PATIENT BLOOD MANAGEMENT FOR PEDIATRIC NON-CARDIAC SURGERY

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DISCLOSURES

None
**OBJECTIVES FOR PEDIATRIC PATIENT BLOOD MANAGEMENT**

- To discuss the challenges of peri-operative bleeding & blood transfusion in children having non-cardiac surgery.
- To outline recent international evidence-based guidelines for PBM for pediatrics for non-cardiac surgery.
- To briefly introduce the concept of translating guidelines to practice and the goals of a pediatric PBM program.

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**PEDIATRIC PERIOPERATIVE TRANSFUSIONS BY TOP 20 NON-CARDIAC SURGERIES**

<table>
<thead>
<tr>
<th>Category</th>
<th>By Frequency</th>
<th>Percent Transfused</th>
</tr>
</thead>
<tbody>
<tr>
<td>HEMISPHERECTOMY</td>
<td>100% (n=5)</td>
<td>100% (n=5)</td>
</tr>
<tr>
<td>ECMO</td>
<td>86% (n=6)</td>
<td>83% (n=24)</td>
</tr>
<tr>
<td>LIVER TRANSPLANT</td>
<td>66% (n=68)</td>
<td></td>
</tr>
<tr>
<td>CRANIAL REMODELING</td>
<td>43% (n=11)</td>
<td></td>
</tr>
<tr>
<td>MAJOR HIP SURGERIES</td>
<td>41% (n=135)</td>
<td></td>
</tr>
<tr>
<td>MAJOR ABDOMINAL SURGERY</td>
<td>40% (n=2)</td>
<td></td>
</tr>
<tr>
<td>SPINAL SURGERY</td>
<td>39% (n=5)</td>
<td></td>
</tr>
<tr>
<td>FREE FLAP/GRFT</td>
<td>34% (n=3)</td>
<td></td>
</tr>
<tr>
<td>SPLENECTOMY</td>
<td>34% (n=5)</td>
<td></td>
</tr>
<tr>
<td>ORTHO VASCULAR SURGERY</td>
<td>29% (n=6)</td>
<td></td>
</tr>
<tr>
<td>ESOPHAGEAL ATRESIA</td>
<td>25% (n=2)</td>
<td></td>
</tr>
<tr>
<td>BONE RADICAL RESECTION/RECONSTRUCTION</td>
<td>23% (n=5)</td>
<td></td>
</tr>
<tr>
<td>HEPATIC RESECTION</td>
<td>23% (n=4)</td>
<td></td>
</tr>
<tr>
<td>RENAL TRANSPLANT</td>
<td>19% (n=13)</td>
<td></td>
</tr>
<tr>
<td>NEPHRECTOMY</td>
<td>17% (n=74)</td>
<td></td>
</tr>
<tr>
<td>THORACIC SURGERY</td>
<td>15% (n=20)</td>
<td></td>
</tr>
<tr>
<td>CENTRAL VENOUS LINE AND PORT-A-CATH</td>
<td>14% (n=22)</td>
<td></td>
</tr>
<tr>
<td>MEDICAL</td>
<td>13% (n=158)</td>
<td></td>
</tr>
<tr>
<td>GENERAL MISC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BONE MARROW ASPIRATE/LEP</td>
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</tbody>
</table>

*Children ages 0-21 years who underwent elective, non-cardiac surgery over a one-year period at a single institution.

*Resulting data set: 32,348 patients over approximately 80 variables (2017-2018)
GOALS OF INTRAOPERATIVE BLEEDING MANAGEMENT IN THE PEDIATRIC PATIENT

- Restore/maintain O2 delivery to vital organs & tissues.
- Maintain hemodynamic stability and normovolemia.
- Achieve hemostasis, prevent and treat hyperfibrinolysis and dilutional coagulopathy.
- Avoid hypotension, hypothermia, acidosis, hypocalcemia, hyperkalemia, & coagulopathy.
- Avoid over-transfusion and transfusion-related side effects.

Children who received a RBC transfusion (6987/114,935) had an associated increased risk for

- 30-day mortality (2.8% vs. 1.4%)*
- Complications:
  - wound infection (6.5% vs. 5.2%)*
  - pulmonary (31.3% vs. 19.9%)*
  - neurologic (1.0% vs. 0.3%)*
  - cardiac (1.1% vs. 0.4%)*
  - septic (2.7% vs. 1.5%)*
  - prolonged hospital LOS; 5d (IQR: 4-9) vs 3d (IQR: 1-8)*

6% of pediatric patients in US hospitals receive a blood transfusion

* All p<0.001
* ACS NSQIP 2012 and 2013 Peds databases
On one hand, a blood transfusion may be clinically necessary for life and maintaining vital organ perfusion.

