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Survival Outcomes with Hyponatremia in Paediatric Intensive Care of Tertiary Care Hospital

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ABSTRACT

Objective: To determine the frequency of mortality in patients with hyponatremia admitted in the Paediatric intensive care setting.

Study Design: Cross-sectional study.

Place and Duration of Study: Department of Paediatrics, Combined Military Hospital, Rawalpindi, Pakistan, from Jan to Jul 2022.

Methodology: The study was based on a sample of 118 patients admitted for intensive care between the ages of 1 to 12 years with a serum sodium of less than 135 mmol/L. Patients who had artefactual hyponatremia or those who only developed the electrolyte imbalance during admission were excluded. Patients were documented for demographic data, and the degree of hyponatremia was classified according to severity, while the requirement for mechanical ventilation and inotropic support was also noted. Patients were followed up till discharge or death. Data was analyzed by SPSS 26.0.

Results: We studied a population with a mean age of 5.76±3.17 years. Most of the patients, 74(57.8%) were male. Male patients tended to have a lower serum sodium level compared to females, (p=0.029). Younger patients tended to develop more severe hyponatremia, (p<0.001), the case being similar with patients with lower weights, (p<0.001). The study also showed that patients with a lower sodium level on admission tended to have a longer hospital stay, (p=0.021), but this did not influence mortality, (p=0.177).

Conclusion: Hyponatremia on admission occurs more frequently in younger children who weigh less. The imbalance is associated with longer hospital stays but does not affect mortality.

Keywords: Hyponatremia, Intensive Care, Mortality.

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INTRODUCTION

Hyponatremia is defined as a serum sodium level of less than 135 mmol/L in the pediatric population.[1] The primary etiology of this imbalance in children revolves around the presence of an excess of free water which can occur in hypovolemic patients with a low extra-cellular fluid volume, in normovolemic patients with excess antidiuretic hormone (ADH) secretion, or in hypervolemic patients with normal ADH levels but decreased circulating volume. All these scenarios have the propensity to develop in the intensive care setting as these patients are more susceptible to fluid shifts, excess ADH production and, iatrogenically, due to over-hydration.[2,3]

Significant hyponatremia is associated with potentially devastating complications: Patients have the tendency to develop cerebral oedema, raised intra-cranial pressure, increased intra-cranial blood flow and, in extreme cases, tonsillar herniation.[4] These complications typically manifest as headaches, nausea/vomiting, transient apnea, altered consciousness or, in severe cases, rhabdomyolysis, seizures, coma or even death.[5,6] Management of electrolyte disturbances represents a significant hurdle in the management of the critically ill, but even more-so in the pediatric age group: Mild cases can be managed with cessation of hypo- or isotonic fluid/fluid restriction and/or diuretic therapy, while more severe cases require management with hypertonic saline.[7,8] However, this presents its own set of problems: Rapid correction of hyponatremia may result in the development of Osmotic Demyelination Syndrome (ODS) which may culminate in death due to pontine myelinolysis.[9] Careful, step-wise correction is required to avoid this complication.[7,10]

The frequency at which serious complications arise among pediatric patients suffering from hyponatremia in critical care settings remains uncertain within Pakistani study populations. Early recognition of the complication and the timely institution of appropriate management is imperative to prevent both short- and long-term morbidity and

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mortality. The primary objective of this study was to assess how frequently adverse outcomes arise among children diagnosed with hyponatremia who are admitted to intensive care. By evaluating the incidence of these outcomes, the research aims to increase awareness among clinicians regarding the need for heightened vigilance when managing pediatric patients with hyponatremia. Additionally, understanding the frequency of complications can help guide the level and intensity of clinical management required for these vulnerable patients.

METHODOLOGY

This descriptive cross-sectional study was conducted from Jan to Jul 2022 in the Department of Paediatrics, Combined Military Hospital, Rawalpindi, Pakistan. 128 patients, whose parents/guardians gave informed consent, were admitted to the Paediatric Intensive Care Unit (PICU) were selected for the study. Institutional Ethical Review Committee approved the study protocol (ERC # 304/CMH Rwp) All patients were selected via non-probability consecutive sampling. The WHO sample size calculator was used to calculate the sample size keeping a confidence level (1-α) of 95%, an absolute precision (d) of 0.07 and an anticipated population proportion of 20.4%, which was the proportion of hyponatremic pediatric patients admitted for critical care in whom mortality occurred.[11]

Inclusion Criteria: Patients of both genders, between the ages of 1 and 12 years, and suffering from hyponatremia at the time of presentation, defined as serum sodium less than 135 mmol/L, were included in the study.

