



ORIGINAL ARTICLE

Acute diarrheal illness with severe complications in a Pediatric Intensive Care Unit

Enfermedad diarreica aguda con complicaciones graves en una Unidad de Cuidados Intensivos Pediátricos

Doença diarreica aguda com complicações graves em Unidade de Terapia Intensiva Pediátrica

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ABSTRACT

**Introduction:** acute diarrheal disease is one of the main childhood health problems worldwide. **Objective:** to characterize patients under one year of age diagnosed with severe acute diarrheal disease admitted to a Pediatric Intensive Care Unit of the Hospital Infantil "Hermanos Cordové" from September 2019 to September 2021. **Method:** a retrospective and descriptive study was conducted in 60 patients admitted to this institution. The variables studied were: age, sex, reason for admission, length of stay, risk factors, symptoms and signs, complications, and treatment plans. **Results:** children under three months of age (58.3%) and boys (60%) predominated. Hydromineral imbalance was the primary reason for admission (75%); 10% of children were hospitalized for more than ten days. Vomiting (48.3%) was the most common clinical manifestation accompanying diarrhea, and metabolic acidosis was the most frequent

complication (70%). The most frequently used hydration plan was Type C (51.7%). **Conclusions:** severe diarrheal disease is more common in males and in children under three months of age. Hydromineral imbalance disorders are the primary cause of the disease, and its main risk factors are age under three months, malnutrition, and mixed breastfeeding. The cardinal clinical manifestations are fever and vomiting. Metabolic acidosis is the main complication, and Type C hydration plan was the most frequently used in patients.

**Keywords:** acute diarrheal disease; complications; diarrhea; children; intensive care



## RESUMEN

**Introducción:** la enfermedad diarreica aguda constituye uno de los principales problemas de salud infantil a nivel mundial. **Objetivo:** caracterizar a los menores de un año con diagnóstico de enfermedad diarreica aguda con complicaciones graves ingresados en una Unidad de Cuidados Intensivos Pediátricos del Hospital Infantil Cordové” en el período septiembre 2019 a septiembre 2021. **Método:** estudio retrospectivo descriptivo en 60 pacientes ingresados en dicha institución. Se estudiaron las variables: edad, sexo, motivo de ingreso, estadía, factores de riesgo, síntomas y signos, complicaciones y planes de tratamiento. **Resultados:** predominaron los niños menores de tres meses (58,3 %) y sexo masculino (60 %). El desequilibrio hidromineral fue el motivo de ingreso fundamental (75 %); el 10 % de los niños estuvo ingresado por más de diez días. Los vómitos (48,3 %) fueron la manifestación clínica que más acompañó al cuadro diarreico y la acidosis metabólica fue la complicación más frecuente (70 %). El plan de hidratación que más se utilizó fue el C (51,7 %). **Conclusiones:** la enfermedad diarreica aguda con complicaciones graves es más frecuente en el sexo masculino y en edades menores de tres meses. Los trastornos del desequilibrio hidromineral son la causa principal de la enfermedad y sus principales factores de riesgos son la edad menor a los tres meses, la desnutrición y la lactancia mixta. Las manifestaciones clínicas cardinales son la fiebre y los vómitos. La acidosis metabólica es la principal complicación y el plan de hidratación de tipo C fue el más empleado en los pacientes.

