

Original Article

ELECTROLYTES PROFILE OF CRITICALLY ILL PATIENTS ADMITTED TO PEDIATRIC INTENSIVE CARE UNIT (PICU) DR. SOETOMO GENERAL ACADEMIC HOSPITAL**Amalia Citra Octavia^{1a}, Arina Setyaningtyas², Pesta Parulian Maurid Edwar³**¹ Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia² Department of Children Health, Dr. Soetomo General Academic Hospital, Universitas Airlangga, Surabaya, Indonesia³ Department of Anesthesiology and Reanimation, Dr. Soetomo General Academic Hospital, Universitas Airlangga, Surabaya, Indonesia^a Corresponding author: amaliacitraoct@gmail.com**ABSTRACT**

Introduction: Fluid and electrolyte disorders can be affected by various conditions or diseases. Electrolyte disorders are often found in pediatric patients with critically ill conditions and are associated with increased morbidity also mortality that requires extra care in the Pediatric Intensive Care Unit (PICU). **Objective:** To describe the electrolyte profile of critically ill patients with electrolyte disorders admitted to the Pediatric Intensive Care Unit (PICU) Dr. Soetomo General Hospital. **Materials and Methods:** The study was conducted prospectively with a descriptive method in patients with electrolyte disorders aged 1 month – 18 years old admitted to PICU Dr. Soetomo General Hospital, Surabaya in a period from August to November 2018. Data on patient age, gender, electrolyte profile (sodium, potassium, calcium, chloride), and origin before PICU admission were recorded. **Results and Discussion:** From 37 patients with electrolyte disorders showed that patients were dominated by the male in 56.8% (n=21), in the age group of infants or 1-12 months old in 45.9% (n=17). Common main diagnosis in most patients were digestive system disorders in 27% (n=10), followed by central nervous system, respiratory system, kidney and cardiovascular disorders, and the origin before PICU admission were from Emergency Room (ER) in 62.2% (n=23). There were found 97 incidences of electrolyte disorders. Most frequent electrolyte disorders were hypocalcemia in 59.5% (n=22), hypokalemia in 54.1% (n=20), hyponatremia in 40.5% (n=15) and the least was hypochloremia in 35.1% (n=13). Mean serum sodium level was 138.18 ± 12.071 , serum potassium level was 3.608 ± 1.2247 , serum calcium level was 8.057 ± 1.9473 and serum chloride level was 101.45 ± 13.266 . **Conclusions:** Critically ill patients admitted in PICU tend to experience low electrolyte levels.

Keywords: Calcium; Chloride; Electrolyte Disorders; PICU; Potassium; Sodium; Profile**ABSTRAK**

Pendahuluan: Gangguan cairan dan elektrolit dapat dipengaruhi oleh berbagai kondisi atau penyakit. Gangguan elektrolit sering ditemukan pada pasien anak dengan kondisi sakit kritis dan dikaitkan dengan peningkatan morbiditas serta mortalitas yang memerlukan perawatan ekstra di Pediatric Intensive Care Unit (PICU). **Tujuan:** Untuk menggambarkan profil elektrolit pada pasien sakit kritis yang dirawat di PICU RSUD Dr. Soetomo, Surabaya. **Metode dan Bahan:** Penelitian ini dilakukan secara prospektif dengan metode deskriptif pada pasien dengan gangguan elektrolit berusia 1 bulan - 18 tahun yang dirawat di PICU Rumah Sakit Umum Daerah (RSUD) Dr. Soetomo, Surabaya dalam periode dari bulan Agustus 2018 hingga November 2018. Data berupa usia, jenis kelamin, profil elektrolit serum (natrium, kalium, kalsium, klorida), dan asal pasien dicatat. **Hasil dan Pembahasan:** Dari 37 pasien, menunjukkan bahwa pasien didominasi oleh laki-laki sebesar 56,8% (n = 21), pada kelompok usia bayi atau usia 1-12 bulan sebesar 45,9% (n = 17). Diagnosis utama terbanyak pada pasien adalah gangguan sistem pencernaan sebesar 27% (n = 10), diikuti oleh gangguan sistem saraf, pernapasan, ginjal, dan sistem kardiovaskular. Asal pasien sebelum dirawat di PICU berasal dari Instalasi Rawat Darurat (IRD) sebesar 62,2% (n = 23). Ditemukan 97 kejadian gangguan elektrolit pada penelitian ini. Gangguan elektrolit yang paling sering adalah hipokalsemia sebesar 59,5% (n = 22), hipokalemia sebesar 54,1% (n = 20), hiponatremia sebesar 40,5% (n = 15) dan yang paling rendah adalah hipokloremia sebesar 35,1% (n = 13). Kadar natrium serum rata-rata adalah $138,18 \pm 12,071$, kalium serum adalah $3,608 \pm 1,2247$, kalsium serum adalah $8,057 \pm 1,9473$ dan klorida serum adalah $101,45 \pm 13,266$. **Kesimpulan:** Pasien sakit kritis yang dirawat di PICU cenderung mengalami kadar elektrolit yang rendah.

