Serum sodium pattern in paediatric surgical patients on 4.3% dextrose in 0.18% saline infusion

Udefiagbon OE

Department of Surgery, Irrua Specialist Teaching Hospital, Irrua, Edo, Nigeria

Abstract

Background: Perioperative 4.3% dextrose in 0.18% saline maintenance infusion has been the practice in Irrua Specialist Teaching Hospital (ISTH). However, recent studies in the western world have questioned the basis of using such hypotonic infusion, citing the occurrence of hyponatremia (with devastating sequelae sometimes) as the point of objection. The aim of this study was to establish whether hyponatremia is indeed a problem in paediatric surgical patients in our environment. Method: In this prospective observational study, eligible patients who met the inclusion criteria and consented were recruited as they presented to the unit. The age, sex, hospital number, diagnosis, operation, perioperative sodium analyses and observed clinical features of hyponatremia were recorded. Result: Most patients were boys (50; 75.8%). Elective surgeries (49; 74.2%) were more, particularly groin procedures (33; 50.0%). Toddlers (>1-3 years), 30 (45%), were more than other age groups. Within 24hours postoperative, 49 (74.2%) had decreased serum sodium (within normal range) while 18 (27.3%) had hyponatremia but none was symptomatic. Only 14 patients had serum sodium done beyond 24hours, of which 6 (42.9%) had decreased serum sodium (within normal range) while 7 (50%) had hyponatremia and none was symptomatic also. Albeit, the findings were not statistically significant. Conclusion: Hyponatremia does occur in postoperative paediatric surgical patients in our community but not statistically significant. However, a multicentre large scale national study will need to be done to determine its significance and necessity for a shift away from hypotonic infusion as has been done in some western nations.

Keywords: *Perioperative, Infusion, Hypotonic, Hyponatremia.*

Introduction

Fluids and electrolytes management is very important in paediatric surgery because of the unique aspects of fluid and electrolyte metabolism in infants and children.[1] Total body water is about 78% of body weight at term and reduces to approximately 60% by 12 – 18 months of age. The fluid is distributed between the extracellular (20%) and intracellular (40%) spaces with electrolytes dissolved in it. There are baseline electrolyte differences between intracellular and extracellular fluid with potassium predominant in the intracellular space and sodium predominant in the extracellular space. Body fluid exhibit osmolality and for proper cellular function requires a narrow window of normal plasma osmolality, approximately 280–300 mOsm/kg.[1]

Internal fluid shifts across the cell membrane (osmosis) occurs when solute concentration changes in one fluid compartment to correct the change in osmolality and to facilitate equilibrium between the two compartments. Sodium is the main determinant of extracellular fluid osmolality and volume. Thus, any discrepancy will lead to fluid and electrolyte imbalances. Laboratory assessment of serum electrolyte levels is done by measurement of the extracellular electrolyte concentration in blood. Normal serum sodium is in the range of 135 – 145 mEq/L

In most cases of hyponatremia (serum sodium concentration <135mEq/L), there is either sodium depletion or dilution in which case the extracellular water is in excess relative to sodium concentration.[2] Increased secretion of antidiuretic hormone occurs in the postoperative period which increases renal free water reabsorption leading to volume expansion and hyponatremia.[2,3] Routinely, postoperative intravenous fluid therapy is done at maintenance regimen.

Maintenance fluid is the daily requirement aimed at replacing physiologic losses including urine and the insensible losses from sweat, expiration, skin

Corresponding author Dr. Udefiagbon OE
Department of Surgery,
Irrua Specialist Teaching Hospital, Irrua, Nigeria.
Email: dokernie11@gmail.com
Tel: +2348034371910

evaporation, and in the stool. Administration of maintenance fluid to inpatients enables the kidneys to excrete urine with solute load of an osmolality similar to plasma.[4] It helps to maintain body fluid and electrolyte balance with minimal need for renal compensation. The amount of intravenous maintenance fluid is the amount of fluid required by well children with normal hydration but no oral intake.[4] It is usually calculated using the Holliday and Segar's formula; 100mls/kg for first 10kg, 50mls/kg for second 10kg and 20mls/kg for part of weight >20kg.[5] Their work favoured administration of hypotonic fluid (like 4.3% dextrose in 0.18% saline) in children based on the daily requirement of electrolytes; sodium 3mmol/kg and potassium 2mmol/kg.