**Palabras clave:** enfermedad diarreica aguda; complicaciones; diarrea; niños; cuidados intensivos

## RESUMO

**Introdução:** a doença diarreica aguda é um dos principais problemas de saúde infantil em todo o mundo. **Objetivo:** caracterizar pacientes menores de um ano com diagnóstico de doença diarreica aguda grave internados na Unidade de Terapia Intensiva Pediátrica do Hospital Infantil “Hermanos Cordové” entre setembro de 2019 e setembro de 2021. **Método:** foi realizado um estudo retrospectivo e descritivo em 60 pacientes internados nesta instituição. As variáveis estudadas foram: idade, sexo, motivo da internação, tempo de internação, fatores de risco, sintomas e sinais, complicações e planos de tratamento. **Resultados:** predominaram crianças menores de três meses (58,3%) e meninos (60%). O desequilíbrio hidromineral foi o principal motivo de internação (75%); 10% das crianças permaneceram hospitalizadas por mais de dez dias. Vômito (48,3%) foi a manifestação clínica mais comum que acompanhou a diarreia, e a acidose metabólica foi a complicação mais frequente (70%). O plano de hidratação mais utilizado foi o Tipo C (51,7%). **Conclusões:** a doença diarreica grave é mais comum em homens e em crianças menores de três meses. Os distúrbios do desequilíbrio hidromineral são a principal causa da doença, e seus principais fatores de risco são idade inferior a três meses, desnutrição e aleitamento materno misto. As manifestações clínicas cardinais são febre e vômito. A acidose metabólica é a principal complicação, e o plano de hidratação Tipo C foi o mais utilizado nos pacientes.

**Palavras-chave:** doença diarreica aguda; complicações; diarreia; crianças; cuidados intensivos

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## INTRODUCTION

Acute diarrheal disease (AD) constitutes one of the major child health problems worldwide. Acute diarrhea (AD) is defined as a decrease in stool consistency (loose or liquid) and/or an increase in its frequency to three or more in 24 hours, with or without other symptoms.<sup>(1,2,3)</sup> This disease was discovered by a group of scientists in the 1970s and is the cause of viral etiology by rotavirus; later, subsequent studies showed that it participated in the increase of diarrhea mortality rates.<sup>(4)</sup>

Four types of acute diarrhea can be identified: osmotic aqueous, secretory aqueous, non-invasive bloody and invasive bloody.<sup>(5)</sup> The most common etiology of ADE is of infectious origin, produced by bacteria, viruses and, to a lesser extent, parasites. The infectious agents most frequently detected in diarrheal stool samples are diarrheagenic *Escherichia coli*, *Salmonella* spp, *Shigella*, *Campylobacter* and rotavirus. The World Health Organization (WHO) estimates that 1.7 billion children suffer from diarrhea and 525 thousand children under five years of age die each year.<sup>(6,7)</sup>

ADD is considered the second leading cause of death in children less than five years of age in South Asia and Africa; while 0.1% of deaths in children fewer than five years of age due to ADD have been reported in North America and 5.1% in Latin America and the Caribbean. Similarly, in South America, one in eight children die from diarrhea and those who manage to survive are left with degrees of malnutrition and other serious diseases.<sup>(8,9)</sup>

In Latin America, ADE is the fifth leading cause of mortality, accounting for 60-80% of pediatric consultations and 40-50% of hospitalizations. Peru reported 371 812 cases of diarrhea in children aged 1 to 4 years in 2016, while Colombia, for 2015, recorded 3.3 % of deaths in children under five years per 100 000 inhabitants. In Ecuador, the prevalence of AED is approximately 25%, which generates 7.4% of the demand for consultations and 10% of pediatric hospitalizations.<sup>(5)</sup>

In Cuba, in the year 2020, the rate of AED in children under 15 years of age was 262.0 per 1,000 inhabitants, with 62,311 cases reported, with the ages of one to four years being the most affected. By the year 2021, the rate decreased to 201.3, for a total of 52 720 infants with this disease.<sup>(10)</sup> However, in 2023, there has been a significant increase in the number of patients seeking health services for ADD, with a rate of 348.1 per 1 000 inhabitants, with 90 781 cases; ages one to four years old were the most affected, with 43 968 cases.<sup>(11)</sup>

Strengthening active epidemiological surveillance and identifying the risk factors that contribute to the appearance of the disease are fundamental pillars for the prevention of the disease. For this reason, Cuba, through the Maternal and Child Care Program, together with health institutions and universities, plays a fundamental role in the promotion of hygiene in the community. Hence, the interventions and educational talks aimed at the communities, children and families who are admitted to hospitals for this disease; have as a fundamental pillar of treatment: hygiene and diet.



