Original Research

ACUTE DIARRHEA PATIENTS AMONG CHILDREN UNDER FIVE HOSPITALIZED IN A TERTIARY HOSPITAL IN EAST JAVA, INDONESIA

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ABSTRACT

Diarrhea is the second leading cause of morbidity and mortality in children under five years of age in Indonesia after pneumonia. In 2017, diarrhea became an outbreak in 12 provinces. Diarrhea in under-fives can cause several complications and can cause death if it is not treated properly. This study aimed to evaluate the characteristics of acute diarrhea patients in under-fives hospitalized in Dr. Soetomo General Academic Hospital, Surabaya, Indonesia for six months. This study was a descriptive study with retrospective approach which evaluated all acute diarrhea patients hospitalized from July to December 2019. Patients' data were taken from medical records and presented descriptively. Of the total 125 patients, most acute diarrhea patients were male (60%) aged 0 to 24 months (83.2%), had good nutritional status (58.4%), and hospitalized for less than 5 days (60.8%). The most degree of dehydration was mild-moderate dehydration (83.2%), mostly treated with intravenous rehydration (96.8%), the most common comorbidity was anemia (13.4%), and the most electrolyte disorder was hyponatremia (41%), while acid-base disorder was mostly metabolic acidosis (75%).

Keywords: *Diarrhea; acute diarrhea management; tropical disease; child health; pediatric*

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Highlights:

1. The characteristics of acute diarrhea patients among chidren in Tertiary Hospital In East Java was evaluated.
2. The highest incidence of diarrhea was found in the 0-24 months age group, good nutritional status, male sex, and hospitalized in less than 5 days.
3. Mild-moderate dehydration, intravenous rehydration treated, anemia, hyponatremia, and metabolic acidosis were mostly founded.

INTRODUCTION

Diarrhea is a liquid or unformed stools associated with increased frequency of defecation. The increased frequency is defined by three or more bowel movements a day (Rao et al. 2014). The data of the Ministry of Health, Indonesia, in 2020 indicated that diarrhea was the second cause of morbidity and mortality of under-fives in Indonesia after pneumonia. The number of infant and under-fives deaths caused by diarrhea was 760.000 every year, and dominantly occurred in children under five. In addition, 21% of deaths of children in developing countries was caused of diarrhea (World Health Organization 2013). In 2017, diarrhea had become an outbreak in 12 provinces (Ministry of Health 2018).

Diarrhea is still a public health problem in developing countries, such as Indonesia. It was due to its high morbidity and mortality. Therefore, it is necessary to identify the appropriate characteristics of acute diarrhea in order to provide an optimal treatment or therapy results before causing complications. We evaluated the characteristics of acute diarrhea in children under five years old hospitalized at Dr. Soetomo General Academic Hospital, Surabaya.

MATERIALS AND METHODS

A retrospective study was conducted at the Department of Pediatrics in Dr. Soetomo General Academic Hospital, Surabaya, Indonesia, from July to December 2019. The subjects were children diagnosed with acute diarrhea. The inclusion criteria were children aged 0-60 months with main acute diarrhea diagnosis in the hospital, while the exclusion criteria were children aged 0-60 months with the main acute diarrhea diagnosis and undergoing hospitalization with incomplete and illegible medical records. The instrument of the study was medical record of patients.

There were 125 subjects obtained through total sampling method. The data were classified as participant's age, gender, nutritional status, length of stay, given therapy, diarrhea with complications of dehydration (degree of dehydration), electrolyte imbalance, acid-base imbalance, and with comorbidities.

Data retrieval on nutritional status variables was determined based on z-score criteria. Data collection on degree of dehydration was categorized based on WHO criteria. All data were collected and analyzed using IBM SPSS. This research had been approved by the ethics committee of Dr. Soetomo General Academic Hospital with Decree No. 0211/LOE/301.4.2/XI/2020.

RESULTS

There were 143 patients with the main acute diarrhea diagnosis treated at Dr. Soetomo General Academic Hospital, Surabaya, Indonesia from July to December 2019. After considering the inclusion and exclusion criteria, 125 patient data met the criteria and could be used as research samples. A total of 18 patients were excluded due to incomplete and illegible medical records.

Table 1. Distribution of sociodemographic characteristics in patients with acute diarrhea

Sociodemographic Characteristics	Frequency (n)	Percentage (%)
Age		
0-24 months	104	83.2
25-36 months	6	4.8
37-60 months	15	12
Gender		
Male	75	60
Female	50	40
Nutritional status		
Good nutrition	73	58.4
Lack nutrition	22	17.6
Malnutrition	26	20.8
More nutrition	4	3.2
Length of stay		
Less than five days	76	60.8
Equal to or more than five days	49	39.2

In this study, diarrhea patients in children under-five were highest at 0-24 months of age (83.2%), had male sex (60%), mostly had good nutritional status (58.4%), and were hospitalized for less than five days (60.8%) (Table 1).