Many other studies have supported intravenous infusion of 4.3% dextrose in 0.18% saline solution as the fluid of choice for postoperative fluid management in children.[6-8]

However, some authors in the western world have reported the development of hyponatremia with the use of this infusion.[2,9] Intravenous infusion of 4.3% dextrose in 0.18% saline solution is the fluid of choice in the paediatric surgical practice in the research centre but the electrolyte pattern following the fluid therapy has never been evaluated, hence the need for this study.

The aim of this study therefore was to establish whether hyponatremia is indeed a problem in paediatric surgical patients in our community.

Materials and Method

Study Area

The study was carried out in the Paediatric Surgery Unit of Irrua Specialist Teaching Hospital (ISTH), Irrua, located in Edo State. The hospital serves as a major referral centre for patients in Edo Central and North Senatorial Districts, Delta, Ondo, Kogi and some other nearby states.[15]

Study Population

Children between 3 months and 13 years hospitalized in ISTH for a surgical procedure necessitating intravenous infusion of 4.3% dextrose in 0.18% saline solution for at least 3 hours while on nothing by mouth were recruited for the study.

Sample Size Estimation

The formula below was used to calculate an estimated sample size.[16]

$N = 2z^2pq/d^2$

Where N = estimated sample size

Z = the standard normal deviation, usually 1.96 (from standard distribution table) at 95% confidence level

p = 7.5% (0.075); previous studies suggested that 7.5% (0.075) of postoperative patients develop significant hyponatremia within 1 week of surgery.[17]

q = 1- p = 1- 0.075 = 0.925

d = degree of precision desired.

Assuming that an observed difference of 10% (0.1) was desired:

$N = 2 \times (1.96)^2 \times (0.075) \times (0.925) / (0.1)^2 = 53.3$; Approximately = 53

Assuming 80% (0.80) of patients initially included completed the study:

Actual N = N/0.8 = 53/0.8 = 66.25; Approximately = 66

Study Design

This study was a prospective observational study that hoped to determine the proportion of hyponatremia among hospitalized children who fulfilled the inclusion criteria.

Inclusion Criteria[18]

All children (3 months to 13 years) who were admitted into the paediatric surgical ward, who required exclusive intravenous maintenance fluid therapy for at least 3 hours after surgery were eligible for the study.

Exclusion Criteria[18]

- Children with illness that have primary fluid and electrolyte imbalance such as:
  - Shock: Defined as acute circulatory failure resulting in decreased tissue perfusion and manifesting as altered sensorium, hypothermia (<35°C), tachycardia, prolonged capillary filling time (>3 seconds), hypotension (BP < 5th percentile for age), oliguria (<0.5 ml/kg/hr), hypoxemia, hyperlactatemia, requirement of fluid bolus and/ or vasopressors.
  - Diarrhoea and Dehydration: Children presenting with diarrhoea and features of dehydration: lethargy, irritability and altered sensorium, thirst, decreased urine output, sunken eyes and dry mucous membranes, loss of skin elasticity; children with ongoing diarrhoea were excluded even if there was no dehydration.
  - Fluid Overload: Cirrhosis, Congestive heart failure, Acute and Chronic renal failure, Nephrotic syndrome.
- Abnormal serum sodium at Presentation:
  - Hyponatremia: serum sodium < 135mmol/L.
  - Hypernatremia: serum sodium >155mmol/L.

- Severe Protein Energy Malnutrition: Defined as grade III (50-59% of expected weight for age) and grade IV (less than 50% of expected weight for age).
- Child who was receiving drugs which cause abnormality in serum sodium such as diuretics, vasopressin, etc.

Ethical Consideration

The approval of the Ethical and Research Committee of ISTH (ISTH/HREC/20170728/17) was obtained before commencement of the study. An informed consent was obtained from parents/guardian before inclusion of any child in the study.

