to the breakdown of the intestinal barrier and the leakage of bacteria into the bloodstream, worsening symptoms and leading to septicemia (Zhou *et al*., 2024; Kumar *et al*., 2022). In cats, feline panleukopenia virus (FPV) produces similar effects with slight differences. Clinical symptoms appear after an incubation period of 2 to 10 days. Signs begin with loss of appetite and general lethargy, followed by fever that may reach high levels. Infected cats are observed to avoid areas of activity, preferring secluded corners, and not responding to external stimuli as usual. Signs of dehydration appear rapidly due to vomiting and diarrhea, with dry noses and gums and decreased skin elasticity observed (Al-Mashhadani *et al*., 2024). Vomiting in cats is usually yellow and occurs after eating or even on an empty stomach. Diarrhea can be watery or bloody in advanced stages, leading to rapid weight loss and general weakness. Another distinguishing feature in kittens infected with parvovirus is the neurological impact. The virus destroys cells in the cerebellum if the infection occurs during pregnancy or in the first days after birth, causing staggering and difficulty with movement, a condition known as cerebellar hypoplasia (Kim *et al*., 2023). Blood tests in cats show a low white blood cell count and a low platelet count, which weakens the immune system and makes the cat susceptible to secondary infections. Biochemistry tests also reveal imbalances in electrolyte levels, such as sodium and potassium, a direct result of fluid loss (Li *et al*., 2024). A comprehensive and integrated understanding of the clinical signs is a pivotal step in combating parvovirus, especially given the rapid progression of the disease and the difficulty of controlling it in advanced stages. Clinical diagnosis relies heavily on careful observation of these symptoms, in addition to the use of diagnostic methods such as the ELISA test to detect viral antigens in the stool, and PCR tests to confirm the molecular diagnosis (Zhou *et al*., 2024; Kumar *et al*., 2022). Factors that increase the severity of symptoms in both cats and dogs include young age, lack of preventive vaccinations, poor nutrition, and the presence of intestinal parasites that weaken the body beforehand. Furthermore, some dog breeds, such as Rottweilers and Doberman Pinschers, are more susceptible to severe complications of the disease than others (Umar *et al*., 2024). The preventative role of monitoring early clinical signs cannot be overlooked. In many cases, an animal can be saved if anorexia or lethargy is detected and supportive treatment is initiated immediately, including fluid replacement, antibiotics for secondary infections, and antiemetics and antidiarrheals (Mazzaferro, 2020; Prittie, 2004). The clinical signs of parvovirus in cats and dogs reflect the animal's overall health and are used by veterinarians to make diagnostic and treatment decisions. The similarity of symptoms between the two species allows for a standardized approach to care, but individual differences and varying severity of symptoms must be considered depending on the animal's immune status, age, and health history (Zhou *et al*., 2024). Early diagnosis based on clinical signs is the most important tool for saving an animal's life and can mean the difference between recovery and death, especially in cases where advanced diagnostic tools are not readily available. Therefore, it is important to train breeders and owners to detect these signs and respond quickly. Continuous veterinary education for medical staff also contributes to reducing mortality rates and controlling the spread of the virus within

animal communities (Al-Mashhadani *et al.*, 2024). Prevention, including early vaccination, environmental hygiene, and quarantine of infected animals, remains the cornerstone of preventing these signs from appearing in the first place and protecting cats and dogs from the severe consequences of parvovirus disease (Zhou *et al.*, 2024).

