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ORIGINAL ARTICLE

Frequency of hyponatremia in pediatric intensive care unit at a private tertiary care hospital in Lahore.

Atika Sharif[1], Abid Rafiq Chaudhary[2], Muhammad Rashid Ayub[3], Hamna Zaman[4]

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ABSTRACT… Objective: To determine the frequency and outcome of hyponatremia among children admitted at pediatric intensive care unit at Fatima Memorial Hospital, Lahore. **Study Design:** Cross-sectional study. **Setting:** Pediatric Intensive Care Unit, Fatima Memorial Hospital in Lahore. **Period:** August 25, 2022 to August 24, 2023. **Methods:** A total of 310 patients who met the specified criteria for admission to the PICU were included in this study. Patient records were carefully reviewed, and relevant data pertaining to sociodemographic factors, diagnosis, sodium levels, and subsequent outcomes were meticulously recorded. The collected data was then inputted into SPSS version 25 for analysis. In order to assess the relationship between sociodemographic factors, diagnosis, outcome variables, and hyponatremia, a chi-square test was employed. A p-value of less than 0.05 was deemed to be statistically significant. **Results:** Total 310 children admitted at PICU having age 1 month to 12 years were included in study. Gender distribution showed that, 208(67.1%) were males and 102(32.9%) were females. The mean age of the children was 25.97±34.893 months. The mean serum sodium level was 137.32±6.478 mEq/L. Among 310 children admitted at PICU, 84(27.1%) had hyponatremia. The mean stay in PICU was 4.54±3.682 days and mean stay in hospital was 5.37±3.920 days. **Conclusion:** The incidence of hyponatremia was found to be high in the study conducted. Moreover, the occurrence of hyponatremia was significantly linked to an extended length of stay in the pediatric intensive care unit, thereby imposing an additional burden on hospital administration. The prompt identification and rectification of hyponatremia can result in a reduction in both the morbidity associated with the condition and the duration of hospitalization.

Key words: Hyponatremia, Mortality, Pediatric ICU, Serum Sodium Level.

INTRODUCTION

Hyponatremia occurs when blood sodium levels drop below the critical level of 135 mEq/L, representing a common electrolyte imbalance with a prevalence of 15%-30% in hospitalized children. The condition poses a significant risk and its treatment has been associated with higher morbidity and mortality rates in both adults and children. Plasma sodium balance is regulated by ADH, the renin-angiotensin aldosterone system, and natriuretic peptides, where hyponatremia results from excess water retention stimulated by increased ADH release triggered by various factors.[1-3]

Some cases of acute hyponatremia cause excess water to enter cells, resulting in cerebral and non-cardiogenic pulmonary edema, often leading to lasting neurological damage and death if plasma sodium levels fall below 125mEq/L.[4-5] Hyponatremia can stem from water excess or sodium deficiency in the extracellular fluid, requiring both a water source, like intravenous fluid therapy in hospitalized children, and the presence of antidiuretic hormone (ADH) to prevent its elimination.[6-7]

Intravenous maintenance fluids provide essential water and electrolytes to children who cannot eat through the digestive system. While guidelines recommend water intake, sodium, and potassium needs, a hypotonic solution is suggested for maintenance.[8] Though some studies recommend isotonic fluids, agreement on the best choice

1. MBBS, Post graduate Resident FCPS Pediatric Medicine, Fatima Memorial Hospital Shadman, Lahore.
2. MBBS, MCPS, FCPS, Fellowship Pediatric Critical Care Medicine, MRCP, MRCPCH, FRCPCH, Associate Professor, Fatima Memorial Hospital, Shadman, Lahore.
3. MBBS, (Pb), FCPS (Pediatrics), PGPB (Boston) USA, IPPN (Australia), Professor, Fatima Memorial Hospital, Shadman, Lahore.
4. Final Year MBBS Student, FMH College of Medicine and Dentistry Shadman, Lahore.