Methods

Eligible patients were recruited for this study as they presented to the unit. Data were retrieved for each patient which included the age, sex, hospital number, diagnosis, operation, postoperative intravenous fluid used, serum electrolytes preoperative and postoperative, clinical features of hyponatremia and other complications noted.

Detailed Description:

The plan was to study the serum sodium pattern in hospitalized postoperative children, aged 3 months - 13 years following 4.3% dextrose in 0.18% saline intravenous fluid therapy in the postoperative period. The fluid was given at standard maintenance rate— 100 ml/kg for the first 10 kg of body weight, 50 ml/kg for the next 10 kg, and 20 ml/kg for body weight exceeding 20 kg. Venous blood samples were taken to determine serum electrolytes levels at baseline (prior to surgery) and in the postoperative period while the child was on exclusive intravenous maintenance fluid therapy. Commercial products of 4.3% dextrose in 0.18% saline solution produced by Unique Pharmaceuticals Limited and supplied in the hospital were used for this study.

The study measurements were carried out every 24-hour period for at most 48 hours postoperative. For the first 24-hour-period, the venous blood samples were taken just before the patients commenced on oral feeding or at the 24-hour mark postoperative. Similarly, for the second 24-hour-period, the venous blood samples were taken just before the patients were commenced on oral feeding or at the 48-hour mark postoperative for those who were still on nothing by mouth after 48 hours. The serum electrolytes analyses were carried out in the hospital central laboratory by chemical pathologists.

Blood samples (3ml) collected from the study participants under aseptic technique were put in Lithium Heparin bottle. The blood samples were centrifuged at 4,000 revolutions per minute for 5 minutes, following which the electrolytes analyses were done utilising the ion selective electrode system. The values obtained were subjected to statistical analysis.

Assessment of Outcome

The outcome measure was incidence of hyponatremia (defined as serum Na^+ less than 135mmol/L).

Statistical Analysis

Statistical analysis was done using SPSS 21 statistics package. The collected data was entered and sorted; proportions, means and standard deviations were obtained. For categorical variables, chi square test and Fisher's exact test were used. P-value less than 0.05 was considered significant.

Study Limitations

Most of the children that met the inclusion criteria received 4.3% dextrose in 0.18% saline within 24hour-period, hence the effect of prolonged administration could not really be ascertained.

Results

A total of 66 children were involved in the study including males and females in the age range of 3 months to 13 years. Infants (3-12moths) were 13, toddlers (>1-3years) were 30, preschoolers (>3-6years) were 10 and schoolers (>6-13years) were 13. The mean age of the study population was 3.7 ± 3.5 years. Male children were 50 while female children were 16.

Elective surgeries were 49 while emergencies were 17. The specific operations done are shown in table 1.

Table 1: Specific Operations Done

Operation done	*Frequency*	*Percentage (%)*
Groin surgeries	33	50.0
Appendicectomies	7	10.6
Laparotomies	19	28.8
Others	7	10.6

The serum sodium recorded preoperative and postoperative (mostly within the first 24hours and sometimes >24hours) were reported as comparison with drop, rise or same noted. The compared serum sodium pattern recorded within the first 24 hours postoperative are shown in table 2.

Table 2: Serum Na^+ Pattern Recorded within 24 hours Postoperative

Serum Na^+ compared to pre-op	***Frequency***	***Percentage (%)***
Drop	49	74.2
Same	7	10.6
Rise	10	15.2
TOTAL	66	100
Hyponatremia from chemistry	18	27.3
Symptomatic Hyponatremia	0	0

The distribution by age of the compared serum sodium within first 24hours are shown in table 3.

Table 3: Comparison of Paediatric age groups with Serum Na^+ within 24 hours postoperative

This result was not statistically significant as chi square test showed P value > 0.05.