For this reason, the authors of this study posed the following question: What are the clinical, epidemiological and therapeutic features that characterize patients with a diagnosis of AED with severe complications admitted to the Pediatric Intensive Care Units (PICU) of the “Hermanos Cordové” Children's Hospital of Granma during the period from September 2019 to September 2021? The objective of this research is to characterize patients less than one year old with a diagnosis of AED with severe complications admitted to the PICU of said institution during the period from September 2019 to September 2021.

## METHOD

Retrospective and descriptive study with 60 patients admitted to the Pediatric Intensive Care Unit of the “Hermanos Cordové” Children's Hospital of Granma, in the period from September 2019 to September 2021. No sample criteria were used to carry out the study.

*Inclusion criteria:* patients admitted with a diagnosis of ADE with severe complications in the PICU.

*Exclusion criteria:* children admitted to the wards of the “Hermanos Cordové” Children's Hospital with mild episodes of diarrhea.

*Study variables:* age: according to months and days completed at the time of diagnosis (under 3, 3 - 6, 7 - 11 months and 29 days); sex: according to biological sex (male and female); reason for admission: cause of admission of the patient to the PICU for particularized care, observation and/or therapeutic (hydromineral imbalance, acid-base imbalance, bacterial infection, continuous monitoring); length of stay: time elapsed between the dates of admission and discharge of patients to the PICU (less than 7 days, 7 - 10 days and more than 10 days).

Risk factors: any factor that increases the possibility or predisposes to the onset of the disease [less than three months, mixed breastfeeding, non-use of exclusive breastfeeding (EBF), child of an adolescent mother, associated comorbidity, malnourished below the third percentile, low birth weight (LBW), manipulation, child of an elderly mother and others (recent discharge, child abuse, twins and artificial breastfeeding)].

Symptoms and signs: clinical manifestations accompanied by diarrheal disease (fever, vomiting, cyanosis, perfusion disorders, oliguria, respiratory manifestations, urinary manifestations, abdominal distension).

Complications: situation that aggravates and lengthens the course of the disease (metabolic acidosis, persistent diarrheal disease, dysbacteriosis, death, renal failure, sepsis, bronchopneumonia, hypokalemia, hyponatremic dehydration and others: enzymatic deficit, septic shock and multiple organ dysfunctions).



Treatment plans according to the book Pediatrics. Diagnosis and Treatment by a collective of authors specializing in pediatric age care: method to cure and/or prevent the disease and its complications (Plan: A, B, C).<sup>(12)</sup>

*Collection of information:* for the collection of information, the individual clinical histories of the patients (HCI) were reviewed and a database was prepared. A bibliographic review of materials and sources on the different aspects dealt with in the research was carried out. Descriptive statistics were used for data analysis by calculating absolute and relative percentage frequencies.

The research was carried out in compliance with the basic ethical principles: autonomy, beneficence, non-maleficence and justice. The research was carried out with the approval of the Ethics Committee and Scientific Council of the "Hermanos Cordové" Children's Hospital. The information obtained was only used for scientific purposes.

## RESULTS

Table 1 show the distribution of patients according to age, sex and age characteristics. Age under three months predominated (58.3 %) and the most frequent sex was male (60 %). The population mean was 4.49 and the median was 2.5.

**Table 1:** Patients according to age, sex and age characteristics

| Age groups                 | Female    |                    | Male          |               | Total     |              |
|----------------------------|-----------|--------------------|---------------|---------------|-----------|--------------|
|                            | No.       | %                  | No.           | %             | No.       | %            |
| < 3 months                 | 12        | 20,0               | 23            | 38,3          | 35        | 58,3         |
| 4 a 6 months               | 2         | 3,3                | 6             | 10,0          | 8         | 13,3         |
| 7 a 11 months and 29 days  | 10        | 16,7               | 7             | 11,7          | 17        | 28,3         |
| <b>Total</b>               | <b>24</b> | <b>40,0</b>        | <b>36</b>     | <b>60,0</b>   | <b>60</b> | <b>100,0</b> |
| <b>Age characteristics</b> |           |                    |               |               |           |              |
| Cases                      | Mean      | Standard deviation | Minimum value | Maximum value | Median    |              |
| 60                         | 4,49      | ± 3,83             | 0,3           | 12            | 2,5       |              |

Source: medical records.