Exclusion Criteria: Patients who developed hyponatremia during admission, those who had artefactual hyponatremia i.e., patients who had hyponatremia on a single reading, which disappeared on a repeated sample conducted after six hours of first reading, and those aged less than 1 year, and over 12 years were excluded from the study.

All patients were documented for demographic data such as age and gender, at the time of enrollment, which was followed by the recording of clinical parameters such weight, primary diagnosis as well as serum sodium levels at the time of admission as well as six hours afterwards, to confirm the presence of hyponatremia. Additionally, hyponatremia was graded according to severity with mild hyponatremia defined as 130–134.9 mmol/L), moderate as 125–129.9 mmol/L and severe as less than 125 mmol/L. Lastly, data regarding requirement for mechanical ventilation, inotropic support, length of admission in intensive care, and whether patient died or was discharged was also documented along the course of admission.

Data was analyzed using the Statistical Package for the Social Sciences version 26.0. Mean and standard deviation was calculated for quantitative variables specifically age, weight, serum sodium levels on admission, length of hospital stay. Qualitative variables like gender, primary diagnosis, degree of hyponatremia, requirement for assisted ventilation or inotropic support and patient outcome were recorded in terms of frequency and percentage. Patients were grouped according to severity of hyponatremia as above and comparison was made across these groups using the Chi-square test for qualitative variables and the independent samples t-test and the one-way ANOVA were employed for quantitative variables, where applicable.

RESULTS

Our study sample was composed of a total of 128 patients. The mean age of these patients was 5.76±3.17 years, while most of the patients enrolled were male: 74(57.8%). The mean weight was 21.83±8.57 kg. Patients were categorized according to the primary system affected by the illness for which they were admitted, 7(5.5%) had a primarily neurological issue, the respiratory system was primarily affected in 15(11.7%) patients, 11(6.5%) had a cardiovascular complaint, while gastrointestinal complaints were the second most common cause: 27(21.1%). Sepsis was the most common reason for admission in critical care settings, accounting for 33(25.8%) patients. Lastly, primary disorders of the renal system, trauma and miscellaneous causes accounted for 18(14.1%), 10(7.8%) and 7(5.5%) cases. The mean serum sodium level of the sample was 127.15±3.70 mmol/L. A total of 43(33.6%) cases had mild hyponatremia, while 46(35.9%) and 39(30.5%) were moderate and severe, respectively. Assisted ventilation was required by 15(11.7%) patients, while inotropic support was required by 28(21.9%) patients. The mean length of hospital admission for the sample was 14.81±8.32 days. A total of 13(10.2%) patients died during admission, while 115(89.8%) were discharged to home. The results of the study are shown in Table-I, where the different study parameters are organized according to the gender of the patients.

Table-II shows that study results according to severity of hyponatremia. A younger age was associated with a higher incidence of more severe hyponatremia in our sample, (p<0.001). Additionally, lower weight was associated with a higher incidence of more severe hyponatremia, (p<0.001). The length of hospital stay was inversely proportional with the degree of severity of hyponatremia (p=0.021); however, it did not influence mortality, (p=0.177).

Table-I: Gender based Study Parameters (n=128)