Diagnosis

Parvovirus is one of the most serious viral diseases affecting dogs and cats, leading to high mortality rates, especially among young, unvaccinated animals. Early and accurate diagnosis of this virus is crucial to improving recovery chances and providing effective veterinary care. Diagnostic methods vary depending on available resources and include a range of clinical, laboratory, and molecular methods used to confirm the presence of the virus and determine its impact on the infected animal. Understanding the various diagnostic mechanisms enables veterinarians to make accurate and rapid decisions, potentially saving the lives of many animals (Zhou *et al.*, 2024). The diagnosis process usually begins with observing the animal's clinical signs. The most common signs in dogs include loss of appetite, lethargy, vomiting, severe diarrhea, sometimes with blood, fever, and severe dehydration. Similar signs such as diarrhea, loss of appetite, and depression are present in cats, but the symptoms may be more subtle than in dogs. The veterinarian relies on the animal's case history, vaccination history, and age to form an initial assessment of the likelihood of parvovirus infection. However, the clinical signs can mimic those of many other diseases, such as poisoning, bacterial infections, or parasites, requiring additional testing to confirm the diagnosis (Mazzaferro, 2020). Among the initial tests used, a complete blood count (CBC) stands out as an important tool in assessing the animal's overall condition. This test often shows a decrease in the white blood cell count (leukopenia), a classic indicator of parvovirus infection and reflecting the virus's suppressive effect on the bone marrow. Changes in red blood cell count and hemoglobin may also be evident as a result of blood loss caused by bloody diarrhea. Blood chemistry analysis also reveals indicators of dehydration, such as elevated urea and creatinine, and electrolyte disturbances, such as low potassium and sodium. These highlights the severity of the condition and require urgent intervention to treat dehydration and regulate electrolytes (Mazzaferro, 2020). One of the most important field tests used to detect parvovirus is the rapid ELISA test, which detects viral antigens in fecal samples. This test is quick and easy to use in the veterinary clinic, providing results within minutes. This test relies on the presence of viral antigens in the feces and reacts with antibodies immobilized on a test strip to produce a positive or negative result. Despite its high effectiveness, several factors can affect its accuracy, such as the timing of the sample collection, as the virus is not shed in significant quantities in the feces during the first or last days of the disease. Furthermore, recent vaccination with a live vaccine can lead to false positive results, requiring confirmation with a more accurate test (Li *et al.*, 2024). The PCR test is one of the most accurate diagnostic methods for detecting parvovirus. The polymerase chain reaction (PCR) technique amplifies the viral nucleic acid present in a sample, allowing the virus to be detected even in very small quantities. This test is typically performed in specialized laboratories using stool or blood samples. PCR not only confirms infection but can also be used to identify the viral strain and determine whether the infection is caused by a vaccine virus or a real infection. This test is considered the gold standard for confirming infection, but its high cost and requirement for advanced equipment limit its use in some settings (Zhou *et al.*, 2024). Another test used in some advanced centers is immunofluorescence assay (IFA), which allows the virus to be visualized within infected cells using a fluorescence microscope. Samples are taken from the intestinal lining or lymph nodes, and this test shows a characteristic fluorescence if the cells contain the virus. Despite its accuracy, this test has limited use due to its complexity and high cost. Histopathology is also used in cases where intestinal tissue is examined postmortem or during surgery to detect histological changes characteristic of parvovirus, such as villus atrophy, mucosal ulceration, and the presence of intracellular viral bodies (Mazzaferro, 2020). As for serological tests, they are primarily used to determine the level of antibodies in an animal's blood. Although this type of test is not used to diagnose acute infection, it is important for assessing immunity to the virus after vaccination, or to determine whether an animal has been previously exposed to the virus. These tests are also used in epidemiological studies to estimate the prevalence of the disease in a given animal population (Li *et al.*, 2024). In many cases, simply confirming the presence of a virus isn't enough. Your veterinarian must perform a differential diagnosis to rule out other diseases that may cause similar symptoms. This includes a fecal parasitological examination to detect

parasites such as giardia or coccidia, a fecal bacterial culture to detect pathogenic bacteria, and other viral tests to detect viruses such as coronavirus or feline immunodeficiency virus (FIV). These tests help avoid misdiagnosis and provide appropriate treatment based on the type of infection present (Sun *et al.*, 2024). Diagnostic methods are particularly important in settings such as animal shelters or breeding farms, where the infection can spread rapidly among animals if not detected early. Therefore, many institutions employ routine screening protocols that include rapid testing of new animals and isolation of any suspected cases until they are cleared. Staff in these settings are also trained to recognize the early symptoms of parvovirus to quickly respond to any suspected cases (Zhou *et al.*, 2024). With technological advances in veterinary medicine, efforts are underway to develop portable diagnostic devices that can be used in the field to rapidly detect the virus, using technologies such as biosensors or miniaturized molecular assays. These devices aim to provide accurate results in record time and without the need to send samples to a laboratory. The use of artificial intelligence to analyze clinical images or test results is also a recent trend expected to play a significant role in accelerating the diagnostic process and improving its accuracy (Sanaei *et al.*, 2025). Diagnosing parvovirus in dogs and cats requires a combination of clinical expertise and modern diagnostic methods. The strategies used vary depending on the animal's condition, the availability of resources, and the prevalence of the disease in the surrounding environment. Clinical examinations and simple laboratory tests such as CBC and ELISA remain effective tools for diagnosing most cases, while PCR and advanced tests are used to confirm suspected cases or in settings where high accuracy is required. Early diagnosis is the most important factor in increasing survival rates, making it essential for veterinarians to stay up-to-date with the latest diagnostic techniques and methods available (Zhou *et al.*, 2024).

