

Updates in Oral Management of Dehydration and Electrolyte Disturbance in Infants and Children: A Systematic Review

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Abstract

Background: The ability of the first responder to identify and effectively treat hypovolemic shock will determine whether or not a child with severe volume depletion survives in the emergency room. Although the fundamentals of fluid and electrolyte therapy have been studied for decades, the issue is still difficult to resolve because there is no universally accepted therapeutic care approach. **Objectives:** This systematic review aims to study the updated management of dehydration and electrolyte disturbance in children and infants. **Methods:** PubMed, Science Direct, and Google Scholar were systematically searched for relevant literature. Rayyan QRCI was employed throughout this comprehensive process. **Results & interpretation:** This review included a total of ten studies with 2285 patients, and 883 (38.6%) were males. According to this comprehensive study, home-based therapy and ORS were successful in straightforward instances. Other methods, such as ORS plus Xyloglucan and ORS with honeybee added, were secure and efficient in reducing the frequency of vomiting and diarrhea. The electrolyte balance and rehydration of the patients were improved by diluted apple juice, rehydration treatments, and preferred fluids. However, gelatin tannate proved ineffective for rehydrating the child, although it advised against ever stopping breastfeeding. Drugs like intravenous Metoclopramide and Domperidone demonstrated efficacy for treating pediatric dehydration in the event that ORS failed.

Keywords: Dehydration; Diarrhea; Electrolyte disturbance; Children; Systematic review.

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INTRODUCTION

One of the primary causes of pediatric illness and mortality worldwide is dehydration. Between 14% to 30% of baby and toddler mortality worldwide is caused by diarrheal illness and dehydration [1]. Up until 2003, gastroenteritis in the US was responsible for 300 annual deaths, 200,000 hospitalizations, and more than 1.5 million office visits. Since the rotavirus vaccine, norovirus has overtaken rotaviral gastroenteritis as the most common cause of illness in the US. Water makes up approximately 75% of an infant's body weight and up to 60% of an adult's body weight, which is crucial for maintaining cellular homeostasis. Humans would perish within a few days if they didn't drink any water [2].

The human body has an effective system of physiological regulation, including thirst, to maintain fluid and electrolyte balance. Rapid fluid and electrolyte losses in disease conditions like gastroenteritis, which can overwhelm these defense mechanisms, can result in hyponatremia, the most prevalent electrolyte imbalance

in hospitalized patients [3]. The inability of infants and young children to communicate their thirst to carers or to get fluids on their own makes them particularly susceptible. Due to a larger body surface area, they also experience higher insensible losses.

It can be challenging to determine the volume depletion's severity. The clinician would ideally have a starting weight to compare against because every gram of weight lost equals one milliliter of water lost. Unfortunately, it is unusual to find such a baseline weight. Therefore, to determine the extent of dehydration, we should consider both test results and clinical signs and symptoms. Dehydration is typically categorized as mild (volume loss of 3% to 5%), moderate (volume loss of 6% to 9%), or severe (volume loss of 10% or more) [4].

Other than a decrease in urine flow, infants and children with moderate dehydration frequently experience little or no clinical changes. Children with moderate dehydration frequently show dried mucous

membranes, decreased skin turgor, irritability, tachycardia with impaired capillary refill, and deep respirations in addition to decreased urine output and tears. The greatest predictors of clinical dehydration in children of at least 5% were shown to be prolonged capillary refill, aberrant skin turgor, and abnormal respiratory pattern [5]. Children with extreme dehydration exhibit lethargy, tachycardia, hypotension, hyperpnea, delayed capillary refill, and cold and mottled extremities. They may also be in near-shock or shock. They need vigorous isotonic fluid resuscitation right away. When all compensatory mechanisms to maintain organ perfusion are exhausted, hypotension, a very late indication of dehydration, develops [4, 5].

Therapy aims to identify the type and severity of dehydration, correct any water and electrolyte imbalances, satisfy maintenance requirements, and replace ongoing losses. The degree of dehydration is clinically assessed using a weight change or calculated using the signs and symptoms, as previously mentioned.

A blood sodium value can be used to help decide the right fluids to utilize and the right time course for replacement in cases of moderate or severe dehydration. In industrialized nations, intravenous fluids are typically used to do this, however mild-to-moderate hyponatremic dehydration can be successfully treated with oral rehydration.

Aim of the study:

This systematic review aims to study the updated oral management of dehydration and electrolyte disturbance in children and infants.