Variable	Male (n=74)	Female (n=54)	*p*-value
Gender	74 (57.8%)	54 (42.2%)	-
Age (years)	5.39 ± 3.27	6.26 ± 2.99	0.127
Weight (kg)	21.88 ± 8.45	21.76 ± 8.82	0.938
Primary Diagnosis			
Neurological System	4 (5.4%)	3 (5.6%)	0.106
Respiratory System	13 (17.6%)	2 (3.7%)	
Cardiovascular System	5 (6.8%)	6 (11.1%)	
Gastrointestinal System	14 (18.9%)	13 (24.1%)	
Renal System	11 (14.9%)	7 (12.9%)	
Sepsis	18 (24.3%)	15 (27.8%)	
Trauma	3 (4.0%)	7 (12.9%)	
Other	6 (8.1%)	1 (1.9%)	
Serum Sodium Level (mmol/L)	123.96±3.53	129.61± 2.58	0.029
Classification of Hyponatremia according to Severity			
Mild	22 (29.7%)	21 (38.9%)	0.105
Moderate	24 (32.5%)	22 (40.7%)	
Severe	28 (37.8%)	11 (20.4%)	
Assisted Ventilation	11 (14.9%)	4 (7.4%)	0.195
Inotropic Support	15 (20.3%)	13 (24.1%)	0.607
Length of Hospital Stay (days)	15.34 ± 8.34	14.09 ± 8.30	0.405
Outcomes			
Discharge	68 (91.9%)	47 (87.1%)	0.369
Mortality	6 (8.1%)	7 (12.9%)	

Table-II: Analysis According to Severity of Hyponatremia

Variables	Mild	Moderate	Severe	*p*-value
Age	8.74±2.85	5.76±1.51	2.46±0.85	<0.001
Gender				
Male	22(51.2%)	24(52.2%)	28(71.8%)	0.105
Female	21 (48.8%)	22 (47.8%)	11 (28.2%)	
Weight	29.16±7.78	22.43±4.87	13.03±3.14	<0.001
Assisted Ventilation	3(6.9%)	6(13.0%)	6(15.4%)	0.468
Inotropic Support	6(13.9%)	3(6.5%)	9(23.1%)	0.258
Length of Stay (days)	12.14±8.69	15.37±7.65	17.10±8.04	0.021
Mortality	7 (16.2%)	2 (4.3%)	4 (10.3%)	0.177

DISCUSSION

The findings of this study have highlighted more susceptibility of pediatric hyponatremia in younger males. This observation was associated with prolonged hospitalization regardless of underlying diagnosis, which highlights its independent impact on mortality or recovery. These patterns emphasize the need for early identification, careful monitoring, and consistent management practices across care settings. However, the current evidence base remains limited regarding which therapeutic approaches most effectively mitigate complications.

Hyponatremia is a commonly occurring electrolyte imbalance which is more frequently present in malnourished children suffering from acute illnesses, with reported an incidence as high as 48.9% in children admitted with severe acute malnutrition in certain Pakistani pediatric populations.[12] This disorder electrolyte imbalance is associated with significant consequences, both due to the disturbance itself as well as due to the way it is managed as reported by Tauseef *et al*.[13] Furthermore, patients who are admitted to intensive care or are critically ill at the time of presentation typically have a higher incidence of hyponatremia as reported by Al-Sofyani *et al*., with frequencies of hyponatremia as high as 67.2% in children admitted to intensive care units.[11]

In our study, hyponatremia was more common in males. This in keeping with existing literature such as Zhang *et al*., who also noted that hyponatremia in the critical care setting had a male preponderance in the adult population.[14] This difference in prevalence may be attributable to the so-called male disadvantage where differences in male physiology, especially in the first year of life, are associated with an increased risk for morbidity and mortality as reported by Maiolo *et al*.[15] Additionally, our results showed that a younger age was associated with an increased risk of developing severe hyponatremia, which is also in keeping with existing studies in literature such as Park *et al*., and Storey *et al*., which may be attributable to an immature renin-angiotensin-aldosterone homeostatic system for the maintenance of serum sodium levels in the physiological range.[16,17]

Our study demonstrated that children with lower mean body weight had a higher chance of developing more severe hyponatremia, however, it was unclear whether it was due to a lower weight for age, or whether the patients were younger. Yet, this was also in keeping with the findings that younger and malnourished children have a higher risk of developing more severe imbalances, as described earlier. Our results were in accord with those from Bamehrez *et al*., and Monnikendam *et al*., who reported that infants who had lower weights had a

higher incidence of severe hyponatremia as compared to their counterparts with normal weights.[18,19] However, Al-Sofyani *et al*., found no relationship between weight and the incidence of severe hyponatremia. This difference was attributed to the location and season in which respective studies were conducted. Our sample was mostly studied in winter months and in colder climes, while study conducted in Saudi Arabia during summer, when the weather is exceptionally hot might have affected the results.[11]

