ORIGINAL ARTICLE

FREQUENCY OF HOSPITAL ACQUIRED HYPONATREMIA IN A PEDIATRIC TERTIARY CARE SETTING

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Background: Hyponatremia is the most commonly encountered electrolyte disorder in children. In our country the epidemiology of hospital acquired hyponatremia has hardly ever been explored whereas the administration of hypotonic IV fluids is widely practiced here. Therefore we pioneered to conduct this study to determine the frequency of hospital acquired hyponatremia. **Methods:** This was a cross sectional study carried out at Aga Khan University Hospital, Karachi in paediatric ward and ICU over a period of 12 months. All children (>1 month and <15 years of age) admitted in paediatric units and on maintenance IV fluids who had serum sodium level measured on admission ,were included in the study and followed to identify patients who had a drop in serum sodium during hospitalization. Informed consent was taken from parents and collected data was recorded on a *pro forma*. **Results:** A total of 865 patients were enrolled in the study. Hyponatremia was recorded in 405 patients on admission (46.8%) while hospital acquired hyponatremia was documented in 240 children (27.7%). Out of these 142 (59.2%) were male and 98 (40.8%) were female. Mean age of children in hospital acquired hyponatremia group was 60.67 months. Severity of hospital acquired hyponatremia was recorded as mild in 191 (79.6%), moderate in 35 (14.6%) and severe in 14 (5.8%) children. Major disease categories included gastrointestinal disorder (30.4 %), respiratory illness (12.5%), oncological disease (16.3%), cardiovascular disease (11.7%), infectious disease (9.2%) and neurological illness (8.3%). **Conclusion**: Hospital acquired hyponatremia is frequently encountered in our hospitalized children with majority of them receiving hypotonic IV solutions.

Keywords: Hyponatremia, hypotonic, hospital acquired

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INTRODUCTION

One of the most commonly encountered electrolyte abnormality in hospital setting is hyponatremia which is associated with a number of clinical conditions.[1] Complications resulting from hyponatremia are numerous and varied. The more serious ones include the neurological complications that result in significant morbidity and mortality.[2,3] One of the prime risk factors for development of hyponatremia is improper fluid management in patients hospitalized for various medical and surgical conditions, which is currently the subject of huge controversy in paediatric literature.[4] Search for other risk factors which may contribute to hospital acquired hyponatremia is also going on.[5]

The standard IV maintenance fluids for paediatric patients worldwide are hypotonic solutions, based on recommendations by Holliday & Segar about 50 years back.[6] However the safety of this approach had never been evaluated in detail. To date over 50 cases have been reported in children where permanent neurological injury and/or deaths resulted from hospital acquired hyponatremia.[2,3] This includes a prospective clinical case study of 16 children by Arieff[3] and colleagues who were electively hospitalized with generally minor illnesses and developed symptomatic hyponatremia during hospitalization. All 16 patients either died or suffered permanent brain damage. One was mentally retarded, 10 died and 5 were in a persistent vegetative state. Another report by Keating *et al*[7] described 34 paediatric patients with hyponatremia out of which 2 patients died following respiratory arrest and cerebral oedema. The rest survived because of timely and appropriate management.

The major factor attributed to this was the routine use of hypotonic fluids in patients suffering from clinical conditions which are associated with excessive secretion of ADH, thereby resulting in diminished free water excretion. These and multiple other reports led critics to question the standard practice of administering hypotonic solutions to children particularly in clinical settings where there is excess vasopressin release such as after elective surgery, CNS injury or infection and pulmonary disease.

The incidence of hospital induced hyponatremia in children has been reported to be 10% in an observational study by Hoorne and colleagues.[8] Five per cent of these went on to develop hyponatremic encephalopathy. In another study of infants suffering from bronchiolitis who were transferred to ICU, the reported incidence of hyponatremia was 33% with 4% developing neurological injury.[9] Yet another study by Stelfox *et al* reported the occurrence of hyponatremia

(defined by investigators as serum sodium less than 133 mmol/L) in 917 (11%) of 8142 patients admitted to medical /surgical ICUs.[10]

