ORIGINAL ARTICLE

Ro J Pediatr. 2024;73(4)
DOI: 10.37897/RJP.2024.4.8

Electrolyte profile in pediatric patients with intestinal stoma

Wilda Haliza[1], Reza Gunadi Ranuh[1], Alpha Fardah Athiyyah[1], Theresia Novi[2], Andy Darma[1], Khadijah Rizky Sumitro[1], Subijanto Marto Sudarmo[1]

[1]Department of Child Health, Faculty of Medicine, Airlangga University, Dr. Soetomo General Academic Hospital, Surabaya, East Java, Indonesia
[2]Department of Pathology Clinic, Husada Utama Hospital, Surabaya, East Java, Indonesia

ABSTRACT

Background and objectives. Pediatric patient with the intestinal stoma accompanied by or without intestinal resection often suffer from imbalance electrolyte. Electrolyte content at the stool of intestinal stoma depends on location, resection, intake, age, and duration of stoma creation. However, research on electrolytes levels in the blood and stool of pediatric stoma patients remains limited, especially in developing countries.

Materials and methods. An analytical observation study was conducted at Dr. Soetomo General Hospital, Surabaya between April and July 2023. Study participant included 33 pediatric patients (0-18 years old) with the liquid stool of intestinal stoma. The blood and liquid stool of intestinal stoma were examined to determine electrolyte levels with the same procedure. The results of electrolyte are then analyzed by the Spearman or Pearson correlation coefficient, depending on the distribution of the variables.

Results. A total of 33 pediatric patients met the inclusion criteria. We analyzed the electrolyte composition of blood and stool of intestinal stoma, focusing on sodium, potassium, and chloride, and considered the stoma location and intestinal resection. No statistically significant association was found between blood sodium, potassium and chloride levels with stool in the ileostomy group ($p = 0.663$, $p = 0.722$ and $p = 0.798$, respectively). There was also no statistically significant correlation between blood sodium, potassium, and chloride levels and stool in the sigmoidostomy with resection group ($p = 0.188$, $p = 0.188$, and $p = 0.188$). There was no correlation between the levels of sodium ($p = 0.304$), potassium ($p = 0.759$), and chloride ($p = 0.613$) in the blood and stool of the sigmoidostomy without resection group.

Conclusions. There was no correlation between electrolyte of blood and stool of intestinal stoma with location and resection of intestinal. The study found no significant correlations between electrolyte levels in the blood and stool of pediatric patients with intestinal stomas, regardless of stoma location or resection status.

Keywords: electrolyte, pediatric, stool of stoma, resection, ileostomy, sigmoidostomy

Abbreviations

ISE	– Ion Selective Electrode
mEq/L	– milliequivalent per litre
mmol/L	– millimoles per litre
NICU	– Neonatal Intensive Care Unit
RAAS	– Renin Angiotensin Aldosteron System
SPSS	– Statistical Package for the Social Sciences

INTRODUCTION

Creating an intestinal stoma is a surgical procedure that temporarily or permanently opens the digestive tract in the abdomen. This procedure is indicated for various reasons, including diverting feces flow, decompression, protecting gastrointestinal anastomoses, and feeding. In pediatric patients, this can be a step in surgical treatment due to congenital and acquired gastrointestinal abnormalities [1]. This procedure often involves resecting the necrotic

Corresponding author:
Reza Gunadi Ranuh
E-mail: rezagunadi@gmail.com

Article History:
Received: 24 August 2024
Accepted: 18 December 2024

intestine, reducing absorptive area, and disrupting normal gut flora. These lifesaving procedures result in significant complications, especially in pediatrics [2]. The complications lead to high financial losses and morbidity/mortality from physiological and psychological disorders [3,4]. The stoma and resection disrupt fluid and nutrient absorption, causing electrolyte imbalances that can be fatal. Electrolyte disorders are a major management challenge in pediatric patients with intestinal stoma accompanied by resection procedure.

This vulnerable population is at high risk, and understanding electrolyte imbalance mechanisms and consequences is crucial. There is a lack of extensive research on electrolyte levels in pediatric blood and stool of intestinal stoma, particularly in developing nations. Further research is needed to enhance management strategies and outcomes for these critical procedures.

MATERIALS AND METHODS

Patients

This analytical observational study included pediatric patients (0-18 years) with intestinal stoma. It was conducted between April 1st and July 31st, 2023 at Dr. Soetomo General Hospital in Surabaya. Inclusion criteria were age 0-18 years with intestinal stoma and liquid stool. Patients with solid stool from intestinal stoma were excluded.

