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TO STUDY PERIOPERATIVE ELECTROLYTE CHANGE IN CHILDREN UNDERGOING ELECTIVE SURGERY IN A TERTIARY CARE HOSPITAL

Paediatrics

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ABSTRACT

Introduction: Evaluate changes in serum electrolytes levels in the pediatric patients who have undergone elective surgery and the effect of peri-operative iv fluids on these changes.
Materials: Prospective cross-sectional observation study conducted in a tertiary care, teaching hospital on all children aged 1-12 years.
Results: 139 children were finally enrolled in the study. Post-operative hyponatremia found in 14 children (p-value 0.0035). Female gender was noted to be significantly associated with hyponatremia (20.7%) with a p-value of 0.03.
Conclusion: Hyponatremia was found to be significantly associated in post-operative period when RL is used as intra-operative fluid. Hence its use is recommended with caution in children.

KEYWORDS

Hyponatremia, Hypocalcemia

INTRODUCTION:

The requirements of fluids and electrolytes during surgical procedures in children is a matter of debate due to the metabolic and electrolyte abnormalities noticed in these children []. The major electrolytes found in the serum such as sodium, potassium, calcium and chloride are important constituents of body fluids and play a vital role in cellular function and survival. They are essential for regulating fluid balance in respective zones, maintaining the excitability of tissues and acid base equilibrium, substrate transport and osmotic balance and other manifestations associated with life. Intravenous fluids are needed perioperatively by children undergoing surgery to meet the water and electrolyte requirement as a result of perioperative deficits, maintenance requirement and intra-operative losses. Proper correction with appropriate fluids helps in maintaining the circulating blood volume and cardiac output and helps in preventing electrolyte imbalances.

Previous RCTs comparing infusion of isotonic vs hypotonic fluids in pediatric patients have observed that hypotonic fluids can cause iatrogenic hyponatremia in these children [,]. A meta-analysis into intravenous fluid therapy in pediatric surgical patients also brought out risk of hyponatremia where hypotonic fluids were used []. Other studies also note that even when isotonic fluids have been used, incidences of hyponatremia occur likely due to high circulating ADH levels (occurring 6-12 hours post-surgery, decreasing thereafter) []. This high circulating ADH level leads to formation of concentrated urine and when isotonic fluids are used, ECF is expanded but sodium is lost in urine leading to hyponatremia.

Acute and severe electrolyte imbalances can induce a wide variety of clinical disorders, such as severe arrhythmias and neuromuscular dysfunction and are associated with increased morbidity and mortality. The risk posed by these abnormalities increases significantly when more than one electrolyte is deficient, and the severity of the symptoms is commonly associated with the severity of the disorder and the rate at which the disorder progresses. So, this study was planned to evaluate the pattern of changes in the levels of serum electrolytes in the pediatric patients who have undergone elective surgery and the effect of peri-operative iv fluids on these changes.

METHODS:

This cross-section observational study was conducted in the department of Pediatrics Command Hospital (Central Command), Lucknow, a tertiary care, referral and teaching hospital for a period of one year from April 2020 to March 2021. All the patients who fulfilling the eligibility criteria and undergoing surgical procedures in the Command Hospital during this period were recruited in the study after written informed consent. Children with pre-existing cardiac, renal, metabolic and hepatic diseases were excluded. Similarly, those undergoing emergency surgeries and cases where guardians refused permission were excluded. Permission for the study was granted from the Institutional Ethics Committee.

Socio-demographic factors such as age, gender etc. were noted. Pre- and post-surgery blood sample for serum electrolytes such as sodium, potassium and calcium of children will be taken and type and volume of fluid during surgery and post-surgery was measured. Pre-operative samples were obtained at the time of venous access and second sampling was done after 12 hrs post-surgery. The changes observed were correlated with type and volume of fluid of perioperative period. In the cohort, RL was used as intra-operative fluid and DNS was given post-operatively to all children as per institutional protocol.

The sample was calculated on the basis of prevalence using the formula $n = Z^2 P(1-P)/ d^2$. Taking a precision of 5%, Z value 1.96 for two tailed sample and prevalence at 10%, the calculated sample size was found to be 138 patients. The two-sample t-test (Student's t) was used for analysing the quantitative variables with normal distribution. The Chi (χ^2) square test was used where distribution was skewed and for categorical variables. In comparisons using Student's t test, 80% confidence intervals for the mean difference in response provided a range of likely values to assess clinical significance and for all tests of significance, p-values <0.05 were considered statistically significant.

RESULTS:

A total of 152 children were evaluated for the study. 13 patients were rejected due to exclusion criteria, refusal of consent by guardians or break in protocol. A total of 139 children were finally enrolled in the study and analysed for study objectives. The male to female ratio was 3.8 and the approximate percentage distribution of males and females were 79% and 21% respectively. The age group studied was 1 to 12 years with maximum representation in 0-3 years age group. The next common age group was 3 -6 years. The mean age was 3.76 ± 3.1 years. There was no variation in distribution between both genders (p-value 0.79).

The mean weight of the cohort was 14.79 ± 7.0 kg with maximum representation in 5-15 kg weight group (87 patients; 62.6%). The distribution of weight among genders was insignificant (p-value 0.59). Only serum sodium levels were found to have a statistically significant difference (p-value 0.0035) with post-operative hyponatremia found in 14 children.

Table 1: Serum electrolyte values in pre- and post-operative periods.

Electrolyte levels	Pre op	Post op	p-value
Serum Na	139.37 ± 2.96	138.29 ± 3.16	**0.0035***
Serum K	4.54 ± 0.47	4.45 ± 0.45	0.13
Serum Ca	8.91 ± 0.49	8.81 ± 0.45	0.07

The children with post-operative hyponatremia were then analysed for age, gender and weight distribution to evaluate for significant differences with these variables. Only female gender was noted to be significantly associated with hyponatremia (20.7%) with a p-value of 0.03.