Table 2 shows that hydromineral imbalance was the main reason for admission to the PICU (75 %).

Regarding the hospital stay of the patients in the PICU, 50 children (83.3 %) spent less than 7 days in the therapy room, 6.7 % from 7 to 10 days and 10 % more than 10 days.

In relation to the mean length of stay in days of the patients in the PICU, the mean of a total of 60 cases was 4.62; standard deviation +5.23; minimum value 1; maximum value 28; and a median of 3.



**Table 2:** Patients according to age, reason for transfer and average length of stay

| Reason for transfer     | Age group  |      |              |      |                            |      | Total |      |
|-------------------------|------------|------|--------------|------|----------------------------|------|-------|------|
|                         | < 3 months |      | 4 - 6 months |      | 7 to 11 months and 29 days |      |       |      |
|                         | No.        | %*   | No.          | %*   | No.                        | %*   | No.   | %*   |
| Fluid-mineral imbalance | 25         | 41,7 | 6            | 10,0 | 14                         | 23,3 | 45    | 75,0 |
| Acid-base imbalance     | 6          | 10,0 | 2            | 3,3  | 2                          | 3,3  | 10    | 16,7 |
| Bacterial infection     | -          | -    | -            | -    | 1                          | 1,7  | 1     | 1,7  |
| Continuous monitoring   | 4          | 6,7  | -            | -    | -                          | -    | 4     | 6,7  |

\*Total of patients=60

Source: medical record.

Among the most important risk factors were: age under three months (58.3 %); a nutritional assessment of malnourished in 53.3 % of the cases and the non-use of the EML until six months of the child's life (50 %). (Table 3)

**Table 3:** Patients according to risk factors associated with ADEs

| Risk Factors                       | No. | %*   |
|------------------------------------|-----|------|
| Under 3 months                     | 35  | 58,3 |
| Mixed breastfeeding                | 25  | 41,7 |
| Non-use of exclusive breastfeeding | 30  | 50,0 |
| Child of adolescent mother         | 7   | 11,7 |
| Associated comorbidity             | 11  | 18,3 |
| Malnourished                       | 32  | 53,3 |
| Low birth weight                   | 8   | 26,7 |
| Manipulation                       | 9   | 15,0 |
| Child of elderly mother            | 7   | 11,7 |
| Others                             | 14  | 23,3 |

\*Total patients=60

Source: medical records.

Vomiting (48.3 %) and fever (43.3 %) were the clinical manifestations that most often accompanied ADE (Table 4).

**Table 4:** Patients according to clinical manifestations accompanying ADEs

| Symptoms and signs         | No | %*   |
|----------------------------|----|------|
| Fever                      | 26 | 43,3 |
| Vomiting                   | 29 | 48,3 |
| Respiratory manifestations | 14 | 23,3 |
| Urinary manifestations     | 3  | 5,0  |
| Perfusion disorder         | 2  | 3,3  |
| Oliguria                   | 1  | 1,7  |
| Cyanosis                   | 2  | 3,3  |
| Respiratory failure        | 2  | 3,3  |
| Abdominal distension       | 1  | 1,7  |

\*Total patients=60

Source: medical records.



Metabolic acidosis due to dehydration was the most frequent complication in patients with ADE (70.0 %). (Table 5)

**Table 5:** Patients according to the complications presented

| Complications                    | No. | %*   |
|----------------------------------|-----|------|
| Metabolic acidosis (dehydration) | 42  | 70,0 |
| Persistent diarrheal disease     | 4   | 6,7  |
| Dysbacteriosis                   | 8   | 13,3 |
| Renal failure                    | 3   | 5,0  |
| Sepsis                           | 8   | 13,3 |
| Bronchopneumonia                 | 4   | 6,7  |
| Hypokalemia                      | 6   | 10,0 |
| Hyponatremic dehydration         | 5   | 8,3  |
| Other                            | 4   | 6,7  |

\*Total patients=60

Source: medical records.