All participating patients' parents were informed about the study protocol and provided written consent. The study was approved by the Hospital Ethics and Research Committee (no. 0630/KEPK/III/2023).

Laboratory examination

The patients' blood and liquid stool of intestinal stoma were examined to determine electrolyte levels, including sodium, potassium, and chloride. The samples were collected and measured concurrently using Ion Selective Electrodes (ISE). Liquid stool samples required special handling due to significant material accumulation. The samples were centrifuged twice, first at 3000rpm for 15 minutes, then at 15000rpm for 60 minutes to prevent significant amount of stool material sediment that might cause error during electrolyte measuring. The supernatant was collected and examined for electrolyte levels using the ISE method on the Automatic Blood Gas Criticare Case Nova Biomedical device. The device is calibrated annualy.

Data Analysis

The data were coded, tabulated, and inputted into IBM SPSS Statistics Version 21. Inferential testing and descriptive analysis were used to evaluate the research hypothesis. The analysis would employ the Spearman or Pearson correlation coefficient, depending on the distribution of the variables. Statistically significant impact was determined by a p-value ≤0.05.

RESULTS

Total of 53 patients with intestinal stoma, between April 1st and July 31st 2023, were admitted

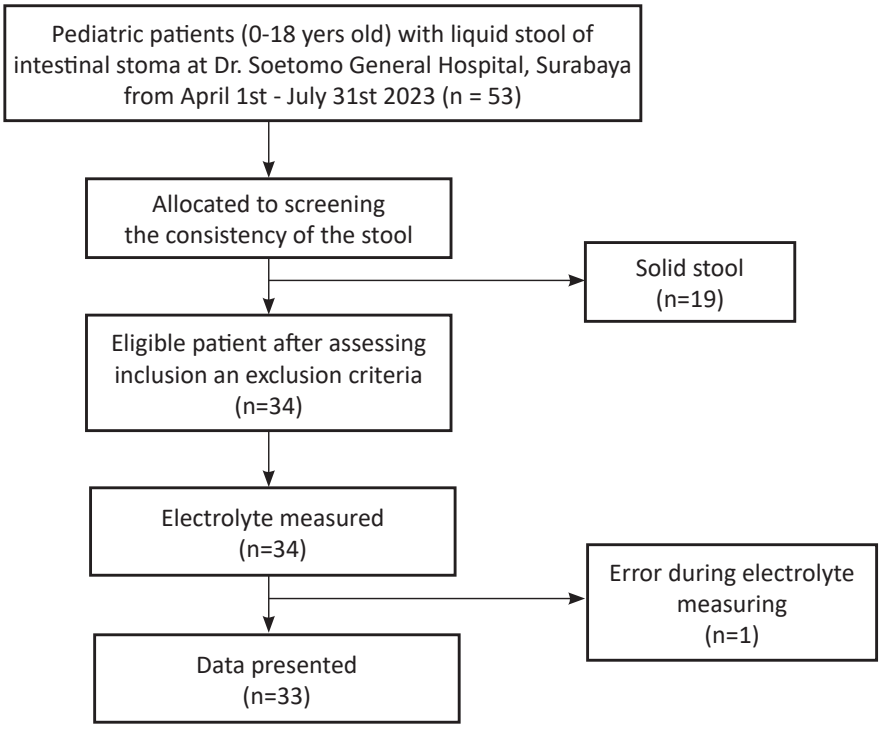

FIGURE 1. Flow chart of patients recruited in the study

to the NICU, Pediatric, and Surgery Ward at Dr. Soetomo General Hospital Surabaya. After screening on stool consistency, 34 patients with liquid stool of intestinal stoma were identified. One sample of the stool was excluded due to the instrument's inability to intrepreted the result of examination. The flowchart and attributes of the subject are outlined in Figure 1 and Table 1.

The subjects of this study were divided based on age, gender, nutritional status, stoma location, intestinal resection procedure and duration of stoma. Stoma location was divided into ileostomy and sigmoidostomy while resection procedure was divided into with and without resection of intestinal

The group of subjects divided based on the location and resection procedure, however due to the limited number of patients and only one patient ileostomy without resection was discovered, ileostomy group are not divided based on the resection procedure.