Patients who develop hyponatremia may require intensive care, the need for telemetry, assisted ventilation and inotropic support, as demonstrated by Hasegawa *et al*.,[21] Our study did not demonstrate any statistically significant increase in requirement based on the severity of hyponatremia. Zheng *et al*., found that severe hyponatremia increased the need for mechanical ventilation. This reflects their focus on bacterial meningitis patients, whereas our study included a broader patient group.[20]

Our study showed that patients with hyponatremia had a prolonged in-hospital stay: The more severe the hyponatremia, the longer the length of hospital admission, which was in keeping with existing literature.[11,20] However, we also noted that there was no increase in mortality associated with the severity of hyponatremia. The results of the study were aligned with Sachdev *et al*., who noted that there was no increase in mortality with severity of imbalance.[21] Conversely, Bindu *et al*., noted that there was a significant correlation between the occurrence of mortality and the severity of hyponatremia, but it must be noted that there was a significant degree of confounding from other factors such as primary disease, time to presentation and method of management.[22]

In summary, the relationship between hyponatremia and mortality remains complex. Our findings, along with those from previous studies, suggest two interpretations: hyponatremia may either directly contribute to increased mortality risk, or it may simply serve as a marker of worsening patient status, reflecting underlying critical illness rather than causing it. Further research is essential to clarify this distinction and guide clinical decision-making.

LIMITATIONS OF STUDY

One significant limitation of this study is the absence of a control arm. Without comparing outcomes between hyponatremic and non-hyponatremic pediatric patients, it is challenging to establish a direct causal relationship between hyponatremia and mortality. A control group would provide valuable insight into whether observed complications are truly attributable to hyponatremia or are influenced by other underlying factors.

Additionally, the study's scope was limited. A broader investigation that incorporates additional confounding variables such as time to hospital presentation, specific management strategies, and monitoring protocols would give more reliable and comprehensive results. Considering these factors is essential for accurately interpreting the impact of hyponatremia on patient outcomes.

Furthermore, pediatric physiology evolves rapidly, and the response to hyponatremia may differ significantly between infants, toddlers, and older children. Therefore, future research should adopt a more targeted approach, focusing separately on each age group. This would help clarify age-specific responses and improve the applicability of findings across the pediatric population.

CONCLUSION

Paediatric hyponatremia can be associated with serious complications. Younger males are at the highest degree of risk for complicated hospital courses and require a higher degree of vigilance. Such patients have longer requirements for in-hospital care, regardless of the underlying diagnosis. Further study should look at management techniques for hyponatremia, to determine whether they are beneficial in improving outcomes.

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Authors' Contribution

Following authors have made substantial contributions to the manuscript as under:

BA & TN: Data acquisition, data analysis, critical review, approval of the final version to be published.

FI & HA: Study design, data interpretation, drafting the manuscript, critical review, approval of the final version to be published.

AK & SHN: Conception, data acquisition, drafting the manuscript, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

REFERENCES

1. Tagarro A, Martín MD, Del-Amo N, Sanz-Rosa D, Rodríguez M, Galán JC, et al. Hyponatremia in children with pneumonia rarely means SIADH. Paediatr Child Health 2018; 23(7): e126-e133. https://doi:10.1093/pch/pxy003
2. Zieg J. Pathophysiology of Hyponatremia in Children. Front Pediatr 2017; 5(1): 213. https://doi:10.3389/fped.2017.00213
3. Langer T, D'Oria V, Spolidoro GCI, Chidini G, Scalia Catenacci S, Marchesi T, et al. Fluid therapy in mechanically ventilated critically ill children: sodium, chloride, and water burden of fluid creep. BMC Pediatr 2020; 20(1): 424. https://doi:10.1186/s12887-020-02322-3