Age group	***Na^+ Drop***	***Na^+ Same***	***Na^+ Rise***	***Hyponatremia***	***Symptomatic***
3-12mths (n=13)	9 (69.2%)	2 (15.4%)	2 (15.4%)	4 (30.8%)	-
>1-3 yrs (n=30)	24 (80%)	2 (6.7%)	4 (13.3%)	7 (23.3%)	-
>3-6 yrs (n=10)	5 (50%)	2 (20%)	3 (30%)	0	-
>6-13 yrs (n=13)	11 (84.6%)	1 (7.7%)	1 (7.7%)	7 (53.8%)	-
	Fisher's exact	***= 53.52***		***P = 0.493***	

For serum sodium recorded within the first 24hours postoperative, 18 children had hyponatremia. The distribution by age of those with hyponatremia is shown in figure 1.

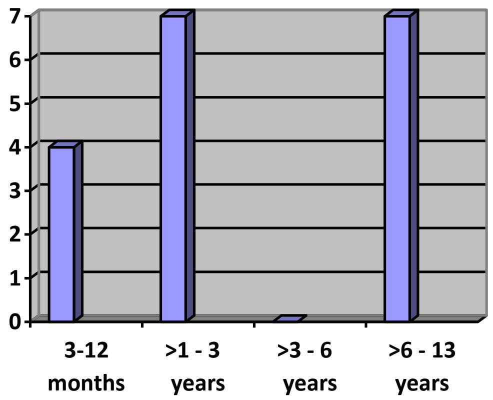

Figure 1: Hyponatremia patients within 24 hours postoperative by age group

The distribution of the compared serum sodium recorded within the first 24hours by sex are shown in table 4.

Table 4: Comparison of Patient sex with Serum Na^+ within 24 hours post-operative.

Sex	***Na^+ Drop***	***Na^+ Same***	***Na^+ Rise***	***Hyponatremia***	***Symptomatic***
Male (n=50)	37 (74%)	6 (12%)	7 (14%)	15 (30%)	-
Female (n=16)	12 (75%)	1 (6.3%)	3 (18.8%)	3 (18.8%)	-
	chi square	***= 17.527***		***P = 0.487***	

P value of 0.487 recorded from chi square test shows that these values were not statistically significant.

The distribution of the compared serum sodium recorded within the first 24hours by the type of operation done and the specific operation done are shown in table 5 and 6 respectively.

Table 5: Comparison of Operation type with Serum Na^+ within 24 hours postoperative

Operation type	***Na^+ Drop***	***Na^+ Same***	***Na^+ Rise***	***Hyponatremia***
Elective surgeries (n = 49)	39 (79.6%)	6 (12.2%)	7 (14.3%)	12 (24.5%)
Emergency surgeries (n = 17)	13 (76.5%)	1 (5.9%)	3 (17.6%)	6 (35.3%)
Chi square	***= 20.567***		***P =0.302***	

P value of 0.302 recorded from chi square test shows that these values were not statistically significant.

Table 6: Comparison of Operation done with Serum Na^+ within 24 hours postoperative

Operation done	***Na^+ Drop***	***Na^+ Same***	***Na^+ Rise***	***Hyponatremia***
Groin surgeries (n = 33)	25 (75.8%)	3 (9.1%)	5 (15.2%)	7 (21.2%)
Appendicectomies (n = 7)	6 (85.7%)	0	1 (14.3%)	3 (42.9%)
Laparotomies (n = 19)	14 (73.7%)	2 (10.5%)	3 (15.8%)	7 (36.8%)
Others (n = 7)	4(57.1%)	2(28.6%)	1 (14.3%)	1 (14.3%)
Fisher's exact	*= 100.470*		*P = 0.954*	

The result was not statistically significant as Fisher's exact test showed P value > 0.05.

The compared serum sodium pattern recorded after 24 hours (between 24 - 48 hours) postoperative are shown in table 7.

Table 7: Serum Na^+ Pattern Recorded between 24 - 48 hours Postoperative

Serum Na^+ compared to pre-op	***Frequency***	***Percentage (%)***
Drop	11	78.6
Same	1	7.1
Rise	2	14.3
TOTAL	14	100
Hyponatremia from chemistry	7	50.0

The distribution by age of the compared serum sodium between 24 - 48 hours are shown in table 8.