However, alternatives to blood product transfusion in our pediatric patients may be the safest choice to avoid transfusion-related adverse events.


X No specific recommendations for the pediatric patient.

✓ Some specific pediatric recommendations.

Both bleeding and transfusion of allogeneic blood products independently increase morbidity, mortality, length of stay and hospital costs.
(Grade B evidence)
Patient blood management programs aim to improve clinical outcomes by using multimodal blood conservation strategies and avoiding unnecessary exposure to blood components.

1. Preoperative screening for anemia is recommended in children at high risk for blood loss, at least 3-4 weeks prior to surgery, to allow sufficient time to diagnosis and manage anemia. Suggest surgery be postponed to optimize unless the surgery is of an urgent nature or must be performed sooner.

2. Guidelines are established for the consideration and use of oral and intravenous iron, and erythropoiesis stimulating agents in all pediatric patients including neonates to prevent or mitigate pre-existing or hospital acquired anemia.
We identified all children aged 1-18 y (n=51,622) and neonates (n=2617) with a recorded preoperative Hct in 2012, 2013, and 2014 ACS NSQIP Peds databases. The primary endpoint was the incidence of in-hospital mortality.

Incidence of neonatal anemia in US Hospitals = 32% as defined as Hct < 40%.

Mortality higher; OR 2.62 (P<0.001) in neonates with preoperative anemia compared to non-anemic neonates.

There is a 60% higher odds of a blood transfusion among children/neonates with anemia.

24% of children were anemic preoperatively.

Mortality increased in children with preoperative anemia compared to children without anemia by 2 fold (OR 2.16, P<0.01); independent of exposure to blood transfusion.

Hospital-Acquired Anemia

3. Specific measures to reduce blood loss and improve hemoglobin concentration in the pediatric population should be employed.

4. Recommend to minimize the frequency and volume of blood sampling for diagnostic laboratory testing ... and provide for a safe return of discard or void volumes.

5. Transfusion guidelines for all blood components should be weight and age appropriate, based on both laboratory & physiologic clinical criteria, not based on a Hb concentration alone, and use restrictive transfusion thresholds for allogeneic RBC transfusion when supported by published evidence and expert consensus.
6. Consider **non-invasive techniques for monitoring of hemoglobin …** whenever possible.

7. Strategies are routinely applied to … monitor and maintain adequate end organ tissue perfusion and oxygenation.

8. **Point-of-care test-guided transfusion algorithms** for pediatric surgical and critically ill patients are available and used to guide blood component therapy when time permits.
9. Written guidelines for monitoring and managing perioperative bleeding are established, based on evidence and expert consensus and are weight and age appropriate.

10. Strategies are routinely applied to maintain hemostasis and include avoiding hemoilution, avoiding hypothermia, avoiding acidosis, preventing & treating metabolic derangements, careful blood pressure control to avoid unplanned hypotension and maintaining adequate end organ tissue perfusion & oxygenation.

11. Pediatric massive hemorrhage guidelines incorporating a massive transfusion protocol based on age/weight should be readily accessible and available.
12. The use of antifibrinolytics should be considered for all pediatric patients at risk of significant bleeding including children undergoing major surgery.

13. The use of intraoperative cell salvage collection and re-administration should be considered for all pediatric patients undergoing moderate/high blood loss surgery.

Table 1. TXA indications, contraindications, and adverse effects.

<table>
<thead>
<tr>
<th>Indications</th>
<th>CONTRAINDICATIONS</th>
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<tbody>
<tr>
<td>Prophylactic/treatment of trauma or surgery with 'major' bleeding/ hemorrhage expected</td>
<td>Preexisting anemia or coagulopathy</td>
</tr>
<tr>
<td>Prophylactic/treatment with 'mild/moderate' bleeding</td>
<td>Preexisting hypofibrinogenemia</td>
</tr>
<tr>
<td>Strong desire to avoid transfusion or blood not an option</td>
<td>Role for controlling bleeding in patients treated with inhibitors of platelet function and new oral anticoagulants</td>
</tr>
<tr>
<td>Preexisting anemia or coagulopathy</td>
<td>Difficult to crossmatch because of antibodies</td>
</tr>
</tbody>
</table>

TXA dosage regime:
- 10-30 mg/kg LD (2g max) and
- 5-10 mg/kg/h*

*based on PK modeling and simulation
16. The decision to **transfuse platelets** should be based on both the platelet count and function and the etiology of the patient’s thrombocytopenia. Platelet transfusion volume should be calculated based on weight and desired increase in platelet increment.