A correlation analysis was conducted using the Spearmann test to examine the relationship be-

TABLE 1. Characteristics of subjects

	Ileostomy (n=14) n (%)	Sigmoidostomy (n=19) n (%)	p-value
Age (mean±SD)			0,349
Neonatus (days)	27 (20)	5,5±2,51 (80)	
Baby (mo)	11,87±6,79 (47,05)	7,33±5,83 (52,94)	
Children (mo)	36,8±1,3 (55,56)	63,25±43,42 (44,44)	
Adolescence (mo)	–	156 (100)	
Sex			0,617
Boy	10 (71,4)	9 (47,4)	
Girl	4 (28,6)	10 (52,6)	
Nutritional Status			0,579
Normal	8 (57,1)	9 (47,4)	
Malnutrition	6 (42,9)	10 (52,6)	
Duration of stoma (days)	550,2±450,23	994,1±1648,15	0,007
Intestinal Resection			0,000
Yes	13 (92,9)	5 (26,3)	
No	1 (7,1)	14 (73,7)	

*p value is significant if <0.05

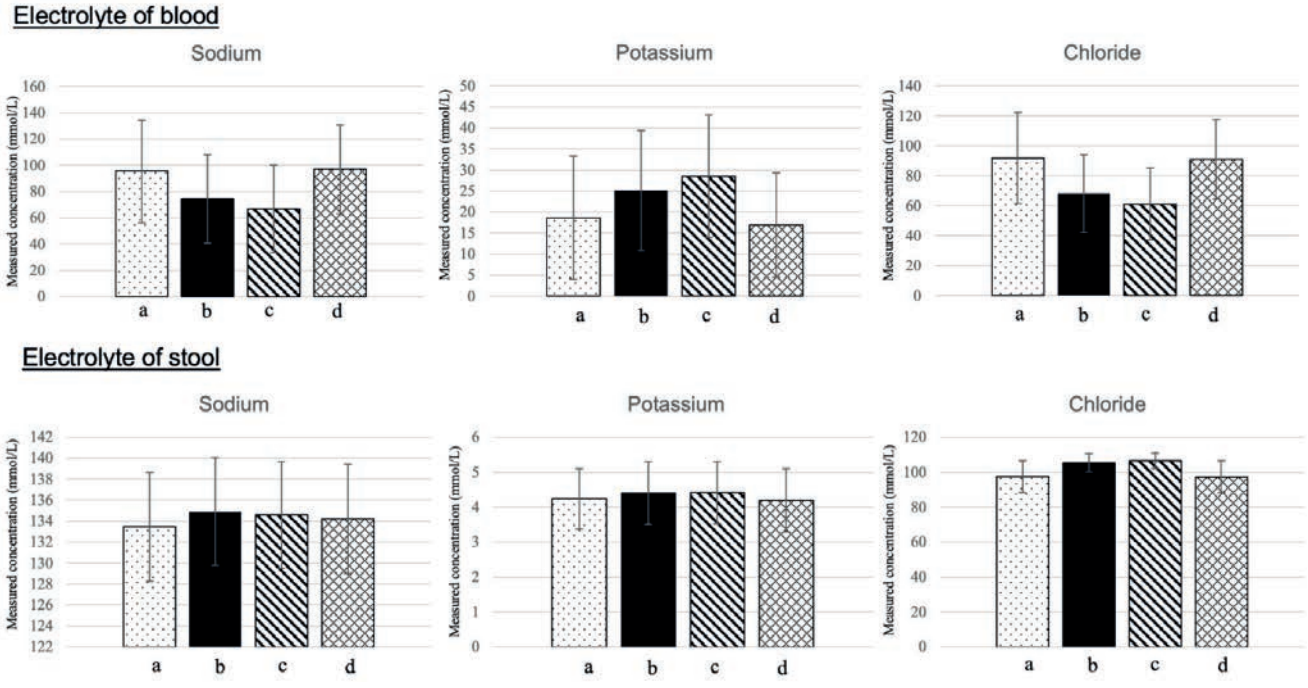

FIGURE 2. Graph of the distribution of each electrolyte in stool of intestinal stoma and blood based on intestinal resection. (a) ileostomy group; (b) sigmoidostomy group; (c) without resection group; (d) with resection group

TABLE 2. Correlation electrolyte of blood and stool of intestinal stoma based on location and intestinal resection

Electrolyte	Ileostomy			Sigmoidostomy without resection			Sigmoidostomy with resection		
	Stool	Blood	p-value	Stool	Blood	p-value	Stool	Blood	p-value
Sodium	95.71±37.56	133±5.09	0.663	67.41±34.23	133±5.09	0.304	94±25.09	136.4±5.32	0.188
Potassium	18.23±14.15	4.15±0.89	0.722	27.46±14.18	4.47±0,90	0.759	18.52±12.84	4.22±1	0.188
Chloride	90.07±29.88	96.28±9.67	0.798	61.07±25.09	106.64±4.58	0.613	88.80±16.33	102.2±5.93	0.188

*p value is significant if <0.05 by using Spearmann Test

tween each electrolyte of blood and stool, taking into account the location and resection. However, no significant findings were found.