Table 8: Comparison of Paediatric age groups with Serum Na^+ between 24 - 48 hours

Age group	***Na^+ Drop***	***Na^+ Same***	***Na^+ Rise***	***Hyponatremia***	***Symptomatic***
3-12mths (n=5)	3 (60%)	1 (20%)	1 (20%)	1 (20%)	0
>1-3 yrs (n=4)	4 (100%)	0	0	3 (75%)	1(25%)
>3-6 yrs (n=1)	1 (100%)	0	0	1 (100%)	0
>6-13 yrs n=4)	3 (75%)	0	1 (25%)	2 (50%)	0
TOTAL = 14					
	Fisher's exact	***= 32.317***		***P = 0.353***	

The finding was not statistically significant as Fisher's exact test gave P = 0.353.

For serum sodium recorded between 24 - 48 hours postoperative, 7 children had hyponatremia. The distribution by age of those with hyponatremia is shown in figure 2.

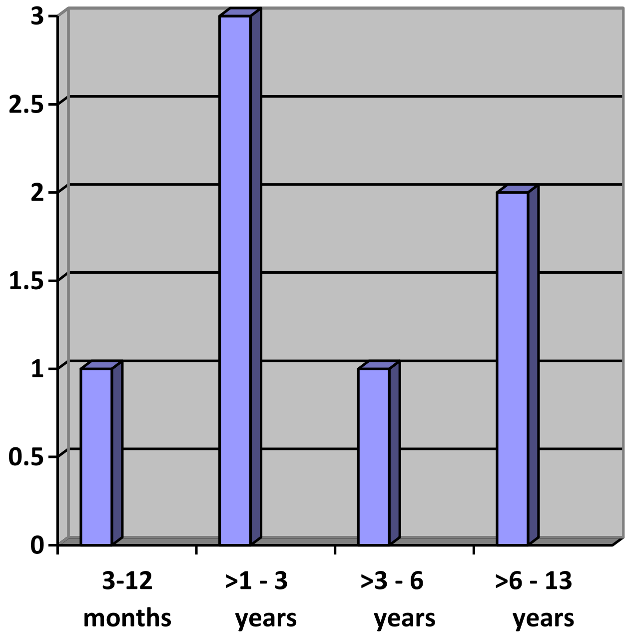

Figure 8: Hyponatremia patients between 24 - 48 hours Postoperative by age group

The distribution of the compared serum sodium recorded between 24 - 48 hours by sex are shown in table 9.

Table 9: Comparison of Patient sex with Serum Na^+ between 24 - 48 hours postoperative

Sex	***Na^+ Drop***	***Na^+ Same***	***Na^+ Rise***	***Hyponatremia***	***Symptomatic***
Male (n=8)	5 (62.5%)	1 (12.5%)	2 (25%)	4 (50%)	1(12.5%)
Female(n=6)	6 (100%)	0	0	3(50%)	0
TOTAL = 14					
	Fisher's	***Exact***	***= 9.236***		***P = 0.510***

Fisher's exact test done showed P value > 0.05; the result is not statistically significant.

The distribution of the compared serum sodium recorded between 24 - 48 hours by the type of operation done and the specific operation done are shown in table 10 and 11 respectively.

Table 10: Comparison of operation type with Serum Na^+ between 24 - 48 hours postoperative

Operation type	*Na^+ Drop*	*Na^+ Same*	*Na^+ Rise*	*Hyponatremia*	*Symptomatic*
Elective (n=5)	5 (100%)	0	0	3 (60%)	1 (20%)
Emergency (n=9)	6 (66.7%)	1 (11.1%)	2 (22.2%)	4 (44.4%)	0
TOTAL = 14					
	Fisher's	*Exact*	*= 8.919*		*P = 0.540*

Fisher's exact test done showed P value > 0.05; the result is not statistically significant.

Table 11: Comparison of Operation done with Serum Na^+ between 24 - 48 hours postoperative

Operation done	*Na^+ Drop*	*Na^+ Same*	*Na^+ Rise*	*Hyponatremia*	*Symptomatic*
Groin surgeries (n = 0)	0	0	0	0	0
Appendicectomies (n = 4)	3 (75%)	0	1 (25%)	2 (50%)	0
Laparotomies (n = 10)	8 (80%)	1 (10%)	1 (10%)	5 (50%)	1 (10%)
Others (n = 0)	0	0	0	0	0
TOTAL = 14					
Fisher's exact	*= 10.933*			*P = 0.379*	

This result was not statistically significant; P = 0.379.

