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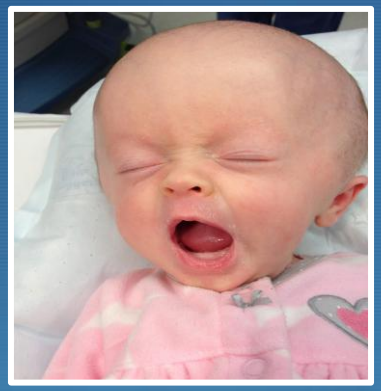

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# PBM in the Pediatric Patient
# Best A&A papers


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**Review of the Top Blood Management Publications in A&A**

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Blood Management

Section Editor: **Marisa B. Marques**

# A Standardized Approach for Transfusion Medicine Support in Patients With Morbidly Adherent Placenta

Anil K. Panigrahi, MD, PhD,* Amanda Yeaton-Massey, MD,† Sara Bakhtary, MD,‡ Jennifer Andrews, MD,§ Deirdre J. Lyell, MD,† Alexander J. Butwick, MBBS, FRCA, MS,* and Lawrence Tim Goodnough, MD‖

Anesth Analg. 2017 Aug;125(2):603-608.

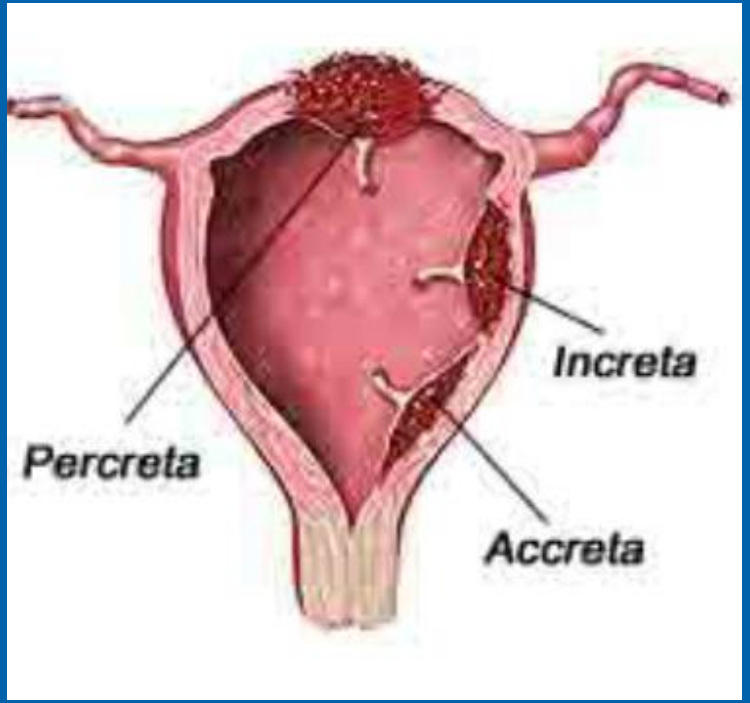
From the Departments of *Anesthesiology, Perioperative, and Pain Medicine and Department of Pathology and †Obstetrics and Gynecology, Stanford University Medical Center, Palo Alto, California; ‡Department of Laboratory Medicine, University of California, San Francisco, San Francisco, California; Departments of §Pathology and Pediatrics and ‖Pathology and Medicine, Stanford University Medical Center, Palo Alto, California.

# INTRODUCTION:

- The incidence of Morbidly Adherent Placenta has increased from 0.8 to 3.0 in 1000 pregnancies, driven by increased rates of cesarean deliveries (32.2% in 2014) of births in USA.

- Average blood loss for a delivery complicated by MAP ranges from 2000 to 5000 mL, frequently requiring substantial transfusion.

- Reported is a single institutional multidisciplinary approach for managing such patients over a 5-year period.




MAP = placenta invades too deeply into uterine wall.

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## METHODS:

- **Retrospective** review of records for patients referred to placental disorders program Stanford University Medical Center with Morbidly Adherent Placenta (MAP) from July 1, 2009, to July 1, 2014.

- Pts at high risk for life threatening hemorrhage were referred if either antipartum radiological evidence or clinical suspicion of MAP.

- **A Morbidly Adherent Placenta** preoperative care plan and checklist was implemented to ensure optimal management of these patients with high risk of peripartum hemorrhage.

# RESULTS:

**Table 1. Demographic and Obstetric Data**

| Characteristics | No Accreta (n = 42) | Microscopic Accreta (n = 39) | Accreta (n = 21) | Increta (n = 17) | Percreta (n = 17) |
|---|---|---|---|---|---|
| Maternal age (y) | 35 (5) | 36 (6) | 37 (6) | 34 (4) | 35 (4) |
| Gravidity | 3 [2–4] | 2 [1–4] | 4 [2–5] | 4 [3–5] | 6 [5–7] |
| Parity | 1 [0–2] | 0 [0–1] | 2 [0–3] | 2 [1–3] | 3 [3–5] |
| Previous CD | 18 (43%) | 8 (21%) | 11 (52%) | 13 (76%) | 17 (100%) |
| Delivery mode | | | | | |
| Vaginal | 16 (38%) | 15 (38%) | 4 (19%) | 2 (12%) | 1 (6%) |
| Cesarean | 26 (62%) | 24 (62%) | 17 (81%) | 15 (88%) | 16 (94%) |
| Postdelivery hysterectomy | 3 (7%) | 1 (3%) | 16 (76%) | 16 (94%) | 17 (100%) |
| Placenta previa (n) | 11 (26%) | 7 (18%) | 12 (57%) | 13 (76%) | 16 (94%) |

Data presented as n (%), mean (SD), median [interquartile range].
Abbreviation: CD, cesarean delivery.

