COMPARATIVE EVALUATION OF ORAL REHYDRATION VERSUS INTRAVENOUS FLUID THERAPY IN DOGS

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Abstract

Fluid therapy is a fundamental component of the management of dehydration in canine pacients, with the choice of route of administration depending on the severity of dehydration, underlying disease, cardiovascular status, gastrointestinal function and the ability of the pacient to tolerate enteral fluids.

Intravenous fluid therapy is widely used in veterinary medicine, however oral rehydration therapy may provide a less invasive and potentially cost-effective alternative in selected clinical cases. The primary objectives of oral rehydration therapy are to restore the hydration and electrolyte balance while also supporting the recovery of appetite through the use of palatable, electrolyte-containing solutions.

This review contains a comparative analysis of the uses of oral rehydration therapy and intravenous fluid therapy in dogs, focusing on their physiological principles, mechanisms of water and electrolyte replacement, clinical indications, advantages and limitations in order to highlight both therapeutic perspectives and future directions for research.

Key words: *dogs, dehydration, oral rehydration therapy, intravenous fluid therapy, electrolytes*

INTRODUCTION

Dehydration represents a disturbance in the body's fluid and electrolyte balance, resulting from a disparity between water intake and fluid losses, which leads to a fluid deficit within the intracellular and extracellular compartments, including the interstitial space [1]. Restoration of normal hydration status can be achieved through enteral fluid administration, predominantly via the oral route, or parenterally, via intravenous or intraosseous access [2].

In veterinary medicine, intravenous fluid therapy serves as a primary intervention for correcting fluid and volume deficits, particularly in clinical scenarios requiring the rapid restoration of tissue perfusion. However, depending on the severity of dehydration and the patient's clinical status, the therapeutic protocol may incorporate or be directed toward oral rehydration therapy [2]. This modality relies on the enteral administration of solutions containing water, electrolytes, and readily absorbable nutrients. The efficacy of oral therapy is contingent upon the structural and functional integrity of the gastrointestinal tract, as well as the patient's ability to tolerate enteral administration [3]. In contrast, intravenous administration enables the direct delivery of fluids into the vascular compartment, ensuring the rapid systemic distribution of water and electrolytes and, when indicated, the concomitant administration of pharmacological agents. This route of administration offers the advantage of precise control over the volume and

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composition of the infused fluids, allowing for the prompt correction of hypovolemia and specific fluid and electrolyte imbalances [2,4].

Nevertheless, both therapeutic modalities present specific indications and limitations, necessitating an individualized approach to patient management [2,3].

MATERIAL AND METHOD

The present article was developed based on a systematic review of the international scientific literature, aiming to comparatively evaluate oral rehydration therapy and intravenous rehydration therapy in dogs. The identification and selection of relevant publications were conducted by querying the PubMed, ScienceDirect, Google Scholar, and ResearchGate databases.

The search strategy was formulated using keywords relevant to the topic, specifically: dog, canine, dehydration, oral rehydration therapy, oral fluid therapy, intravenous fluid therapy, and intravenous rehydration therapy. To enhance the relevance of the retrieved results, these terms were employed both individually and in various combinations, tailored to the specific search parameters of each database.

Scientific publications were included with an emphasis on studies investigating the efficacy, applicability, benefits, and limitations of rehydration therapy within therapeutic protocols applied to canine patients. To maintain the specificity of the analysis, studies focusing primarily on human patients were excluded.

The adopted methodology followed a comparative approach to oral and intravenous rehydration therapy by synthesizing the available evidence regarding the benefits, limitations, indications, and potential clinical applications of both modalities. Furthermore, the analysis of the available data enabled the identification of key directions and perspectives for future research in the field of canine rehydration therapy.

RESULTS

Water is a fundamental component of the body, being indispensable for metabolic processes, thermoregulation, nutrient transport, the maintenance of cellular and tissue function, as well as the normal course of physiological processes. Disruption of the body's fluid balance leads to dehydration, characterized by a body water deficit relative to the physiological requirements of the organism. The maintenance of hydration status results from the equilibrium between water intake and fluid losses. Exogenous fluid intake occurs predominantly via the oral route, through voluntary water consumption and the moisture contained in food, whereas endogenous water is generated through the oxidation reactions of energy substrates. Water losses occur via urine, feces, the skin, the lungs, and saliva. Among these, urinary losses represent the primary component subject to physiological regulation, while fecal, respiratory, and cutaneous losses are classified as insensible water losses. Daily urinary losses comprise obligatory water losses, which occur independently of the patient's hydration status, as well as free water losses, the excretion of which is primarily regulated by the action of antidiuretic hormone (ADH) [1,4].