During the study period, four infant deaths were reported due to complications such as enzyme deficiency, septic shock and multiple organ dysfunctions.

Table 6 shows that the most frequently used hydration plan was C, with 51.7% in the group of children under three months of age.

**Table 6:** Patients according to age and hydration schedule

| Age<br>(months) | Hydration plan |     |        |    |        |      | Total |      |
|-----------------|----------------|-----|--------|----|--------|------|-------|------|
|                 | Plan A         |     | Plan B |    | Plan C |      |       |      |
|                 | No.            | %*  | No.    | %* | No.    | %*   | No.   | %*   |
| < 3             | 4              | 6,7 | -      | -  | 31     | 51,7 | 35    | 58,4 |
| 4 a 6           | -              | -   | -      | -  | 8      | 13,3 | 8     | 13,3 |
| 7 a 12          | 1              | 1,7 | -      | -  | 16     | 26,7 | 17    | 28,3 |

\*Total patients=60

Source: medical records.

## DISCUSSION

In the study, ages younger than three months predominated, a result that differs from that found by Zapata Gonzalez et al.<sup>(13)</sup>, where they show a preponderance of ages between six months and one year for 36.8 %. Similarly, in the thesis of Lujan Flores et al.<sup>(14)</sup> the age groups between six months and two years predominate in 44.2 %.

The authors consider that this result is due to the fact that many of the children arrived with important risk factors that contributed to the complication of the disease. Age younger than three months associated with mixed breastfeeding and low nutritional weight lead to acute diarrheal symptoms which, if not treated in time, can lead to death.

In the study, the most frequent sex was male. This result is similar to the studies of De la Rosa Tomalá<sup>(15)</sup> and Cisneros Trujillo et al.<sup>(16)</sup>, where the male sex was the most predominant, with 59.4% and 53.0%, respectively. However, in the study by Lujan Flores et al.<sup>(14)</sup> the female sex was the most predominant (56.5 %).

The influence of EDA in the male sex is due to the fact that men do not possess the second X chromosome. Genes determine the amount of IgM located in the body and males possess only one. It is important to note that this immunoglobulin causes lysis of bacteria, viruses and other pathogens. IgM is the first type of immunoglobulin synthesized in response to an infection which, in most cases, is the fundamental cause of diarrhea in the pediatric age group. Furthermore, male hormones (androgens) have anti-inflammatory properties, unlike estrogens, which at physiological concentrations have a stimulating effect on cellular and humoral immunity.<sup>(17)</sup>

From the birth of the child until its development, it undergoes a series of consultations where the mother is offered quality information on how to prevent diarrheal diseases through an adequate diet and, mainly, the promotion of SCI as the main preventive measure.

The reason for transfer to the PICU was due to the appearance of hydromineral imbalance disorders, among which we can find metabolic acidosis, hyponatremic dehydration and hypokalemia. The authors consider that these diseases, together with risk factors such as age, no SCI and low nutritional weight, can lead the patient to a fatal outcome. Hence, intensive treatment and hydration plan C is necessary for children with ADE with severe complications.

The length of stay of most patients was less than seven days. This result evidences the quality of the medical care provided by the health services and the efforts of the medical and paramedical personnel to achieve a rapid recovery of the child. In addition, it demonstrates once again the effectiveness of the use of hydration plan C in patients with ADE with severe complications to avoid a fatal outcome.

Among the risk factors that had the greatest impact were age under three months and malnutrition. Any patient under three months of life should be given special attention if he/she arrives at the health services with complicated ADE; this is due to the fact that his/her immune system is not fully developed, which makes him/her vulnerable to infections and gastrointestinal diseases. These ages, associated with other important risk factors such as no SCI and poor feeding, lead the infant to suffer from diarrheal conditions accompanied by disorders of hydroelectrolyte and acid-base imbalance.

