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PEDIATRIC SURGICAL PATIENTS;

COMPARISON OF THE EFFECTS OF BALANCED SALT SOLUTION WITH 1% DEXTROSE AND PEAD'S SOLUTION ON BLOOD GLUCOSE AND SODIUM LEVELS INTRA OPERATIVELY

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ABSTRACT… Almost all the Pediatric surgeons and most of pediatric anesthetists are adhered to traditional paed's solution against recommendations due to fear of hypoglycaemia and not being aware of hyponatremia. **Objective:** To compare the effects of balanced salt solution with1% dextrose and Pead's solution on blood glucose and sodium levels in pediatric surgical patients intra operatively. **Study Design:** Interventional quasi experimental study. **Setting:** Department of Anesthesia, Intensive care and pain medicine in Sheikh Zayed Medical College/ Hospital Rahim Yar Khan (Pakistan). **Period:** December 2014 to February 2015. **Methodology:** 60 patients were enrolled and divided into equal groups named after their respective iv fluids i.e.'Pead's Solution' & 'RLD1'. Patients aged between 1 month and 08 years, without gender discrimination, with ASA 1,2 , fasted according to ASA guidelines undergoing elective surgical procedure general anesthesia were included in this study. Blood sampling for levels of serum sodium and glucose was done pre-operatively and 01 hour post-operatively. **Results:** In immediate post-operative period incidence of hyperglycemia was statistically higher in 'Pead's Solution' group (93.3%;28/30) vs 'RLD1' group(10%;3/30) p=0.000. Relative risk was 9.3 in 'Pead's Solution' compared with 'RLD1' solution. Hyponatremia was statistically higher in 'Pead's Solution' group (56.6%; 17/30) than in'RLD1' group (16.6%;5/30) p=0.001. Relative risk was 3.4 in 'Pead's Solution' compared with 'RLD1' solution. Hypoglycemia and hypernatremia were not found in any patient in either group. **Conclusion:** Our results reflected that 'RLD1'is a better option than 'Pead's Solution' as it is less likely to cause hyponatremia and doesnot cause hypoglycemia. However a large number of clinical trials in almost every teaching hospital are required to convince pediatric surgeons and anesthetists to use evidence based solutions.

Key words: Intra-operative hypotonic fluids; pediatric surgery; postoperative hyponatraemia

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INTRODUCTION

Intraoperative fluid management and electrolyte balance in pediatric surgical patients is of considerable importance and yet debatable.[1] It is aimed at adequate hydration, maintaining basal metabolic requirements & normoglycemia as well as correcting any electrolyte imbalance if present to compensate for fasting periods and to replace any ongoing losses per-operatively.[1,2,3,4] Intra-operative fluid management is the prime responsibility of anaesthesiologists thus imposing a greater challenge upon them.[5]

It's more than five decades when Holiday & Segar proposed volume and composition of parenteral fluids for hospitalised children.[6] Other researchers also suggested addition of dextrose to the parenteral fluids for pediatric surgical patients, in the fear of assumed hypoglycemia due to fasting periods observed by children before surgery.[7,8,9] These parenteral fluids were hypotonic in their composition i.e. 1/5th to ½ Saline with 4.3-5% dextrose.[7,8] The recent prescribing practice of many anesthesiologists for parenteral fluids in pediatric surgical patients is based on these studies. Unfortunately, these hypotonic dextrose containing i/v fluids render the pediatric surgical patients at risk of developing hyperglycemia and hyponatremia, thus increasing peri-operative morbidity and mortality.[10,14]

In UK a survey is done to determine the

current prescribing practise of peri-operative parenteral fluids in pediatric surgical patients by anesthesiologists, and it is found that >67% did not have local departmental policy for fluid prescription. 60.1% anesthesiologists are used to administer hypotonic dextrose I/V fluids to pediatric patients intra-operatively and 75% did so in post-operative period.[15]

In recent past much work is done in this regard and use of such hypotonic dextrose containing i/v fluids in pediatric surgical patients, is challenged by some researchers and thus administration of balanced salt solution with low glucose concentrations is proposed by them in European countries. But unfortunately such an ideal parenteral fluid is unavailable in market and as a result pediatric anesthetists have to prescribe and use suboptimal i/v fluids, that may lead to serious morbidity and mortality.[16]

In the above scenario of developed countries, the current prescribing practise by anesthesiologists working in under-developed or developing countries is held questionable. It has been more than 3 decades, when few researchers conducted studies on the effects of low glucose concentration administration as a part of parenteral fluid in pediatric surgical patients in peri-operative period. But then there was a long pause up till now, and high glucose concentrations are still being used all over the world as well as in our region. We conduct this study in our hospital to demarcate the hazardous effects of different i/v fluids on blood glucose and serum sodium levels in pediatric surgical patients intra operatively. This study may become helpful in reducing the potential complications in pediatric surgical patients in immediate post-operative period due to administration of wrongly chosen i/v fluids per-operatively and it may change the prescribing practice of IV fluids by pediatric anesthetists in our region.