Kata kunci: Gangguan Elektrolit, Kalium, Kalsium, Klorida, Natrium, PICU, Profil.

INTRODUCTION

Sixty percent of the total weight of the human body is water and dissolved components in the form of electrolytes and non-electrolytes. Where electrolytes consist of various kinds of cations and anions. The main cations in the body include Sodium (Na^+), Potassium (K^+), Calcium (Ca^{2+}) and Magnesium (Mg^{2+}). While the main anions in the body include Hydrogen bicarbonate (HCO_3^-), Chloride (Cl^-) and Phosphate (PO_4^{3-}). Electrolytes in the body have a very important role in the continuity of physiological processes and the transport of fluids in the body. Electrolyte disorders can occur if electrolyte concentrations in the body are below or above normal levels.¹

Fluid and electrolyte disorders can be affected by a variety of conditions or diseases. Those are common case in critically ill children, because they often accompany critical illness such as dehydration, severe vomiting, diarrhea, kidney failure, respiratory problems, sepsis, brain damage and heart failure.² For example, hyponatremia often occurs in critically ill children in the Pediatric Intensive Care Unit (PICU) and it is associated with increased morbidity and mortality.³

Electrolyte disorders that are often found in critically ill children, can result in changes of the body's physiological processes. The result is a circulatory failure due to an imbalanced volume reduction, muscle weakness, lethargy, acute respiratory failure to apnea, cardiac arrhythmia, heart murmur, tachycardia, hypotension, convulsions to coma.

Pediatric patients with critically ill conditions that experienced electrolyte disorders and almost all electrolyte disorders

are sequelae, this requires extra care and supervision to optimize the condition of the body. In this study we evaluated the general characteristics of patients admitted to our PICU and diagnosed as having electrolyte disorders.

To our knowledge, there is still no specific data or research available in Indonesia, especially in Surabaya, which shows the profile of electrolyte disorders in critically ill patients, especially children. Therefore, this study is expected to bring benefits and can be used as a source of information about the electrolyte profile of critically ill patients admitted to Pediatric Intensive Care Unit (PICU) Dr. Soetomo General Hospital.

MATERIAL AND METHOD

This study was conducted in the PICU of Dr. Soetomo General Hospital, Surabaya and included 37 patients with electrolyte disorders out of 60 patients admitted to PICU from August 2018 to November 2018. With the inclusion criteria were critically ill patients who had just entered and received intensive care at PICU aged 1 month to 18 years old who experienced electrolyte disorders, meanwhile the exclusion criteria were critically ill patients who had just entered and received intensive care at PICU aged 1 month to 18 years who did not experience electrolyte disorders.

Demographic and clinical data were collected from the medical records, included gender, age, primary diagnosis, serum electrolyte levels (sodium, potassium, calcium, chloride), and origin before PICU admission.

The medical ethical committee of Dr. Soetomo General Hospital Surabaya approved this study. (0428/KEPK/VII/2018).



For the statistical analysis, we used Statistical Program for Social Sciences (SPSS) v20.0 software for presenting frequencies, percentages and data distributions.

RESULT AND DISCUSSION

A total of 37 patients with electrolyte disorders out of 60 patients admitted to PICU aged from 1 month to 18 years old. The result of this study showed that the characteristics of the patients were dominated by the male in 56.8% (n=21). The Majority of the patients were in the age group of infants or 1-12 months old in 45.9% (n=17). The common main diagnoses in most patients were digestive system disorders in 27% (n=10) followed by the central nervous system, respiratory system, kidney, and cardiovascular disorders. These patients' origin before PICU admission was dominated from the Emergency Room (ER) in 62.2% (n=23). The Demographic profile of these patients is presented in Table 1.

