

ALLOWABLE BLOOD LOSS

Keywords:	Allowable Blood Loss (By Age)
Author:	Andrew M. Breglio MD DPhil, John B. Eck MD; Duke University, Durham NC

Question

A 3.5-month-old, 6.0 kg male with a history of craniosynostosis of the sagittal suture presents for endoscopic repair. His preoperative hematocrit is 36%. Assuming a hematocrit transfusion threshold of 21%, which volume best estimates the patient's allowable surgical blood loss before requiring red cell transfusion?

- A. 60 mL
- B. 120 mL
- C. 240 mL
- D. 360 mL

Key Points

- Preoperative calculation of allowable blood loss (ABL) is one tool that can be used to determine when blood product administration may be necessary and can be helpful for smaller patients for whom lesser volumes of blood loss can be clinically significant.
- A hemoglobin transfusion threshold of 7 g/dL (hematocrit of 21%) is appropriate for most hemodynamically stable patients, however, acute blood loss and certain comorbidities stand as important exceptions.

Calculation of Allowable Blood Loss

- Allowable blood loss (in mL) can be calculated as follows:

$$ABL = EBV \times \frac{(HCT_i - HCT_f)}{HCT_{av}}$$

EBV = estimated blood volume (in mL)
 HCT_i = initial preoperative hematocrit (in %)
 HCT_f = final hematocrit after blood loss (in %), the patient-specific transfusion threshold
 HCT_{av} = average of initial and final hematocrit

- Depending upon the rapidity of blood loss, the use of HCT_{av} in the denominator, instead of the often-used HCT_i may better account for change in the hematocrit over the course of intraoperative blood loss. As lost blood is replaced with crystalloid or colloid solution intraoperatively, each milliliter of lost blood contains progressively less hemoglobin¹.
- Regardless of the specific formula used, ABL is merely an estimate of when blood loss is significant enough to consider transfusion, and should not be used as a standalone transfusion trigger.
- Estimated blood volume (EBV) can be calculated from the patient's age and size as follows²:

Age	Average Blood Volume (mL/kg)
Premature Neonate	90-100
Neonate	80-90
Infant 3 months to 1 year	70-80
Child >1 year of age	70

Hemoglobin Transfusion Thresholds

- The benefits of red blood cell (RBC) transfusion need to be weighed against the risks of acute or delayed transfusion reactions, alloimmunization, physiologic derangements (e.g., electrolyte abnormalities and hypothermia), and exposure to allogeneic blood.
- A hemoglobin transfusion threshold of 7 g/dL was initially extrapolated from studies performed in adults. Subsequent pediatric studies have reinforced this threshold.
- A randomized control study of 637 stable, critically ill children compared restrictive (hemoglobin of 7 g/dL) versus liberal (9.5 g/dL) transfusion thresholds and found that patients in the restrictive group received 44% fewer transfusions with no differences observed in the primary outcome of new or progressive multiple-organ dysfunction nor in the secondary outcomes including 28-day mortality, length of stay, sepsis, transfusion reactions, and infection rates³.
- A Cochrane meta-analysis including both adult and pediatric patients across a range of clinical specialties similarly found that restrictive transfusion threshold (7-8 g/dL) was associated with 43% fewer red cell exposures without detectable differences in 30-day mortality or morbidity, compared to a more liberal threshold⁴.
- A higher transfusion threshold may be appropriate in some patient contexts, including neonates, acute blood loss from either surgery or trauma, cyanotic congenital heart disease, acute brain injury, malignancy, hereditary anemias, or in patients with hemodynamic instability or signs of tissue hypoxia⁵.

Estimating Blood Loss

- The approximate absorptive capacity of common surgical sponges is⁶:
 - 4" x 4" gauze: ~10 mL blood
 - Ray-Tec sponge: ~20 mL blood
 - Laparotomy sponge: ~100 mL blood
- Visual estimation of blood volume in suction canisters which also contain irrigation fluid has been shown to be quite inaccurate and to vary significantly between providers⁷
- More quantitative methods for estimating blood loss include:
 - Gravimetric method: Used surgical sponges are weighed. Their dry weight is subtracted to determine the weight of absorbed blood; 1 g = 1 mL of blood.
 - Colorimetric method: Digital images are taken of used surgical sponges. Image feature extraction is used together with the measured preoperative hematocrit to calculate blood loss.

References

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Answer: C. Using this patient's preoperative and threshold hematocrits (36% and 21%), weight of 6.0kg, and age-specific average blood volume of 75mL/kg, the allowable blood loss is 237mL.