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Fluid choice during perioperative care in children: A survey of present-day proposing practice by anesthesiologists in a intertiary care hospital

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Original Article

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ABSTRACT

Background: Perioperative fluid therapy in pediatrics has always been a challenging avenue for anesthesiologists. Inappropriate choice of fluid leads to multiple side effects, for instance iatrogenic hyponatremia. Our aim was to observe the current practice of perioperative fluid therapy in pediatric population undergoing surgery in a tertiary care hospital.

Methods: After obtaining approval from the Departmental Research Review Committee, a survey form including questions was emailed to anesthesiologists from January 2015 to June 2015. Individual responses were recorded and analyzed.

Results: Overall response was 100% from consultant and resident, and total 55 anesthesiologists were participated in this survey. Majority of anesthesiologist have used, 1/2 dextrose saline (52.7%) as fluid of choice in routine intraoperative maintenance, while Hartmann's solution (41.8%) and normal saline 0.9% (5.5%) were used for rest of the them. The Holliday-Segar method for maintenance fluid was mentioned by 92.7% of anesthesiologists.

Conclusion: The use of hypotonic fluid in perioperative care in pediatric population is still being practiced despite the current guidelines. These results point to a considerable gap between the available evidence and practice.

Key words: Fluid therapy; hyponatremia; pediatrics; practice guideline

Introduction

Perioperative fluid therapy in children has always been a challenge for anesthesiologists. Nonetheless, researches progressed to devise guidelines defining safer vistas in pediatric fluid management during surgery;[1] there are case reports of serious morbidity or death related to inappropriate fluid administration in previously healthy children.[2] There has been no distinction between minor and major surgeries in this regard, and adverse outcomes have been reported for surgeries including tonsillectomy, orchidopexy, reduction of fractures, and appendicectomy.[3] Nonadherence to international guidelines either due to ignorance or unawareness on the part of medical professionals, consequent with continued administration of large volumes of hypotonic intravenous fluids despite the presence of a low plasma sodium,[4-9] is a major causative factor. Several intravenous fluid solutions are commonly used in pediatric practice at our hospital such as 1/5th, 1/3rd, and 1/2 dextrose saline, isotonic saline, and lactated ringer's solution. We had no previous guidelines for perioperative pediatric fluid management.

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The objective of this study was to observe the current prescribing practice of perioperative fluid therapy in children in a tertiary care hospital.

Methods

After obtaining approval from the Departmental Research Review Committee, consultants and trainee anesthesiologists at the tertiary care hospital were included in this survey from January 2016 to June 2016. One of the investigators handed over the survey form containing different questions regarding perioperative fluid management practice, and their responses according to the practice were recorded. The questionnaire also included details about the level of training, experience in clinical anesthesia, and the frequency of anesthetizing pediatric patients per month. The form also described choice of fluid for routine intraoperative maintenance and its calculation formula and selection of type of fluid as well as calculation formula when prescribing fluids for replacement of blood losses. The forms were analyzed at the completion of the designated study time [Table 1].

Statistical analysis

All statistical analyses were performed using Statistical Package for the Social Sciences Version 19 (SPSS Inc., Chicago, IL, USA). Frequency and percentage were calculated for categorical variables and mean/median and SD/IQR were reported for numeric variables.

Results

Total 55 respondents were included in this study. Of these, 28 were consultant anesthesiologists and the rest were trainees. The practice experience in years ranged from 6 months to 33 years. 69% of participants responded to anesthetizing children occasionally and 31% had regular pediatric sessions, of which 25.4% had once in a week list while 5.6% had two lists per week. The most prescribed choice for routine intraoperative fluid maintenance was 1/2 dextrose saline (52.7%) [Table 2]. Other choices were Hartmann's solution (41.8%) and normal saline 0.9% (5.5%). Overall, 52.7% of participants chose a hypotonic dextrose saline solution for intraoperative use, of them 47.3% indicated that they tend to use only Hartmann's solution or saline 0.9%. The reason of specific choice of fluid was not asked in the questionnaire form.