Correspondence Address:
Dr. Atika Sharif
Department of Pediatric Medicine
Fatima Memorial Hospital Shadman, Lahore.
atikasharif360@gmail.com

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remains elusive, with some sources supporting hypotonic fluid use for maintenance therapy.[9-10]

In a study conducted by Juan et al, a total of 5550 children were included in a hospital setting. The study revealed that hyponatremia occurred in 534 cases, accounting for 9.6% of the sample. Among these cases, hospital-acquired hyponatremia was observed in 42 cases, representing 1.4% of the total. The majority of the hyponatremia cases were classified as mild, with 486 out of 534 cases (91.0%), while a smaller proportion showed moderate hyponatremia, with 46 out of 534 cases (8.6%). Severe hyponatremia was only observed in two cases, accounting for 0.4% of the total. Notably, no complications such as encephalopathy, pulmonary edema, or deaths were reported during the study period as a result of hyponatremia.[1]

In Shawana Bibi's study, 27.7% of 865 children had hospital-acquired hyponatremia, with 59.2% males and 40.8% females. Of these cases, 67.1% were on medical service and 32.9% on surgical service. Hyponatremia severity: 79.6% mild, 14.6% moderate, 5.8% severe. 64.6% experienced sodium drop in <48 hours, 35.4% after. Half strength dextrose saline (D5 0.45%) was common at 56.3%. Major diseases linked to hyponatremia: gastrointestinal (30.4%), respiratory (12.5%), oncological (16.3%), cardiovascular (11.7%), infectious (9.2%), neurological (8.3%).[11]

Given the aforementioned information and the possible necessity of mitigating both the morbidity and mortality rates among the pediatric population by means of preventing hospital-induced hyponatremia, it is imperative that such efforts be focused in the city of Lahore. Hence, the purpose of this study is to gain a deeper understanding of this issue and subsequently classify the occurrence of hyponatremia as well as its outcomes, with the ultimate aim of providing recommendations to prevent its incidence in the Pediatric Intensive Care Unit (PICU).

METHODS

The investigation was carried out at the Pediatric Intensive Care Unit, located at Fatima Memorial Hospital in Lahore, spanning the time period from August 25, 2022, to August 24, 2023. Following the acquisition of authorization from the hospital's Ethical Committee (FMH-25/10/2022-IRB-1142) (18-1-23) and the obtaining of written informed consent from the parents or guardians, a total of 310 patients who met the selection criteria were included in this study. A sample size of 310 was calculated using 95% confidence level with 5% margin of error and 27.7% anticipated proportion of hospital acquired hyponatremia.[11]

The inclusion criteria for this study were children aged 1 month to 12 years who were admitted to the Pediatric Intensive Care Unit (PICU) and required measurement of sodium/electrolyte levels. Patients who were admitted to the PICU but did not require sodium/electrolyte measurement were excluded. A review of patient charts was conducted to gather socio-demographic information, diagnosis details, and sodium levels. These recorded data were then used to identify cases of hyponatremia and to evaluate outcomes. Hyponatremia was defined as serum sodium levels <135 mEq/L. Outcomes were labeled as length of hospital stay (days), length of PICU stay (days), discharged home or death.

Data was inputted and analyzed using the 25th iteration of the Statistical Package for the Social Sciences (SPSS). A descriptive analysis was conducted on all variables, with categorical variables being presented in the form of frequency and percentages, and quantitative variables being presented as mean and standard deviation, depending on the distribution of the variable. Visual representations in the form of bar charts and pie charts were created for the categorical variables. To examine the association between socio-demographic, diagnosis, and outcome variables, as well as hyponatremia, a chi-square test was employed. A p-value of less than 0.05 was deemed statistically significant. Age and gender were controlled for by stratification, and a post-stratification chi-square test was performed with a significant p-value of ≤ 0.05.

RESULTS

A total of 310 pediatric patients, ranging in age

from 1 month to 12 years, were incorporated into the study conducted at the Pediatric Intensive Care Unit (PICU). The gender distribution indicated that 208 (67.1%) were male and 102 (32.9%) were female. The average age of the subjects was 25.97±34.893 months. In terms of age distribution, 276 (89.0%) of the children were aged ≤72 months, while 34 (11.0%) exceeded this age threshold.