Alongside water, electrolytes represent essential components of fluid and electrolyte balance, contributing to the maintenance of systemic homeostasis and the regulation of water distribution between the intracellular and extracellular compartments.

Sodium (Na^+) is the primary cation of the extracellular compartment and plays a central role in regulating water distribution across the body's fluid compartments. Hypernatremia is encountered less frequently and occurs predominantly in conditions characterized by an impaired

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thirst mechanism, such as hypothalamic lesions, or following excessive sodium ingestion, including salt intoxication. Hyponatremia is more commonly associated with hypovolemia and may arise in the context of gastrointestinal fluid and electrolyte losses, particularly through vomiting and diarrhea. Intestinal sodium absorption occurs predominantly in the jejunum and colon and, to a lesser extent, in the ileum, being closely coupled with the transport of other electrolytes, particularly chloride. This interdependence contributes to the maintenance of the body's fluid, electrolyte, and osmotic balance [1].

Chloride (Cl^-) is the principal anion of the extracellular compartment and is found in significant concentrations in gastric secretions, where it is associated with hydrogen and sodium ions. It participates in maintaining osmolarity and acid-base balance, with its concentration being closely correlated with that of bicarbonate. Alterations in chloride concentration may occur concomitantly with acid-base disturbances, particularly in the context of gastrointestinal losses or the administration of parenteral infusion solutions [1].

Potassium (K^+) is the primary cation of the intracellular compartment and plays an essential role in maintaining membrane potential, neuromuscular excitability, and cellular volume. Hyperkalemia is particularly encountered in patients with renal impairment, resulting from decreased potassium excretion. Conversely, hypokalemia may initially progress with subtle or nonspecific clinical manifestations, with clinical signs becoming more overt in cases of severe deficits [1].

Dehydration is a frequently encountered clinical complication in pediatric and juvenile canine patients under 2 years of age, a vulnerability attributed to both a higher proportion of total body water (which can reach 70%) and the immaturity of renal function. These physiological characteristics predispose them to a major risk of decompensation, particularly in the context of gastrointestinal pathologies associated with significant volume depletion [1,13]. At the opposite end of the spectrum, a high-risk category is represented by geriatric patients (over 8 years of age), in whom senescence is accompanied by a progressive decline in renal function, generating electrolyte and acid-base imbalances. Additionally, the impairment of neurological osmoregulatory mechanisms induces hypodipsia (a physiological decrease in the sensation of thirst), thereby facilitating the insidious onset of a fluid deficit [5]. Due to anatomical conformations that induce upper airway obstructive syndrome, brachycephalic dogs exhibit an inefficient heat dissipation mechanism. Consequently, through the compromise of thermoregulation—normally achieved via thermal polypnea—these patients are frequently exposed to episodes of hyperthermia, invariably accompanied by dehydration [6].

Furthermore, the level of physical activity is a major contributing factor to the onset of fluid and electrolyte imbalances. Working, hunting, and sporting dogs are the most vulnerable to developing dehydration. High ambient temperatures in the dog's climate and living environment increase the incidence rate of dehydration, as evidenced by numerous studies investigating dehydration in dogs working in hot environments and evaluating various hydration strategies for these animals [7,8,9].

Dehydration represents a frequent complication of numerous conditions in domestic animals; in dogs, dehydration is predominantly encountered in gastrointestinal disorders, particularly those associated with vomiting and diarrhea, whereas in cats, it is commonly observed in chronic kidney disease as a result of the progressive loss of urine-concentrating

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ability and consequent urinary water losses [2,10].

The clinical presentation of a canine patient upon physical examination is determined by the degree and severity of dehydration. In mild dehydration (4–5%), clinical signs include tacky oral mucous membranes and a normal return of the skin tent. Dehydration of 6–7% already results in a delayed return of the skin tent and dry oral mucous membranes. In addition to the aforementioned signs, sunken eyes within the orbits (enophthalmos) and a thready pulse are indicative of 8–10% dehydration. At levels exceeding 12%, patients begin to exhibit weight loss and alterations in consciousness may occur [11].

The therapeutic efficacy of oral rehydration solutions and enteral fluids is dictated by the interaction between their osmolarity and the architecture of the transport systems at the enterocyte level [12]. These solutions are generally formulated as hypotonic fluids, with an osmolarity ranging between 215 and 260 mOsm/L, a fundamental characteristic that prevents the induction of high osmotic pressure within the intestinal lumen and thereby avoids triggering osmotic diarrhea [13].