METHODOLOGY

The PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines were followed in conducting this systematic review [6].

Study Design and Duration

September 2023 marked the start of this systematic review.

Search strategy

To discover the pertinent literature, a thorough search was conducted across three main databases: PubMed, Google Scholar, and Science Direct. We limited our search to English and considered each database's specific needs. The following keywords were transformed into PubMed Mesh terms and used to locate the pertinent studies; "Electrolyte disturbances," "Dehydration," "Diarrhea," "Vomiting," "Children," "Infants," and "Management." The Boolean operators

"OR" and "AND" matched the required keywords. Publications with full English text, available free articles, and human trials were among the search results.

Selection criteria

We considered the following criteria for inclusion in this review:

- Study designs that investigated the management of electrolytes and dehydration and electrolytes disturbances in children and infants.
- Only infants and young children.
- Studies conducted between 2010-2023
- Only human subjects.
- English language.
- Free accessible articles.

Data extraction

The search technique's output was double-checked using Rayyan (QCRI) [7]. By modifying the results of the combined search with a set of inclusion/exclusion criteria, the researchers evaluated the relevance of the titles and abstracts. Each paper that met the requirements for inclusion underwent a careful examination by the reviewers. The authors talked about methods for resolving disputes. The approved study was uploaded using a data extraction form that had already been created. The authors extracted data about the study titles, authors, study year, country, participants, gender, management, and main outcomes. A separate sheet was created for the risk of bias assessment.

Strategy for data synthesis

Utilizing information from pertinent research, summary tables were made to offer a qualitative evaluation of the findings and study elements. The most effective method for using the data from the included study articles was selected after the data for the systematic review were retrieved.

RESULTS

Search Results

A total of 704 study articles resulted from the systematic search, and 113 duplicates were deleted. Title and abstract screening were conducted on 591 studies, and 512 studies were excluded. 79 reports were sought for retrieval, and no articles were retrieved. Finally, 79 studies were screened for full-text assessment; 45 were excluded for wrong study outcomes, 10 for the wrong population type, and 4 articles were letters to the editors. Ten eligible study articles were included in this systematic review. A summary of the study selection process is presented in Figure 1.