Table 1. Demographic profile of Patients

Characteristics	n(%)
Gender	
Male	21 (56.8)
Female	16 (43.2)
Age	
Infants (1-12 months old)	17 (45.9)
Children (1-10 years old)	15 (40.5)
Adolescents (11-18 years old)	5 (13.5)
Main diagnosis	
Cardiovascular system disorders	1 (2.7)
Kidneys disorders	4 (20.8)
Digestive system disorders	10 (27.0)
Others	22 (59.5)
Origin before PICU admission	
Emergency Room (ER)	23 (62.2)
General ward	11 (29.7)
Referral from other hospital	3 (8.1)

Initial serum electrolyte levels of sodium, potassium, calcium, and chloride were observed when these patients first arrived at PICU. Out of 37 patients, there were found 97 incidences of electrolyte disorders. Most frequent electrolyte disorders were hypocalcemia in 59.5% (n=22), followed by hypokalemia in 54.1% (n=20), followed by hyponatremia in 40.5% (n=15), and the least was hypochloremia in 35.1% (n=13). The distribution of electrolyte disorders in our study population is presented in Table 2.

In this study, characteristics of critically ill patients with electrolyte disorders at PICU Dr. Soetomo General Hospital Surabaya based on gender was dominated by the male in 56.8% compared to female in 43.2%. Also, in another study conducted in PICU of Children's Hospital, Kanpur Medical College also obtained the same results, patients who experienced electrolyte disorders in PICU were also dominated by the male in 61% compared to female in only 38%.⁴

Table 2. Incidences of Electrolyte Disorders

Electrolyte Disorders*	N (%)
Hyponatremia	15 (40.5)
Hypernatremia	9 (24.3)
Hypokalemia	20 (54.1)
Hyperkalemia	3 (8.1)
Hypocalcemia	22 (59.5)
Hypercalcemia	3 (8.1)
Hypochloremia	13 (35.1)
Hyperchloremia	12 (32.4)

*each patient(s) could experience more than one electrolyte disorders

Patients were grouped into 3 age groups, namely infants (0 years), children (1-10 years) and adolescents (11-18 years). The results of this study showed that it was dominated by the age group of infants (0 years) with the highest percentage in 45.9%, this happened because infants are more susceptible to electrolyte

disorders because physiologically, the total fluid in the body changes drastically before birth until the age of 1 year. At 24 weeks of pregnancy, total fluid in the baby's body is about 80% of total body mass. This amount continues to change until the age of the first year to 60% of total body mass.⁵ Other studies have shown that pediatric patients suffering from electrolyte disorders were dominated by infants, especially under 6 months old.⁶ However, other studies conducted in PICU of Children's Hospital, Kanpur Medical College showed a different result, the dominance was by toddlers in 34.4%.⁴

These patients' origin before entering PICU were varied. Mostly they were from the emergency room (ER), general ward, and referral from other hospitals. This showed that patients with critical illness with electrolyte disorders needed intensive care and treated immediately in PICU.

In this study, the main diagnosis of patients was categorized into 4 groups, namely cardiovascular system disorders, kidney disorders, digestive system disorders, and other system disorders (can be respiratory, nervous, endocrine and metabolic disorders, hematology, etc.). The results showed that the most common diagnosis of patients was digestive system disorders, central nervous system disorders, followed by kidney system disorders and cardiovascular system disorders. This showed different results with research conducted at the PICU of Children's Hospital, Kanpur Medical College found that the common main diagnosis was central nervous system then followed by respiratory system disorders and sepsis.⁴

Almost all electrolyte disorders are sequelae that follow disease and make these patients need intensive care at PICU.⁵ So that, each patient must have a primary diagnosis/major illness besides the electrolyte

disorders. Based on this research, we found 97 incidences of electrolyte disorders in critically ill patients admitted to PICU Dr. Soetomo General Hospital Surabaya. Serum electrolyte levels were observed, those were 4 main electrolytes that routinely examined in each patient. Namely sodium, potassium, calcium and chloride.

In sodium electrolyte, the normal standard value for sodium electrolyte level used at PICU Dr. Soetomo General Hospital, Surabaya was 136 - 144 mmol/L. In this study, it was found that the results were dominated by hyponatremia condition in 40.5% with an average serum sodium level of 138.18 ± 12.071 mmol/L, and mostly in infants. In patients with hyponatremia, the most common primary diagnosis was central nervous system disorders (meningoencephalitis to seizures), respiratory system disorders (pneumonia), and others (leukemia, diabetic ketoacidosis due to type 1 diabetes mellitus, cholestasis to dengue shock syndrome). According to research conducted by Bhalla et al., hyponatremia is the most common cause of seizures in infants⁷, and in research conducted by Perkin et al., hyponatremia is a common cause of seizures without fever in infants in PICU and related to drastically reduced body fluid.⁸ Other research conducted at King George's Medical University Hospital, India showed that pediatric patients with type 1 diabetes mellitus who suffered from diabetic ketoacidosis, commonly suffered from hyponatremia.⁹ However, in this study, hypernatremia patients were dominated by a diagnosis of acute diarrhea severe dehydration. These results are different from research conducted at M. Djamil Academic Hospital Padang, acute diarrhea with severe dehydration in pediatric patients showed that the most electrolyte disorders experienced was hyponatremia.^{5,10} Hypernatremia conditions in patients in PICU