Methodology

This Qausi-experimental study was conducted at Department of Anesthesia, Intensive care and pain medicine in Sheikh Zayed Medical College/Hospital Rahim Yar Khan (Pakistan), from December 2014 to February 2015. Sample size was calculated with WHO sample size calculator (details ahead). After approval from hospital ethical committee, we enrolled 60 patients and divided them in two equal groups.

Parents of the patients were informed about study and written consent was obtained. Patients aged between 1 month and 08 years, without gender discrimination, with ASA 1, 2 (Table-a), fasted according to ASA guidelines (Table-b) undergoing elective surgical procedure requiring anesthesia were included in this study. Children of diabetic mothers, critically ill, premature or small for gestational age neonates and children requiring emergency surgery were not included in the study.

ASA Class	Definition
I	Normal healthy patient
II	Patient with mild systemic illness (no functional limitations)

Table-a

Ingested Material	Minimum Fast
Clear Liquids	2 hours
Breast Milk	4 hours
Light Meal, Infant Formula	6 hours

Table-b

Our primary hypothesis was that Pead's Solution (fluid with high glucose i.e. 4.3% and low sodium concentrations 0.18%) causes hyper glycemia in pediatric surgical patients when used intra-operatively. Secondary hypothesis was that Pead's Solution causes hyponatremia in pediatric surgical patients when used intra-operatively. Our tertiary hypothesis was that Ringer Lactate (balanced salt solution) with 1% dextrose does not cause hypo-glycemia when use in fasted pediatric surgical patients.

Two groups were named after their respective i/v fluid i.e. 'Pead's Solution' Group and 'RLD1' group. Patients were randomized equally in both groups by lottery method i.e. 30 patients in each

group. IV fluid was calculated according to body weight and the original formula proposed by Holiday and Segar i.e. 4ml/kg/hr for 0-10 kgs, 40ml + 2ml/kg/hr for 10-20kgs and 60ml + 1ml/kg/hr above 20 kg.

The 30 patients in 'Pead's Solution' group received i/v fluid commercially available containing 4.3% dextrose and 0.18% NaCl(1/5thsaline)with total osmolarity 300 mOsm/L (238 mOsm/l of dextrose + 62 mOsm/l of NaCl). While 30 patients in 'RLD1' group received the solution, which was prepared in operation theatre by adding 20 ml 5% Dextrose water in 80 ml of Ringer lactate solution in 100 ml burette with total osmolarity 275 mOsm/l (55 mOsm/l of 1% Glucose + 220 mOsm/l of Ringer Lactate) for pediatric surgical patients (Table-c). Blood sampling for levels of sodium and glucose was done pre-operatively and 01 hour post-operatively. Hyponatremia was defined as serum Sodium <135mEq/L, Hypernatremia as serum Sodium >150 mEq/L, Hypoglycemia as blood Glucose<100mg/dl and hyperglycemia as blood Glucose >180mg/dl.

All the data collected was entered on a proforma.

Fluid	Sodium (mEq/L)	Chloride mEq/L	Potassium mEq/L	Calcium mEq/L	Lactate mEq/L	Dextrose Gm/100 ml	Osmolarity mOsm/L
Pead's	31	31	-	-	-	4.3	300
RLD1	104	87.2	3.2	2.4	22.4	1.0	275

Table-c

Statistical Analysis

Sample size was calculated with WHO sample size calculator. It was estimated from our findings in 10 pilot patients. Our pilot study had demonstrated that patients given 'Pead's Solution' developed hyperglycemia. Based on α=0.1 % (0.001), Power =99%, mean glucose level 282$\pm$69 vs 153.2$\pm$46 in 'Pead's Solution' group vs 'RLD1' group respectively, the sample size of 14 patients per group was estimated. After approval from hospital ethical committee, we enrolled 60 patients and divided them in two equal groups.

Statistical analysis was done by using SPSS version 17. Quantitative variables were presented as Mean and Standard Deviation and qualitative variables as percentages. T-test was applied to compare the Means of variables while qualitative variables were compared by using chi-square test, where p-value<0.05 was taken significant. Relative Risk was calculated manually from the frequency table.

RESULTS

Analysis of demographic data is tabulated ahead. (Table-I) shows percentage number of male, female patients in both groups.