Mingo Morocho<sup>(18)</sup> in his thesis for his medical degree shows that malnutrition was one of the factors most associated with ADE (72.0%). This result coincides with the present study. Other authors agree that the non-use of SCI before six months of age contributes in the future to the child suffering from this disease.<sup>(1,3)</sup>

De la Rosa Tomalá<sup>(15)</sup> in her thesis on sociocultural risk factors related to ADEs found that 87.5% of parents are in the habit of feeding their child from a street vendor, and do not wash their child's hands before eating. These results are not similar to those of this study.



Most of the children were malnourished at the time of admission to the ward, a result attributed to the fact that many of the family members had a low socioeconomic level and others were feeding their children an inadequate diet. Poor nutritional status increases the risk of death.<sup>(4)</sup>

In malnourished children, recovery from diarrheal episodes may take twice as long as in those with good nutritional status. Poor nutritional status results in systemic immunological abnormalities, defects in cell-mediated immunity, a decrease in the population of IgA-producing cells and small intestinal bacterial overgrowth.<sup>(4)</sup> In a study by Estrada Tamayo, et al.<sup>(4)</sup> normal-weight children predominate (55.1 %), a result that differs from the present investigation.

Vomiting and fever were the most frequent symptoms in patients admitted to the PICU, a result that agrees with Mingo Morocho,<sup>(18)</sup> where these clinical manifestations were present in 77.9% and 71.4%, equally. Similarly, Mena Miranda et al.<sup>(19)</sup> in their research, 72.4 % of the complicated cases presented vomiting together with ADE; this was not the case with fever, where only 10.3 % of the patients suffered from this symptom.

Metabolic acidosis (dehydration) was the most frequent complication presented by the children. The authors consider that it is important to point out that when ADEs are not treated in a timely manner, the most common complications are acid-base disorders, which also include hypokalemia and hyponatremia.

Mena Miranda et al.<sup>(19)</sup> show in their study that the most common complication was dehydration in 35.8%. Also in the study of Zapata Gonzalez et al.<sup>(13)</sup> dehydration was present in 55.2 % of all patients with ADE. These results are opposite to those obtained in the present investigation.

Regarding the hydration plan, the most commonly used was C. This plan is the one used in the hospital by protocol for patients arriving with severe dehydration (SD). Patients who cannot achieve vascular access should be administered oral rehydration salts (ORS) through a nasogastric tube at a rate of 20 ml/kg/h for six hours. In the case of intravenous route, 100ml/kg of lactated Ringer's solution is administered; if this product is not available, saline plus potassium chloride can be substituted. Infants with SD are evaluated every one hour and, if their condition does not improve, the infusion rate should be increased.<sup>(12)</sup>

## CONCLUSIONS

Acute diarrheal disease with severe complications is a condition that is more frequent in males and in children under three months of age. Disorders of hydromineral imbalance are the main cause of the disease and its main risk factors are age younger than three months, malnutrition and mixed breastfeeding. The cardinal clinical manifestations of this entity are fever and vomiting. Metabolic acidosis is the main complication and type C hydration plan was the most used in patients.



The authors of the present study recommend perfecting the actions aimed at reducing or eradicating the predisposing risk factors for the development of ADE with severe complications. Likewise, strategies should be designed to improve the health care process of Severe Diarrheal Disease related to early diagnosis through an optimal interrogation and thorough physical examination.

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The authors declare that there are no conflicts of interest.

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Anabel María Céspedes González: conceptualization, data curation, research, formal analysis, methodology, validation, project management, original draft-writing, drafting-revising, and editing.

Delmis Esther Montero Verdecia: conceptualization, research, supervision, visualization, writing-revision and editing.

Yunior Meriño Pompa: methodology, visualization, original draft, drafting-revision and editing.

Mirtha Ofelia Rondón Peña: methodology, visualization, original draft-writing, drafting-revising and editing.

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