Dr. Soetomo General Hospital Surabaya may be caused by the physiological mechanism of the patient's body which tends to maintain the discharge of electrolytes, resulting in sodium retention.¹¹

In potassium electrolyte, the normal standard value for potassium electrolyte level used at PICU Dr. Soetomo General Hospital, Surabaya was 3.8 - 5.0 mmol/L. In this study, it was found that the results were dominated by hypokalemia in 54.1% with an average potassium level of 3.608 ± 1.2247 mmol / L, and mostly in infants. In patients with hypokalemia, the most common primary diagnosis was respiratory system disorder, for example, pneumonia. According to other research conducted by Sankaran et al., hypokalemia is one of the signs of disease severity in patients suffered from bacterial pneumonia, beside hypophosphatemia and hypocalcemia.¹² On the other hand, the most common primary diagnosis of patients with hyperkalemia were endocrine and metabolic system disorders, especially diabetic ketoacidosis due to type 1 diabetes mellitus. The condition of diabetic ketoacidosis can cause hyperkalemia because of patients with type 1 diabetes mellitus experience absolute insulin deficiency due to defects in beta cells of the pancreas as their natural insulin producer. Without insulin, the blood glucose level in the patient's body will increase, and induced the activation of lipolysis (the breakdown of body fat cells). Along with the release of ketones into the blood, so that the blood becomes acidic.¹³ Conditions of acidosis and high glucose levels in blood make fluid and potassium move out of cells, so hyperkalemia can occur. Hyperkalemia is also caused by a reduced ability of the kidneys to excrete out of the body through urine, according to the data obtained in this study, the most common cause was kidney disorders,

for example, was acute kidney injury. The same thing was also obtained from other studies conducted at PICU Southern India, that one complication of pediatric patients with acute kidney injury is hyperkalemia, and others were metabolic acidosis and sodium electrolyte disorders.¹⁴

In calcium electrolyte, the normal standard value for calcium electrolyte level used at PICU Dr. Soetomo General Hospital, Surabaya was 8.5 - 10.1 mg/dL. In this study, it was found that the results were dominated by hypocalcemia in 59.5% with an average calcium level is 8.057 ± 1.9473 mmol/L, and mostly in infants. In patients with hypocalcemia, the most common primary diagnosis was digestive system (acute diarrhea followed by severe dehydration) and central nervous system disorders. According to research conducted at Dr. Sardjito Teaching General Hospital in 2013-2016, pediatric patients under 5 years old, who had diarrhea with severe dehydration, showed that the most electrolyte disorder experienced was hypocalcemia too.¹⁵ The most common form of central nervous system disorder experienced was a seizure. The Seizure happens due to irritability in the central nervous system and weak muscle contractility. Hypocalcemia results in decrease of nerve cell excitation threshold so that it results in repetitive movement response due to a single stimulus. According to Baines et al. it was stated in his journal that hypocalcemia was the most frequent case found in critically ill pediatric patients, whereas according to the study by Perkin et al., it was found that hyperkalemia was the rarest case in pediatric patients at PICU.⁸ Pediatric patients with hypercalcemia were far fewer cases than the incidence rate in adult patients and one of the causes of hypercalcemia was impaired of parathyroid hormone production and kidney



disorders.¹⁶ And this applied also in this study because we only found three hypercalcemia patients.

Finally, in chloride electrolyte, the normal standard value for chloride electrolyte level used at PICU Dr. Soetomo General Hospital, Surabaya was 97 - 106 mmol/L. In this study, it was found that the results were dominated by hypochloremia in 35.1% with an average chloride level of 101.45 ± 13.266 mmol/L, and mostly in infants also children. In patients with hyperchloremia, the most common primary diagnosis was digestive system disorder, especially acute diarrhea followed by severe dehydration. Whereas in patients with hypochloremia, the most common primary diagnosis was respiratory system disorder. Hyperchloremia affects many adult patients with critical illness and tends to have a poor prognosis, and there are still no data showing the same thing in pediatric patients with critical illness.⁶

CONCLUSION

In conclusion, the present study showed that critically ill patients with electrolyte disorders admitted to the Pediatric Intensive Care Unit (PICU) were tend to experience low electrolyte levels. The most frequent were hypocalcemia, hypokalemia, hyponatremia, and hypochloremia.

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Conflict of Interest

There is no conflict of interest and funding in the writing of this article.

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