The average serum sodium concentration was recorded at 137.32±6.478 mEq/L. Among the 310 admitted pediatric patients, 84 (27.1%) presented with hyponatremia. Regarding the outcomes for these children, 184 (59.4%) were discharged home, 111 (35.8%) were transferred to the ward, and 15 (4.8%) succumbed to their conditions. The mean duration of stay in the PICU was 4.54±3.682 days, whereas the average length of hospital stay was 5.37±3.920 days.

Analysis of hyponatremia stratified by gender and age revealed no statistically significant differences (p>0.05). Similarly, when assessing the length of stay in the PICU and overall hospital stay relative to gender and age, no significant differences were detected (p>0.05).

Gender	Frequency	Percent
Male	208	67.1
Female	102	32.9
Total	310	100.0
Age groups		
≤72 months	276	89.0
>72 months	34	11.0
Total	310	100.0
Hyponatremia		
Yes	84	27.1
No	226	72.9
Total	310	100.0
Outcome of patient		
Discharged home	184	59.4
Discharged to ward	111	35.8
Expired	15	4.8
Total	310	100.0

Table-I. Frequency distribution of demographic variables

	Age (months)	Length of stay in PICU (days)	length of stay in hospital (days)	Serum sodiumlevel (mEq/L)
Mean	25.97	4.54	5.37	137.32
Std. Deviation	34.893	3.682	3.920	6.478
Minimum	1	1	1	118
Maximum	168	27	29	165

Table-II. Mean values of different variables

Variables		Hyponatremia		P-Value
		Yes	No	
Gender	Male	61(29.3%)	147(70.7%)	0.207
	Female	23(22.5%)	79(77.5%)	
Age groups	≤72 months	78(28.3%)	198(71.7%)	0.189
	>72 months	6(17.6%)	28(82.4%)	

Table-III. Stratification of hyponatremia with respect to gender and age

Variables		Outcome of Patients			P-Value
		Dischargedhome	Dischargedto ward	Expired	
Gender	Male	120(57.7%)	78(37.5%)	10(4.8%)	0.670
	Female	64(62.7%)	33(32.4%)	5(4.9%)	
Age groups	≤72 months	162(58.7%)	100(36.2%)	14(5.1%)	0.742
	>72 months	22(64.7%)	11(32.4%)	1(2.9%)	

Table-IV. Stratification of outcome of patients with respect to gender and age

Outcomes	Gender	n	Mean	Std. Deviation	P-Value
Length of stay in PICU (days)	Male	208	4.80	3.913	0.077
	Female	102	4.01	3.110	
Length of stayin hospital (days)	Male	208	5.73	4.150	0.210
	Female	102	4.64	3.303	

Table-V. Stratification of length of PICU and hospital stay with respect to gender

Outcomes	Age groups	n	Mean	Std. Deviation	P-Value
Length of stay in PICU (days)	≤72 months	276	4.52	3.789	0.818
	>72 months	34	4.68	2.694	
Length of stayin hospital (days)	≤72 months	276	5.30	3.970	0.395
	>72 months	34	5.91	3.493	

Table-VI. Stratification of length of PICU and hospital stay with respect to age

Hyponatremia	Outcome of Patients			P-Value
	Dischargedhome	Discharged toward	Expired	
Yes	38(45.2%)	37(44.0%)	9(10.7%)	0.001
No	146(64.6%)	74(32.7%)	6(2.7%)	

Table-VII. Comparison of outcome of patients with hyponatremia

Outcomes	Hyponatremia	n	Mean	Std. Deviation	P-Value
Length of stay in PICU (days)	Yes	84	4.35	3.632	0.574
	No	226	4.61	3.706	
Length of stayin hospital (days)	Yes	84	5.24	3.886	0.717
	No	226	5.42	3.940	

Table-VIII. Comparison of length of PICU and hospital stay with hyponatremia

DISCUSSION

Hyponatremia, the most frequently observed electrolyte imbalance in children receiving hospital care, has been identified as a prominent concern. The present study, which encompassed a diverse group of participants, revealed that the mean age of the enrolled individuals was 25.97 months. Out of a total of 310 subjects, it was found that 67.1% were male while the remaining 32.9% were female.