Risk factors

Parvovirus is one of the most dangerous and impactful viruses affecting dogs and cats, causing serious and rapidly progressive complications, especially in young or unvaccinated animals. Parvovirus is known for its ability to infect rapidly dividing cells, particularly those of the gastrointestinal tract, bone marrow, and immune system, leading to severe inflammation and rapid loss of vital functions. The danger of this virus lies in its rapid spread, its ability to persist in the environment for long periods, and its difficulty in treating advanced stages. To better understand how this virus spreads and the factors that increase the likelihood of infection, it is necessary to analyze the biological, behavioral, and environmental risk factors surrounding exposed animals (Peng *et al.*, 2025; AVMA Guidelines, 2022). In dogs, puppies between 6 weeks and 6 months of age are most susceptible to the virus. This is because the maternal immunity the pup receives from its mother begins to wane at this stage, while the pup has not yet received the full vaccinations necessary to combat the virus. This "immune gap" creates a dangerous window of opportunity for the virus to penetrate the pup's body and cause damage. If vaccination is not provided in a timely manner, the pup is highly susceptible to a rapid and severe progression of symptoms, which can lead to death within days (Decaro and Buonavoglia, 2012). In addition to age, breed plays an important role in determining a dog's susceptibility to infection. Veterinary studies have shown that breeds such as Rottweilers, Doberman Pinschers, Pit Bulls, and Labradors are more susceptible to infection and less responsive to treatment. Scientists believe this is due to genetic factors that influence the effectiveness of the immune response in these breeds. Mixed-breed dogs, on the other hand, have shown greater resilience and a better ability to resist infection, suggesting that genetic diversity may play a protective role (Houston *et al.*, 2016; Glickman *et al.*, 2004). In cats, age is a similar factor in risk, with kittens under 4 months of age being most susceptible to feline parvovirus, also known as panleukopenia. This virus is characterized by rapid replication in bone marrow cells, leading to a severe drop in white blood cell count, which explains the name "panleukopenia." Kittens that were not vaccinated early, or those weaned prematurely, are quickly at risk, especially if they do not receive adequate nutritional and health care (Truyen, 2006; Ellis, 2015). Immune status is one of the most important factors determining whether an infection will occur, and if so, how severe it will be. Dogs and cats that are malnourished, deficient in essential vitamins, or infected with other diseases such as internal parasites are more susceptible to developing a more severe infection. In cats, in particular, coinfection with feline immunodeficiency virus (FIV) or feline leukemia virus (FeLV) severely weakens the immune system and makes a parvovirus infection more deadly. These immune-compromising viruses reduce the number of defense cells, allowing parvovirus to quickly take

hold of the body (Addie *et al.*, 2020; Levy *et al.*, 2008). Environmentally, the environment in which an animal lives plays a fundamental role in increasing or decreasing the risk of infection. Animals living in crowded conditions such as shelters, breeding farms, or houses with large numbers of animals are at greater risk. These environments facilitate transmission through contact with surfaces, food, water, and even air laden with viral particles. Because parvovirus can survive in the environment for up to a year without losing its infectious capacity, daily hygiene and disinfection are crucial in preventing the spread of the disease (CDC Animal Health, 2021; Battilani *et al.*, 2019). Vaccination is the most important preventative measure, and failure to adhere to the vaccination schedule poses a significant risk. Many pet owners are unaware of vaccination schedules or delay them, exposing their animals to infection. There are even cases where a puppy or kitten receives only one dose, without completing the required three-dose program in the first weeks of life. It should be noted that partially vaccinated animals are not fully immune and can still contract the disease if exposed to the virus extensively (Squires *et al.*, 2025). Another important behavioral factor is the animal's exposure to physical or psychological stress, such as early weaning, moving from one home to another, travel, or even a visit to the veterinarian. All of these events can lead to a temporary decrease in immunity, allowing the virus to take hold. Also included in this context are a sudden change in diet or separation from the mother or siblings, which are common experiences in the lives of puppies and kittens, but have profound effects on health (Kogan *et al.*, 2019). Coinfection is a complicating factor that is often overlooked. Puppies infected with intestinal parasites such as worms, or cats suffering from fungal or bacterial infections, are less able to resist parvovirus. Other viruses, such as canine coronavirus, can also increase the severity of symptoms when combined with a parvovirus infection. For this reason, veterinarians recommend screening animals with parvo for co-morbidities that could affect the treatment plan (Decaro *et al.*, 2010; Greene's Infectious Diseases, 2021). In areas lacking regular veterinary care, such as slums or remote villages, infection rates are much higher. This is due to a lack of awareness about the importance of vaccination and hygiene, as well as some breeders resorting to treating cases at home without veterinary consultation, which exacerbates the situation and spreads the infection to other animals. Furthermore, the high cost of treatment makes many owners reluctant to take their animals to the veterinarian, especially if they appear active in the early stages of infection. This is despite the fact that parvovirus is known to initially present with mild symptoms before rapidly progressing to severe disease (World Small Animal Veterinary Association, 2022). Ultimately, prevention remains the first and strongest line of defense against parvovirus. Strict vaccination programs, improved nutrition, hygiene, and screening new animals before introducing them to existing populations are all essential steps to protect dogs and cats from this deadly virus. Despite the virus's power and rapid spread, knowledge and disciplined management are key to controlling it and preventing its spread in animal environments (Companion Animal Parasite Council, 2023).