The participants also provided information on how they calculate intraoperative maintenance fluids. The majority (92.7%) of participants followed calculation by the formula 4 + 2 + 1, originally described by Holliday and Segar[4-9] [Table 1]. Only 4% of participants used formula method to prescribe maintenance fluid. When prescribing fluid for replacement of blood loss, isotonic fluids were the most common (78%) choice of fluid used (saline 0.9%, Hartmann's solution, or colloidal solution). All of them replaced blood volume with crystalloid in a ratio of 1:3 and colloid 1:1.

Table 1: Survey Questioner regarding current practice of perioperative fluid therapy in children

Questioner for participants	Response
Consultants	Duration of experience _____
Trainees	Duration of experience _____
Frequency with which they anaesthetized children	Twice/week
	Once/week
	Once/month
Choice of fluid for intra operative maintenance	Normal Saline
	Ringers lactate
	1/2 strength Dextrose saline
	1/3 Dextrose Saline
	1/5 Dextrose Saline
	Dextrose 5%
	Colloids
	Other combination
How fluid is calculate to prescribe	
If fluid is being transfused on replacement blood loss then what will be fluid choice and formula	

Table 2: Survey responses regarding current practice of perioperative fluid therapy in children (*n*=34)

Fluid therapy	*n* (%)
Choice of fluid for intraoperative maintenance	
R/L	23 (41.8)
D/S 1/2	29 (52.7)
N/S	3 (5.5)
Fluid calculation for prescription	
4/2/1 rule	51 (92.7)
Formula method	
100 mL/kg for the first 10 kg	4 (7.3)
50 mL/kg for the next 10 kg	
20 mL/kg for every kg over 20 (divide by 24 for hourly rate)	
If fluid is being transfused for replacement of blood loss then fluid choice and formula	
R/L 3:1	27 (49)
Colloid 1:1	11 (20)
N/S 3:1	16 (29)
FFPs formula	1 (2.0)

Results are expressed as *n* (%). R/L: Ringer lactate; D/S: Dextrose saline; N/S: Normal saline; FFPs: Fresh frozen plasmas

Discussion

The most prominent finding of this survey of a sample of 55 anesthesiologists, who anesthetize children, is that 52.7% of participants used hypotonic dextrose saline

solutions during intraoperative phase when they are giving anesthesia to the children. A lot of case reports are reported which showed finding of neurological injuries as a result of hospital-acquired hyponatremia in children, most of them observed after routine surgery for the common pediatric surgical indications,[9] and highlighted the importance of this issue. It has been advocated that the use of isotonic saline in the perioperative period would prevent most cases of hospital-acquired hyponatremia. Children are particularly most susceptible group of population to get effected by acute hyponatremia[10] and become symptomatic at higher plasma sodium concentrations as compared to adults. It is frequently observed that more than 50% of children with serum sodium <125 meq/L tend to develop hyponatremic encephalopathy. Hyponatremic encephalopathy is a serious complication of hyponatremia that can result in death or permanent neurological injury. The true incidence of hyponatremic encephalopathy in hospitalized children is unknown as large prospective studies have not been done.[3] Besides that, dilutional hyponatremia also occurs when there is a source of electrolyte-free water and an inability to excrete free water from the kidney.

Antidiuretic hormone release from posterior pituitary gland is regulated by osmotic stimuli so that healthy kidneys are able to excrete large amount of diluted urine in response to a water excess by suppression of antidiuretic hormone release. Plasma osmolality is thus regulated within very fine limits despite wide differences in fluid intake. Antidiuretic hormone release is also controlled by a variety of non-osmotic stimuli as well, such as decreased in extracellular fluid volume and hypovolemia, pain, nausea, stress and drugs like morphine. Central nervous system and pulmonary disorders contribute to this disturbance. These nonosmotic stimuli override the osmotic control; therefore, the perioperative period is characterized by high concentrations of antidiuretic hormone and failure to excrete a free water load and meanwhile administration of hypotonic fluids in this situation will lead to hyponatremia. An observational study in a tertiary children's hospital indicated a 10% incidence of hospital-acquired hyponatremia in children presenting to the emergency department, and in the hospital-acquired hyponatremia group, children have received significantly more electrolyte-free water in the form of hypotonic intravenous fluids.[6] During intraoperative phase, intravenous fluids are used as replacement option to expand the extracellular fluid volume, to maintain systemic arterial pressure or replace abnormal fluid losses, and as "maintenance" fluid to replace insensible and urinary losses when oral intake is suspended.[11] The justification for fluid administration needs to be carefully measured during the intraoperative and postoperative periods to avoid adverse consequences related to the fluid have used.