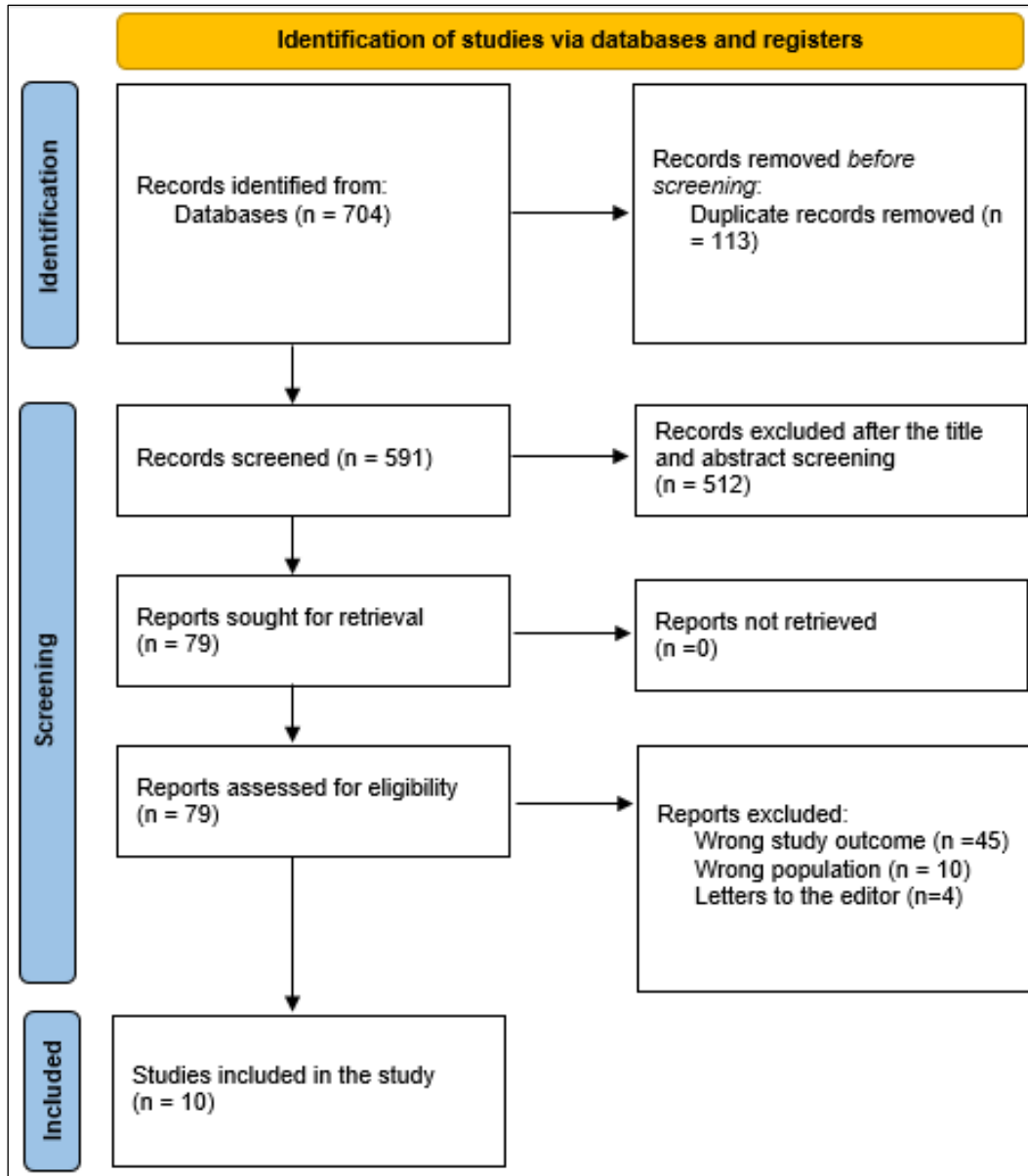


Figure 1: PRISMA flowchart summarizes the study selection process

Characteristics of the included studies

Table (1) presents the sociodemographic characteristics of the included study articles. Our results included ten studies with a total of 2285 patients, and 883 (38.6%) were males. Six studies were randomized control trials (RCTs) [9, 11, 13-16], two were prospective in nature [8, 10], one was a case-control study [12], and one was retrospective in nature [17].

Table (2) presents the clinical characteristics. Two studies reported that ORS and home-based therapy were effective in simple cases [8, 10].

Abdulrhman *et al.*, reported that the frequency of vomiting and diarrhea was considerably lower in patients who received honeybee added to ORS [12]. ORS

plus Xyloglucan was also a safe and effective option [16].

Diluted apple juice and rehydration solutions followed by preferred fluids resulted in improvement in the patients' electrolyte profile and rehydration [9].

Kołodziej *et al.*, reported that gelatin tannate was ineffective on children's rehydration but recommended never to take a break from breastfeeding [11].

Zinc supplement was only effective in children with zinc deficiency in the first place. In case of failure of ORS, drugs like intravenous Metoclopramide and Domperidone showed efficacy for managing dehydration in children [13, 14].

Table 1: Study design, country and participants characteristics of the included studies

| Study | Study design | Country | Participants | Mean age (months) | Males (%) |
|---|---------------|---------|--------------|-------------------|------------|
| Chakravarthi & Kumar, 2019 [8] | Prospective | India | 97 | 1 month-5 yrs | 53 (54.6%) |
| Freedman <i>et al.</i> , 2016 [9] | RCT | Canada | 647 | 28.3 ± 15.9 | 331 (51.1) |
| Dagar <i>et al.</i> , 2016 [10] | Prospective | India | 434 | 1 month-5 yrs | 236 (54.4) |
| Kolodziej <i>et al.</i> , 2018 [11] | RCT | Poland | 72 | 27.7±29.3 | 39 (54.2) |
| Abdulrhman <i>et al.</i> , 2010 [12] | Case-control | Egypt | 100 | 13.3± 9.3 | 57 (57) |
| Al-Ansari <i>et al.</i> , 2011 [13] | RCT | Qatar | 167 | 4.2 ± 3.2 (yrs) | 85 (50.9) |
| Marchetti <i>et al.</i> , 2011 [14] | RCT | Italy | 540 | 1-6 (yrs) | 272 (50.4) |
| Patro <i>et al.</i> , 2010 [15] | RCT | Poland | 141 | 22.3±12.6 | 75 (53.2) |
| Pleșea Condratovici <i>et al.</i> , 2016 [16] | RCT | Romania | 36 | 4.33 ± 3.80 (yrs) | 15 (41.7) |
| Hao <i>et al.</i> , 2020 [17] | Retrospective | China | 51 | 21.1 ± 7.4 | 18 (35.3) |