4. Zieg J, Ghose S, Raina R. Electrolyte disorders related emergencies in children. BMC Nephrol 2024; 25(1): 282. https://doi:10.1186/s12882-024-03725-5
5. Lavagno C, Milani GP, Uestuener P, Simonetti GD, Casaulta C, Bianchetti MG, et al. Hyponatremia in children with acute respiratory infections: A reappraisal. Pediatr Pulmonol 2017; 52(7): 962-967. https://doi:10.1002/ppul.23671
6. Reakes E, Drak D, Gracey D. A suspected case of hyponatraemia induced rhabdomyolysis: a case report. BMC Nephrol 2022; 23(1): 180. https://doi:10.1186/s12882-022-02787-7
7. Rout P, Badireddy M. Hyponatremia. [Updated 2025 Dec 13]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2026 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK470386/
8. Mazzolai M, Apicella A, Marzuillo P, Rabach I, Taddio A, Barbi E, et al. Severe hyponatremia in children: a review of the literature through instructive cases. Minerva Pediatr 2022; 74(1): 61-69. https://doi:10.23736/S2724-5276.21.05856-4
9. Danyalian A, Heller D. Central Pontine Myelinolysis. [Updated 2023 Aug 8]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2026 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK551697/
10. Fernández-Sarmiento J, Pérez A, Echeverri MA, Jimenez P, Joachim MA, Andrés-Jagua. Association Between Hyponatremia and Maintenance Intravenous Solutions in Critically Ill Children: A Retrospective Observational Study. Front Pediatr 2021; 9: 691721. https://doi:10.3389/fped.2021.691721
11. Al-Sofyani KA. Prevalence and Clinical Significance of Hyponatremia in Pediatric Intensive Care. J Pediatr Intensive Care 2019; 8(3): 130-137. https://doi:10.1055/s-0038-1676635
12. Raza M, Kumar S, Ejaz M, Azim D, Azizullah S, Hussain A et al. Electrolyte Imbalance in Children with Severe Acute Malnutrition at a Tertiary Care Hospital in Pakistan: A Cross-Sectional Study. Cureus 2020; 12(9): e10541. https://doi:10.7759/cureus.10541
13. Tauseef A, Zafar M, Syed E, Thirumalareddy J, Sood A, Lateef N, et al. Prognostic importance of deranged sodium level in critically ill patients: A systemic literature to review. J Family Med Prim Care 2021; 10(7): 2477-2481. https://doi:10.4103/jfmpc.jfmpc_2291_20
14. Zhang X, Li XY. Prevalence of hyponatremia among older inpatients in a general hospital. Eur Geriatr Med 2020; 11(4): 685-692. https://doi:10.1007/s41999-020-00320-3
15. Maiolo V, Reid AM. Looking for an explanation for the excessive male mortality in England and Wales since the end of the 19th century. SSM Popul Health 2020; 11(1): 100584. https://doi:10.1016/j.ssmph.2020.100584
16. Park SW, Shin SM, Jeong M, Cho DH, Lee KH, Eisenhut M, et al. Hyponatremia in children with respiratory infections: a cross-sectional analysis of a cohort of 3938 patients. Sci Rep 2018; 8(1): 16494. https://doi:10.1038/s41598-018-34703-1
17. Storey C, Dauger S, Deschenes G, Heneau A, Baud O, Carel JC, et al. Hyponatremia in children under 100 days old: incidence and etiologies. Eur J Pediatr 2019; 178(9): 1353-1361. https://doi:10.1007/s00431-019-03406-8
18. Bamehrez M. Incidence of Hyponatremia and Associated Factors in Preterm Infants in Saudi Arabia. Cureus 2022; 14(4): e23869. https://doi:10.7759/cureus.23869
19. Monnikendam CS, Mu TS, Aden JK, Lefkowitz W, Carr NR, Aune CN, et al. Dysnatremia in extremely low birth weight infants is associated with multiple adverse outcomes. J Perinatol 2019; 39(6): 842-847. https://doi:10.1038/s41372-019-0359-0
20. Zheng F, Ye X, Shi X, Lin Z, Yang Z, Jiang L. Hyponatremia in Children with Bacterial Meningitis. Front Neurol 2019; 10(1): 421. https://doi:10.3389/fneur.2019.00421
21. Sachdev A, Pandharikar N, Gupta D, Gupta N, Gupta S, Venkatraman ST et al. Hospital-acquired Hyponatremia in Pediatric Intensive Care Unit. Indian J Crit Care Med 2017; 21(9): 599-603. https://doi:10.4103/ijccm.IJCCM_131_17
22. Bindu MH, Beeregowda Y. Study of hyponatremia in critically ill children admitted to paediatric intensive care unit. Eur J Pharm Med Res 2017; 4(1): 427–431.