



WAKE UP SAFE[®]

The Pediatric Anesthesia Quality Improvement Initiative

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Over the past 4 years, seven cases of hyperkalemia-associated cardiac arrest or near-cardiac arrest during massive transfusion have been reported to Wake Up Safe. Of these, three patients had documented hyperkalemia and four were suspected of having hyperkalemia. The case profiles submitted were as follows: an infant undergoing myelomeningocele repair; an infant undergoing resection of an abdominal tumor; a premature neonate undergoing resection of sacrococcygeal teratoma; an infant undergoing sagittal synostectomy for craniosynostosis; a neonate undergoing resection of a facial mass; a child undergoing cardiac surgery with cardiopulmonary bypass support; and a teenager in extremis undergoing emergency laparotomy for free air. In two of these patients, the serum potassium levels exceeded 8 mmol/L during transfusion of red blood cell (RBC) units that were 21 and 28 days old in one patient, and 23 days old in the other. In the third case, serum potassium level exceeded 6 mmol/L after transfusion of RBC units that were 5 days old. In the other four cases, either other comorbid conditions were likely the primary cause of the cardiac arrest or near-cardiac arrest, and/or more specific information regarding the plasma potassium or RBC units was not available. Between 1998 and 2004, before the establishment of Wake Up Safe's registry, the Pediatric Perioperative Cardiac Arrest (POCA) registry received reports of eight patients who developed hyperkalemic cardiac arrest related to blood transfusion.ⁱ

Wake up Safe, a component of The Society for Pediatric Anesthesia

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Recommendations

Based on the cases reported to Wake Up Safe and a review of the existing literature, we recommend the following:ⁱⁱ

1. Anticipate blood loss and transfuse before significant hemodynamic compromise occurs.
2. Use peripheral intravenous (IV) catheters preferentially over central venous lines for massive transfusion.
3. Use larger bore (>23 G) peripheral IV catheters over smaller gauges.ⁱⁱⁱ
4. When massive transfusion is anticipated, a Transfusion Medicine consult is beneficial in determining the transfusion policy for the hospital and what effective measures are available to reduce the potassium delivered in stored RBCs. These measures are institution-dependent and may include the following:
 - a. Use of “fresh” RBCs for massive transfusion. The definition of “fresh” is arbitrary and often refers to RBC units that are within 7 days of collection.
 - b. Plasma volume reduction
 - c. Reduction of additive solution
 - d. Washing of RBCs either by the Blood Bank or by using an intraoperative cell salvage machine
 - e. Minimizing the time interval between irradiation and transfusion.
5. If significant hyperkalemia does occur, treatment options include the following:
 - a. Discontinue potassium-containing IV fluids and replace with normal saline.
 - b. Calcium chloride 20 mg/kg IV (max 1 g) or calcium gluconate 60 mg/kg IV (max 3 g)
 - c. Dextrose 0.25-1 g/kg and insulin 0.1 unit/kg IV.^{iv} The maximum is the adult dose of 25-50 g dextrose and 5-10 units of regular insulin.^v
 - d. Sodium bicarbonate 1-2 mEq/kg IV

- e. Albuterol by nebulizer
- f. Hyperventilation
- g. Terbutaline 10 mcg/kg load then 0.1-10 mcg/kg/min
- h. Furosemide 0.1 mg/kg IV
- i. Kayexalate 1-2 g/kg/dose via gastric tube or per rectum
- j. **Dialysis** if refractory to treatment
- k. If cardiac arrest occurs, institute PALS CPR. Activate ECMO (if available) if cardiac arrest > 6 min.

ⁱ Bhananker SM, Ramamoorthy C, Geiduschek JM, Posner KL, Domino KB, Haberkern CM, Campos JS, Morray JP. Anesthesia-related cardiac arrest in children: update from the Pediatric Perioperative Cardiac Arrest Registry. *Anesth Analg* 2007; 105: 344-50.

ⁱⁱ Lee AC, Reduque LL, Luban NLC, Ness PM, Anton B, Heitmiller ES. Transfusion-associated hyperkalemic cardiac arrest in pediatric patients receiving massive transfusion. *Transfusion* 2014; 54: 244-54.

ⁱⁱⁱ Miller MA, Schlueter AJ. Transfusions via hand-held syringes and small-gauge needles as risk factors for hyperkalemia. *Transfusion* 2004; 44: 373-81.

^{iv} Coté C, Lerman J, Anderson B. *Coté and Lerman's a Practice of Anesthesia for Infants and Children* [e-book]. Elsevier Health Sciences; 2013. Available from: R2 Digital Library, Ipswich, MA. Accessed September 5, 2014.

^v Miller R. *Miller's Anesthesia, 2 Vol Set* [e-book]. Elsevier Health Sciences; 2010. Available from: R2 Digital Library, Ipswich, MA. Accessed September 6, 2014.