DISCUSSION

A total of 33 patients with ileostomy and sigmoidostomy participated in our study. The majority were boy, consistent with previous findings showing a boy predominance in ileostomy patients [5-7]. Boys have a higher risk of intussusception, leading to more ileostomies [8].

Malnutrition is common in patients with cancer and intestinal diseases, often due to malabsorption and prolonged hospitalization. Studying nutrition in intestinal stoma patients is challenging due to varied indications, ages, and comorbidities. There is currently no specialized nutritional's tool for individuals with intestinal stomas that accounts for factors like stoma location, output volume, and primary cause [9]. Nutritional intervention is crucial both before and after stoma creation surgery. Previous studies have emphasized the importance of a patient's nutritional status and other factors, such as age and indication for the stoma, prior to the operation [10,11]. Restoring gastrointestinal health through proper nutrition before surgery is also considered important [11].

In this study, malnutrition was found on nine patients with ileostomy and underwent to resection procedure. Intestinal resection, especially on small intestinal with a massive resection length, will result in short bowel syndrome, a condition characterized by malnutrition and secondary malabsorption due to loss of small intestine function and rapid intestinal transit.

Complications that occur are weight loss, protein malnutrition, prolonged diarrhea, steatorrhea, electrolyte disorders and fat-soluble vitamin deficiencies [12].

Electrolyte balance is crucial for function of body and electrolyte abnormalities can cause disorders that are clearly visible from clinical conditions and can lead to life threatening complications. Maintaining the balance of body fluid and electrolyte composition in individuals requires homeostasis mechanism. The most common electrolytes in the body are sodium, potassium and chloride, measurement of levels can be done with various methods, but the most commonly used is using ISE [13]. The results of this study showed electrolyte values in the stool of intestinal stoma (based on location of stoma and intestinal resection procedure) with variable values with a wide range.

Study on electrolyte levels in adult ileostomy showed a narrower range compared to this study, specifically sodium (30-80mEq/L vs 26-135mEq/L), potassium (3-6mEq/L vs 4-43.4mEq/L) and chloride (15-30mEq/L vs 38-125mEq/L) [14]. The difference is due to the subjects in this study were mostly neonates and infants with immature gastrointestinal tract function and some patients were sampled several days after surgery where intestinal edema still occurs and can interferes with the absorption of fluids and electrolytes on the surface of the intestinal mucosa [15]. The restricted number of the subjects may cause bias the results of this study.

Our analysis examining the relationship between blood and stool of intestinal stoma electrolyte levels, considering intestinal resection, did not yield significant results. To our knowledge, there are no directly comparable prior studies, highlighting the novelty and significance of our research.

Theoretically, stool of intestinal stoma's electrolyte levels should be inversely proportional to blood levels. However, our analysis did not find significant correlations, likely due to the body's complex mechanisms for maintaining electrolyte balance [1,16-18].

Further research is needed to explore the dynamics of Renin-Angiotensin-Aldosteron System (RAAS) and other homeostatic mechanisms in pediatric patients with intestinal stoma, to provide insights into managing these patients more effectively and developing targeted therapies to mitigate electrolyte imbalances.

Limitation of the study

This study had several limitations. It was conducted exclusively at a single health center, over a limited timeframe, and with a restricted number of subjects. Additionally, the study has some biases that cannot be definitively eliminated, including the omission of evaluating electrolyte excretion in urine.

CONCLUSION

This investigation demonstrated the absence of a correlation between the electrolyte levels in the stool of intestinal stoma and blood, and the location of the stoma and resection.

Conflict of interest: The authors have no conflict of interest to disclose

Author's contributions:
Conceptualization, W.H., R.G.R., A.F.A., S.M.S, A.D.; methodology, W.H., R.G.R., A.F.A., T.N., S.M.S. and A.D.; validation, W.H., R.G.R., A.F.A. and T.N.; formal analysis, W.H.; investigation, W.H., R.G.R., A.F.A. and T.N.; resources, W.H.; data curation, W.H. and T.N.; writing – original draft preparation, W.H.; writing – review and editing, R.G.R., A.F.A., S.M.S., A.D. and K.R.S.; visualization, W.H.; supervision, R.G.R. and A.F.A.; project administration, W.H.; funding acquisition, W.H., R.G.R, A.F.A. and A.D.

Acknowledgements:
We gratefully acknowledge the support and motivation of our Head of Department, Muhammad Faizi, MD, PhD, and the Child Health department staff, which enabled us to complete this study.