Economic impacts

Parvovirus is among the most economically devastating viral diseases in the pet industry, particularly in dogs and cats. Despite the virus's small size and simple genetic makeup, its financial repercussions for individuals, veterinary institutions, shelters, and the pet owner community far exceed what might be expected from an animal viral disease. Parvovirus not only affects the animal's health but also causes direct and indirect losses that weigh heavily on the budgets of individuals and related organizations (Decaro and Buonavoglia, 2012; Goddard and Leisewitz, 2010). First, it's important to recognize that parvovirus is a highly contagious virus that primarily affects unvaccinated puppies and kittens, leading to severe symptoms including vomiting, bloody diarrhea, fever, dehydration, and immune collapse. As a result, the cost of treatment borne by the owners of infected animals is one of the most significant direct economic impacts. Veterinary treatment costs for a single case can range from $300 to over $1,500, depending on the severity of the case and the country. These costs include examination fees, laboratory tests (especially ELISA testing to confirm infection), medications, intravenous fluids, antibiotics, antiemetics, and ongoing nursing care, which can last from 5 to 10 days at the veterinary hospital (Stuetzer and Hartmann, 2014). This cost represents a significant burden for animal owners, particularly in middle- or low-income countries, where some may be forced to abandon their animals or leave them untreated due to their inability to cover the costs. This can lead to painful social and human consequences, as well as an increased likelihood of disease outbreaks (Kapil and Cooper, 2008; FAO,

2020; Aljabory *et al*., 2021). In addition to the cost of treatment, there are indirect costs that burden the breeder or institution. Infected animals require immediate isolation, which requires the allocation of separate rooms, sterilized tools, and clean spaces away from other animals. This isolation requires additional human effort, increasing the burden on veterinarians and assistants. Furthermore, disinfectants suitable for dealing with parvovirus, such as concentrated bleach, can be expensive when used in large quantities and for long periods, especially in group settings such as shelters (AVMA Guidelines, 2019). Shelters and shelters are among the hardest hit economically by parvovirus outbreaks. A single outbreak often requires testing and quarantining dozens of other animals, suspending adoptions, and halting new animal admissions until the situation is under control. These measures result in direct losses in donations or adoption fees, as well as increased operating expenses related to medical and food supplies. In some cases, controlling the outbreak requires the temporary closure of the shelter, a devastating economic blow (Mirković *et al*., 2017). At the veterinary clinic level, parvovirus infection may seem like an opportunity to increase income given the high cost of treatment, but the reality is more complex. The disease requires intensive, round-the-clock care, which drains clinic resources and forces staff to work long hours at the expense of other patients. Furthermore, dealing with parvovirus cases can pose a risk to the other animals in the clinic, leading some clinics to refuse to treat advanced cases to avoid the complications and costs associated with sterilization and infection control. This, in turn, leads to lost profit opportunities and disruption to normal business operations (Nelson and Couto, 2019). The economic impact also extends to the animal sales sector. If parvovirus is discovered in a litter of puppies or kittens destined for sale, it often leads to a halt in sales, loss of trust from buyers, and the destruction of some animals (in the event of death), representing a direct financial loss. Some breeders incur thousands of dollars as a result of the deaths of large numbers of puppies within days, especially if the sale is wholesale or for export. Environmental sterilization, cage disinfection, and rebuilding trust with customers also requires significant time, effort, and money (Grevot *et al*., 2011; CFSPH, 2020). It is clear, then, that the economic impacts of parvovirus are not limited to the cost of treatment or prevention alone, but extend to many areas, including production, distribution, marketing, research, and veterinary services. This is evident when considering any major outbreak of the virus, as waves of losses mount from the infected animal to the affected markets and communities (FAO Animal Health Reports, 2021; Mosa *et al*., 2023). Addressing the economic impacts of parvovirus requires comprehensive strategic planning that includes periodic prevention campaigns, educating breeders, supporting low-cost vaccination programs, and activating early detection and isolation networks. Providing financial incentives or discounts on vaccines is also an effective way to reduce infection rates, thereby limiting the ultimate cost to individuals and society (CDC Companion Animal Health Program, 2020). Ultimately, controlling the economic impacts of parvovirus disease depends largely on farmer awareness, the efficiency of the veterinary system, and coordination among animal welfare agencies. The greater the knowledge and adherence to preventive measures, the less losses and financial burdens will be, and the safer and more sustainable environments will be possible for both animals and their human communities (WHO-OIE Collaboration Reports, 2019).