Table 2: Comparison of post-op sodium levels with patient characteristics.

Variables	Values	Hypo-natremia	Normo-natremia	TOTAL	p-value
1. Gender	F	6	23	29	0.03*
	M	8	102	110	
2. Age (years)	0-3	7	67	74	0.72
	3-6	4	21	25	
	6-9	2	22	24	
	9-12	1	15	16	
3. Weight (kg)	5-15	9	78	87	0.93
	15-25	4	32	36	
	25-35	1	13	14	
	35-45	0	2	2	

DISCUSSION:

Maintenance fluids are used in clinical practise where children need supportive care and enteral administration is not possible. In spite of common use of intravenous fluids in peri-operative setting, a consensus is lacking on the best parenteral fluid for use [6]. Appropriate fluid needs to have a composition of electrolytes which preserves the child's extracellular volumes and simultaneously decreases the chances of complications of developing volume disturbances such as fluid overload or volume depletion and electrolyte disturbances such as hyponatremia or hypernatremia [iv]. Intravenous fluids have both potential for great benefit as well as harm especially in patients with fragile physiology such as sick children or those undergoing operative procedures under general anesthesia.

In children undergoing surgical procedures, isotonic crystalloids are required for maintaining homeostasis. Anaesthetists have been using Ringer's Lactate (RL) and 0.9% NaCl (NS) routinely in children intraoperatively. However, past few years there has been mounting evidence that even relatively hypotonic fluids such as RL has been responsible for hyponatremia, especially in children undergoing major surgical procedures [vii]. Post -operative hyponatremia is effectively prevented by using 0.9% NS even in presence of SIADH due to trauma and surgery. RL contains approximately 130 mmol/l of sodium concentration which is much lesser than present in plasma and has potential to cause hyponatremia [viii]. In addition, other electrolyte disturbances are potentially possible which has not been investigated previously. Hence this exercise was done in children undergoing short surgical procedures to evaluate these children for electrolyte disturbances postoperatively and correlate it to the intra-operative fluids used.

The total number of participants were 139 selected out of 152 patients evaluated for the study. Male and female participants were 110 and 29 respectively. The male to female ratio was 3.8 and the approximate percentage distribution of males and females were 79% and 21% respectively. The age group studied was 1 to 12 years with maximum representation in 0-3 years age group. The next common age group was 3 -6 years. The mean age was 3.76 $\pm$ 3.1 years. There was no variation in distribution between both genders (p-value 0.79). The mean weight of the cohort was 14.79 $\pm$ 7.0 kg with maximum representation in 5-15 kg weight group (87 patients; 62.6%). The distribution of weight among genders was insignificant (p-value 0.59).

All the children were given RL intra-operatively in OT as per the protocols used by the anaesthesia team. The serum levels of sodium, potassium and calcium were evaluated for all children in addition to noting their age, gender and weight. On comparing the difference between pre- and post-op Na levels in our cohort was significant with p-value of 0.0035. Mean pre- and post-op serum Na levels in our cohort were 139.37 ± 2.96 and 138.29 ± 3.16 mg%. The overwhelming majority of patients had Na levels between 135-145 mg/dl (80.5%). In contrast both serum potassium and calcium levels were found to be comparable. The mean pre- and post-op K levels in our cohort were 4.54 ± 0.47 and 4.45 ± 0.45 mg%. Majority of patients had serum K levels between 4-5 mg/dl (57.5%). The distribution of pre- and post-op K levels in our cohort was non-significant (p-value 0.13). The mean pre- and post-op serum calcium levels were 8.91 ± 0.49 and 8.81 ± 0.45 mg% with maximum distribution between 8-9.5mg% levels (92%). The distribution of pre- and post-op serum calcium levels was not found to be significant with p-value of 0.07.

The two groups of patients found to have hyponatremia and normo-natremia postoperatively were then compared against the variables studied i.e., age, gender and weight of the children under evaluation. The number of male and female children reporting with post-op hyponatremia were 8 and 6 patients respectively. The distribution of post-op hyponatremia between both genders was significant (p-value 0.03*). On comparison of children with post-op hyponatremia with those with normo-natremia according to the age groups, the maximum number were found to be in 0-3 years (7 children; 9.5%) with maximum percentage distribution in 3-6 years age group (16%). The distribution of cohort between various age groups was insignificant (p-value 0.72). The children who had hyponatremia in post-op period were also compared with children with normo-natremia according to weight. The distribution between different weight groups was found to be insignificant (p-value 0.93). Maximum patients with hyponatremia (~9%) were in weight groups of 5-15 kg and 15-25 kg.

A similar study was done by Shrestha et al. [ix] in 109 children less than 15 years of age undergoing surgery. In their study asymptomatic hyponatremia was found in 10 children (9.2%) children immediate post-operative period. All these children were prescribed RL as intra-operative fluid. This was found to be comparable to our study which had 14 patients (10.07%) having mild hyponatremia postoperatively in the range of 131-134 mg/dl. However, as a confounding factor all these children were given hypotonic maintenance fluids before undergoing surgery. Also, the authors reported a higher incidence of 39.4% hyponatremia when second serum sample after 12-24 hours was tested. This could be explained most likely by use of hyponatremic fluids in post-operative period by the authors. Similarly, Steele et al. [89] demonstrated mild hyponatremia in 22 adult women in post-operative period on using near isotonic solution of RL. The significant association of hyponatremia in female gender in our study should not be considered very significant due to the under-representation of female gender in the cohort. Moreover, the male children were in majority in the study due to minor structural defects such as penile hypospadiasis and the females in the cohort were likely admitted for more severe illnesses.

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