TITLE: Management of a pediatric trauma patient (with a bleeding disorder) ... when there is too little information and too little time

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GOALS: Participants in this problem-based learning discussion will:
1. Discuss the clinical and logistical challenges pertinent to the care of a pediatric trauma patient
2. Identify the key actions that are needed in order to resuscitate an unstable child that may need a transfusion with/without a bleeding disorder
3. Develop strategies that may be applicable to the care of a broader population of pediatric trauma patients

CASE DESCRIPTION:
A 6-year-old boy (20 kg) has just arrived at your hospital’s trauma bay following transfer from an OSH. The EMTs report the child is stable and conscious but has multiple long bone fractures (bilateral open femurs and closed left humerus), as well as possible chest and abdominal injuries following a MVA. A C-collar and bilateral 20 gauge antecubital IVs are in place. P 120, BP 110/50, R 28, SpO2=99% (with 100% non-rebreather mask).

The trauma surgeon would like you to assess and manage this child’s airway and breathing as well as provide pain medication and sedation if needed.

How will you proceed?

What role will you assume in the overall management including the performance of the primary and secondary survey as an anesthesiologist?

The EMT also reports that someone at the accident scene stated this child might have a bleeding disorder.

How will this information alter your assessment and resuscitation of this child in the trauma bay?

At this point, what additional laboratory studies will you order to assist with the management of this child’s bleeding/transfusion?
The Trauma surgeon has requested that the anesthesiology team assist with the transport of this child to the CT scanner as well as provide sedation given the patient’s tentative condition. The child is conscious but is becoming more combative.

**How will you accomplish this?**

The orthopedist says he needs to perform bilateral ORIFs of the femur fractures and a closed reduction and casting of the left humerus. The general surgeon confirms that there is a splenic laceration but for now he will just follow serial H/H’s for evidence of continued bleeding prior to performing an exploratory laparotomy. H/H = 8.5/25.5.

**How will you proceed?**

**How will the diagnosis of a “bleeding disorder” impact your management? When will you transfuse this patient?**

A grandparent has just arrived and states the child has von Willebrand’s Disease. Apparently, he receives regular treatment at home and has been hospitalized in the recent past at an unknown OSH.

**What additional labs will you order now? How will you monitor this patient’s status intra-operatively?**

**How will you decide what blood products and/or factors to transfuse prior to surgery? How does cryoprecipitate differ from fresh frozen plasma?**

Following an unremarkable induction, surgery begins. Shortly after incision, the child suddenly becomes hypotensive (BP 60/35, P 135). The orthopedist reports that there is minimal bleeding from the surgical site.

**How will you treat this child’s hypotension?**

**What is your differential diagnosis of this hypotension? If you suspect intra-abdominal bleeding, how will you proceed?**

The OR nurse asks if you would like to activate the massive transfusion protocol (MTP).

**How will you respond? Is there an ideal ratio of blood components in a MTP? Is this ratio different for a child vs. an adult patient?**

**What laboratory studies will you use to guide transfusion in the OR if you decide to initiate a MTP?**
Following resuscitation and transfusion, the child’s BP stabilizes and surgery is completed without further incident. The trauma service asks you for recommendations for postoperative sedation/pain management in the PICU.

**What are your recommendations for sedation? Postoperative pain management?**

**When will you extubate this patient? What are your extubation criteria?**

**MODEL DISCUSSION OUTLINE:**

I. Introduction
Trauma is a leading cause of death for children in many countries including the U.S.A.\(^1\) In addition, the need for transfusion within the first 24 hours after admission in the pediatric trauma patient is associated with increased mortality, especially when the transfusion involves multiple units and/or the development of a coagulopathy.\(^2\) The incidence of death from trauma as well as massive transfusion is higher the younger the child or infant.

II. Assessment of the Pediatric Trauma Patient
ATLS, PALS, as well as AAP published guidelines for the management of the pediatric trauma patient, may provide practitioners with templates for the early evaluation and management of the pediatric trauma patient.\(^3\) A primary survey should concentrate on evaluating and securing the airway and ventilation, stabilizing the hemodynamic status, performing a gross neurological exam, as well as exposing and examining the patient for evidence of life-threatening injuries. The secondary survey should encompass a more detailed head-to-toe physical exam, obtaining a complete medical history, and performing laboratory and radiological studies. The standard trauma series performed in most trauma bays includes radiological films of the c-spine as well as AP chest and abdomen.