A fundamental aspect, however, is that oral rehydration therapy requires the gastrointestinal tract to be functioning properly. The integrity and absorption capacity of the gastrointestinal tract are essential, absolutely limiting factors for the therapy's effectiveness. The absorption of water and electrolytes in the intestine is strictly dependent on the optimal function of enterocytes and the maintenance of gastrointestinal motility [12]. Specifically, water and sodium are efficiently absorbed in the intestine only in the absence of severe lesions, whereas potassium is subject to complex mechanisms of absorption and secretion throughout the entire gastrointestinal tract, dynamics which can be profoundly disrupted in disease conditions [1,12].

From a practical perspective, the range of solutions used in dogs varies from plain water, without electrolyte supplementation, to advanced formulations that combine electrolytes with substances intended to improve palatability. At the biochemical level, modern enteral solutions often incorporate glucose polymers, such as maltodextrin, rather than simple sugars, thereby maintaining a low overall osmotic load [14]. Sodium is the critical ion for expanding extracellular volume, while potassium and chloride are essential for correcting intracellular deficits [2,4], and buffering agents are imperative for combating metabolic acidosis [13]. This category increasingly includes commercial solutions, such as Oralade or Viyo Recuperation, designed to simultaneously provide water, electrolytes, and components that support nutritional needs [3,14].

Therefore, the effectiveness of volume resuscitation using enteral fluids (administered voluntarily or via a nasoesophageal tube) is critically dependent on two inseparable factors: the optimized biochemical composition of the solution and the maintenance of the patient's gastrointestinal function [2,14].

Two categories of solutions are used in intravenous rehydration therapy: crystalloids and colloids.

Crystalloids are the main category of solutions used in intravenous therapy and can be selected based on the patient's fluid status, electrolyte imbalances, and therapeutic objectives. Hypertonic solutions, primarily sodium chloride in concentrations ranging from 3% to 23.4% can be used in situations where rapid expansion of intravascular volume is required. Isotonic solutions include 0.9% sodium chloride and balanced crystalloid solutions, such as Plasma-Lyte A and Normosol-R, while hypotonic solutions are used primarily for maintenance and include, among others, 0.45% sodium chloride, Normosol-M in 5% dextrose, or

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appropriately diluted 5% dextrose-based solutions. Therefore, intravenous therapy offers greater flexibility in terms of the rapid and controlled correction of volume deficit and certain electrolyte imbalances [2,15]

Colloids are volume-replacement solutions containing high molecular weight particles dispersed in an aqueous solvent, and they are primarily used to expand intravascular volume. Among natural colloids, albumin is the primary example, while synthetic colloids include dextrans and hydroxyethyl starch (HES). Their volume-expanding effect is based primarily on an increase in plasma oncotic pressure and the retention of water in the intravascular compartment [2,15,16].

Although there are a number of studies conducted involving other animal species, research on oral rehydration therapy in dogs remains limited, and further investigation is needed regarding the effectiveness and optimization of rehydration protocols suitable for this species.

A major advantage of oral rehydration therapy is the ability to combine the correction of fluid and electrolyte deficits with nutritional support, without the need for vascular catheterization. The effectiveness of this approach has been demonstrated in dogs with gastrointestinal disorders. In canine patients with hemorrhagic diarrhea and moderate dehydration, the oral administration of rehydration solutions was associated with reduced treatment costs, increased body weight, and a decrease in the workload of the staff involved in patient care [17]. Furthermore, in dogs suspected of having parvovirus, early initiation of oral rehydration therapy may help limit enterocyte atrophy and support the intestinal regeneration process [18]. These findings highlight that oral therapy may offer benefits that go beyond simply correcting fluid deficits, while simultaneously helping to maintain gastrointestinal function and support nutritional status.

However, the use of oral therapy is restricted in certain clinical situations. It may be insufficient or contraindicated when the patient is unable to voluntarily consume fluids, has persistent or recurrent episodes of vomiting, has impaired gastrointestinal motility, has severe gastrointestinal dysfunction, or has hypovolemia and severe dehydration requiring rapid restoration of circulating volume. In these situations, enteral administration may not always achieve therapeutic goals to be achieved within an appropriate timeframe. When voluntary intake is not possible but gastrointestinal function is sufficiently preserved, feeding devices such as a nasogastric tube or esophagostomy can be used to provide oral administration [2,3,14].