- 136 patients referred for morbidly adherent placenta over 5 years from 2009-2014.
- History of previous C-section was more common among women with diagnosis MAP (76%-100%).
- 89% of patients with PA or variants underwent postpartum hysterectomy, compared to only 5% of patients with no or microscopic PA.

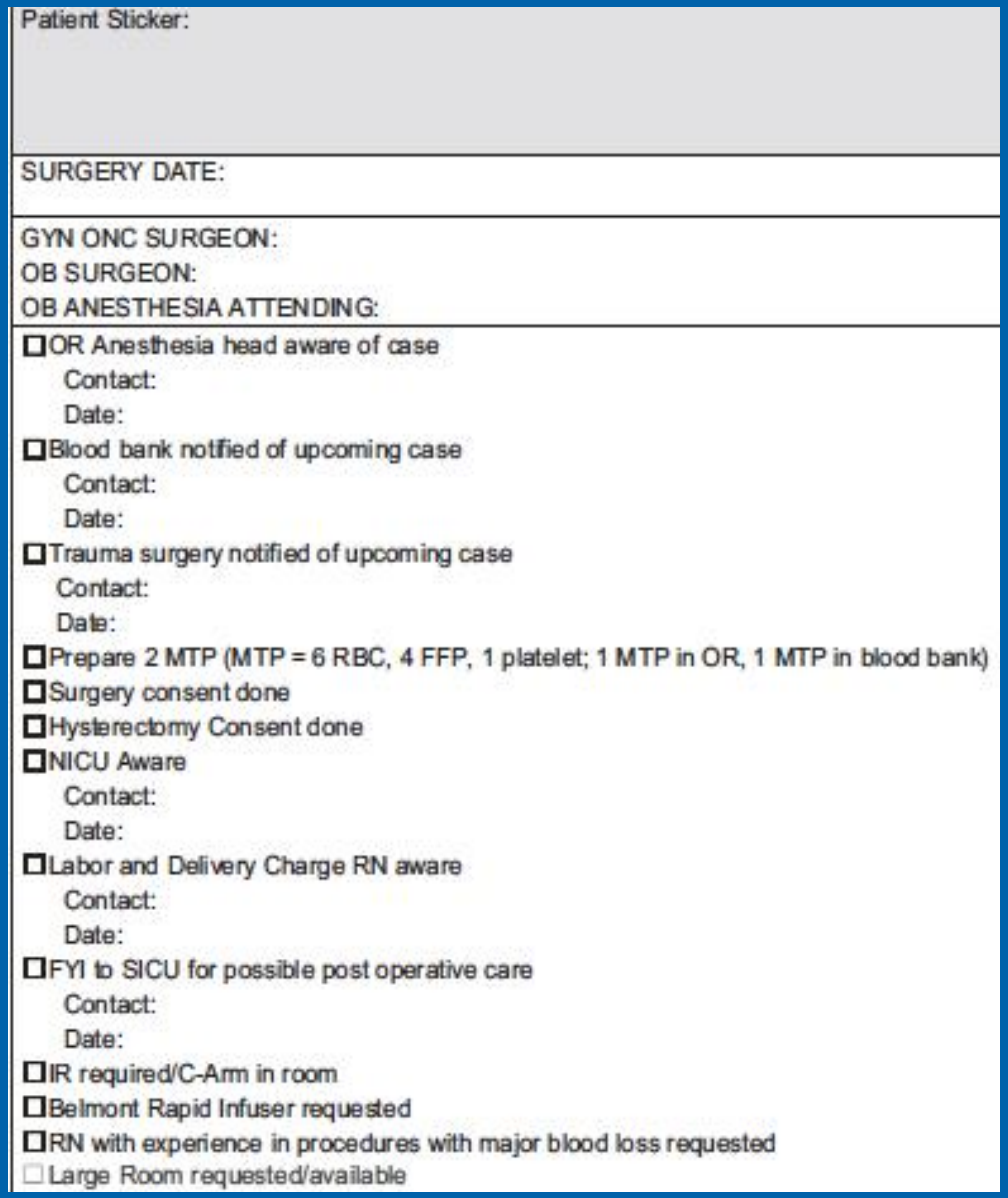
# RESULTS:

**Table 2. Blood Product Use**

| Blood Products | No Accreta (n = 42) | Microscopic Accreta (n = 39) | Accreta (n = 21) | Increta (n = 17) | Percreta (n = 17) |
|---|---|---|---|---|---|
| Products issued | 14 (33%) | 17 (44%) | 19 (90%) | 17 (100%) | 17 (100%) |
| RBC units | 4 [4–12] | 4 [2–12] | 12 [6–24] | 13 [7–18] | 16 [6–27] |
| Plasma units | 0 [0–6] | 1 [0–4] | 4 [4–12] | 10 [4–12] | 8 [4–14] |
| Platelet units | 0 [0–3] | 0 [0–1] | 2 [1–3] | 1 [1–2] | 2 [1–3] |
| Cryoprecipitate units | 0 [0–0] | 0 [0–0] | 0 [0–0] | 0 [0–1] | 1 [0–4] |
| Patients transfused with any blood product | 8 (19%) | 11 (28%) | 15 (71%) | 14 (82%) | 14 (82%) |
| RBC units[a] | 2 [0–5] | 2 [0–4] | 4 [2–14] | 6 [1–10] | 8 [2–13] |
| Plasma units[a] | 2.5 [0–11.5] | 2 [0–4] | 4 [0–12] | 4 [0–8] | 6 [4–11] |
| Platelet units[a] | 1 [0–4] | 0 [0–1] | 1 [0–3] | 0 [0–2] | 1 [1–3] |
| Cryoprecipitate units[a] | 0 [0–2] | 0 [0–0] | 0 [0–1] | 0 [0–1] | 0 [0–2] |