*NM=Not mentioned

Table 2: Clinical characteristics and outcomes of the included studies

| Study | Treatment | Main outcomes |
|---|---|---|
| Chakravarthi & Kumar, 2019 [8] | ORS | They respond well to the ORS and fluid correction that the WHO advises. 60.8% of cases had moderate dehydration, whereas 39.1% of cases had severe dehydration. Isonatremic and hyponatremic dehydration were also present in 59.8% and 33% of the patients, respectively. There was hypokalemia in 44.3% of patients. |
| Freedman <i>et al.</i> , 2016 [9] | Dilute apple juice and preferred fluids vs electrolyte maintenance solution | When compared to electrolyte maintenance solution, oral hydration with diluted apple juice followed by their preferred fluids led to fewer treatment failures in children with moderate gastroenteritis and minimal dehydration. The use of diluted apple juice and other preferred fluids on a case-by-case basis may be a suitable substitute for electrolyte maintenance fluids in children with moderate gastroenteritis and minor dehydration in many high-income nations. |
| Dagar <i>et al.</i> , 2016 [10] | ORS | The results of our investigation confirm the importance of efficient ORS in preventing the negative effects of diarrhea. With the use of home-based fluids or ORS, the mild character of the sickness can be simply & efficiently handled at the household level. The most frequent electrolyte imbalance was hyperchloraemia (42.40%), which was followed by hyperkalemia (26.40%) and hypernatremia (20.60%). |
| Kolodziej <i>et al.</i> , 2018 [11] | Gelatine tannate | For the treatment of acute gastroenteritis in children under the age of five, gelatine tannate, given as a supplement to rehydration, was ineffective. There should never be a break in breastfeeding. Regular feeding should continue unaltered, including milk consumption. In children aged 6 months to 5 years who live in nations with a high prevalence of zinc deficiency or who exhibit indications of malnutrition, oral zinc supplementation shortens the duration of diarrhea. |
| Abdulrhman <i>et al.</i> , 2010 [12] | Honey-bee added to ORS | When compared to the control group, the frequency of vomiting and diarrhea was considerably lower in the honey-treated group (P .001 and P .05, respectively). Adding honey to ORS aided in rehydrating the body and sped up the recovery process after vomiting and diarrhea. |
| Al-Ansari <i>et al.</i> , 2011 [13] | Metoclopramide (IV) | In children with gastroenteritis who were admitted for intravenous fluid hydration, intravenous metoclopramide showed promise as a treatment for persistent vomiting and may be regarded as a secure substitute for ondansetron. |
| Marchetti <i>et al.</i> , 2011 [14] | Domperidone | The trial results would show the effectiveness of domperidone, which is widely used in clinical practice despite inadequate evaluation and a contentious safety profile, as opposed to ondansetron, which is not yet authorized in Italy despite evidence supporting its efficacy in treating vomiting. This is after the initial ORS administration in the ED failed. |
| Patro <i>et al.</i> , 2010 [15] | Zinc supplement | Children who live in a nation where zinc deficiency is uncommon do not seem to benefit from zinc treatment for diarrhea. |
| Pleșea Condratovici <i>et al.</i> , 2016 [16] | Xyloglucan + ORS | In clinical practice, the administration of xyloglucan along with ORS is an effective and secure choice for treating acute diarrhea in the pediatric population. It has a quick beginning of action and reduces types 6 and 7 stools. |
| Hao <i>et al.</i> , 2020 [17] | ORS and anti-epileptic drugs | The symptoms of all the kids, including an electrolyte shortage, were treated. Tonic-clonic or focal convulsions and mild gastroenteritis (vomiting, diarrhea) are the clinical manifestations of benign convulsions with mild gastroenteritis (BCWG), a situation-related seizure. Hyponatremia and mild metabolic acidosis are both possible. The condition has a good prognosis; lumbar puncture and long-term antiepileptic medications are not required and should not be suggested. |

DISCUSSION

The majority of kids who present with dehydration from diarrhoea or emesis continue to lose fluids until the gastroenteritis clears up. Therefore, to achieve normovolemia, continuous losses must be replenished in addition to giving fluids and electrolytes to meet maintenance and deficit demands. In general, fluids with the same electrolyte composition should be used to replace ongoing losses milliliter for milliliter. Normal saline (NS) with 0.45% and 10–15 mEq/L potassium chloride (KCl) are generally used to replenish losses through emesis or nasogastric drainage. Additionally, bicarbonate is lost through diarrhea; thus, replenishment may help people with severe acidosis [18].