REFERENCES

1. Garg M, Burrell LM, Velkoska E, Griggs K, Angus PW, Gibson PR, Lubel JS. Upregulation of Circulating Components of The Alternative Renin-Angiotensin System in Inflammatory Bowel Disease: A Pilot Study. *J Renin Angiotensin Aldosterone Syst.* 2015;16(3):559-69. doi: 10.1177/147032031452108
2. Johnson, P. Intestinal Stoma Prolapse and Surgical Treatments of This Condition in Children: A Systematic Review and a Retrospective Study. *Surgical Science.* 2016;7(9):400-26. doi: 10.4236/ss.2016.79057
3. Coletta R, Zulli A, O'Shea K, Mussi E, Bianchi A, Morabito A. Minimizing Enterostomy Complication in Neonates, Lessons Learnt from Three European Tertiary Centres. *Children.* 2022;9(2):162. doi: 10.3390/children9020162
4. Pal N, Poonam Jangra A, Mishra V. Analysis of complications and management of abdominal stoma. *Int Surg J.* 2019;6(8):2828. doi: 10.18203/2349-2902.isj20193325
5. Kann B. Early Stomal Complications. *Clin Colon Rectal Surg.* 2008;21(1):23-30. doi: 10.1055/s-2008-1055318
6. Mikala FH, Athiyyah AF, Hariastawa IGBA, Ranuh IGMR. Descriptive Study of Pediatric Patients with Ileum Stoma at Inpatient Installation of Dr. Soetomo General Hospital Surabaya. Jurnal Ilmiah Mahasiswa Kedokteran Universitas Airlangga. 2021;12(01):1-5. https://doi.org/10.20473/juxta.V12I12021.1-5
7. Anyanwu LJ, Mohammad A, Oyebanji T. A descriptive study of commonly used postoperative approaches to pediatric stoma care in a developing country. Ostomy Wound Manage. 2013;59(12):32-7. PIMD: 24334363
8. dos Santos OJ, Filho NS, Filho AKD, Desterro VS, Silva MVT, Prado RDPES, Silva MVT. Children and Adolescents Ostomized in a Reference Hospital: Epidemiological Profil. Journal of Coloproctology. 2016; 36(2): 75-9. http://dx.doi.org/10.1016/j.jcol.2016.03.005
9. Lennard-Jones, JE. and Shivananda, S. Clinical Uniformity of Inflammatory Bowel Disease at Presentation and During the First Year of Disease in the North and South of Europe. *Eur J Gastroenterol Hepatol.* 1997;9(4):353-9. doi: 10.1097/00042737-199704000-00007
10. Michońska I, Polak-Szczybyło E, Sokal A, Jarmakiewicz-Czaja S, Stepien AE, Deren K. Nutritional Issues Faced by Patients with Intestinal Stoma: A Narrative Review. *J Clin Med.* 2023;12:510. doi: 10.3390/jcm12020510
11. Fulham J. Providing Dietary Advice for the Individual with a Stoma. *Br J Nurs.* 2008;17(2):22-7. doi: 10.12968/bjon.2008.17.Sup1.28146
12. Clatterbuck B, More L. Small Bowel Resection. National Center for Biotechnology Information. StatPearls. 2023. PMID: 299396673
13. Udensi UK, Tchounwou PB. Potassium Homeostasis, Oxidative Stress, and Human Disease. *Int J Clin Exp Physiol.* 2017;4(3):111-22. doi: 10.4103/ijcep.ijcep_43_17
14. Rombeau J. Physiologic and Metabolic Effects of Intestinal Stomas. In: Victor W. Fazio, James M. Church, James S. Wu, eds. Atlas of Intestinal Stomas. Springer Nature. 2012;5:59-67. doi: 10.1007/978-0-387-78851-7_4
15. Baker ML, WilliamS RN, Nightingale JMD. 2010. Causes and management of a high-output stoma. *Colorectal Disease.* 13(2):191-7. doi: 10.1111/j.1463-1318.2009.02107.x
16. Arnott SM, Zollinger B, Haviland S, Ng M, Obias V. A nutritional screening threshold for optimal outcomes after Hartmann's reversal. *Int J Colorectal Dis.* 2022;37(9):2041-8. doi: 10.1007/s00384-022-04236-1
17. Hall JE, Hall ME, Hall J. 2021. Guyton and Hall textbook of medical physiology. Philadelphia, Pa: Elsevier.
18. Fountain JH, Kaur J, Lappin SL. Physiology, Renin Angiotensin System. National Center for Biotechnology Information. StatPearls [Internet]. 2023 March 12; https://www.ncbi.nlm.nih.gov/books/NBK470410/. PMID: 29261862