- High rates of blood transfusion from 82% (PI and PP), 71% (PA) and 28% (microscopic PA) vs 19% in No Accreta group
- Includes all patients referred to Stanford placental disorders program.

# MORBIDLY ADHERENT PLACENTA CASE FORM



Patient Sticker:

SURGERY DATE:

GYN ONC SURGEON:
OB SURGEON:
OB ANESTHESIA ATTENDING:

- ☐ OR Anesthesia head aware of case
  - Contact:
  - Date:
- ☐ Blood bank notified of upcoming case
  - Contact:
  - Date:
- ☐ Trauma surgery notified of upcoming case
  - Contact:
  - Date:
- ☐ Prepare 2 MTP (MTP = 6 RBC, 4 FFP, 1 platelet; 1 MTP in OR, 1 MTP in blood bank)
- ☐ Surgery consent done
- ☐ Hysterectomy Consent done
- ☐ NICU Aware
  - Contact:
  - Date:
- ☐ Labor and Delivery Charge RN aware
  - Contact:
  - Date:
- ☐ FYI to SICU for possible post operative care
  - Contact:
  - Date:
- ☐ IR required/C-Arm in room
- ☐ Belmont Rapid Infuser requested
- ☐ RN with experience in procedures with major blood loss requested
- ☐ Large Room requested/available

Figure: Preoperative checklist from our program in placental disorders used to prepare for surgical management of patients with Morbidly adherent placenta.

Steps taken to insure all members of the multidisciplinary team are alerted to the case, blood products are prepared, and supplies for management of massive hemorrhage are readily available.

Section Editor: Marisa B. Marques

# A Standardized Approach for Transfusion Medicine Support in Patients With Morbidly Adherent Placenta

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## CONCLUSION:

- We found that massive hemorrhage is predictable when abnormal placentation is identified pre-delivery and blood product support is substantial regardless of the degree of placental invasiveness.

- The protocol provides immediate access to sufficient volumes and types of blood products at delivery for patients at highest risk for life-threatening obstetric hemorrhage.

- For patients with a diagnosis of MAP scheduled for planned cesarean delivery with possible hysterectomy, a programmatic checklist that mobilizes a multidisciplinary team, including proactive transfusion medicine support, represents best practices.

## Take home message:

Implementation of a single center QI project for women under going C-section for MAP at high risk for massive hemorrhage using a predetermined care protocol – transfusion medicine outcomes reported.

## Future directions:

What is the generalizability of these best practice guidelines?
Are maternal and fetal outcomes improved by using protocol ?
Will this change the practice at other institutions to improve care?
How can the PBM care be further improved?

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# Relationship Between Preoperative Anemia and In-Hospital Mortality in Children Undergoing Noncardiac Surgery

David Faraoni, MD, PhD, FCCP, James A. DiNardo, MD, FAAP, and Susan M. Goobie, MD, FRCPC

Anesth Analg. 2016; 123(3):1582-7

BACKGROUND:

- The incidence of anemia in children from birth to 4 years of age is 20% in industrialized countries according to the World Health Org.
- Studies have reported a strong relationship between preoperative anemia and perioperative mortality in adults undergoing non-cardiac surgery.
- The relationship between preoperative anemia and in-hospital mortality had not been investigated in the pediatric surgical population.
- We hypothesized that children with preoperative anemia undergoing non-cardiac surgery may have an increased risk of in-hospital mortality.

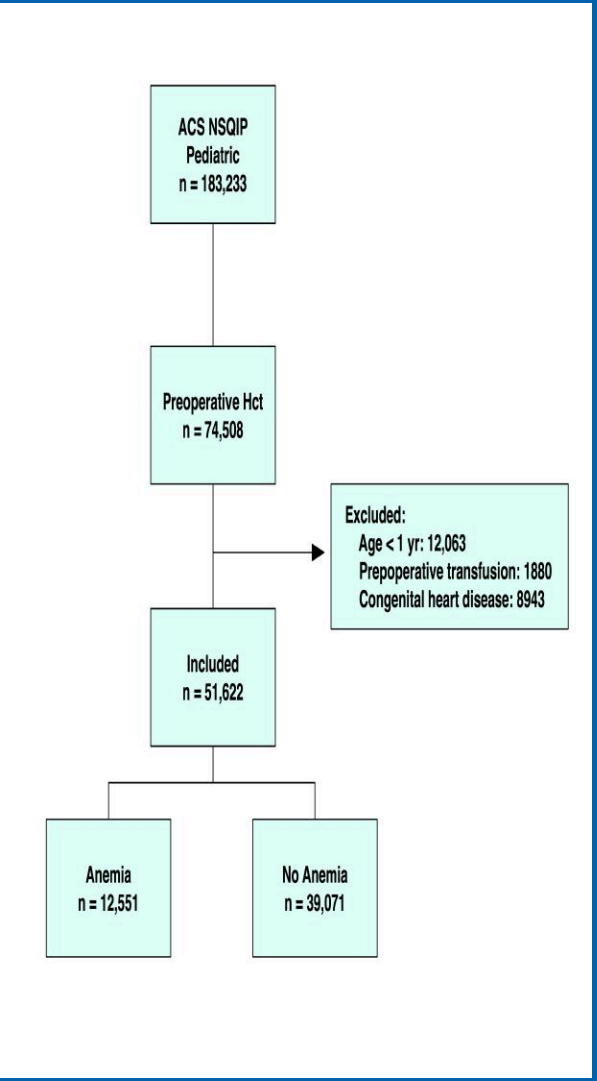
# METHODS:

- All children aged 1-18 years old with a recorded preoperative Hct in the 2012, 2013, & 2014 ACS NSQIP Peds databases.

- The endpoint was defined as the incidence of in-hospital mortality. Children with preoperative anemia were identified based on their preoperative hematocrit defined by age adjusted limits.

- Demographic and surgical characteristics, as well as co-morbidities were considered as potential confounding variables in a multivariable logistic regression analysis.

- A sensitivity analysis was performed using propensity-matched analysis.



**RESULTS:**

- 41% (74,508) of children had a preop. Hct recorded.

- 24% (12,551) of children were anemic preoperatively.

- Preoperative anemia was associated with higher odds for in-hospital mortality (OR: 2.17, 95% CI: 1.48-3.19, $P < 0.001$) using multivariable logistic regression analysis, and after adjustment for RBC transfusion.

- After propensity matching, the presence of preoperative anemia was also associated with higher odds of in-hospital mortality (OR: 1.75, 95% CI:1.15-2.65, $P = 0.004$).

**Table 1. Demographic Characteristics and Comorbidities in Children With and Without Preoperative Anemia**

| Variables | Anemia (n = 12,551) | No anemia (n = 39,071) | *P* Value |
|---|---|---|---|
| Male (%) | 6471 (52) | 20,191 (52) | 0.815 |
| Age group (y) | | | <.001 |
| ≥1–2 | 845 (7) | 1972 (5) | |
| ≥2–4 | 1375 (11) | 2502 (6) | |
| ≥4–7 | 2176 (17) | 4616 (12) | |
| ≥7–12 | 3407 (27) | 11,590 (30) | |
| ≥12 | 4748 (38) | 18,391 (47) | |
| ASA physical status | | | <.001 |
| I | 2902 (23) | 12,130 (31) | |
| II | 4970 (40) | 17,560 (45) | |
| ≥III | 4647 (37) | 9318 (24) | |
| Emergency surgery (%) | 5846 (47) | 19,786 (51) | <.001 |
| Prematurity | | | <.001 |
| <24 wk | 30 (.2) | 233 (.6) | |
| ≥24–36 wk | 2624 (21) | 8986 (23) | |
| ≥36 wk | 9900 (79) | 29,852 (76) | |
| Inpatient (%) | 10,857 (86) | 31,095 (80) | <.001 |
| Respiratory disease (%) | 250 (2) | 771 (2) | 0.897 |
| Oxygen supplementation (%) | 433 (3) | 499 (1) | <.001 |
| Mechanical ventilation (%) | 303 (2) | 456 (1) | <.001 |
| Neurological disease (%) | 1627 (13) | 6199 (16) | <.001 |
| Seizure (%) | 919 (7) | 2863 (7) | 0.983 |
| Stroke (%) | 397 (3) | 1022 (3) | 0.001 |
| Immune disease (%) | 622 (5) | 486 (1) | <.001 |
| Chronic use of steroids (%) | 910 (7) | 1271 (3) | <.001 |
| Hematological disorders (%) | 1297 (10) | 634 (2) | <.001 |
| Neoplasm (%) | 1692 (13) | 1967 (5) | <.001 |
| Inotropic support (%) | 113 (1) | 285 (0.7) | 0.057 |
| Surgery within 30 d (%) | 5427 (43) | 14,515 (37) | <.001 |
| Surgical complexity (RVU) | 11 (9–20) | 11 (9–21) | 0.016 |
| RBC transfusion (%) | 1445 (12) | 4218 (11) | 0.025 |
| In-hospital mortality (%) | 69 (.6) | 52 (.1) | <.001 |

Data are presented as n (%) or median (interquartile range).

Abbreviations: ASA, American Society of Anesthesiologists; RBC, red blood cell; RVU, relative value unit.