This review reported that ORS and home-based therapy were effective in simple cases [8, 10]. Abdulrhman *et al.*, reported that the frequency of vomiting and diarrhea was considerably lower in patients who received honeybee added to ORS [12]. ORS plus xyloglucan was also a safe and effective option [16].

An accurate assessment of the degree of dehydration is necessary to decide whether to administer oral rehydration therapy (ORT) or intravenous therapy to a kid [19]. Parenteral fluid therapy in a child with an overestimated fluid deficit can also result in unwarranted IV interventions, longer hospital stays, fluid overload, and hyponatremia [19-21]. In contrast, ORT in a child with an underestimated fluid deficit can cause acidosis, electrolyte disturbances, acute kidney injury, and death. It is crucial to keep an eye on a dehydrated child because even while receiving fluid therapy, hydration status might alter (resulting in variable degrees of dehydration and overhydration).

Pure honey is a widely available source of glucose and fructose and is bactericidal for many pathogenic organisms, including enteropathogens like *Salmonella* species, *Shigella* species, enteropathogenic *Escherichia coli*, and other Gram-negative organisms [22]. When honey was used in place of glucose in the ORS, it was found to reduce the length of time that bacterial diarrhea lasted and did not increase the length of time that nonbacterial diarrhea lasted [23]. Regarding this, a medical device containing xyloglucan, a substance produced from the seeds of the tamarind tree (*Tamarindus indica*), has been created and recently acquired European clearance (MED class III) for restoring the physiological functioning of the intestinal walls. The xyloglucan-containing product has been created specifically for the control and alleviation of symptoms connected to diarrheal events of different aetiologies, such as abdominal tension and frequent emissions of feces. It is available as capsules for adults and powder for pediatric usage [24].

We found that diluted apple juice and rehydration solutions followed by preferred fluids

improved the patients' electrolyte profile and rehydration [9]. However, Kołodziej *et al.*, reported that gelatin tannate was ineffective on children's rehydration but recommended never taking a breastfeeding break [11]. In case of failure of ORS, drugs like intravenous metoclopramide and Domperidone showed efficacy for managing dehydration in children [13, 14]

Lack of water/level of dehydration. The clinician must first ascertain whether the hypovolemic shock is present, which is an emergency and always indicates severe dehydration. The various types of dehydration can be identified with a thorough medical history and additional physical examination [25]. The amount of fluid needed to correct dehydration must be estimated, and the severity of the dehydration must be determined to determine whether parenteral or oral rehydration will be used (severe dehydration) [26]. When managing a child with hyponatremia, it's critical to know if the patient is hypovolaemic, euvolaemic, or hypervolaemic based on intravascular volume [25].

In children with mild-to-moderate isotonic dehydration, oral rehydration therapy can safely and successfully restore intravascular volume as much as the kid is able to tolerate it [27]. ORT is recommended as the first line of treatment for children who are mildly and moderately dehydrated by the American Academy of Paediatrics, WHO, and Centres for Disease Control [27-29]. ORT should be the first-line therapy for mild-to-moderate dehydration, with intravenous therapy administered only if oral therapy fails, according to a systematic review and meta-analysis that identified no clinical difference in rehydration among children receiving oral versus intravenous fluids [30].

Because they don't have the right amounts of sodium and glucose to encourage salt and water absorption, beverages such as apple juice, tea, ginger ale, colas, sports drinks, and chicken broth shouldn't be used to rehydrate [27, 30, 31].

Keeping in mind that the bedside assessment for dehydration is still only at the best clinical estimations, it is crucial to closely follow patients as they rehydrate. The kidney frequently corrects under- and overestimation errors in the computation of fluid estimates when it is working optimally [32, 33].

CONCLUSION

This systematic review reported that, ORS and home-based therapy were effective in simple cases. Other forms, such as honeybee added to ORS and ORS plus xyloglucan, were safe and effective in decreasing the frequency of vomiting and diarrhea. Diluted apple juice and rehydration solutions followed by preferred fluids improved the patients' electrolyte profile and rehydration. However, gelatin tannate was ineffective on children's rehydration, but it recommended never taking a breastfeeding break. In case of failure of ORS, drugs

like intravenous Metoclopramide and Domperidone showed efficacy for managing dehydration in children.

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