By comparison, intravenous rehydration therapy allows for the direct administration of fluids into the vascular compartment via a peripheral or central venous catheter. This route of administration ensures faster and more precise control of fluid intake and enables the rapid restoration of intravascular volume. For this reason, intravenous therapy is particularly indicated in patients with severe dehydration, hypovolemia, severe gastrointestinal tract impairment, inability to administer or absorb fluids enterally, as well as in clinical situations requiring rapid stabilization [2,4,11].

In dogs with cardiovascular disease, intravenous fluid administration should be approached with caution, as excessive or too rapid administration can lead to increased cardiac filling pressures and the development of volume overload. In these situations, enteral fluid administration may serve as an alternative or complementary method. Furthermore, oral therapy may offer advantages in patients with hypoproteinemia, particularly in situations in which rapid expansion of the intravascular compartment must be avoided

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[2]. Furthermore, recent data highlight the importance of the integrity of the endovascular glycocalyx, an essential component of micro vascularization, whose structure and function may be impaired under conditions of hypervolemia, including in the context of excessive or prolonged administration of intravenous fluids [4,19].

An important aspect in the comparative evaluation of the two methods is that oral and intravenous therapy should not necessarily be considered mutually exclusive alternatives. In patients with severe dehydration or hypovolemia, a combined or sequential protocol may be instituted. In the initial stage, intravenous therapy can be used to rapidly restore circulating volume and correct significant electrolyte imbalances; thereafter, once the patient has stabilized and gastrointestinal function has resumed, the transition to oral or enteral therapy can be made during the maintenance and recovery phase. This approach allows for a gradual reduction in the need for intravenous fluids and the integration of the nutritional and gastrointestinal benefits of enteral therapy (Table 1) [2,14].

Table 1. A comparative analysis of oral and intravenous rehydration therapy [2-4,11-14,17]

Characteristic	Oral/Enteral Rehydration Therapy (ORT)	Intravenous Fluid Therapy (IVFT)
Main route of administration	Oral or enteral administration via a feeding tube (e.g., nasogastric tube or esophagostomy tube)	Intravenous administration via a peripheral or central venous catheter
Eligible patients	Patients with mild to moderate dehydration, clinically stable, who can tolerate enteral fluid administration	Patients with moderate to severe dehydration, hypovolemia, cardiovascular compromise, or those unable to tolerate enteral administration
Gastrointestinal function	Requires adequate gastrointestinal motility and absorptive capacity	Independent of gastrointestinal absorption
Main limitation	Ineffective or insufficient when gastrointestinal absorption is impaired or when rapid circulatory restoration is required	Invasive method, associated with additional risks related to catheterization and fluid overload
Potential complications	Vomiting, aspiration in case of improper administration, electrolyte imbalances, and inadequate fluid delivery	Volume overload, electrolyte imbalances, phlebitis, catheter-associated complications, and infection

CONCLUSIONS

A comparative analysis of oral and intravenous rehydration therapy in dogs emphasizes the importance of individualized treatment based on the severity of dehydration, hemodynamic status, functional integrity of the gastrointestinal tract, and the clinical characteristics of each patient. Both methods of fluid administration help restore fluid and electrolyte balance, but they have distinct indications, advantages, and limitations that must be considered when establishing a treatment protocol.

Oral rehydration therapy is an effective, less invasive option, particularly recommended for patients with mild to moderate dehydration who are clinically

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stable and have preserved gastrointestinal function. In addition to correcting fluid and electrolyte deficits, it can help maintain bowel function and nutritional status and is associated with reduced costs and a lower need for medical interventions. In contrast, intravenous therapy remains indispensable in the management of patients with severe dehydration, hypovolemia, or significant gastrointestinal dysfunction, due to its ability to quickly and controlled restore circulatory volume and tissue perfusion.

These two methods should be considered complementary approaches rather than competitive therapeutic interventions and can be integrated into the same rehydration protocol. Thus, the initial use of intravenous fluid therapy to stabilize critically ill patients, followed by a transition to oral or enteral administration, may represent an appropriate therapeutic strategy, depending on clinical progression and gastrointestinal tolerance.

The available scientific literature highlights a relatively few clinical studies dedicated to evaluating oral rehydration therapy in dogs, compared to research on intravenous fluid administration. This limitation underscores the need for additional clinical studies aimed at evaluating the efficacy of oral rehydration solutions, identifying the optimal transition point between intravenous and oral therapy, standardizing treatment protocols, and identifying optimal patient selection criteria.

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