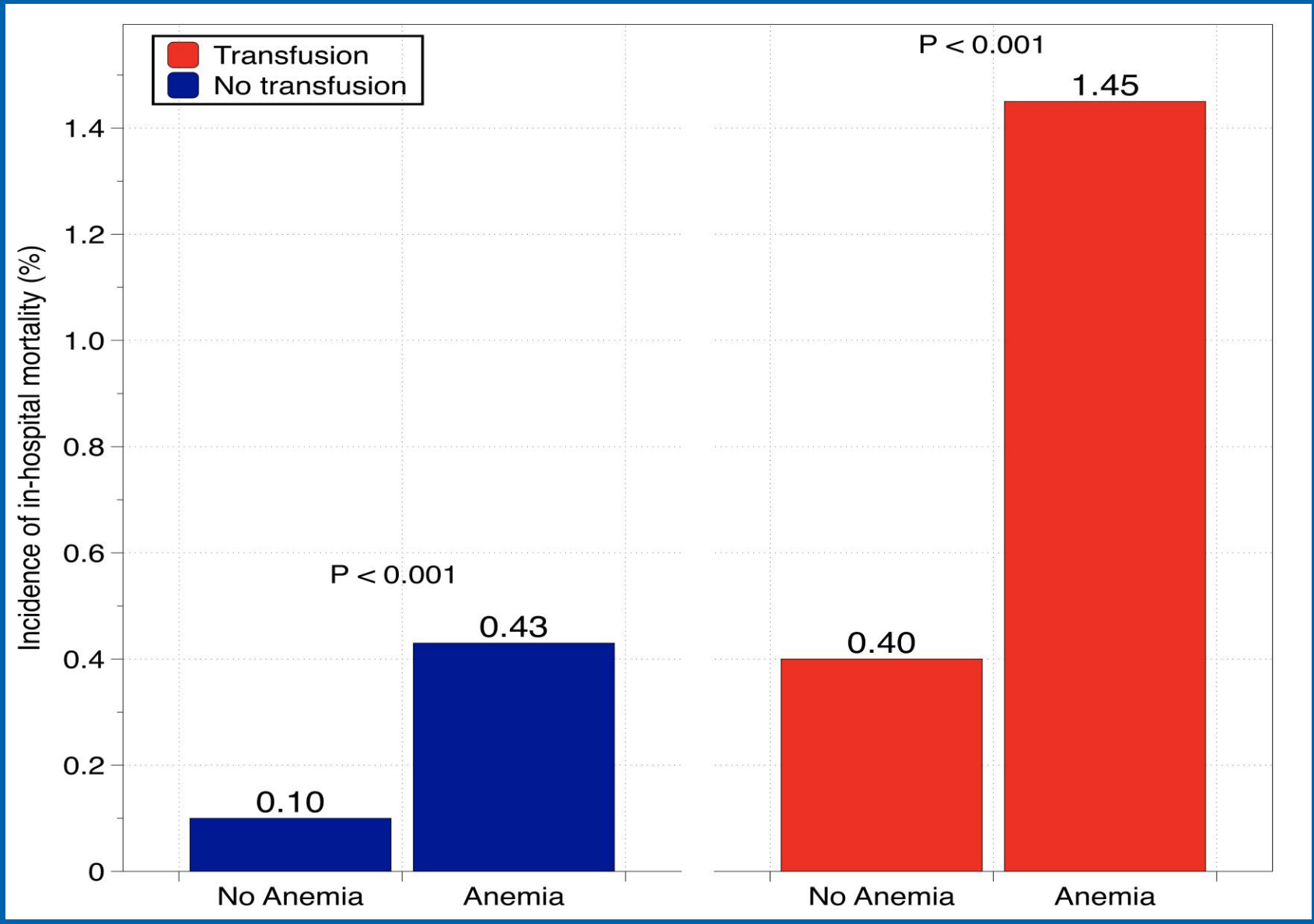
**Table 2. Multivariable Analysis of Factors Associated In-Hospital Mortality**

| Variables | B (SE) | Odds Ratio | 95% CI | *P* Value |
|---|---|---|---|---|
| Anemia | 0.77 (.20) | 2.17 | 1.48–3.19 | <.001 |
| RBC transfusion | 0.76 (.22) | 2.13 | 1.39–3.26 | <.001 |
| Neurological disorders | 0.75 (.20) | 2.11 | 1.13–3.11 | <.001 |
| Emergency surgery | 0.83 (.17) | 2.29 | 1.56–3.35 | <.001 |
| Inotropic support | 1.40 (.36) | 4.06 | 2.00–8.21 | <.001 |
| Mechanical ventilation | 1.59 (.24) | 4.91 | 3.06–7.89 | <.001 |
| Neoplasm | 1.61 (.20) | 5.00 | 3.40–7.35 | <.001 |
| ASA physical status ≥ III | 2.55 (.37) | 12.84 | 6.20–26.62 | <.001 |

Data were obtained from multivariable logistic regression and presented as regression coefficient (B), standard error (SE), odds ratio (OR), 95% confidence interval (CI), and Wald test *P* value.

Abbreviations: ASA, American Society of Anesthesiologists; CI, confidence interval; RBC, red blood cell.

# Incidence of in-hospital mortality in children with anemia for those with and without red blood cell transfusion.



# Relationship Between Preoperative Anemia and In-Hospital Mortality in Children Undergoing Noncardiac Surgery

David Faraoni, MD, PhD, FCCP, James A. DiNardo, MD, FAAP, and Susan M. Goobie, MD, FRCPC

**CONCLUSIONS:**

- The incidence of preop. anemia in children in US hospitals is 24%.
- Children with preoperative anemia are at increased risk for in-hospital mortality.
- Further studies are needed to assess if the correction of preoperative hematocrit, through the development of patient blood management programs, could improve patient outcomes or simply avoid blood transfusion.

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## Take home message:

*In US hospitals 24% of children (age 1-18yr) were anemic preoperatively.

*Anemic children have 2X the risk of death which is increased if they require a blood transfusion.

(independent association not cause and effect)

## Future directions:

How can the PBM care be further improved to optimize anemia preoperatively?

Would the mortality rate be improved by treating preop. anemia ?

Will you change your practice??