Table 2. Distribution of clinical characteristics in patients with acute diarrhea

Clinical Characteristics	Frequency (n)	Percentage (%)
Degree of dehydration		
Without dehydration	4	3.2
Mild-moderate dehydration	104	83.2
Severe dehydration	17	13.6
Therapy		
Intravenous rehydration		
Yes	121	96.8
No	4	3.2
Antibiotics		
Yes	40	32
No	85	68
Zinc		
Yes	111	88.8
No	14	11.2
Probiotics		
Yes	86	68.8
No	39	31.2
Comorbidities		
Pneumonia	7	5.5
Anemia	17	13.4
Febrile seizure	2	1.6
Without comorbidities	101	79.5

In this study, almost all patients (96.8%) had dehydration complications, while 4 patients (3.2%) were not dehydrated. A total of 104 patients (83.2%) had acute diarrhea with mild to moderate dehydration, while 17

patients (13.6%) had acute diarrhea with severe dehydration. As much as 96.8% of the patients were given *intravenous rehydration* therapy. Meanwhile, 40 (32%) patients were given antibiotic therapy, 111 (88.8%) patients were given zinc, and 86 (68.6%) patients were given probiotics. Acute diarrhea patients who had pneumonia as many as 7 patients (5.5%), anemia as many as 17 patients (13.4%), and febrile seizures as many as 2 patients (1.6%), while those who did not have comorbidities were as many as 101 patients (79.5%). One patient with acute diarrhea could have more than one comorbidity.

Table 3. Laboratory characteristics distribution in patients with acute diarrhea

Laboratory Characteristics	Frequency (n)	Percentage (%)
Electrolyte disturbance		
Yes	37	29.6
Hyponatremia	18	41
Hypernatremia	5	11.4
Hypokalemia	17	38.6
Hyperkalemia	4	9
No	25	20.0
Untested	63	50.4
Acid-base disturbance		
Yes	12	9.6
Metabolic acidosis	9	75
Respiratory acidosis	3	25
No	7	5.6
Untested	106	84.8

A total of 29.6% patients had electrolyte disturbances complications and 9.6% of patients had acid-base disturbances complications. In patients with electrolyte disturbances complications, 41% of them had acute diarrhea with hyponatremia complications, 11.4% had hypernatremia complications, 38.6% had hypokalemia complications, while 9% of patients had acute diarrhea with hyperkalemia complications. Twelve patients who had acute diarrhea with acid-base disturbances, 75% of the patients had acute diarrhea with metabolic acidosis complications, while 25% of the patients were accompanied by respiratory acidosis. One acute diarrhea patient could have two balance disorders at the same time.

DISCUSSION

The pathophysiology of diarrhea includes osmotic, secretory, and inflammatory diarrhea. Osmotic diarrhea occurs when absorbable solutes, such as lactose are not properly absorbed and water is retained in the intestinal lumen. Infections that damage intestinal epithelial cells, either directly or through toxins, cause malabsorption and osmotic diarrhea. Secretory diarrhea results from toxin-mediated active secretion of water into the intestinal lumen. It has been observed that during cholera infection, Shiga toxin is produced by *E.coli* and *Shigella* species. Diarrhea can be caused by intestinal inflammation associated with infection. After ingestion, enteric organisms attach to enterocytes and form colonies in the intestinal epithelium. One of two pathways is generally followed depending on the pathogen; either mucosal invasion or enterotoxin production.

The studies showed that the incidence of diarrhea in under-five patients hospitalized at Dr. Soetomo General Academic Hospital, Surabaya, was highest at the age of 0-24 months (83.2%). This study had similar results with a study conducted by Maryanti et al (2017), that the age group under 3 years were affected by diarrhea more. This could be caused by incomplete formation of enzymes in children under 2 years, so that food absorption was less than optimal (Behrman et al. 2000). In general, children less than 2 years of age tend to put their hands or other objects in their mouths, so that poor hygiene levels could increase the risk of diarrhea in children.

Acute diarrhea patients in children under five were dominated by male patients (60%). In a study conducted by Selvia (2017), the incidence of diarrhea mostly occurred in male under-fives (63.3%). The exact cause of this was unknown currently; possibly because boys are more-active than girls, making it easier to be exposed to diarrhea-causing agents (Sujana 2014). The nutritional status of acute diarrhea patients was mostly in a good nutritional status (58.4%). Diarrhea could occur in all groups of children, including children who had good nutritional status. Iskandar (2015) found no significant relationship between nutritional status and diarrhea incidence, because most of the causes of acute diarrhea are viruses transmitted through poor sanitation and hygiene.