Treatment

Parvo treatment does not rely on directly eliminating the virus, as it is well known that viruses cannot be killed by antibiotics, unlike bacteria. Rather, treatment relies primarily on supporting the body's ability to fight the virus on its own by strengthening the immune system, replacing lost fluids, controlling secondary symptoms, and preventing secondary bacterial infections that can exploit a weakened immune system in the presence of the virus. Therefore, parvo treatment is often complex and requires direct and intensive veterinary intervention (Prittie, 2004; Greene, 2021). The first step in managing a suspected case of parvovirus is a thorough clinical evaluation by a veterinarian. This evaluation is based on clinical signs, such as severe bloody diarrhea, persistent vomiting, loss of appetite, depression, high or low fever, and significant dehydration. After the initial evaluation, the diagnosis is usually confirmed using rapid tests, the most common of which is the ELISA test, which detects parvovirus antigens in fecal samples. In some cases, complete blood counts may be ordered to assess the severity of dehydration, white blood cell count, the presence of secondary infections, and organ function (Decaro and Buonavoglia, 2012; Sykes, 2014). Once the infection is confirmed, treatment begins immediately, as time is crucial to increasing the chances of survival. Treatment

typically begins with stabilizing the affected animal, with intravenous fluid replacement a critical step. The animal loses large amounts of water and electrolytes due to diarrhea and vomiting, leading to severe dehydration and an imbalance of electrolytes, such as sodium and potassium. Therefore, the animal is provided with appropriate solutions, such as Ringer's lactate or balanced salt solution, with glucose and potassium added as needed and based on the animal's condition (Greene, 2021; Zacher and Stuetzer, 2019). Controlling vomiting is another critical component of the treatment plan, as persistent vomiting prevents absorption of solutions or oral medications and increases the severity of dehydration. Therefore, antiemetic medications, such as metoclopramide or marobantant, are used, often given intravenously or intramuscularly. Once the patient stabilizes, oral medications can be gradually switched to oral medications (Prittie, 2004). Because parvovirus significantly weakens an animal's immune system, the intestines become susceptible to secondary bacterial infections, which can be fatal. Therefore, antibiotics are used in the treatment plan, not to combat the virus itself, but rather to prevent or treat secondary bacterial infections. Broad-spectrum antibiotics such as ampicillin, ceftazidime, or enrofloxacin are used, depending on the animal's condition, age, and white blood cell count. The antibiotic is carefully selected to avoid adverse effects, especially in young animals (Greene, 2021; Sykes, 2014). In the later stages of treatment, after the dehydration has stabilized, the focus is on nutritional and immune support. Often, the animal is unable to eat during the first few days due to poor appetite and vomiting. However, once vomiting has stopped and the condition has stabilized, gradual introduction of nutrition is encouraged, either orally or, in severe cases, via a feeding tube. The diet provided should be easily digestible, low in fat, and high in nutritional value. Certain veterinary nutritional formulas specifically designed for convalescence are ideal at this stage (Zacher and Stuetzer, 2019). Additionally, immune serum or plasma from recovered dogs containing antibodies against the virus is sometimes used, especially in critical cases or in very young puppies. This method aims to provide the body with antibodies ready to fight the virus, and is particularly useful when the animal's immune system is too weak to produce them on its own. This method is not widely used due to its cost, but it has proven effective in some studies and cases (Kalli *et al*., 2010). Another therapeutic element is the use of immunostimulants, such as interferon alpha, which work to enhance the immune system's response to fight viruses. Although these treatments are not an essential part of the treatment protocol in all clinics, their use may improve the chances of recovery in some moderate to severe cases, especially when used early in the course of infection (Appel and Parrish, 2013; Zacher and Stuetzer, 2019). Treatment must be carried out in a clean, completely isolated environment, as the virus is highly contagious and can survive in the environment for long periods. Therefore, the infected animal should be isolated, and strict disinfection procedures should be followed, using effective solutions such as bleach at a ratio of 1:30, to prevent the spread of infection to other animals in the same household or clinic. Hands should also be washed and clothing changed before and after handling the infected animal (WSAVA, 2022; Greene, 2021). During the treatment period, the animal must be constantly monitored, and vital signs such as temperature, respiration rate, heart rate, and general responsiveness must be measured. This monitoring requires the presence of trained veterinary staff, making treatment preferable to a veterinary hospital rather than at home, except in mild cases or when constant medical supervision is available at home. The duration of treatment varies from case to case, but typically ranges from 5 to 10 days. In some cases, signs of improvement may appear within the first few days, while others deteriorate rapidly despite intensive intervention. This is due to the strength of the immune system, age, and rapid diagnosis (Sykes, 2014; Houston *et al*., 2016). After an animal recovers from parvo, the process doesn't end there. The animal needs a recovery period of several weeks, during which it must be provided with appropriate nutrition, regular monitoring, and possibly supplemented with some strengthening medications. The animal must also be revaccinated at the appropriate time, once its immune system has stabilized, to protect it from future infections, especially if it was not vaccinated prior to the infection (Wsava, 2022). Although treatment can save an animal's life if initiated early, in some cases, the response is insufficient, and death occurs. The psychological and morale factors are part of the suffering, both for the animal's owner and the veterinarian. The high cost of treatment is another challenge, as it can exceed some families' budgets, leaving them in a difficult position between wanting to save the animal and being unable to cover the costs of treatment. For this reason, early vaccination and

prevention are always recommended as a better and more effective solution than post-infection treatment (Greene, 2021; Prittie, 2004).