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# Surveying the Literature: Synopsis of Recent Key Publications

Original Investigation

## Association of Preoperative Anemia With Postoperative Mortality in Neonates

Susan M. Goobie, MD, FRCPC; David Faraoni, MD, PhD; David Zurakowski, PhD; James A. DiNardo, MD

*JAMA Pediatr*. doi:10.1001/jamapediatrics.2016.1032
Published online July 18, 2016.

**Findings** Using the American College of Surgeons National Surgical Quality Improvement Program database, preoperative anemia of a hematocrit level of less than 40% (found in 32% of neonates) was associated with increased postoperative in-hospital mortality.

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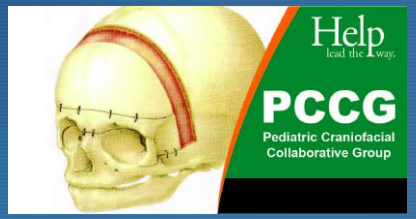


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# Endoscopic Versus Open Repair for Craniosynostosis in Infants Using Propensity Score Matching to Compare Outcomes: A Multicenter Study from the Pediatric Craniofacial Collaborative Group.

Anesth Analg. 2018 Mar;126(3):968-975.

Douglas R. Thompson, MD,* David Zurakowski, MS, PhD,† Charles M. Haberkern, MD, MPH,*‡
Paul A. Stricker, MD,§ and Petra M. Meier, MD, DEAA,† The Pediatric Craniofacial Collaborative Group‖

# INTRODUCTION:

- The North American Pediatric Craniofacial Collaborative Group (PCCG) established a Pediatric Craniofacial Surgery Perioperative Registry to evaluate outcomes in infants and children undergoing craniosynostosis repair.

- We hypothesized better perioperative outcomes for endoscopic surgery vs open craniosynostosis (blood loss, complications and ICU and hospital stay) using propensity matching to balance difference between groups.

## METHODS:

- Thirty-one institutions contributed data from 2012 to 2015.

- We analyzed 1382 infants <12 months undergoing open cranial vault reconstruction or endoscopic craniectomy.

- The primary outcomes included transfusion data, ICU utilization, hospital length of stay, and perioperative complications; secondary outcomes included anesthesia and surgical duration.

- Comparison of unmatched groups (ESC: N = 311, open repair: N = 1071) and propensity score 2:1 matched groups (ESC: N = 311, open repair: N = 622) were performed by conditional logistic regression analysis.

# RESULTS:

**Table 1. Patient Characteristics: Endoscopic Strip Craniectomy Versus Open Surgical Repair Before and After Propensity Score Matching[a]**

| | Before Matching | | After Matching | |
|---|---|---|---|---|
| **Variable** | **ESC (N = 311)** | **Open (N = 1071)** | **ESC (N = 311)** | **Open (N = 622)** |
| Age (mo) | 3 (2–4) | 7 (4–9) | 3 (2–4) | 5 (3–6) |
| Weight (kg) | 6.0 (5.3–6.7) | 7.8 (6.7–8.9) | 6.0 (5.3–6.7) | 7.0 (6.2–7.9) |
| Gender, n (%) | | | | |
| Male | 216 (70) | 672 (63) | 216 (70) | 405 (65) |
| Female | 95 (30) | 399 (37) | 95 (30) | 217 (35) |
| Race, n (%) | | | | |
| Caucasian | 240 (77) | 862 (80) | 240 (77) | 515 (82) |
| Black | 15 (5) | 60 (5) | 15 (5) | 25 (4) |
| Asian | 7 (2) | 28 (3) | 7 (2) | 10 (2) |
| Other | 39 (13) | 116 (11) | 39 (13) | 69 (11) |
| Not recorded | 10 (3) | 5 (1) | 10 (3) | 3 (1) |
| ASA class, n (%) | | | | |
| I | 46 (15) | 188 (18) | 46 (15) | 119 (19) |
| II | 222 (71) | 689 (64) | 222 (71) | 396 (64) |
| III | 43 (14) | 183 (17) | 43 (14) | 98 (16) |
| IV | 0 (0) | 11 (1) | 0 (0) | 9 (1) |
| Craniosynostosis syndrome, n (%) | 14 (5) | 87 (8) | 14 (5) | 44 (7) |
| Preoperative | | | | |
| Hgb (g/dL) | 11.2 (10.5–11.7) | 11.8 (11.1–12.4) | 11.2 (10.5–11.7) | 11.6 (11.0–12.3) |
| HCT (%) | 33 (31–34) | 35 (33–37) | 33 (31–34) | 34 (32–36) |
| Platelet count ($10^9$/L) | 437 (363–524) | 389 (321–470) | 437(363–524) | 415 (344–490) |
| Diagnosis, n (%) | | | | |
| Sagittal | 175 (56) | 508 (47) | 175 (56) | 402 (64) |
| Metopic | 60 (19) | 194 (18) | 60 (19) | 73 (12) |

- Imbalances in baseline age and weight are inherent due to surgical selection criteria for ESC.
- Quality of propensity score matching in balancing age and weight between ESC and open groups was assessed by quintiles of the propensity scores