In addition, most acute diarrhea patients had a length of stay for less than five days (60.8%). The similar results were obtained in a study that more patients were hospitalized for less than five days (90.4%) compared to patients who were hospitalized more than equal to five days (9.6%) (Yusuf 2011). According to Widiantari and Widarsa (2013), the length of stay for acute diarrhea was determined by the duration of diarrhea, the severity of the disease, and a history of recurrent illness which affected the healing process and the restoration of intestinal mucosal function.

Based on the degree of dehydration of diarrhea patients in children under five, the most was mild to moderate dehydration as much as 83.2%. This was in accordance with a study by Wibisono et al. (2015) that obtained more degrees of dehydration at mild-moderate degrees of

dehydration, as many as 26 children (86.7%). The higher the frequency of diarrhea, the more the excretion of the fluids, which can cause dehydration.

In this study, the most under five acute diarrhea patients used parenteral rehydration fluid therapy. Asyikin (2017) stated that parenteral rehydration was the main therapy in diarrhea patients. The main treatment for diarrhea was to provide a replacement fluid using electrolyte fluids (Ministry of Health 2010). In this study, as much as 32% of acute diarrhea patients received antibiotic therapy. Antibiotics were needed in diarrhea patients to treat infections caused by bacteria and fungi. Inappropriate use of antibiotics could kill the normal flora needed by the children's body, so that it had a higher risk of adverse effects due to bacterial infections caused by incomplete formation of the child's immune system. It would also incur much more unnecessary medical expenses (Asyikin 2017).

Antibiotics therapy in acute diarrhea cases in children did not provide a significant improvement in clinical outcome, because the cause of diarrhea could not always be treated with antibiotics (Trisnowati et al. 2017). Soenarto et al. (2009) stated that rotavirus infection was the main cause of diarrhea in under-fives. In this study, 88.8% of acute diarrhea patients received zinc therapy. These results were similar to a study conducted by Asyikin (2017) that zinc therapy was given to 71.23% of patients with acute diarrhea. Zinc administration as a diarrhea therapy could prevent complications. In the acute diarrhea treatment, zinc could reduce diarrhea episodes duration, and reduce the frequency and volume of stools (Siswidiasari et al. 2014).

In this study, acute diarrhea treatment using probiotics were 86 cases (68.8%). Probiotics are living microorganisms that are intended to have health benefits when consumed or applied to the body by improving balance of intestinal microflora (Siswidiasari et al. 2014). In cases of acute diarrhea in children, probiotics had been widely used, but it had not been recommended by the WHO. In a study, probiotic supplementation was proven to be effective and significant in reducing the duration of diarrhea compared to patients who only received standard rehydration and zinc therapy alone (Mulyani et al. 2016). Probiotics could be used as an effective adjunct therapy in acute diarrhea infections and reduce the frequency and duration of diarrhea so as to minimize the economic burden by decreasing the length of stay (Asyikin 2017).

This study had also indicated that the most common diseases that accompanied diarrhea were anemia (13.4%), followed by pneumonia (5.5%), and febrile seizures (1.6%). Franca et al. (2009) stated that diarrhea accompanied by anemia could be associated with risk factors for diarrhea, such as malnutrition. Malnutrition could interfere with hematopoiesis process which causes anemia due to bone marrow atrophy. Therefore, children who suffered from iron deficiency anemia would be more susceptible to microorganisms (Pratama 2016). Diarrhea accompanied by acute lower respiratory tract infections was the highest cause of morbidity and mortality in children under-five. Co-infection in children was more commonly suspected because incomplete formation of the child's immune system. Several studies have shown that diarrhea and pneumonia often occur together (Walker et al. 2013).

Dehydration became a factor associated with the incidence of seizures in diarrhea patients. Patients with dehydration would have a lack of fluids and electrolytes which could lead to fever. An increase in body temperature could change the balance of neuron cell membranes and diffusion of potassium and sodium ions in a short time with the result of an electrical discharge. With the help of neurotransmitters, electrical discharge could extend to all cells and surrounding cell membranes, causing seizures (Wibowo et al. 2020). Diarrhea patients who had comorbidities should be treated according to the disease and indications while still prioritizing therapy for fluid stabilization if accompanied by dehydration (Sari 2010).