Prevention and control

Parvovirus is one of the most deadly and widespread viral diseases among dogs and cats, especially in their early stages of life. Despite the disease's severity and difficulty in treatment, prevention and control remain largely possible and effective if the right measures are followed at the appropriate time. In fact, controlling parvovirus does not require advanced techniques as much as it requires veterinary and household awareness, and adherence to a set of basic steps that begin at the animal's birth and continue throughout its life (Decaro and Buonavoglia, 2020). The first and most important method of preventing parvovirus is regular preventative vaccination, which is the backbone of protecting pets from infection. It is recommended that puppies and kittens receive their first parvovirus vaccination between 6 and 8 weeks of age, followed by a series of booster doses every 3 to 4 weeks until 16 weeks of age, followed by annual vaccinations or as recommended by a veterinarian (American Veterinary Medical Association [AVMA], 2023). Vaccination does not guarantee absolute protection in all cases, but it significantly reduces the likelihood of infection or mitigates the severity of symptoms if infection occurs. Many cases of infection that lead to death occur in animals that did not receive the required doses in a timely manner or were separated from their mothers before they acquired natural immunity from their milk (Day *et al*., 2020). Natural immunity complements vaccines, as a puppy or kitten receives antibodies from its mother during breastfeeding that provide temporary protection. This immunity, known as "maternal immunity," is particularly important during the first weeks of life. For this reason, a puppy or kitten should not be separated from its mother too early, as this increases the risk of direct exposure to various viruses and microbes without adequate immune defense (Schultz *et al*., 2018). In addition to vaccination, environmental hygiene plays a pivotal role in preventing the spread of the virus. Parvovirus can survive in the environment for long periods, possibly several months, especially in damp, cool areas, where it can survive in soil or surfaces contaminated with feces. Therefore, extreme care must be taken to clean and disinfect animal housing areas using strong disinfectants effective against the virus, such as sodium hypochlorite (diluted bleach), at a ratio of at least 1:30. Surface cleaning with soap and water is not sufficient to eliminate the virus; disinfectants proven effective against parvo must be used (Ní Leathlobhair *et al*., 2021). Another control measure is strict veterinary isolation if any animal shows symptoms of suspected parvovirus. The infected animal must be immediately isolated from other healthy animals, especially those that have not yet been vaccinated, as the infection is easily transmitted through feces, contaminated food and water utensils, or even on shoes and clothing. Due to the severity of the infection, a dog may only be infected by walking past an area contaminated with feces carrying the virus. Therefore, it is strictly forbidden for unvaccinated animals to mix with infected animals, or to enter areas where cases have been reported, unless the area has been thoroughly disinfected (Stavisky *et al*., 2020). It is also important to educate pet owners and families about the seriousness of parvovirus, its contagious nature, the importance of upgrading vaccinations, and monitoring for early symptoms. Symptoms such as loss of appetite, vomiting, bloody diarrhea, and lethargy should not be ignored, as prompt intervention not only saves the animal's life but also prevents transmission to other animals. In many cases, outbreaks in shelters or farms are caused by ignoring a single individual case that continued to spread the virus without being isolated or treated (Mila *et al*., 2020). Shelters and farms play a critical role in controlling parvovirus due to the high density of animals they house. These facilities are required