**Table 2. Comparison of Outcomes Between Endoscopic Strip Craniectomy and Open Surgical Repair: Propensity Score Matched Groups**

| Outcome | Endoscopic Repair (N = 311) | Open Surgical Repair (N = 622) | *P* Value |
|---|---|---|---|
| Primary | | | |
| RBC blood products given[a] | 80 (26%) | 503 (81%) | <.001[b] |
| Amount (mL/kg) | 19.6 (14.6–31.6) | 26.9 (17.6–39.0) | .035[b] |
| Coagulation products given[c] | 8 (3%) | 100 (16%) | <.001[b] |
| Amount (mL/kg) | 21.2 (12.3–59.5) | 24.6 (18.3–38.0) | .729 |
| Intraoperative BDEs | 0 (0–1) | 1 (1–1) | <.001[b] |
| Use of antifibrinolytics | 46 (15%) | 349 (56%) | <.001[b] |
| Hypotension requiring pressors | 8 (3%) | 23 (4%) | .369 |
| Venous air embolism | 4 (1%) | 5 (1%) | .484 |
| Hypothermia, temperature <35°C | 70 (22%) | 160 (26%) | .296 |
| Postoperative intubation | 6 (2%) | 60 (10%) | <.001[b] |
| Cardiac arrest[d] | 0 (0%) | 1 (0.2%) | 1.000 |
| ICU stay (d) | 0 (0–1) | 2 (1–3) | <.001[b] |
| Hospital LOS (d) | 2 (2–2) | 4 (3–5) | <.001[b] |
| Secondary | | | |
| Anesthesia time (min) | 168 (142–205) | 248 (193–307) | <.001[b] |
| Surgical duration (min) | 70 (48–98) | 130 (89–189) | <.001[b] |

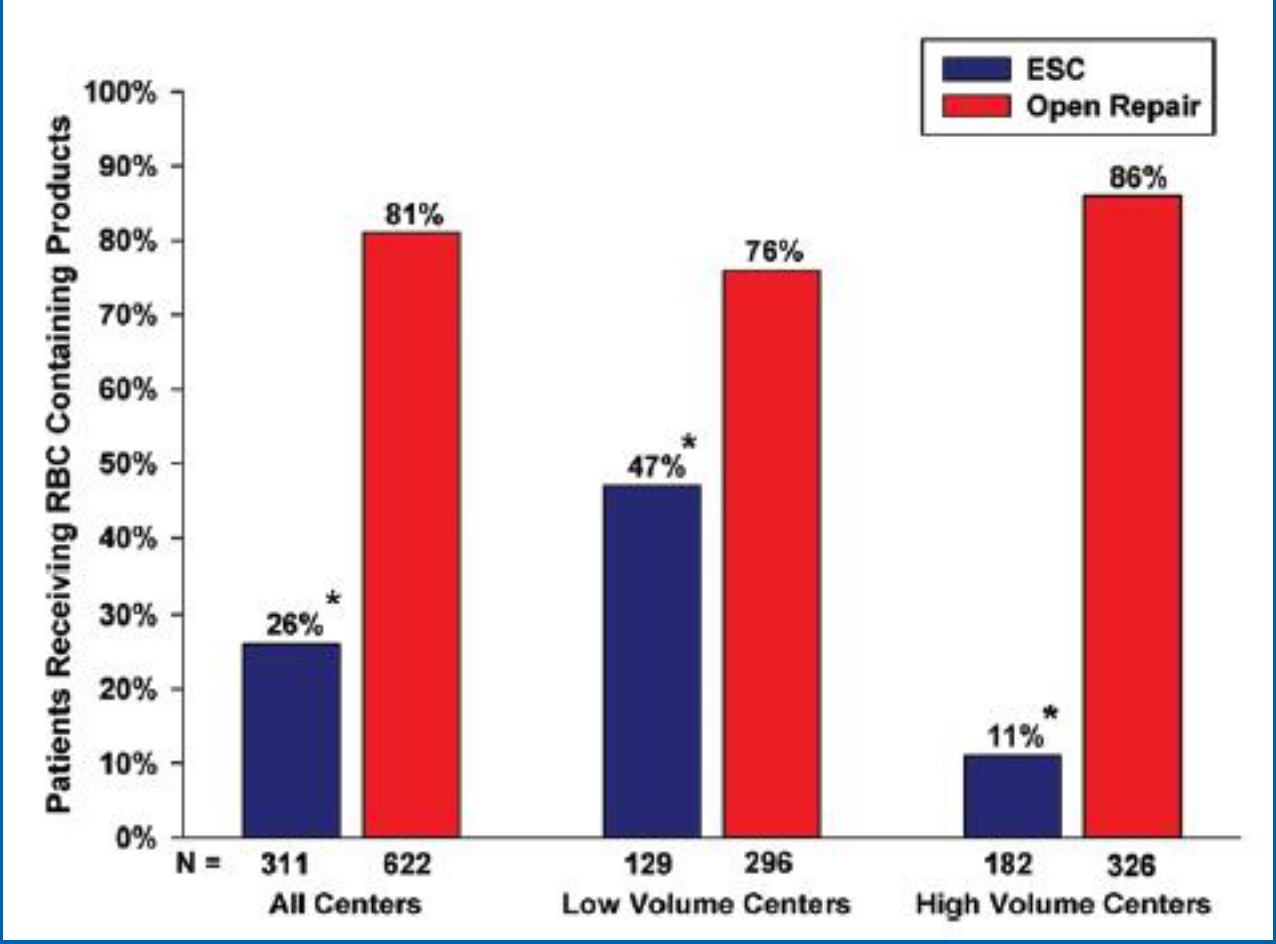


**Figure 2.** Administration of red blood cell containing products between endoscopic strip craniectomy (ESC) and open procedures stratified by center volume. Percentages of patients who received