The true incidence of hyponatremic encephalopathy which is the major consequence of hyponatremia leading to permanent brain injury is not known due to lack of large prospective studies. Three different studies by Wattad *et al*, Sarnaik *et al* and Halberthal *et al* have reported the incidence of hyponatremic encephalopathy as 53%, 60% and 78% respectively in children with serum sodium less than 125 mEq/l.[11–13]

In Pakistan , epidemiology of hospital acquired hyponatremia in paediatric population has hardly ever been explored. The few studies which have been published in local literature either represent adult population or have been carried out elsewhere.[14] The need for carrying out such a study in paediatric population is particularly important because children are at a higher risk of developing hyponatremic encephalopathy due to a higher brain to intracranial volume ratio.

The afore mentioned studies have contributed a great deal to paediatric literature allowing investigators to better understand the epidemiology of hospital acquired hyponatremia, to study the risk factors associated with it and to determine its impact on clinical and economic outcomes.[10] However the results of these studies may not be generalizable to our population. Therefore keeping in view the paucity of data in local literature regarding the frequency of hospital acquired hyponatremia in paediatric population, we pioneered to carry out this study which is aimed at initiating data collection in this context. This data would serve as basis for creating awareness among medical professionals about the magnitude of hospital acquired hyponatremia and for devising evidence based strategies to address this problem.

MATERIAL AND METHODS

This cross-sectional study was conducted at the department of paediatrics and child health Aga Khan University Hospital Karachi over a period of 12 months. All children admitted to the hospital who had a serum sodium level measured on presentation were enrolled in the study. Informed consent was obtained from parents/guardians. These were then followed to identify those who were receiving maintenance I/V fluids and had subsequent serum sodium measurements taken during hospitalization in order to record a fall in serum sodium (i.e., below 135 mmol/L). All serum Na measurements were taken by direct ion –selective electrode method to exclude laboratory artefact, i.e., pseudo-hyponatremia. Approval of ethical committee was taken. The collected data was entered in *pro forma* and analysed using SPSS-17.

RESULTS

A total of 865 children were enrolled in the study, out of which 758 (87.6%) got admitted in the paediatric ward while 107 (12.4%) were recruited from ICU. Five hundred and forty seven (63.2%) were male and 318 (36.8 %) were female. Six hundred and seventy four children (77.9%) were admitted in paediatric medicine service whereas 191 (22.1%) got admitted under care of paediatric surgery. Mean age of the participants was 56.64 months.

Hospital acquired hyponatremia was documented in 240 children (27.7%). Out of these 142 (59.2%) were male and 98 (40.8%) were female. One hundred and sixty one (67.1%) patients were admitted in medical service while 79 (32.9%) got admitted in surgical service. One hundred and ninety nine patients (82.9%) were admitted in ward whereas 41 (17.1%) got admitted in ICU. Mean age of these children was 60.67 months. Severity of hospital acquired hyponatremia was recorded as mild in 191 (79.6%), moderate in 35 (14.6%) and severe in 14 (5.8%) of children. One hundred and fifty five children (64.6%) showed a drop in serum sodium in less than 48 hours while 85 patients (35.4%) had a drop in serum sodium in more than 48 hours. Ninety (37.5%) children underwent a surgical procedure. Half strength dextrose saline (D5 0.45%) was the most commonly received maintenance fluid (56.3%). Major disease categories among the hospital acquired hyponatremia group included gastrointestinal disorder (30.4%), respiratory illness (12.5%), oncological disease (16.3%), cardiovascular disease (11.7%), infectious disease (9.2%) and neurological illness (8.3%). (Table-2)

Table-1: Descriptive statistics of patients with hospital acquired hyponatremia (n=240)

Characteristics	Number	Percentage
Gender		
Male	142	59.2
Female	98	40.8
Location		
Ward	199	82.9
ICU	41	17.1
Speciality		
Medicine	161	67.1
Surgery	79	32.9
Surgical procedure		
Yes	90	37.5
No	150	62.5
Severity of hyponatremia		
Mild	191	79.6
Moderate	35	14.6
Severe	14	5.8
Drop in serum sodium		
<48 hrs	155	64.6
>48 hrs	85	35.4
Type of IV fluid		
D5 0.18	41	17.1
D5 0.3	56	23.3
D5 0.45	135	56.3
D5 0.9	8	3.3