GENDER	GROUPS		TOTAL N=60 (%)
	PEAD'S SOLUTION n=30 (%)	RLD1 n=30 (%)	
MALE	18 (60)	15 (50)	33 (55)
FEMALE	12 (40)	15 (50)	27 (45)

Table-I

Mean And standard deviation of weight, age and Hb in both groups is in Table-II.

Groups	Age (years)	Weight (Kgs)	Hb (g/dl)
Pead's Solution Mean	2.5833$\pm$1.69	10.3500$\pm$6.13	10.2400$\pm$1.90
RLD1 Mean	4.5167$\pm$2.67	16.6333$\pm$6.87	9.9400$\pm$1.59

Table-II

Pre-operative findings were same in both groups. In immediate post-operative period incidence of hyperglycemia was statistically significant in 'Pead's Solution' group (93.3%; 28/30) vs 'RLD1' group (10%;3/30) p=0.000. Relative risk was 9.3 in 'Pead's Solution' compared with 'RLD1' solution. Hyponatremia was statistically significant in 'Pead's Solution' group (56.6%; 17/30) than with 'RLD1' group (16.6%;5/30) p=0.001. Relative risk

was 3.4 in 'Pead's Solution' compared with 'RLD1' solution. Hypoglycemia and hypernatremia were not found in any patient in either group (TABLE-III).

Variables	Groups		Relative Risk	P-Value
	Pead's Solution n(%)	Ringer Lactate D1 n(%)		
Hyperglycemia > 180 mg/dl	28/30 (93.3)	3/30 (10)	9.3	0.000
Hyponatremia <135 mEq/l	17/30 (56.6)	5/30 (16.6)	3.4	0.001
Hypoglycemia <100mg/dl	0/30 (0)	0/30 (0)	-	-
Hypernatremia >150 mEq/l	0/30 (0)	0/30 (0)	-	-

Table-III

Graphical presentation of hyperglycemia and hyponatremia in both groups, clearly indicating the risk ratio in both the groups.

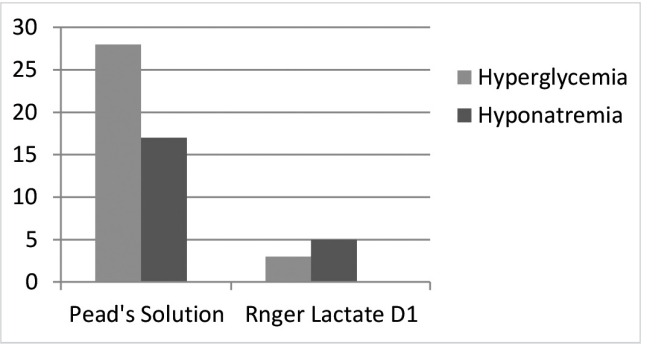

Figure-I. Comparison of hyperglycemia and hyponatremia between 2 groups.

DISCUSSION

The results of this study revealed that our all three hypothesis are correct.

Hyperglycemia: In our study presence of hyperglycemia in post-operative period is 93.3% vs 10% in 'Pead's Solution' group vs 'RLD1' groups respectively and this was statistically significant (p=0.000). The risk of developing hyperglycemia is 9.3 times more with 'Pead's Solution' which contained higher concentration of glucose (4.3%) than with 'RLD1' solution which contained only 1% glucose. Previous data favours our results.[5,17,18]

Literature suggests that hyperglycemia is associated with increase morbidity and mortality in pediatric surgical patients in peri-operative period.[22] It leads to osmotic diuresis and consequently dehydration and electrolyte imbalance.[3] It also has hazardous effects on brain. Under hypoxic conditions, excessive glucose can cause increase levels of Lactate, decreases intracellular pH and consequently cellular death.[23,24] So it is clear from our results as well as previous data that high concentrations of glucose in the intra operative period are not required in pediatric surgical patients and 1% glucose we used in 'RLD1' group is a better option.

Hyponatremia

In immediate post-operative period 56.6% vs 16.6% patients developed hyponatremia in 'Pead's Solution' group vs 'RLD1' group respectively and this difference was statistically significant (p=0.001). Relative risk indicates that risk of developing hyponatremia is 3.4 times more with 'Pead's Solution' which contained low concentrations of Sodium i.e. 31 mEq/l than with 'RLD1' solution (sodium=104 mEq/l). Previous data favours our results.[19]

Literature reveals that under surgical and anesthetic stress, ADH is released in the body which causes water retention leading to tissue edema and decreased urine output.[21] In such conditions of fluid over load, if hypotonici/v fluids are administered it may lead to further aggravation and worsening of edema as well as decrease urine out. This risk of hyponatremia along with oliguria can be decreased if parenteral fluids with balanced salt used for volume replacement per-operatively.