Rotavirus is the leading cause of life-threatening diarrheal diseases among young children. Rotavirus infection of enterocytes causes the invasion of the virus, the formation of viroplasms (VI), and the release of the virus and its toxin NSP4 (nonstructural protein). Intracellular NSP4 (iNSP4) induces an increase in intracellular Ca2 + mainly through er release and PLC-independent mechanism. NSP4 released from the apical side raises intracellular calcium levels through receptor-mediated PLC-dependent mechanisms.

The increase in calcium caused by NSP4 disrupts microvillus cytoskeleton as well as barrier function, increases the flow of paracellular water and electrolytes, and causes diarrhea (Hodges & Gill 2010). Several mechanisms have been proposed that underlie the decreased resorption function of the epithelium, contributing to the pathogenesis of rotavirus-induced diarrhea. These mechanisms include loss of infected enterocytes and NSP4-mediated disruption of sodium-associated solute carriers involved in reabsorption of large amounts of water under physiological conditions. However, the contribution of reduced epithelial absorption to rotavirus-induced diarrhea is unclear due to the effectiveness of oral rehydration therapy to rapidly correct electrolyte and water loss in children with severe diarrhea caused by rotavirus. Some studies suggest that a

sufficient number of enterocytes have intact sodium glucose cotransporters 1 and that rotavirus does not infect all enterocytes. Another explanation is that rotavirus infection increases epithelial cell turnover, which may promote absorption of oral rehydration solution (Crawford et al. 2017).

A total of 29.6% of acute diarrhea patients had electrolyte disturbances. Electrolyte disturbances in the study were mostly hyponatremia (41%), followed by hypokalemia (38.6%), hypernatremia (11.4%), and hyperkalemia (9%). This was in accordance with research conducted by Alfa (2019), that acute diarrhea patients who had sodium electrolyte disorders occur more in hyponatremia (77.9%) compared to hypernatremia (22.1%). In acute diarrhea patients with potassium electrolyte disorders, more hypokalemia (64.3%) was found than hyperkalemia (35.7%).

The incidence of diarrhea in children was mostly caused by an infection that caused damage to the intestinal epithelium and increased intestinal permeability, thus causing diarrhea. The intestinal epithelium functions in the absorption of body fluids. Most absorption of body fluids by the intestines was regulated by sodium and potassium pumps. This could cause electrolyte disturbances in diarrhea patients, especially in sodium and potassium (Nemeth & Pfleghaar 2020). Wololi et al. (2016) stated that hyponatremia in diarrhea was caused by a combination of water and sodium loss, and water retention to compensate for volume loss. Hypokalemia in acute diarrhea could occur due to loss of potassium from the gastrointestinal tract. Diarrhea in children could cause direct loss of potassium because the concentration of potassium in feces could reach 80-90 mEq/L. Hypokalemia could occur due to vomiting resulting in excessive potassium expenditure in children with diarrhea. Vomiting may caused by metabolic alkalosis or the presence of secondary hyperaldosterone because of arising hypovolemia from vomiting or dehydration. This will increase potassium excretion and causes hypokalemia (Kardalas et al. 2018).

In this study, as many as 12 acute diarrhea patients in children had acid-base disturbances. Most of them had metabolic acidosis, which was as many as 9 patients, while 3 other patients had respiratory acidosis. This was in accordance with research by Jurnalis et al. (2008) which said that metabolic acidosis was the most common complication of acute diarrhea. Metabolic acidosis in diarrhea was caused due to the loss of bicarbonate through the stool. In diarrhea children who had anorexia, there could be an increase in organic acid levels in the blood due to the breakdown of body fat and protein to meet calorie needs. There was a decrease in circulation to the kidneys and tissues in diarrhea patients with severe dehydration which caused impaired excretion of organic acids by the kidneys and accumulation of lactic acid due to tissue hypoxia. It also caused metabolic acidosis in diarrhea patients (Sinuhaji 2007).

Strength and limitation

The study addresses an important public health issue in Indonesia, which is the high prevalence of diarrhea in under-fives.The study can help health professionals and policymakers to better understand the disease and design appropriate interventions. The study is limited by its retrospective design, which means that the researchers relied on medical records for data collection. This may lead to incomplete or inaccurate data.

CONCLUSION

In this study, the highest incidence of diarrhea was found in the 0-24 months age group, male sex, good nutritional status, and hospitalized in less than 5 days. The most degree of dehydration was mild-moderate dehydration, mostly treated with intravenous rehydration, and the most comorbidity was anemia, while the most electrolyte disturbance was hyponatremia, and the acid-base disturbance was mostly metabolic acidosis.

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Conflict of interest

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Author contribution

SMS and S - conseptual, study design, analysis data. AFA- write and revised the manuscript. AFt- validation of all manuscript data.

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