to be regularly disinfected, and strict protocols are implemented when receiving any new animals. New animals are screened before being introduced with other animals, and it is preferable to isolate them for an observation period of 7 to 14 days, during which their general health is monitored, their vaccination history is verified, and they are free of signs of underlying infection (Stull *et al*., 2016). In addition, proper breeding is an indirect means of controlling parvo, especially in areas where uncontrolled dog and cat breeding is widespread. Uncontrolled breeding of animals results in the birth of large numbers of puppies and kittens without adequate veterinary care. These animals are often susceptible to the virus, making them potential hotbeds for disease outbreaks. Therefore, awareness and sterilization programs targeting animal owners should be encouraged to reduce unplanned births and ensure better care for the remaining animals (Companion Animal Parasite Council [CAPC], 2022). Another supportive measure is to avoid introducing small animals to public or

crowded places, such as parks or adoption centers, before completing their vaccination schedule. Many owners make the common mistake of taking their puppies or kittens for walks before completing their vaccinations, increasing the likelihood of exposure to dangerous viruses. Partial environmental isolation should be maintained until the animal develops a sufficient level of immunity (AVMA, 2023). In actual cases of infection, controlling the disease requires rapid veterinary intervention, not only to treat the condition but also to contain the source of infection. Infected cases should not be handled haphazardly or without expertise, as any error in isolation or hygiene could lead to an epidemic disaster in the home or clinic. Therefore, it is advisable not to attempt to treat an infected animal at home without medical advice, or at least to take all precautions when treating the infected animal under supervision (Decaro *et al*., 2020). Ultimately, parvovirus prevention relies on an interconnected series of measures, beginning with proper vaccination, followed by environmental hygiene, community awareness, rapid isolation, and veterinary supervision. All of these measures, despite their apparent simplicity, represent the primary line of defense against the spread of one of the most dangerous viruses threatening the lives of dogs and cats. Proper veterinary awareness, coupled with the cooperation of breeders, can prevent significant health, economic, and psychological losses caused by this deadly disease (Schultz *et al*., 2018).

Conclusions and Recommendations

Parvovirus remains a serious and highly contagious disease affecting both dogs and cats, particularly unvaccinated young animals. Early diagnosis, effective isolation, and supportive treatment are crucial for recovery. Continued public awareness and vaccination efforts are essential to control its spread and reduce mortality in susceptible animal populations.

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Novelty Statement

In this research, various important biological, environmental, clinical and vaccination-related factors are explained in relation to the parvovirus disease in dogs and cats along with highlighting the need for timely diagnosis and prevention of the disease.

Author's Contribution

Ahmed Hamzah Mosa played a role in conceptualizing the study, reviewing the literature, collecting data for analysis, writing the manuscript, and making the final revisions of the study. Hamed A. H. Aljabory contributed to the literature review, overseeing the scientific validity of the manuscript, preparing the manuscript for publication, and approving it for publication.

Generative AI and AI-assisted technology statement

The authors declare that no generative AI and AI assisted technology was used in the creation of this manuscript.

Conflict of interests

The authors declare that they have no conflict of interests.

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