A similar investigation conducted by Naseem F et al unveiled that the majority of cases, accounting for 74.3%, were children below the age of 5. Furthermore, it was observed that males constituted a significant majority at 60.4%, while females made up the remaining 39.6%. On the contrary, Ali SH et al reported that out of the 150 children examined in their study, 91 were male while the remaining 59 were female. These children were admitted to the emergency pediatric unit, and their average age was determined to be 18.62 months.[12-13]

Consistently, Mahapatra C et al have consistently reported that the average age of the study participants was recorded to be 18.41 months, showcasing a relatively young population. Moreover, it was observed that males were the most prevalent gender, constituting 63.2% of the participants, while females accounted for 36.8% of the cohort. This gender disparity highlights the need for further investigation into potential underlying factors that may contribute to these observed differences.

In addition, in this study, the rate of hyponatremia, or low levels of sodium in the blood, is 27.1% in the cases examined. These figures highlight a great amount of hyponatremia within the study population and call for further investigation of reasons and consequences for those affected.

In contrast to Mahapatra C et al, however, Naseem F et al showed only slightly higher hyponatremia prevalence 23.5 percent in their own work. It may be a result of variation in the study design, a difference in the size of the sample, or a difference in the characteristics of the populations under investigation. As such, the results of such studies should be interpreted and compared properly in view of these factors.

Also, Paidy AR et al conducted their own investigation about the incidence of this disease by fact finding the rate of hyponatremia and concluded that there is a lesser prevalence of 16.8 % which might indicate an unevenness of the rate of infection of this condition in diverse populations or setting. These results prompt more research to identify contributory factors and strategies to prevent hyponatremia so as to

reduce the burden of hyponatremia.

Mahapatra C. et al had an interesting finding, notably a significantly higher incidence of hyponatremia found in their study of 58.9 percent. The high significance of this difference in comparison to previously mentioned studies highlights the need for conducting several studies to have a complete idea of prevalence and impact of hyponatremia in various populations.

Overall the studies by Mahapatra C et al, Naseem F et al and Paidy AR et al offer important information on the prevalence and incidence rates of hyponatremia in various groups. These studies' observations of the variations reflect the need for future research to gain a deeper understanding of the determinants of hyponatremia and for development of preventive and management strategies.[12,14-15]

The most commonly seen electrolyte abnormality in the intensive care unit (ICU) is hyponatremia, defined as abnormally low levels of sodium in the plasma. A heightened likelihood of morbidity and mortality is associated with this electrolyte disturbance. In critically ill children with bronchiolitis, the coexisting baseline fragmentation in renal free water excretion, exacerbated by a high water intake from external sources, additionally increases the risk of developing hyponatremia. Of note, though a greater number of patients with hyponatremia had received intubation, duration of ventilatory support was not significantly prolonged in patients with hyponatremia compared to those with normal sodium levels.[16]

In an independent investigation concerning intubated individuals, it was revealed that the occurrence of hyponatremia yields comparable ventilatory demands as those individuals who do not exhibit this condition. The absence of adverse consequences associated with hyponatremia might be attributed to the meticulous oversight of serum sodium levels. It is worth noting that hyponatremia tends to be more prevalent among juvenile patients in critical care settings due to their intricate clinical condition and the presence of comorbidities that are interconnected with their health status.[16-18]

CONCLUSION

The incidence of hyponatremia was found to be high in the study conducted. Moreover, the occurrence of hyponatremia was significantly linked to an extended length of stay in the pediatric intensive care unit, thereby imposing an additional burden on hospital administration. The prompt identification and rectification of hyponatremia can result in a reduction in both the morbidity associated with the condition and the duration of hospitalization.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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AUTHORSHIP AND CONTRIBUTION DECLARATION	
1	**Atika Sharif:** Study conception and design, data collection, data analysis, discussion writing, manuscript preparation.
2	**Abid Rafiq Chaudhary:** Study conception and design, data analysis, interpretation of results, review of article.
3	**Muhammad Rashid Ayub:** Review of article.
4	**Hamna Zaman:** Data collection and interpretation.