'Pead's Solution' is a routinely used iv fluid in pediatric surgical patients per-operatively as well as post-operatively. It contains only 31 mEq/l sodium, 31 mEq/l chloride and 4.3% glucose. This solution is isotonic before infusion. After infusion, glucose get metabolised by liver

and the remaining fluid has now only 62mOs/l osmolarity which is extremely hypotonic. It may lead to severe morbidity and mortality. In 'RLD1' group we prepared a solution with 275 mOsm/l osmolarity and sodium 104 mEq/L (seeTable-c). After infusion, when 1% glucose get metabolised, the remaining solution has now 220 mOsm/l osmolarity. With this solution less patients developed hyponatremia. The patients who developed hyponatremia in this group were found to be having infusions of 'Pead's solution' as maintenance fluid in pre-operative period in pediatric surgical ward, which justifies this finding.

Hypoglycemia

In our study not a single patient developed hypoglycemia in either group. In past there were arguments for and against the peri-operative use of glucose containing iv fluids. Some researchers suggested higher concentrations of glucose (4.3%-5%) as a part of parenteral maintenance fluid in fear of developing hypoglycemia in children due to periods of fasting before surgery. Current practise of administration of iv fluids with higher glucose concentrations is based on that hypothesis. But some other researchers reported that hypoglycemia is not a finding in fasting children even when low glucose concentrations were used as a part of parenteral fluids and this favours our results.[1,19,20]

We know that surgical and anesthetic stress increases blood glucose levels by suppression of Insulin release in the body. On the other hand under anesthesia, basal metabolic rate decreases and thus demand also decreases[2,3]. This clearly shows that extra amounts of exogenous glucose are not required per-operatively. So, low concentrations of glucose i.e. 1% as a part of maintenance iv fluid are sufficient to fulfil children's energy requirement. We used 1% glucose in one group and it proved to be enough not to cause hypoglycemia in pediatric surgical patients.

Hypernatremia

In our study not a single patient developed hypernatremia in either group.

Literature shows that the kidneys of children are immature and cannot tolerate sodium loads. Moreover higher Concentration of chloride in normal saline (154mmol/L) as compared to plasma (95-105mmol/L) may result in hyper chloremic metabolic acidosis. So, keeping this in mind we did not use 0.9% saline (Na= 154 mEq/l) in our study groups. Instead we prepared an iv fluid which contained sodium approximately 104 mEq/l i.e. 0.6% saline (RL D1 group), which did not cause hypernatremia or hyperchloremic acidosis after intra-operative administration. Rather our results revealed that serum sodium levels in immediate post-operative period in 'RLD1' group remained with in adequate range. So, it is clear, that 104mEq/l sodium (0.6% saline) will not expose the pediatric surgical patients to the danger of developing hypernatremia, thus making 'RLD1' solution a better option.

Limitations

This study is single-centred and sample size is small. We did not include neonates in our study.

CONCLUSION

On the basis of results of our study, we suggest that a balanced salt solution (1 % glucose in Ringer's Lactate) should be used intra-operatively in pediatric surgical patients to avoid serum electrolytes, acid base and blood glucose abnormalities. In France,_this solution is commercially available as specific peri-operative paediatric i.v. solution (B66—1% glucose in Ringer's lactate) which is available in the Paris public hospital system.[25] We suggest that as this ideal solution is not commercially available in most parts of world, so pediatric anesthetists themselves can make such a parenteral solution for intra operative administration in pediatric surgical patients according to our composition. And the use of hypotonic IV fluids like 'Pead's Solution' with higher glucose (4.3%) and low sodium (31 mEq/l) concentrations should be avoided intra-operatively in pediatric surgical patients. We also suggest to perform more studies to evaluate this further at different centres in our region along with the cooperation of Pediatric surgical ward.

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"Sometimes by losing a battle
you find a new way to win the war."

Donald Trump

AUTHORSHIP AND CONTRIBUTION DECLARATION

Sr. #	Author-s Full Name	Contribution to the paper	Author=s Signature
1	Dr. Sairah Sadaf	Prepared performa, conducted study, took samples for pre-op and post op glucose and sodium levels, born expenditure of lab tests, analyzed data, wrote manuscript including tables and graph	
2	Dr. Haq Dad Durrani	Idea to conduct study on topic, guided in developing performa, searched and helped to search literature related to article, analyzed data of first of pilot study of first 10 patients, calculated sample size, guided in writing manuscript and suggested amendents in it.	