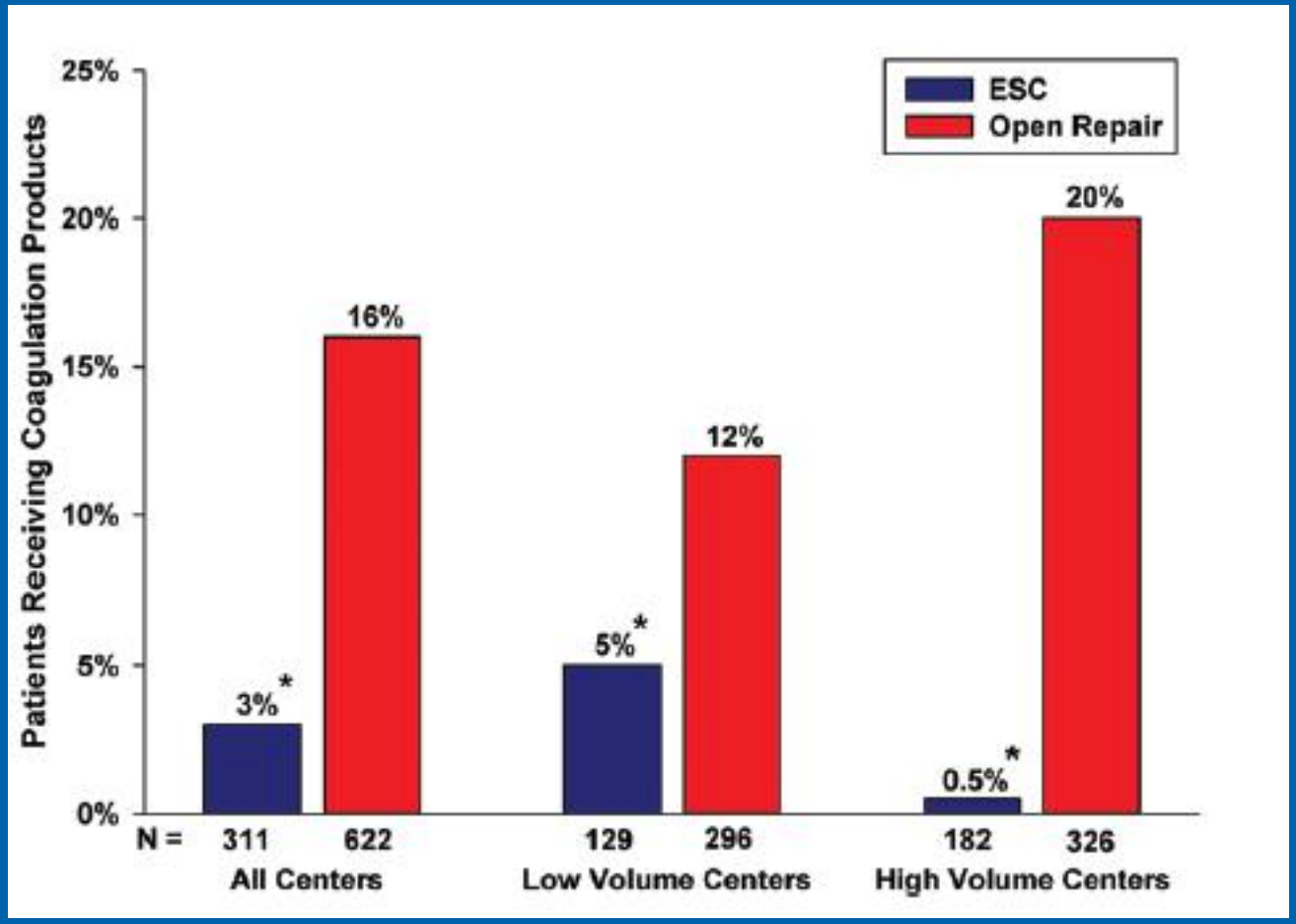


**Figure 3.** Administration of coagulation products between endoscopic strip craniectomy (ESC) and open procedures stratified by center volume. Percentages of patients who received coagulation products (fresh frozen plasma, platelets, cryoprecipitate) in the endoscopic and open surgical groups based on all 30 centers (933 age- and weight-

**Endoscopic Versus Open Repair for Craniosynostosis in Infants Using Propensity Score Matching to Compare Outcomes: A Multicenter Study from the Pediatric Craniofacial Collaborative Group**

Douglas R. Thompson, MD,* David Zurakowski, MS, PhD,† Charles M. Haberkern, MD, MPH,*‡ Paul A. Stricker, MD,§ and Petra M. Meier, MD, DEAA,† The Pediatric Craniofacial Collaborative Group‖

(Anesth Analg 2018;126:968–75)

## CONCLUSION:

- This multicenter study of endoscopic versus open craniosynostosis repair represents the largest comparison to date.

- It demonstrates striking advantages of ESC for young infants that may result in improved clinical outcomes, including reduced blood transfusion, as well as increased safety.

## Take home message:

*Implementation of a multicenter center QI project to define national benchmarks and to improve care.

*Highlights minimally invasive surgical technique is a PBM strategy.

*Difference in small volume vs. large volume centers re transfusion.

## Future directions:

Will this change the practice at other institutions ?

Can PBM be further improved (antifibrinolytics)?

– goal to keep the blood in the patient and decrease allogeneic blood product exposure.

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