In addition, during the intraoperative period, stress response to surgery causes maximal release of antidiuretic hormone and it leads to lowering of urinary loss. Insensible losses (sweating/respiratory water losses) are also diminished; thus, the requirement for maintenance fluids intraoperatively would be low. However, there is a need to maintain the mean arterial pressure to counter the effect of anesthetic agents and to replace fluid deficits due to fasting and ongoing losses associated with the surgery. These deficits and losses are from the extracellular compartment and should logically be replaced by that solution approximating the composition of extracellular fluid, and the use of hypotonic solutions would be expected to result in a net decrease in plasma sodium. Most of the published literature regarding fluids in the pediatric anesthetic literature has been concerned with the need for glucose-containing supplements during surgery,[12-14] rather than considering the sodium content of maintenance fluids.

It is surprising that 52.7% of anesthetists in this survey indicated that they give hypotonic dextrose saline intraoperatively, and this practice may be related to concerns about intraoperative hypoglycemia, especially in small infants who undergone prolonged surgeries. However, for routine surgery, these concerns may be exaggerated as fasting times have been relaxed in recent years and even healthy infants have been shown to maintain blood glucose concentrations within normal limits during surgery, with or without added dextrose.[15] Fluids containing dextrose 5% are linked with hyperglycemia, which may have some deleterious effects such as diuresis, dehydration, and electrolyte disturbances, especially in small preterm infants with undeveloped tubular function. Furthermore, several studies have already been established that hyperglycemia will also increase the risk of ischemic brain or spinal cord injury. Especially, those infants who have faced profound hypothermic circulatory arrest for cardiac surgery, with high prearrest blood glucose levels, are associated with postoperative neurological deceits.[12,13,16] It is proven that intraoperative glucose is no longer required in the maintenance fluid for the majority of children[17] except in the neonates; still controversies and certain hesitations persist. The normal glucose infusions used have concentrations ranging from 5% to 10%, these solutions may produce hyperglycemia, which could be troublesome. The differences in the capability of the neonate to metabolize ketone bodies, free fatty acids, and lactate for energy mean that hyperglycemia may indisputably protect the neonatal brain from ischemic injury, which is in strident contrast to the adult brain. Previously, Larsson

et al.[18] described that hypoglycemia was found only in those neonates <48 h old. Later on, it was established that 1% glucose solution has shown no evidence of hypoglycemia or hyperglycemia in the neonates during surgery.[19] It is also concluded that a lower concentration of glucose solutions should be administered to neonates and should be monitored to prevent the risk of hypoglycemia.

We are clearly stated that some limitations were in a questionnaire survey, there were very few anesthesiologists who are specialist in pediatric anesthesia practice contributed to the survey, and all of them belonged to single hospital only.

In summary, this survey has indicated that the current advocating practice in significant numbers of anesthesiologists may be placing children at threat of iatrogenic hyponatremia using hypotonic fluids intraoperatively. However, it was a single center study and there is a need to have a multicenter large scale –design study data to further strengthen its validity, though this is the limitation of the study.

Conclusion

International guidelines have largely superseded the use of hypotonic fluids with isotonic solutions. We recommend that development of institutional guidelines for pediatric perioperative fluid management and their implementation by means of education and dissemination will definitely minimize the risk of iatrogenic dilutional hyponatremia and hyperglycemia. Isotonic fluids should be promoted for improved perioperative safety of pediatric population undergoing surgical procedures.

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Conflicts of interest

There are no conflicts of interest.

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