Discussion

For over six decades hypotonic infusions like 4.3% dextrose in 0.18% saline solution have been the maintenance infusion of choice for paediatric surgical patients in the perioperative period barring any electrolyte derangement and pathologic fluid losses.[7,19-21]

The same trend has been the practice in the paediatric surgical unit where this research work was carried out. In recent times however, the occurrence of hyponatremia with the use of this infusion have been reported by some authors necessitating their shift from this longstanding trend.[11,22-24] This study addresses the pattern of serum sodium changes in the patients seen in our local practice receiving 4.3% dextrose in 0.18% saline infusion.

The toddler (>1-3 years) age group had the peak age distribution of 30 (45%) as most paediatric operations requiring maintenance infusion regimen in the perioperative period like herniotomies, groin explorations are common in this age group.[25-27] Male patients, 50 (75.8%), were more in this study as groin procedures (like herniotomy) were the commonest surgeries done and these are commoner in males.[19,28]

The commonest operation type was elective procedures, 49 (74.2%), such patients were more likely to meet the inclusion criteria of normal serum sodium prior to surgery. Emergency cases 17 (25.8%) are more prone to having deranged serum sodium prior to surgery.[29,30]

Since inguinoscrotal swellings are the commonest presentation in most paediatric surgery units, groin surgeries (33, 50.0%) were the commonest operations done. [25-28] Surgical indications necessitating laparotomy (19, 28.8%) are more likely to have deranged serum sodium prior to surgery, hence not many of such cases met the inclusion criteria.[3]

Forty-nine patients (74.2%) had a drop in serum sodium when compared with preoperative values while 18 (27.3%) had hyponatremia as defined by laboratory normal value (135-145mmol/L). Intravenous 4.3% dextrose in 0.18% saline infusion being a hypotonic fluid is a source of electrolyte-free water.[31] Metabolic response to surgery act as a stimulus for ADH secretion which cause renal tubular reabsorption of water.[32] The dilutional effect of these two factors consequently could have resulted in majority of the patients studied having a drop in serum sodium within 24 hours postoperative as demonstrated by other researchers.[23,33-37] Ouchi and Sugiyama in a Japanese study comparing isotonic and hypotonic fluids during anaesthesia induction in paediatric patients undergoing maxillofacial surgery showed significant differences within 24 hours between the two groups with reduced concentrations of sodium recorded for those who got hypotonic fluid.[38] Similar studies by Choong et al and Wang et al also confirmed drop in serum sodium following administration of hypotonic fluid like 4.3% dextrose in 0.18% saline solution.[39,40]

For each of the age group studied, majority had a drop in serum sodium within 24 hours postoperative viz: 3-12 months (69.2%), >1-3 years (80%), >3-6 years (50%) and >6-13 years (84.6%). Postoperative decrease in serum sodium appears to affect all the age groups. The paediatric age bracket is a known risk factor for occurrence of hyponatremia with hypotonic fluid infusion as demonstrated by a study carried out by Shafiee et al.[41]

Both genders recorded comparative high percentages of drop in serum sodium within 24 hours postoperative with male patients having 74% and female patients having 75%. This shows that sex is not a recognized factor as against infusion type and patient's age in the occurrence of hyponatremia with maintenance fluid therapy.[41]

Of the patients who had a drop in serum sodium within 24 hours postoperative, relatively more emergency patients (6 out of 13 making 46%) had hyponatremia compared to the elective patients (12 out of 39 making 31%). Surgical cases presenting for emergency operations are more likely to cause a higher non-osmotic stimulation of ADH with consequent hyponatremia.[32] This also explains why the percentage of patients having hyponatremia was relatively higher in those who had appendectomies (42.9%) and surgeries involving laparotomy (36.8%).