Table-2: Distribution of disease category in patients with hospital acquired hyponatremia (n=240)

	Frequency	Percentage
Gastrointestinal disorders	73	30.4
Respiratory illnesses	30	12.5
Neurological diseases	20	8.3
Cardiovascular disorders	28	11.7
Genitourinary diseases	8	3.3
Oncology	39	16.3
Infectious diseases	22	9.2
Haematology	5	2.1
Hepatobiliary diseases	5	2.1
Trauma/Burns/Poisoning	7	2.9
Endocrine diseases	1	0.4
Metabolic disorders	1	0.4
Dermatology	1	0.4

DISCUSSION

The frequency of hospital acquired hyponatremia found in our study was 27.7% which confirm that it is not uncommon for hospitalized children to develop hyponatremia. A significant proportion of children in hospital acquired hyponatremia group were documented to have been receiving hypotonic maintenance IV fluids (96.7%) with only 3.3% being administered full strength dextrose saline (D5 0.9%). Most of the patients (94.2 %) had mild to moderate hyponatremia during hospitalization with only 14 patients having a serum sodium concentration of less than 125 mEq/L. It was also observed that approximately two thirds of our cases (64.6%) with hospital acquired hyponatremia had a drop in serum sodium in less than 48 hours after admission, which can be related in large part to intravenous fluid administration. Gastrointestinal disorders particularly acute gastroenteritis accounted for majority of hospital acquired hyponatremia. Respiratory, cardiovascular and oncological illnesses were the other leading causes of hospital acquired hyponatremia. The aforementioned findings are comparable to studies carried out elsewhere.

The frequency of hyponatremia on admission was 46.8% in our study which confirms that this is the most frequently encountered electrolyte disturbance in children. Literature contains multiple studies with varying incidence of hyponatremia in hospitalized children. Hasegawa et al showed the incidence of hospital acquired hyponatremia to be 17% (serum sodium of less than 135 mEq/L on admission).[15] Another study by Don and colleagues recorded hyponatremia in 45% of children with pneumonia (serum sodium of less than 135 mEq/L on admission).[16] In another study by Armon *et al* the incidence of hyponatremia in patients on intravenous fluids was 24% (serum sodium less than 135 mEq/L) and 5% had serum sodium concentration less than 130 mEq/L.[17] The variation in results is probably due to different sample sizes and variation in study population.

Similarly Hoorn and co-workers documented hyponatremia in 22% of children (97 out of 432 patients) in emergency department.[11] The frequency of hospital acquired hyponatremia in the same study was however 10 % (40 out of 432 patients). This group also included those patients who were hyponatremic on presentation, but their serum sodium concentration increased to more than 136 mmol/L and then fell again to <136 mmol/L on a subsequent measurement.

In our study however, we strictly defined hospital acquired hyponatremia as only those patients who had normal serum sodium on admission and who subsequently became hyponatremic. With this strict definition, our incidence of hospital acquired hyponatremia (27.7%) is probably too high and the results may reflect an overestimation of actual incidence of hospital acquired hyponatremia. One reason for this may be that usually the serum sodium levels are measured only in those patients who are expected to have electrolyte imbalance for example patients with acute gastroenteritis. This also might explain as to why the gastrointestinal disorders formed the major disease category among patients with hospital acquired hyponatremia.

CONCLUSION

The magnitude of hospital acquired hyponatremia is enormously high in hospitalized children and so is the routine use of hypotonic IV solutions as part of maintenance fluid therapy. It is established in literature that hospital acquired hyponatremia is attributable to a great extent to the administration of hypotonic IV fluids particularly in situations where there is excess AVP secretion. It is also known that hospital acquired hyponatremia puts patients at risk of neurological complications including permanent brain damage and even death. We therefore suggest that the routine use of hypotonic IV solutions should be avoided till we have revised guidelines for appropriate fluid management of hospitalized children and IV fluid prescription should be individualized for each hospitalized child.

AUTHOR'S CONTRIBUTION

AH, AGB: Supervised the whole study. SB: Data collection & analysis. SB: Discussion. SYHG, SRAS: Technical Assistant.

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