17. The decision to **transfuse fresh frozen plasma** should be based on laboratory studies, including point of care viscoelastic testing if available, the patient’s clinical status and the etiology of the patient’s coagulopathy. FFP transfusion volume should be calculated based on weight and desired improvement in coagulation indices.

18. The decision to **transfuse cryoprecipitate** should be based on laboratory studies, including point of care viscoelastic testing if available, fibrinogen concentration, the patient’s clinical status and the etiology of the patient’s coagulopathy. Cryoprecipitate transfusion volume should be calculated based on weight and desired increase in fibrinogen concentration and improvement in coagulation indices.

**Restrictive Transfusion targets for ‘yellow products’**

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**SPECIAL INTEREST ARTICLE**

Society for the advancement of blood management administrative and clinical standards for patient blood management programs. 4th edition (pediatric version)

Susan M. Gooble | Trudi Gallagher | Irwin Gross | Arysh Shander

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**Current Opinion**

**Pediatric non-red cell blood product transfusion practices: what’s the evidence to guide transfusion of the ‘yellow’ blood products?**

Andrea U. Steinbicker, Eva Wittenmeier, and Susan M. Gooble

**KEY POINTS**

- Good-quality evidence for transfusion of the non-red blood cell products in the pediatric population is low and current guidelines mainly depend on expert opinion.
- Daily practice for bleeding and nonbleeding children, very often substitutes the ‘yellow’ blood products, which include fresh frozen plasma, cryoprecipitate, platelets, or fibrinogen concentrate without a well-defined clinical indication.
- Efforts should be made to diagnose and treat the underlying cause of the coagulopathy and to tolerate mild coagulopathy in clinically stable children.
- A restrictive transfusion strategy should be encouraged for the non-red blood cell products when clinically appropriate.
- Substitution of ‘yellow’ blood products can be clinically necessary and efficacious to treat coagulopathic bleeding but also can increase the risk for allergic and nonallergic serious hazards of transfusion reactions and therefore should be used with a goal-directed approach in pediatric patients.

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@sgoobie1
Identify patients at increased risk.
Identify areas that need improvement.
Targeted interventions to reduce bleeding and decrease transfusion.
Quality improvement initiatives—require dedication and care-giver education.
Translate evidence-based guidelines/recommendations into clinical practice.

Goals: reduce variability, better allocation of resources, improve quality of care, improve safety and reduces costs

<table>
<thead>
<tr>
<th>Preoperative</th>
<th>Intraoperative</th>
<th>Postoperative</th>
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</thead>
<tbody>
<tr>
<td>Diagnosis and treat anemia</td>
<td>Careful blood pressure and fluid management</td>
<td>Treat and tolerate anemia</td>
</tr>
<tr>
<td>Stimulate Erythropoiesis</td>
<td>Restrictive vs liberal transfusion practice</td>
<td>Restrictive transfusion strategy</td>
</tr>
<tr>
<td>Implementation of PBM program</td>
<td>Massive Hemorrhage Protocol/Transfusion algorithms/POC testing</td>
<td>Transfusion algorithms</td>
</tr>
<tr>
<td></td>
<td>Optimize surgical technique</td>
<td>Tolerate coagulopathy and treat with Vit. K</td>
</tr>
<tr>
<td></td>
<td>Antifibrinolytics</td>
<td>Antifibrinolytics</td>
</tr>
<tr>
<td></td>
<td>Topical hemostatic agents</td>
<td>Minimize iatrogenic blood loss</td>
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<tr>
<td></td>
<td>Consider recombinant coagulation products</td>
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<td></td>
<td>Cell salvage</td>
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PATIENT BLOOD MANAGEMENT FOR PEDIATRIC NON-CARDIAC SURGERY. TAKE HOME MESSAGE

Will you change your practice?

- Bleeding and transfusion is associated with increased morbidity & mortality in children.
- A blood transfusion can be life-saving or life-threatening.
- Use standardized evidence-based multimodal PBM guidelines.
- Evidence-based protocol driven care can reduce variability, improve quality of care, improve safety and reduce costs.
- Future high-quality research in targeted PBM interventions focusing on patient centered outcomes is needed.


FOR MORE INFORMATION, GO TO: SABM.ORG