Minor procedures like groin surgeries (e.g. herniotomies) also recorded a high number of cases with hyponatremia, 38.9% of all patients with hyponatremia within 24 hours postoperative. A similar occurrence of hyponatremia in more than 50% of cases of previously healthy children who underwent minor surgeries was reported by Moritz and Ayus in 2003.[42]

Although 74.2% of patients only had a drop in the serum sodium (with values within normal range), 27.3% had laboratory hyponatremia values within 24 hours postoperative. This compares with studies done by Eulmesekian et al where 31% developed hyponatremia at 24 hours and that done by Armon et al where 24% developed hyponatremia.[43,44] However, much higher value (80.1%) was recorded in a randomized controlled trial done in Canada by Choong et al.[45]

A study involving serum sodium recorded about one hour post administration of anaesthesia, in patients who were receiving hypotonic infusion, reported hyponatremia in the early postoperative period.[38] On the other hand, some other workers cited its occurrence to be related with prolonged infusion (at least 48 hours) of the hypotonic fluid.[46-49] This latter finding might explain why some patients (7, 10.6%) had same postoperative values as the preoperative values within 24 hours of infusion. Ten patients (15.2%) actually had a rise in serum sodium (but within normal range) within 24 hours postoperative. The short postoperative period (within 24 hours) may explain these findings but human and technical errors as well as peculiar physiologic difference of the patients involved cannot be ruled out.

In this study, only 14 patients had cause to have serum sodium done after 24 hours (between 24 and 48 hours) because most of the patients that met the inclusion criteria were well children admitted for minor procedures which did not require intravenous infusion beyond 24 hours. The 14 patients included those who had appendicectomies (4) and those who had surgeries involving laparotomy (10). Amongst the 14, those who had emergency surgeries (9) were more than those who had elective surgeries (5) since most of the emergency cases required prolonged infusion.
Fifty percent of the patients analysed between 24 – 48 hours period had hyponatremia compared to 27.3% recorded within first 24 hours period. This corroborates the findings from some other studies, that with prolonged infusion of hypotonic infusion, more patients develop hyponatremia.[46-49] The increasing dilutional effect of the electrolyte-free water in this infusion can explain this occurrence.[31] A greater number of these hyponatremia patients (4 out of 7 making 57.1%) had emergency surgeries as against 3 (42.9%) who had elective surgeries. Emergency surgeries are more likely to predispose to hyponatremia as previously emphasized.[32]

Eleven of these patients (78.6%) had a drop in the serum sodium compared to the preoperative values. This compares with the 74.2% who had a drop within 24 hours of repeating serum sodium while the patients were on intravenous 4.3% dextrose in 0.18% saline infusion. Studies have shown that non-osmotic ADH stimuli is highest within the first 24 - 48 hours postoperative and this could explain the reduction of serum sodium in this study.[32] However, one patient (7.1%) had same serum sodium while 2 (14.3%) had a rise in the serum sodium (within normal range) compared to preoperative value during the 24 – 48 hours period.

None of the patients involved in this study developed hypernatremia (serum sodium >145mmol/L). This compares with other studies reviewed; none reported hypernatremia with use of hypotonic infusion.[18,22,33-56]

Maintenance fluid volume and infusion type (hypotonic fluids) as prescribed by Holliday and Segar have been established by evidenced based studies to cause hyponatremia in postoperative paediatric surgical patients. While some blamed the quantity of fluid given, others fault the hypotonic fluid and the syndrome of inappropriate increased secretion of ADH related to surgical response. Although most studies showed significant occurrence of hyponatremia, only few cases of symptomatic hyponatremia were recorded. Most studies showed that while hyponatremia occurs early in postoperative paediatric patients, symptoms usually develop with prolonged infusion.

This study corroborated most of the findings from literatures reviewed. A good number had decreased serum sodium (74.2%) and hyponatremia (27.3%) within 24 hours postoperative. The percentage with hyponatremia increased to 50% after 24 hours. These findings were of clinical significance despite the small sample size.

From the above findings, the author recommends that a multi-centre large scale national study be done to determine whether there should be a shift away from hypotonic infusion as postoperative fluid in paediatric patients.

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