Perioperative fluids for pediatrics

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Abstract
In recent years, many studies and case reports have shown that hypotonic fluids may lead to serious hyponatremia or hyperglycemia. However, even recently, hypotonic fluid is general acceptance and use for perioperative. The objective of this review is to assess the more appropriate fluids for pediatrics in perioperative period. Many reports have shown that hypotonic fluids, such as containing 30.8 - 74 mEq/L sodium, decrease blood sodium levels. On the other hand, isotonic fluids included with 140 mEq/L sodium enabled maintenance of blood sodium concentration, due to its similarity to normal blood sodium concentrations. Solutions with glucose concentration of 5% are associated with an unacceptably high blood glucose level. In more lower glucose concentration, 2% are associated with an unacceptably high blood glucose level. There were not hypoglycemia and hyperglycemia with fluids containing 1% glucose. In conclusion, isotonic fluids with 1% glucose help to avoid hyponatremia and hyperglycemia in pediatric and may, therefore, enhance patient safety. Currently, I recommend use of isotonic fluids with 1% glucose for pediatrics in perioperative period.

Introduction
Maintenance fluid therapy in children is based on Holliday and Segar’s recommendations to use hypotonic fluids containing 30 mEq/L sodium with 5% glucose [1]. In perioperative for pediatrics, based on these recommendations, hypotonic fluids containing 30.8 - 90 mEq/L sodium with 2.6 - 5% glucose are commonly used; these hypotonic fluids have slightly higher levels of sodium than the Holliday and Segar’s recommendations [2,3].

In recent years, many studies and case reports have shown that hypotonic fluids may lead to serious hyponatremia or hyperglycemia [2,4-8]. However, even recently, hypotonic fluid is general acceptance and use for perioperative [2,3].

Table 1 shows fluid that is generally distributed. In this article, I discuss the appropriate fluids for pediatrics in perioperative period.

Sodium concentration
Many reports have shown that hypotonic fluids, such as those containing 30.8 - 74 mEq/L sodium, decrease blood sodium levels [8,9]. In the perioperative period, the risk of developing hyponatremia is increased because of stress-induced secretion of antidiuretic hormone [10,11]. The hyponatremia is associated with considerable morbidity and mortality [12,13], including cerebral edema. In pediatric patients, even a small decrease in sodium levels can lead to cerebral herniation due to the limited room available in the rigid skull to accommodate the swollen brain [10]. In addition, the ability of the pediatric brain to adapt to hyponatremia is poorer than that of adults [14]. Reports have shown that hypotonic fluids cause hyponatremia, with the resultant fall in sodium levels leading to serious neurologic outcomes in 2 of 40 patients who received hypertonic fluids [4]. In this previous report, decrease in sodium from 142 to 128 mEq/L led to cardiac arrest, and postmortem examination revealed brain cell swelling [4]. Thus, a decrease in sodium levels must be avoided. Reportedly, hypotonic fluids lead hyponatremia or serum sodium reduction [3,15-18]. (Table 2) Contrary, reportedly, in the post-appendectomy period, the use of hypotonic solution (30.8 mEq/L) did not increase the risk of hyponatremia when compared to isotonic saline [19]. Moreover, reportedly, when administered at the appropriate maintenance rate, hypertonic solution (77 mEq/L) did not result in serum sodium reduction during the first 12 hours of fluid therapy in hospitalized children [20]. On the other hand, isotonic fluids included with 140 mEq/L sodium enabled maintenance of blood sodium concentration, due to its similarity to normal blood sodium concentrations [21]. Recently, It recommended replacing hypotonic fluids with isotonic fluids during the perioperative period in pediatrics [2].

Glucose concentration
The next topic is the presence/absence of the necessity of administration of glucose during surgery. Surgical stress has been shown to increase blood glucose concentrations without a concomitant increase in plasma insulin concentrations [22]. Thus, despite the use of non-glucose fluids, blood glucose concentrations increase and plasma insulin concentrations decrease in adult patients undergoing surgery [22]. In pediatric patients, on the other hand, surgical stress alone does not increase blood glucose concentrations when non-glucose fluids are used [23]. This indicates a difference in the glucose response to surgical stress between pediatric and adult patients. There are, reportedly, differences in whole body and brain glucose metabolism between these two patient populations; in particular, brain metabolism changes markedly during development [24]. Glucose is essential for the normal brain to function and hypoglycemia exerts important effects on the central nervous system. For example, increases in regional blood flow with a loss of cerebrovascular autoregulation can lead to clinical consequences.
It is well known that a severe lack of glucose enhances lipolysis, leading to ketogenesis. Use of non-glucose fluids increased plasma concentrations of nonesterified fatty acids and ketone bodies, at the end of and after surgery [27]. It indicates lipid mobilization. Table 3 shows nonesterified fatty acids and ketone bodies concentration that was associated by fluids. Use of 1% glucose fluids reportedly maintains nonesterified fatty acids and ketone bodies concentration that was associated by fluids. These may have revealed a lack of glucose with the use of 1% glucose solutions. Thus, future study is expected to clarify plasma ketone bodies and nonesterified fatty acids concentrations with 1% glucose fluids.

### Conclusion

Isotonic fluids with 1% glucose help to avoid hyponatremia and hyperglycemia in pediatric and may, therefore, enhance patient safety. Currently, I recommend use of isotonic fluids with 1% glucose for pediatrics in perioperative period.

### References

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