III. Management of the Pediatric Trauma Patient
The most common injuries seen in the pediatric trauma patient are secondary to blunt trauma rather than penetrating trauma with over 50% suffering some form of head injury. Though less common than in adult trauma patients, injuries involving the chest (pneumothorax, pulmonary and myocardial contusion, etc.) and abdomen (liver and splenic injuries) must be ruled out. Therefore, the most common early interventions are usually related to the performance of diagnostic radiological studies such as CT scans of the chest, abdomen and pelvis. Given these studies most often require transport of a child to another site, the issues of stabilization, sedation, and obtaining a secure airway must be addressed. The respective roles of the pediatric trauma surgeon, pediatric anesthesiologist, and other members of the trauma team may vary locally but should be both formalized as well as flexible enough to adapt to the acute challenges and dilemmas that may need to be addressed early in the management of the pediatric trauma patient.

Any sudden change in a child’s condition during the perioperative period should initiate a re-evaluation of any/all injuries based on the earlier findings of the primary and secondary surveys as well as the acute presentation. When there is availability and expertise, effective diagnostic modalities such as
ultrasonography and TEE as well as standard monitoring should be employed to aid in the determination of the underlying etiology of injury and/or instability. When intra-abdominal injury is suspected, the focused abdominal sonographic exam for trauma (FAST) is now usually performed rather than a diagnostic peritoneal lavage (DPL).

**IV. Management of Transfusion**

While fluid resuscitation with isotonic crystalloid is most often initiated in a child upon arrival to the trauma unit, early blood transfusion must be considered prior to receiving laboratory confirmation of anemia in the face of signs consistent with hemorrhagic shock such as tachycardia, hypotension, skin pallor, etc., especially when there is overt evidence of substantial blood loss. In the infant and child, hypotension may be a relatively late presenting sign compared to the adult trauma patient.

**B. Massive transfusion**

Definitions vary regarding what amount of relative blood loss constitutes “massive” blood loss in a child and/or warrants the use of a massive transfusion protocol. In some centers, the replacement of greater than 40ml/kg in 24 hours would be categorized as a massive transfusion. In addition to serial hemoglobin values, other parameters that may be used to guide transfusion therapy include heart rate, blood pressure, central venous pressure (if available), and serial ABGs with particular attention to evidence of an increasing metabolic acidosis via a decreasing pH with increasing base deficit and lactate levels.

Institutions that care for trauma patients should strongly consider implementing a massive transfusion protocol (MTP) in order to optimize the acute mobilization of blood products as well as the management of massive transfusion and its complications during the care of the pediatric trauma patient. Complications related to massive transfusion include dilutional thrombocytopenia, reduction of coagulation factors with coagulopathy, hypothermia, electrolyte abnormalities such as hypocalcemia, hypomagnesemia, and hyperkalemia, and transfusion reactions.

The transfusion of blood components in many MTPs call for a 1:1:1 ratio of PRBCs:FFP:Platelets with cryoprecipitate administration either scripted in the protocol per number of total units administered or per practitioner bedside assessment via serial fibrinogen levels. A marked increase in fibrin split products with low fibrinogen levels is consistent with disseminated intravascular coagulation (DIC). Recombinant Factor VIIa (rFVIIa) infusion is now being included in many MTPs, especially when there is evidence of a coagulopathy that is refractory to blood component therapy. At this time, the use of rFVIIa is off-label in the treatment of pediatric trauma patients. However, there is growing evidence that there can be a significant reduction in blood product administration following the administration of rFVIIa. Of note, some centers use a starting dose as high as 90 mcg/kg IV.

**C. Von Willebrand Disease**

Von Willebrand Disease (vWD) is the most common inherited bleeding disorder with a prevalence that may be as high as 1%. Children may have a normal platelet count and coagulation screening tests. However, children with vWD often have a prolonged aPTT. Laboratory tests used to diagnose vWD
include factor VIII assay, von Willebrand factor (vWF) activity, and vWF antigen. Types I and III are quantitative deficiencies of vWF whereas type II is more of a qualitative defect of the vWF itself. While FFP and cryoprecipitate contain factors VIII and vWF, definitive therapy for acute bleeding in children with vWD is infusion of vWF (ristocetin cofactor activity)-containing FVIII (coagulant activity) concentrate [vWF/FVIII]. Desmopression (DDAVP) in a dose of .3 mcg/kg IV may also be considered as a primary therapy and can be given while awaiting vWF/FVIII concentrate in order to increase FVIII and vWF levels in 30-60 minutes. Continued infusion of vWF/FVIII concentrate should be considered for several days following trauma and/or an acute episode of bleeding in order to keep factor activity within a normal range. Antifibrinolytic therapy such as tranexamic acid has also been described and used in the management of at-risk children with vWD in the acute perioperative period.

REFERENCES: