



PATIENT BLOOD MANAGEMENT

puede ser utilizada en el paciente pediátrico ?

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INTRODUCCIÓN



- ❖ Vinculo misterioso y mágico entre la Vida y la sangre
- ❖ La transfusión sanguínea ha salvado millones de vidas
- ❖ Aumento de la morbimortalidad
- ❖ Riesgos infecciosos y no infecciosos
- ❖ Respuesta inmunomoduladora por la transfusión sanguínea(TRIM)

Red blood cell transfusion in critically ill children: A narrative Review
Pediatr Crit Care Med. 2011 ;12:174-183

REVIEW ARTICLE

Serious hazards of transfusion in children (SHOT)

Elaine Harrison & Philip Bolton

Royal Hospital for Sick Children, Glasgow, Scotland, UK

Los efectos adversos son más frecuentes en los niños

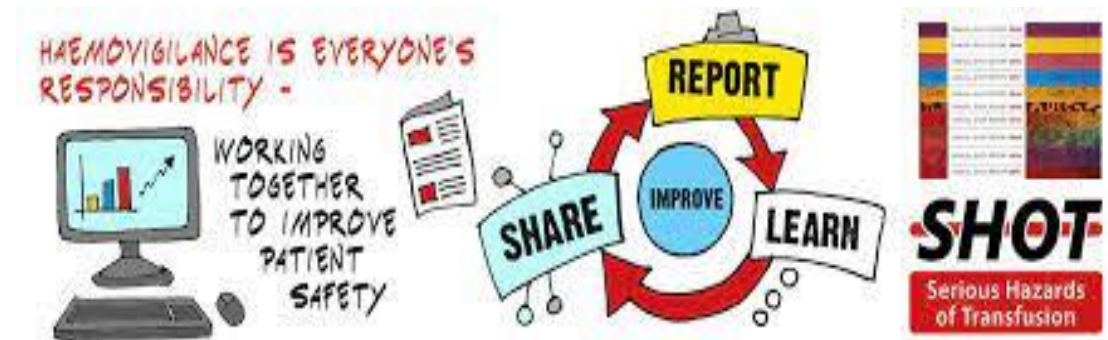
Más del 80% de los reportes de SHOT

Desconocimiento de indicaciones específicas en los pacientes pediátricos

Complicaciones :

Niños 10.7/1000 unidades transfundidas

Adultos 2.5/1000 unidades transfundidas



Pediatric Anesthesia 2011;21:10–13

British Journal of Haematology 2013;163:303-314

Clin Lab Med 2021 ; 41: 51-67

Paediatric SHOT summary from 2021



Paediatric cases accounted for 7.6% (136/1790) of total cases analysed, excluding near miss and right blood right patient reports.



There were 2 deaths possibly related to transfusion, one was related to transfusion-associated necrotising enterocolitis and the other was due to transfusion delay.



Protocols must be in place for the management of massive haemorrhage in infants and children. These should include guidance on the appropriate component volumes to be used in resuscitation. Staff involved in paediatric transfusions must be fully trained to these protocols.



Hyperkalaemia is a recognised complication of large volume transfusion in neonates and infants, and 'fresh' red cells are recommended for this situation to reduce risk.



Hospitals should ensure the correct use of the paediatric red cell transfusion formula, with the Hb units in g/L.



Paediatric medical and nursing education must include specific transfusion requirements for patients with haemoglobinopathies and processes must be in place to ensure these are communicated effectively to the hospital transfusion laboratories to ensure safe transfusions.

Aumento de días estancia en UCI
Aumento de días de ventilación mecánica
Aumento de infecciones nosocomiales
Aumento de mortalidad

Bateman ST, Lacroix J, Boven K, et al: Anemia, blood loss, and blood transfusions in North American children in the intensive care unit.
Am J Respir Crit Care Med 2008; 178:26

295 pacientes UCIP . Transfusión liberal aumento de mortalidad

Kneyber MC, Hersi MI, Twisk JW , et al: Red blood cell transfusion in critically ill children is independently associated with increased mortality.
Intensive Care Med 2007; 33: 1414–1422

1639 pacientes : aumento mortalidad , estancia UCI y hospitalaria

Stone TJ, Riesenman PJ, Charles AG: Red blood cell transfusion within the first 24 hours of admission is associated with increased mortality in the pediatric trauma population: A retrospective cohort study.
J Trauma Manag Outcomes 2008; 2:9

277 pacientes quemados

Pacientes transfundidos mayor incidencia de sepsis ; FOM, muerte

Eschke MG, Chinkes DL, Finnerty CC, et al: Blood transfusions are associated with increased risk for development of sepsis in severely burned pediatric patients.

Crit Care Med 2007; 35:579–583

455 pacientes en UCI

GR mas de 14 días de almacenamiento asociado a mayor incidencia de muerte y FOM

Gauvin F, Spinella PC, Lacroix J, et al: Association between length of storage of transfused red blood cells and multiple organ dysfunction syndrome in pediatric intensive care patients.

Transfusion 2010; 50: 1902–1913

977 pacientes en UCIP - USA

GR mas de 13 días de almacenamiento alta incidencia de FOM y estancia en UCI

Karam O, Tucci M, Bateman ST, et al: Association between length of storage of red blood cell units and outcome of critically ill children: A prospective observational study.

Crit Care 2010; 14:R57

Porque debemos utilizar estrategias de ahorro sanguíneo ?

Evidencia de aumento de morbimortalidad

Disminución progresiva de los donantes

Múltiples riesgos de la terapia transfusional

Altos costos



Patient Blood Management
Anesthesiology 2012; 116:1367-76

PATIENT BLOOD MANAGEMENT

Es aproximación basada en evidencia multidisciplinaria y multimodal
Aplicable a todos los pacientes

objetivo
disminuir la morbimortalidad por la transfusión sanguínea
mejorar el resultado de los pacientes



Transfus Med Hemother 2012;39:67–72

Society for the advancement of patient blood management. 2022. <https://sabm.org/>

PATIENT BLOOD MANAGEMENT

- Avance en la medicina transfusional en los últimos 50 años
- OMS : (World Health Alliance Resolution A63.R12)
Es una estrategia para promover la seguridad de los pacientes y una alternativa a la terapia transfusional
- **The Joint Comisión :**
Mejorar los resultados clínicos y la seguridad de los pacientes

PATIENT BLOOD MANAGEMENT

Why certification?

True, you can implement a program and begin to reap the benefit. But to maximize the returns on your effort and investment, having a knowledgeable third party review your processes and practices may ensure that you make continuous quality improvements. When considering the impact of further reducing blood usage by even 1% on patient outcomes, reduced hospital stays, readmissions, risk reduction and on your bottom line, the effort and cost involved with certification is insignificant by comparison.

"The AABB and Joint Commission reviewers validated aspects of our PBM program where we are doing well, and suggested other areas where we could improve. In a program that spans so many departments, this external review provides the clout we needed to gain the necessary engagement and adoption throughout the hospital."

--Steven M. Frank M.D., Johns Hopkins Health System Blood Management Program, Patient Blood Management Certification pilot site

What can my hospital do to prepare?

- Assess your readiness by reviewing the specific AABB Standards for a Patient Blood Management Program (available at aabb.org/marketplace).
- Get your standards questions answered at standards@aabb.org.
- Visit www.aabb.org/pbm for patient blood management resources.
- Email qualityhospitals@jointcommission.org with any questions and for an application.

Patient Blood Management Certification for Your Hospital and Patients



Patient Blood Management Certification



Patient Blood Management Certification

The Joint Commission and AABB have teamed up to offer Patient Blood Management Certification. Based on the AABB Standards for a Patient Blood Management Program, this new voluntary certification is available to hospitals and critical access hospitals that are accredited by The Joint Commission.

What is Patient Blood Management?

Patient Blood Management is an evidence-based, multidisciplinary approach to optimizing care of patients who might need transfusion. It encompasses all aspects of patient evaluation and clinical management surrounding the transfusion decision-making process, including the application of appropriate indications, as well as minimization of blood loss and optimization of patient red cell mass.

Patient Blood Management by the Numbers

- Blood transfusion is the most common procedure performed during hospitalization.
- 11% of all hospital stays with a procedure include transfusion.
- 50% of red blood cell transfusions are found inappropriate.
- Nearly 14 million allogeneic red cell units are transfused each year at a cost to hospitals of over \$3 billion (average red cell \$225/unit).

What's in it for my hospital?

It's not easy implementing a cross-functional patient blood management program that is sustainable and scalable. But implementing practices to reduce unnecessary transfusions that reflect your hospital's needs in a phased approach can reap such benefits as:

- Risk reduction in fewer adverse events and incidents
- Improved patient outcomes
- Reduced hospital stays, readmissions, and lengths of stay
- Ensuring blood availability for those most in need
- Optimized care for those who may need transfusion
- Fostering collaboration throughout the hospital
- Providing a competitive edge in the marketplace
- Enhanced staff recruitment and development
- Cost savings

Successes achieved through blood management programs

Positive results from hospitals that have implemented programs include:

- Implementation of an anemia management program that resulted in a reduction of red blood cell transfusion by 62%
- A 25% reduction in hospital stays for non-transfused vs. transfused patients
- Transfusion guideline implementations have been associated with 47% reduction in the odds of death and 50% decrease in total hospitalization costs after cardiac surgery
- A hospital's first year of implementation expenses for blood decreased \$510,000

Patient blood management



Volume 2 December 2005
ISSN 1448-482X

UPDATES IN >

**Blood Conservation
and Transfusion
Alternatives**

JOURNAL OF THE AUSTRALASIAN ASSOCIATION FOR BLOOD CONSERVATION



James Isbister

JAMA | Special Communication

Patient Blood Management Recommendations From the 2018 Frankfurt Consensus Conference

Patient Blood Management
Guidelines: Module 6

**Neonatal and
Paediatrics**

Received: 18 October 2018 | Revised: 30 November 2018 | Accepted: 10 December 2018
DOI: 10.1111/pan.13574

SPECIAL INTEREST ARTICLE

WILEY **Pediatric Anesthesia**

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

Susan M. Goobie¹ | Trudi Gallagher² | Irwin Gross³ | Aryeh Shander⁴

Diferencias con adultos

No se trata solo de utilizar volúmenes más pequeños



Diferencias en consumo de oxígeno gasto cardiaco

Diferencia en la tolerancia a las pérdidas sanguíneas

Transfus Med Rev. 2016; 30(4):235-41.
Paediatr Anaesth. 2019; 29(3):231-36.

Diferencias con adultos

Gasto cardiaco:

- Neonato: 350mL/Kg/min
- Lactante: 150mL/kg/min
(A expensas de FC)

Volemia:

70-90 mL/Kg

Gasto cardiaco:

70mL/Kg/min

Volemia:

60-70 mL/Kg

Niveles de Hb:

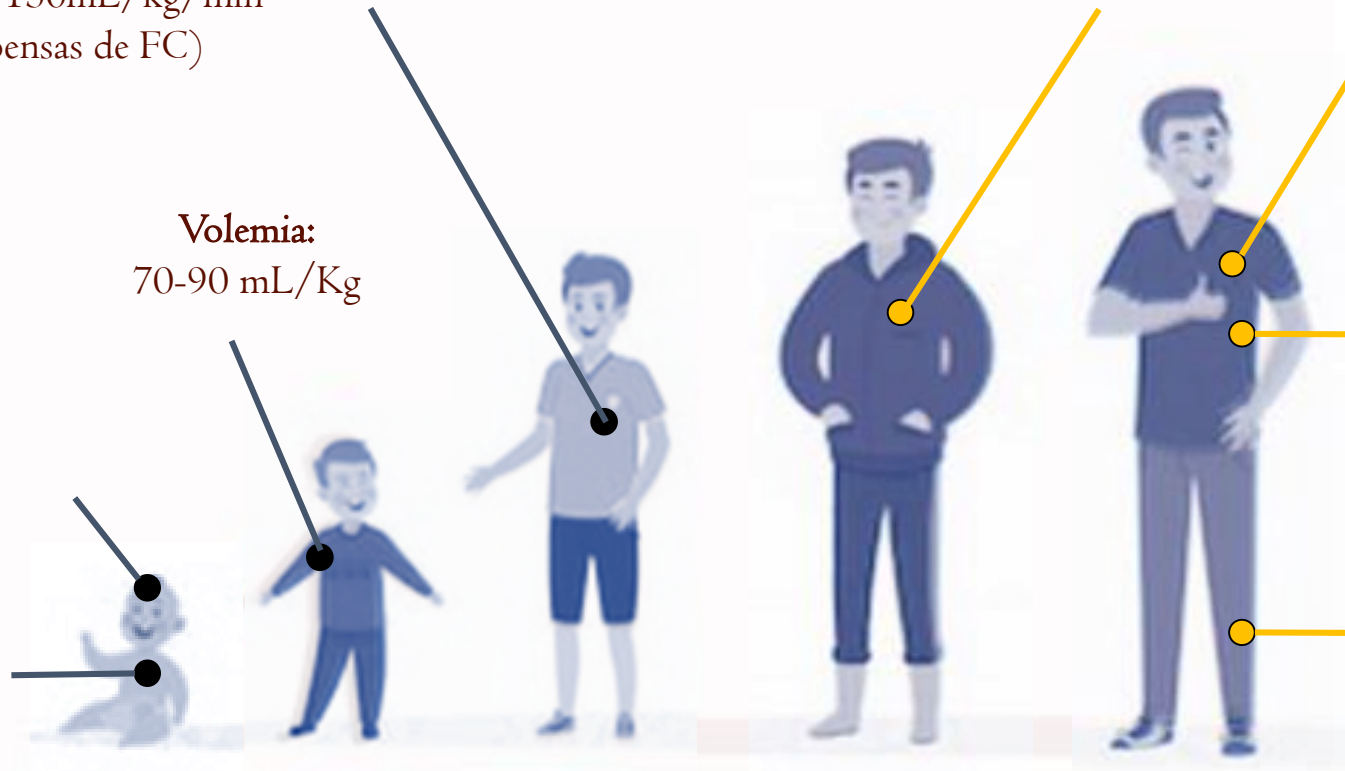
- Hombres: >13 g/dL
- Mujeres: >12 g/dL

Niveles de Hb:

- RN: 14-20 g/dL (HbF)
- Lactante: 10-14 g/dL
- Niños: 12-13.5 g/dL (HbA)

Tasa de consumo de oxígeno:
5.8mL / 100g / min

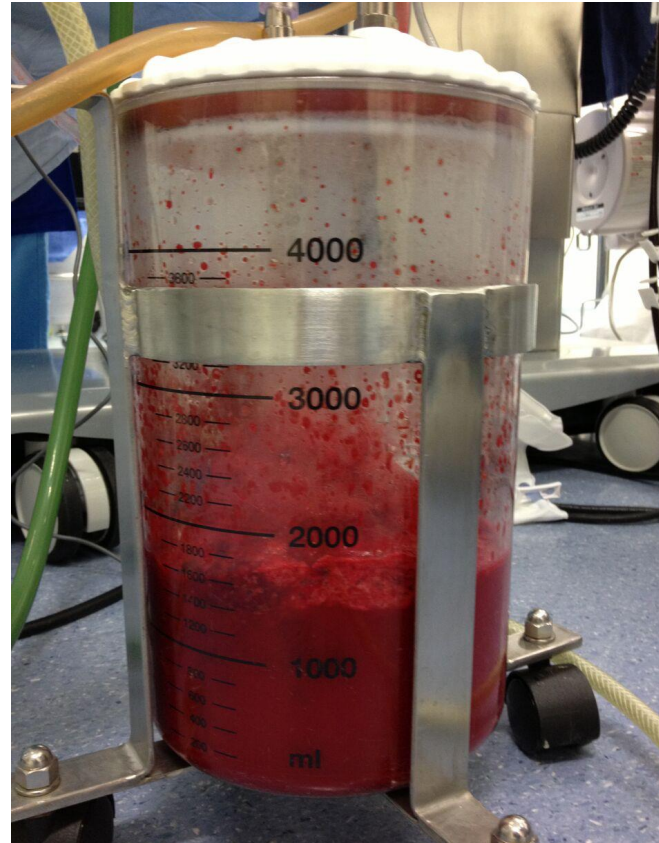
Tasa de consumo de oxígeno:
3.5mL / 100g / min



Diferencias con adultos



Lactante de 8 kg
80mL/kg
(Volumen intravascular : 600 ml mL)



Adulto de 70 Kg
60mL/kg
(Volumen intravascular : 4.200mL)

Predictores de la transfusión sanguínea

Concentración preoperatoria de Hemoglobina

Perdidas sanguíneas

Umbral transfusional

PATIENT BLOOD MANAGEMENT

Optimización del volumen eritrocitario

Reducción de las pérdidas sanguíneas
Optimización de la coagulación

Aumento de la tolerancia individual a la anemia
Transfusiones basadas en evidencia

Patient Blood Management Is a New Standard of Care to Optimize Blood Health

Susan M. Goobie, MD, FRCPC

2021, the WHO called for implementation of PBM as a global standard of care.⁶ The WHO policy statement, “The Urgent Need to Implement PBM,” is an appeal to transform awareness into implementation. This call for action creates a sense of urgency for health care entities to implement PBM; “a systematic, multidisciplinary, multiprofessional concept to routinely minimize these risk factors, and, in so doing, significantly and cost-effectively improve health and clinical outcomes for hundreds of millions of medical and surgical patients, pregnant women, neonates, children, adolescents, elderly people, and the population as a whole”.⁶ A full WHO PBM implementation guide is to follow this year.

PATIENT BLOOD MANAGEMENT

PRE	<ul style="list-style-type: none">• Detect anemia• Identify underlying disorder(s) causing anemia• Manage disorder(s)• Refer for further evaluation if necessary• Treat suboptimal iron stores/iron deficiency/anemia of chronic disease/iron-restricted erythropoiesis• Treat other hematinic deficiencies• Note: Anemia is a contraindication for elective surgery	<ul style="list-style-type: none">• Identify and manage bleeding risk• Minimize iatronic blood loss• Procedure planning and rehearsal• Preoperative autologous blood donation (in selected cases or when patient choice)	<ul style="list-style-type: none">• Assess/optimize patient's physiological reserve and risk factors• Compare estimated blood loss with patient-specific tolerable blood loss• Formulate patient-specific management plan using appropriate blood conservation modalities to minimize blood loss, optimize red cell mass and manage anemia• Restrictive transfusion thresholds
INTRA	<ul style="list-style-type: none">• Timing surgery with hemotological optimization	<ul style="list-style-type: none">• Meticulous hemostasis and surgical techniques• Blood-sparing surgical techniques• Anesthetic blood conserving strategies• Autologous blood options• Pharmacological/hemostatic agents	<ul style="list-style-type: none">• Optimize cardiac output• Optimize ventilation and oxygenation• Restrictive transfusion thresholds
POST	<ul style="list-style-type: none">• Stimulate erythropoiesis• Be aware of drug interactions that can increase anemia	<ul style="list-style-type: none">• Vigilant monitoring and management of postoperative bleeding• Avoid secondary hemorrhage• Rapid warming/maintain normothermia (unless hypothermia specifically indicated)• Autologous blood salvage• Minimize iatronic blood loss• Hemostasis/anticoagulation mgntment• Prophylaxis of upper GI hemorrhage• Avoid/treat infections properly• Be aware of adverse effects of medication	<ul style="list-style-type: none">• Optimize anemia reserve• Maximize oxygen delivery• Minimize oxygen consumption• Avoid/treat infections promptly• Restrictive transfusion thresholds

Multidisciplinary multimodal team approach

Aumento de la masa eritrocitaria



Aumento de la masa eritrocitaria

La anemia factor de riesgo para transfusión sanguínea

Predictor independiente de mortalidad

Afecta 30-40% de los niños

10-15 % países industrializados

Alta incidencia de anemia en Niños críticos

Recomendación SABM (Society Advanced Blood Management)

Medir Hemoglobina –Hematocrito en Cirugías de alto riesgo de Sangrado

28 días antes del procedimiento

Iniciar Tratamiento de la anemia de acuerdo a la etiología

(Hierro– Eritropoyetina)

Pediatr Crit Care Med 2012; 13:204 –209

Transfus Med Hemother 2012;39:67–72

Reducción de las pérdidas sanguíneas



Reducción de las pérdidas sanguíneas

Preoperatorio

Evaluación pre anestésica

Detección de pacientes con trastornos de la coagulación

Cirugías con alto riesgo

Transplante Hepático

Cirugía cardíaca

Craneosinostosis

Escoliosis

Neurocirugía

Trauma



Reducción de las pérdidas sanguíneas

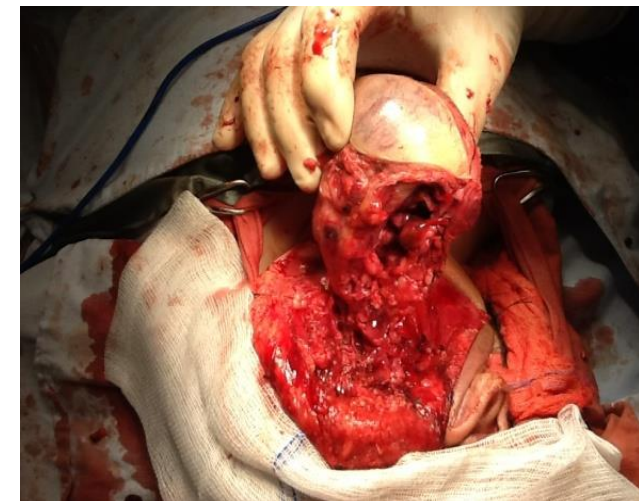
Intraoperatorio

- Técnica quirúrgica
- Cirugía mínimamente invasiva
- Cirugía laparoscópica
- Cirugía robótica



Reducción de las pérdidas sanguíneas

Embolización preoperatoria



Reducción de las pérdidas sanguíneas Intraoperatorias

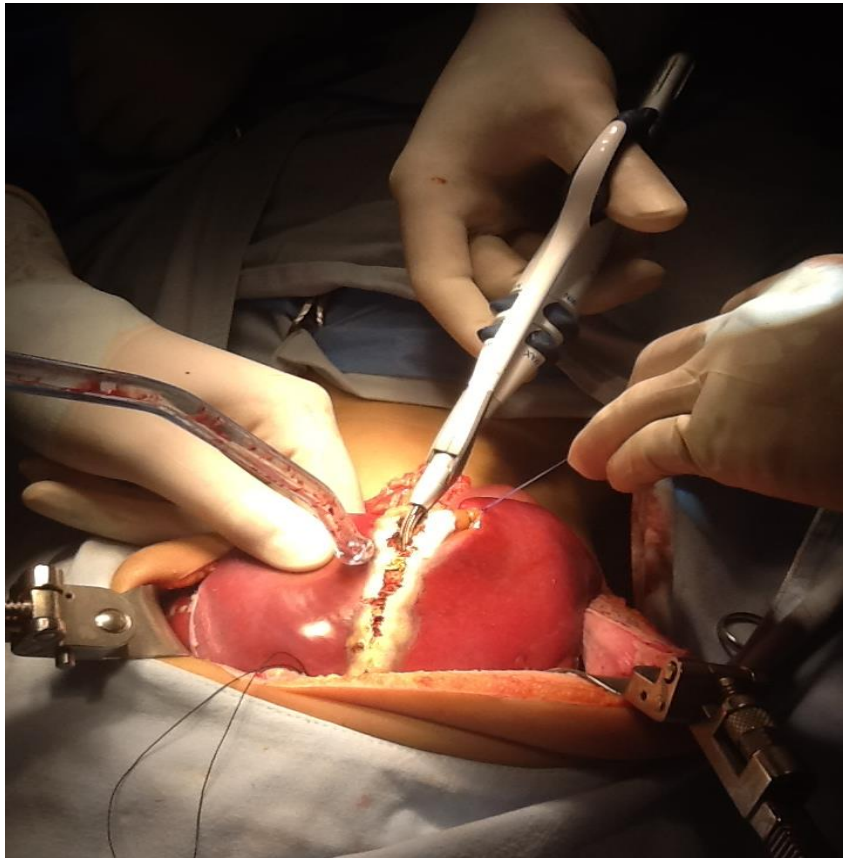
Dispositivos de electrocoagulación
Posición del paciente
Hipotensión controlada
Uso de torniquete
Vasoconstrictores
Evitar hipotermia, acidosis, hipocalcemia

Pediatric Anesthesia 2014 (24):678-689

European Journal of Anaesthesiology 2009; 26:722–729

Reducción de las pérdidas sanguíneas Intraoperatorias

Disminución de la Presión venosa Central



Reducción de las pérdidas sanguíneas Intraoperatorias



Hemodilucion Normovolemica Aguda

Cell Saver

Agentes hemostáticos sistémicos

Antifibrinoliticos

Desmopresina

Complejo protrombinico

Concentrado de fibrinógeno

FactoXIII

Factor VIIa

Agentes hemostáticos tópicos

Aumentar la tolerancia individual a la anemia
Implementar Umbral transfusional



Aumentar la tolerancia individual a la anemia

Transfusión de acuerdo al estado hemodinámico
Perfusión de órganos
Tasa de extracción de oxígeno

La meta es tratar pacientes y no tratar números

La disminución del umbral transfusional ha disminuido la incidencia de transfusiones en un **40%**

Estrategia restrictiva es una herramienta costo efectiva
para disminuir la terapia transfusional



Estrategias preoperatorias

Optimización de la masa eritrocitaria



- Evaluation oportuna del paciente (3 - 4 semanas antes de cirugía).
- Disminuir número y volumen de flebotomías.
- Hierro y eritropoyetina (EPO)
- Donacion autóloga preoperatoria
- Umbral de transfusión restrictivo

Eritropoyetina Preoperatoria

Descripción:

La eritropoyetina es una glucoproteína que estimula la formación de eritrocitos a partir de sus progenitores, actuando como factor estimulante de la mitosis y hormona de diferenciación. Con la administración de epoetina beta aumentan el número de eritrocitos, los valores de hemoglobina (Hb) y la cifra de reticulocitos, al igual que la velocidad de incorporación de hierro.

USO CLÍNICO:

Epoetina beta se ha utilizado en población pediátrica para las siguientes indicaciones:

- Tratamiento de la anemia sintomática asociada a la enfermedad renal crónica (A).
- Anemia sintomática secundaria a prematuridad (A).
- Anemia sintomática secundaria a tratamiento con quimioterapia mielosupresora (E: *off-label*).

Estrategia útil en niños en cirugía cardíaca, escoliosis , craneosinostosis

Esquema de administración:

600 UD /kg semanal por 3-4 semanas previas a la cirugía

100-300 UD/kg 2-3 a la semana por 3- 4 semanas previa a la cirugía



Preoperative Autologous Blood Donation: Waning Indications in an Era of Improved Blood Safety

Ralph Vassallo ^{a,*}, Mindy Goldman ^b, Marc Germain ^c, Miguel Lozano ^d, for the BEST Collaborative

^a *Blood Systems, Inc, Scottsdale, AZ*

^b *Canadian Blood Services, Ottawa, ON, Canada*

^c *Medical Affairs, Héma-Québec, Québec, QC, Canada*

^d *Hemotherapy Section, Hospital Clinic de Barcelona, Barcelona, Spain*

Cirugías con pérdidas sanguíneas mayores del 20% del VSC

- Duración de la extracción 3 a 4 semanas previas a la cirugía
- Frecuencia de extracción : 1 vez a la semana
- La ultima extracción puede realizarse 72 horas antes de la cirugía
- La DAP no es costo efectiva en niños menores



Preoperative Autologous Blood Donation: Waning Indications in an Era of Improved Blood Safety

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^c Medical Affairs, Héma-Québec, Québec, QC, Canada

^d Hemotherapy Section, Hospital Clinic de Barcelona, Barcelona, Spain

Indicaciones de DAP en niños

Grupos sanguíneos raros

Cirugía de escoliosis

Pacientes o padres que se rehúsen a la transfusión allogenica

Desventajas de la DAP

Efectos adversos con la recolección de sangre

Errores humanos

Riesgo de infecciones por contaminación bacteriana

Lesiones por almacenamiento de los GR recolectados

Costos

ESTRATEGIAS INTRAOPERATORIAS



Hemodilucion Normovolemica Aguda

Como se realiza la HNA ?

- ✓ Umbral transfusional
- ✓ Calculo de Volumen sanguineo a extraer
- ✓ Cuidados generales
- ✓ Re infusión de GR recolectados

Efectos Fisiológicos de la HNA

- ✓ Disminución de la viscosidad sanguínea
- ✓ Mejoría de la perfusión tisular
- ✓ Disminución de la resistencia vascular periférica
- ✓ Aumento del gasto cardiaco a través del volumen sistólico
- ✓ Aumento de la extracción de oxigeno por los tejidos
- ✓ Aumento del retorno venoso

HEMODILUCIÓN NORMOVOLEMICA AGUDA

Beneficios

- ❖ Bajo costo
- ❖ Disminuye la necesidad de transfusión allogenica
- ❖ Fácil y rápida de realizar
- ❖ No requiere test de laboratorio
- ❖ Mínimo riesgo de errores transfusionales
- ❖ No lesiones de almacenamiento
- ❖ No alteraciones metabólicas de la sangre almacenada
- ❖ Contiene todos los factores de coagulación y plaquetas

Disminución costos transfusionales en un 50 a 75%.

Pediatric Anesthesia 2014 (24):678-689

Transfusión Alternativas in Transfusión Medicine 2006; 8:35-40

Intraoperative cell salvage

C. Carroll* and F. Young

Salford Royal NHS Foundation Trust, Salford, UK

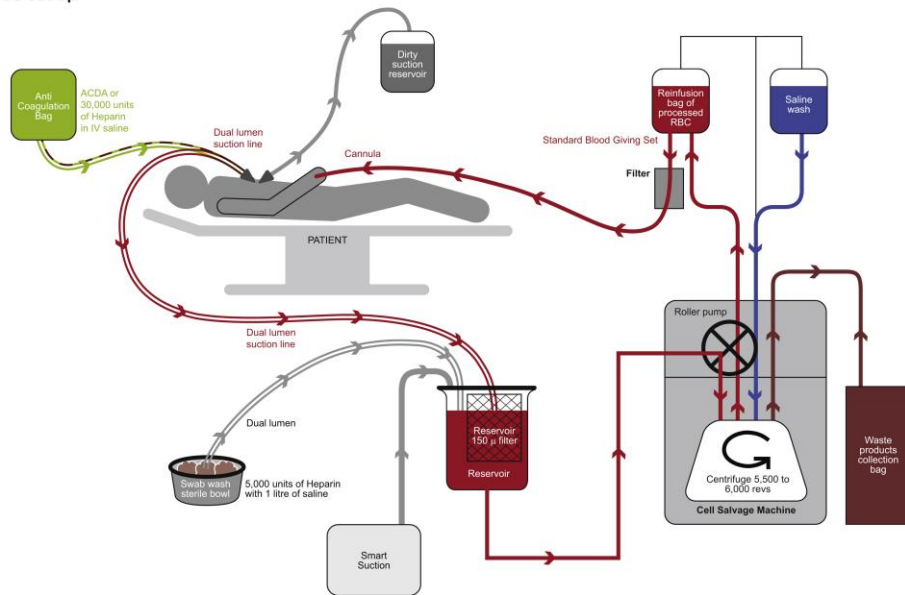


Intraoperative cell salvage

C. Carroll* and F. Young

Salford Royal NHS Foundation Trust, Salford, UK

CS Set Up



- ✓ Perdidas sanguíneas anticipadas mayores del 10% del VSC
- ✓ Cirugía con alto riesgo de sangrado
- ✓ Pacientes con alto riesgo de sangrado
- ✓ Pacientes con múltiples anticuerpos
- ✓ Grupos sanguíneos raros
- ✓ Pacientes que se rehúsan a recibir la transfusión allogénica

CELL SAVER

RIESGOS

- Hemolisis
- Embolismo aéreo
- Rx febriles no hemolíticas
- Coagulopatía
- Contaminación con medicamentos
- Agentes infecciosos

CONTRAINDICACIONES

- Lesiones tumorales
- Campo quirúrgico contaminado (infecciones, abscesos)
- Perforación intestinal
- Presencia de cemento
- Presencia de agentes hemostáticos tópicos

CME **The Efficacy of Antifibrinolytic Drugs in Children Undergoing Noncardiac Surgery: A Systematic Review of the Literature**

David Faraoni, MD, FCCP* and Susan M. Goobie, MD, FRCPC†

Reducing blood loss and blood transfusion profoundly impacts health care worldwide by significantly decreasing morbidity and mortality, decreasing costs, and improving health care for infants and children undergoing major surgery involving significant blood loss.

The American Medical Association and the Joint Commission's September 2012 National Summit on Overuse identified blood transfusion as one of the 5 most important health care-related overuse issues in the world today. Furthermore, the World Health Organization (World Health Organization resolution WHA63.12) in May 2012 recommended patient blood management strategies as important in the care of surgical patients worldwide.



Tranexamic acid and perioperative bleeding in children: what do we still need to know?

Susan M. Goobie^a and David Faraoni^b

Comprehensive multimodal PBM is recommended by several leading organizations (e.g., World Health Organization, American Society of Anesthesiologists, European Society of Anaesthesiology, Australian National Blood Authority among others) [15–18]. Prophylactic administration of TXA is considered an essential component of an effective perioperative PBM strategy and expert consensus guidelines recommend TXA to be considered for all pediatric patients undergoing high blood loss surgery [17,18,19[■]].

Table 3. TXA dosing regimes for various desired therapeutic plasma levels.

Targeted therapeutic TXA plasmatic concentration	Low 20 $\mu\text{g/ml}$	Intermediate 70 $\mu\text{g/ml}$	High 150 $\mu\text{g/ml}$
Loading dose (mg/kg)	10	30	50
Maintenance infusion rate (mg/kg/h)	5	10	15

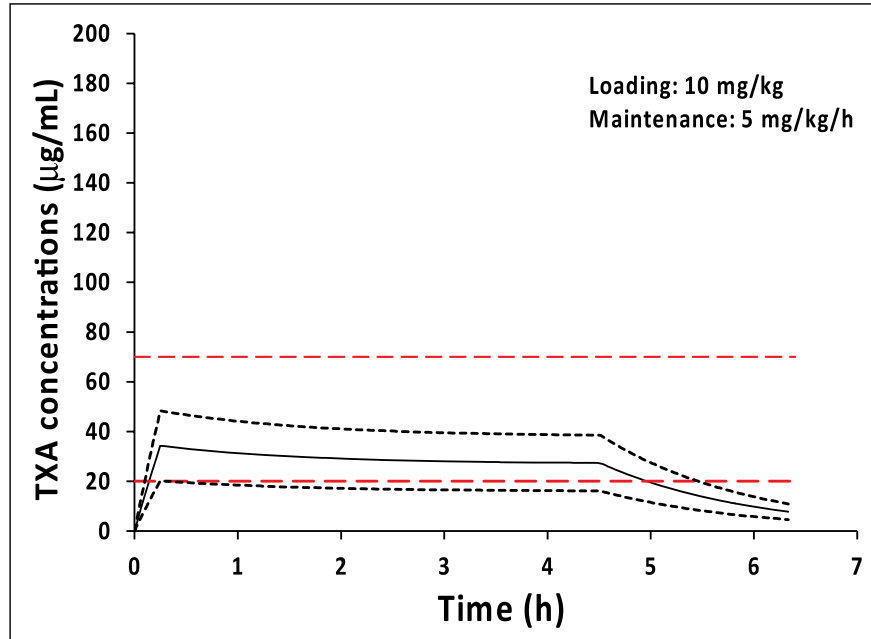


FIGURE 2. TXA plasma concentration time curve simulations for TXA 10mg/kg loading dose and 5-mg/h/kg maintenance infusion rate. A 95% confidence interval shown around the mean; the dashed lines indicate the 95% confidence interval around the means which is represented by the solid line (for an interpatient variability of 25% coefficient of variation). TXA plasma concentration therapeutic target for 20 and 70 $\mu\text{g/ml}$ shown in dotted lines.

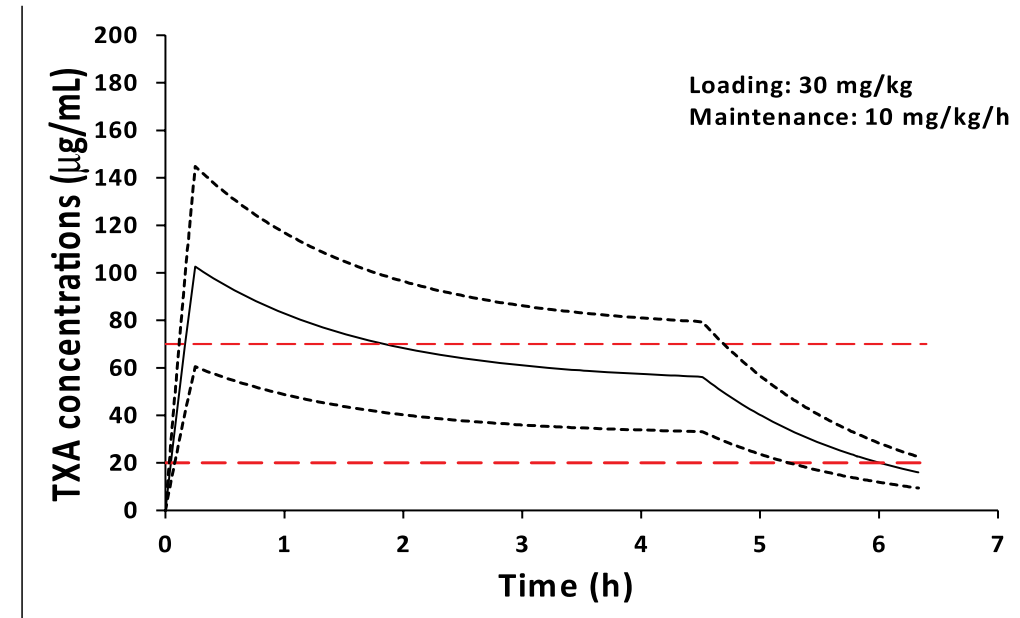


FIGURE 1. TXA plasma concentration time curve simulations for TXA 30mg/kg loading dose and 10mg/kg/h maintenance infusion rate. A 95% confidence interval is shown around the mean; the dashed lines indicate the 95% confidence interval around the mean which is represented by the solid line (for an interpatient variability of 25% coefficient of variation). TXA plasma concentration therapeutic target for 20 and 70 $\mu\text{g/ml}$ shown in dotted lines.

■ SPECIAL ARTICLE

CME **Update on Applications and Limitations of Perioperative Tranexamic Acid**

Prakash A. Patel, MD, FASE,* Julie A. Wyrobek, MD,† Alexander J. Butwick, MBBS, FRCA, MS,‡
Evan G. Pivalizza, MD,§ Gregory M. T. Hare, MD, PhD, FRCPC,|| C. David Mazer, MD,||
and Susan M. Goobie, MD, FRCPC¶

Tranexamic acid (TXA) is a potent antifibrinolytic with documented efficacy in reducing blood loss and allogeneic red blood cell transfusion in several clinical settings. With a growing emphasis on patient blood management, TXA has become an integral aspect of perioperative blood conservation strategies. While clinical applications of TXA in the perioperative period are expanding, routine use in select clinical scenarios should be supported by evidence for efficacy. Furthermore, questions regarding optimal dosing without increased risk of adverse events such as thrombosis or seizures should be answered. Therefore, ongoing investigations into TXA utilization in cardiac surgery, obstetrics, acute trauma, orthopedic surgery, neurosurgery, pediatric surgery, and other perioperative settings continue. The aim of this review is to provide an update on the current applications and limitations of TXA use in the perioperative period. (*Anesth Analg* 2022;135:460–73)

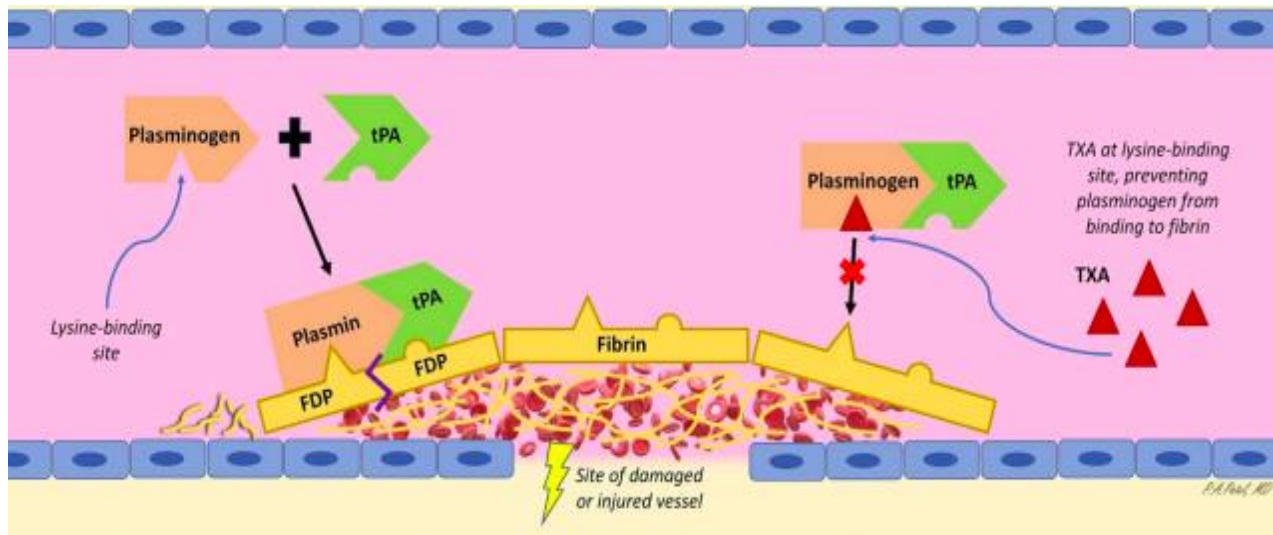


Table 7. Tranexamic Acid in Pediatric Surgery: Key Take-Home Points

TXA for prophylaxis or treatment in pediatric surgery with high/moderate risk of bleeding is recommended to reduce blood loss and transfusion.

Dosing regimens for pediatric surgery have been suggested based on pharmacokinetic modeling and simulation, which also account for bleeding risk.

TXA use in pediatric cardiac surgery should also account for additional bleeding risk, as well as the patient's age and cardiopulmonary bypass circuit prime.

Seizures are not a contraindication to use of TXA in pediatric surgery.

Given that pediatric trials are often small or single center, thrombotic risk in the pediatric population is often extrapolated from larger multicenter adult trials, which is low.

Abbreviation: TXA, tranexamic acid.

Table 1. Typical Dosing Regimens for Perioperative TXA Administration

Setting	Typical TXA dosing regimen ^a	Notes
Adult cardiac surgery ^{10,11}	10–30 mg/kg IV loading dose; then 2–16 mg/kg/h infusion; ±1–2 mg/kg for pump prime	Target plasma concentrations 20–100 µg/mL (depending on desired degree of fibrinolysis inhibition) ^b
Obstetrics ⁸	1 g IV over 10 min; can repeat 1-g IV if bleeding persists after 30 min	Recommended to give within first 3 h of birth
Acute trauma ^{6,12}	1 g IV over 10 min; then 1 g infused over 4–8 h	Recommended to give within first 3 h of injury (ideally within first hour)
Orthopedic surgery ^{13,14}	10–20 mg/kg IV in single or divided doses (or 1–3 g topical dose)	Target plasma concentration ≥10 µg/mL
Neurosurgery ¹⁵	10 mg/kg IV loading dose; then 0.5–2 mg/kg/h infusion	
Pediatric surgery ¹⁶	10–30 mg/kg IV loading dose; then 5–10 mg/kg/h infusion	Maximum loading dose 2 g; target plasma concentrations between 20 and 70 µg/mL ^b
Pediatric cardiac surgery ^{16–18}	30 mg/kg (age <12 mo) or 10 mg/kg (age ≥12 mo) IV loading dose; then 10 mg/kg/h infusion; ±addition to pump prime for concentration of 60 µg/mL	Maximum loading dose 2 g; intermediate target plasma concentration 60 µg/mL (lower target concentration of 20 µg/mL or higher target concentration of 150 µg/mL requires dosage scheme adjustment) ^b

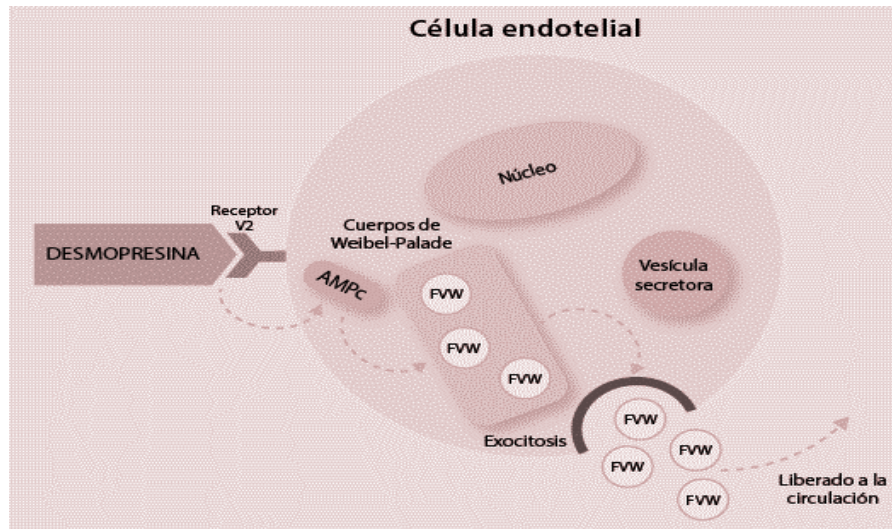
REVIEW

Desmopressin in treatment of haematological disorders and in prevention of surgical bleeding

Peter J. Svensson ^{a,1}, Peter B.F. Bergqvist ^{b,2}, Kristian Vinter Juul ^{b,3}, Erik Berntorp ^{a,*}

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^b Ferring Pharmaceuticals A/S, Kay Fiskers Plads 11, 2300 Copenhagen S, Denmark



Desórdenes congénitos

- Enfermedad de Von Willebrand tipo I
- Hemofilia A leve
- Desórdenes plaquetarios
- Desórdenes vasculares

Desórdenes adquiridos

- Síndrome de VWB adquirido, hemofilia A adquirida
- Uremia, cirrosis hepática, disfunción plaquetaria por aspirina.

↑ 3-5x los niveles de FVIII y FvW

Factor Concentrates for Perioperative Bleeding: Old Drugs with New Approaches

Ian J. Welsby, BSc, MBBS, FRCA (Eng), and Jerrold H. Levy, MD, FAHA, FCCM



Complejo Protrombinico
Concentrado de Fibrinogeno
Factor XIII
Factor VIIa



Anesth Analg 2015;121: 4-5
Anesth Analg 2013;116:15-34



REVIEW

Viscoelastic testing in pediatric patients

Thorsten Haas¹  | David Faraoni² 

6 | CONCLUSION

In conclusion, the use of a VET-based transfusion algorithm offers a feasible approach and has been shown to improve bleeding management and rationalize blood product transfusion in adults and children. When used, specific algorithms should be used based on the patient's age, comorbidities (eg, cardiac or liver disease), and the type of surgery performed. Further studies are urgently needed to confirm the effect of implementing VET-based transfusion algorithms on transfusion requirements, outcomes, and costs in different pediatric surgical specialties.

Red Blood Cell Transfusion: Decision Making in Pediatric Intensive Care Units

Jacques Lacroix, MD, FRCPC, FAAP, Pierre Demaret, MD, and Marisa Tucci, MD, FRCPC

El umbral transfusional y la terapia restrictiva
Herramienta mas efectiva para disminuir
la transfusión allogenica

Umbral transfusional en niños Hb de 7 gr/dl
Estado hemodinamico- perfusión tisular

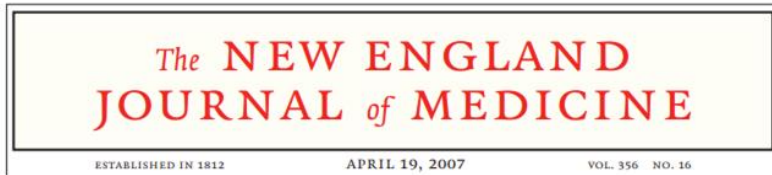
Semin Perinatol 2012 ;36:225-231

Hematology 2012;517-521

Can J Anesth 2013 ; 60:168–175

UMBRAL TRANSFUSIONAL

TRIPICU Study (2007)



Transfusion Strategies for Patients
in Pediatric Intensive Care Units

637 pacientes de UCI.
7 VS. 9.5 g/dL
Umbral restrictivo
no inferior

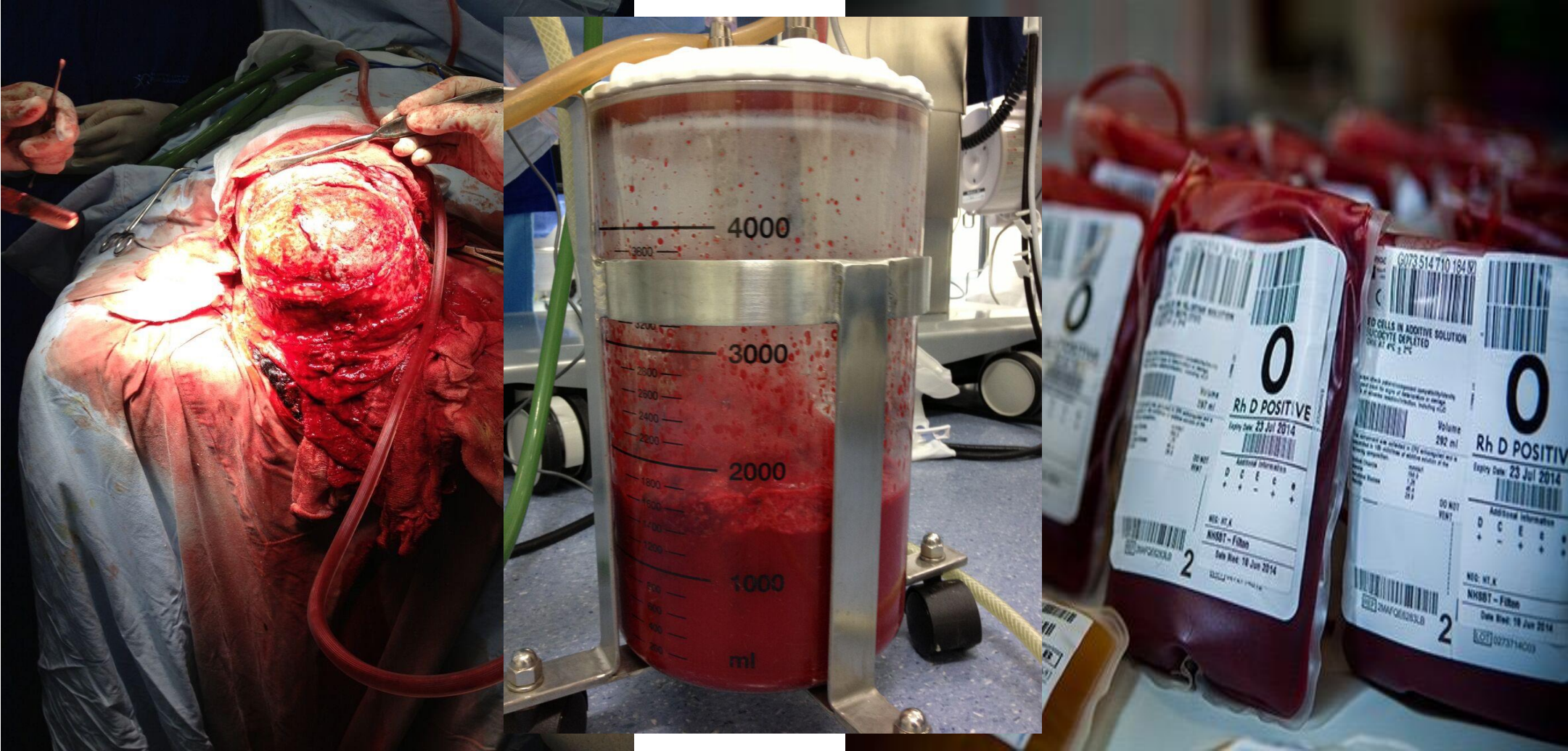
HHS Public Access
Author manuscript
Pediatr Crit Care Med. Author manuscript; available in PMC 2019 September 01.

Published in final edited form as:
Pediatr Crit Care Med. 2018 September ; 19(9): 884–898. doi:10.1097/PCC.0000000000001613.

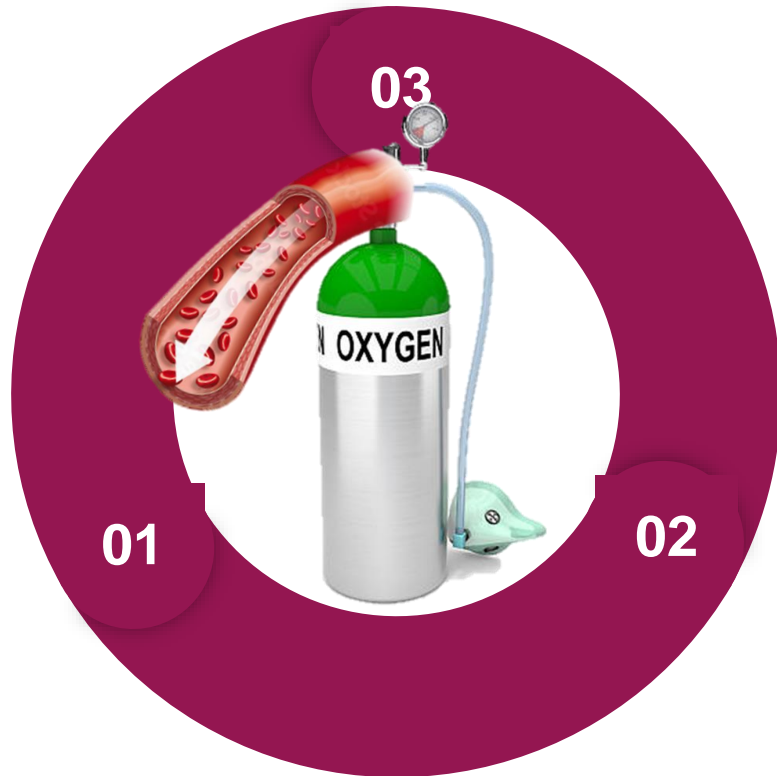
**Consensus Recommendations for Red Blood Cell Transfusion
Practice in Critically Ill Children from the Pediatric Critical Care
Transfusion and Anemia Expertise Initiative**



UMBRAL TRANSFUSIONAL



Estrategias postoperatorias



Optimización de la tolerancia fisiológica a la anemia

- Balance de entrega y demanda de oxígeno.
- Disminuir número y volumen de flebotomías.
- Umbral de transfusión restrictivo.

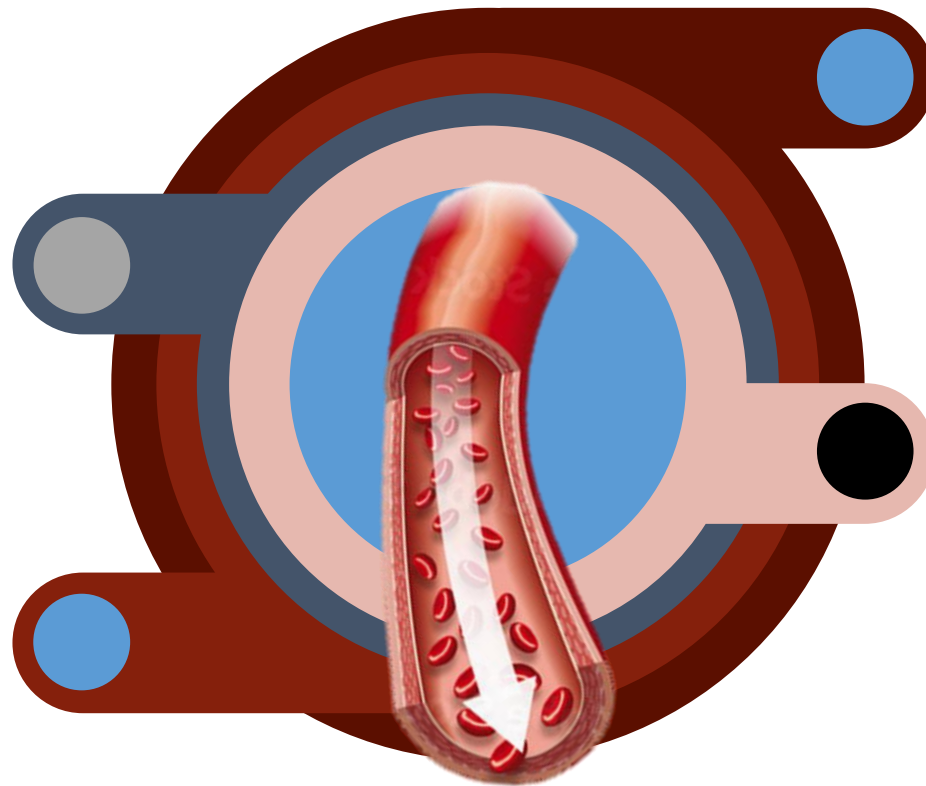
Transfus Med Rev. 2016; 30(4):235-41.
Paediatr Anaesth. 2019; 29(3):231-36.

Balance de entrega y demanda de oxígeno

$$DO_2 = GC \times CaO_2$$

Optimizar gasto
cardiaco

Optimizar
volemia



Optimizar oxigenación

Disminuir consumo
metabólico de oxígeno

Disminución del número de flebotomías

Limitar el número de pruebas y el volumen de las muestras



Transfus Med. 2018; 28(2):117-31.

Paediatr Anaesth. 2019; 29(3):231-36.

National Blood Authority. Patient Blood Management Guidelines: Module 6. 2016.

A Contemporary Analysis of Phlebotomy and Iatrogenic Anemia Development Throughout Hospitalization in Critically Ill Adults

Luke J. Matzek, MD,*† Allison M. LeMahieu, MS,‡ Nageswar R. Madde, MS,‡
Daniel P. Johanns, CPT,§ Brad Karon, MD, PhD,§ Daryl J. Kor, MD,*†|| and Matthew A. Warner, MD*†||



Exploring Contemporary Phlebotomy Practices in Critically Ill Adults



Blood loss through diagnostic phlebotomy can worsen anemia in critically ill patients, and there exists a need to improve it

However, there is a significant gap in knowledge regarding contemporary phlebotomy practices



Observational cohort study of 6,194 adults requiring intensive care unit (ICU) admission



Phlebotomy techniques...



Hemoglobin concentrations...



Red blood cell transfusions...

...were studied

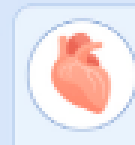
The study found that:



Surgical patients experienced:
↑ Frequency of blood draws
↑ Total volume of blood drawn



ICUs saw...
↑ Frequency
↑ Volume
...of laboratory draws than general wards



Cardiac surgical ICU
→ Highest frequency of draws



Medical ICU
→ Highest daily phlebotomy volume



The highest volumes of blood drawn



- ! Longest hospitalizations
- ! Lowest hemoglobin concentrations
- ! Highest blood transfusion utilization

More intensive phlebotomy techniques are associated with reduced hemoglobin concentrations and a higher need for blood transfusion in critically ill patients

Reducción de las pérdidas sanguíneas Post-operatorias

Profilaxis para Hemorragia tracto digestivo
Minimizar pérdidas iatrogénicas
Mantener Normotermia
Cell saver

Conclusiones

Alto riesgo de complicaciones y morbimortalidad con la transfusión allogenica

Complicaciones son mas frecuente en los niños

Mayores implicaciones por mayor expectativa de vida

Aumento de costos en salud

Desperdicio de un recurso Medico limitado

La transfusión sanguínea debe estar indicada en situaciones donde los beneficios realmente sobrepasen los riesgos

Conclusiones

PBM destaca el uso apropiado de los componentes sanguíneos para mejorar los resultados en los pacientes

Estrategias de Patient Blood Management

Optimización de la masa eritrocitaria
Disminución de las pérdidas sanguíneas
Disminución del umbral transfusional

Aproximación multidisciplinaria y multimodal

Implementación de PBM en las instituciones de salud



Pediatric Patient Blood Management Programs: Not Just Transfusing Little Adults



Ruchika Goel ^{a,b}, Melissa M. Cushing ^a, Aaron A.R. Tobian ^{c,*}

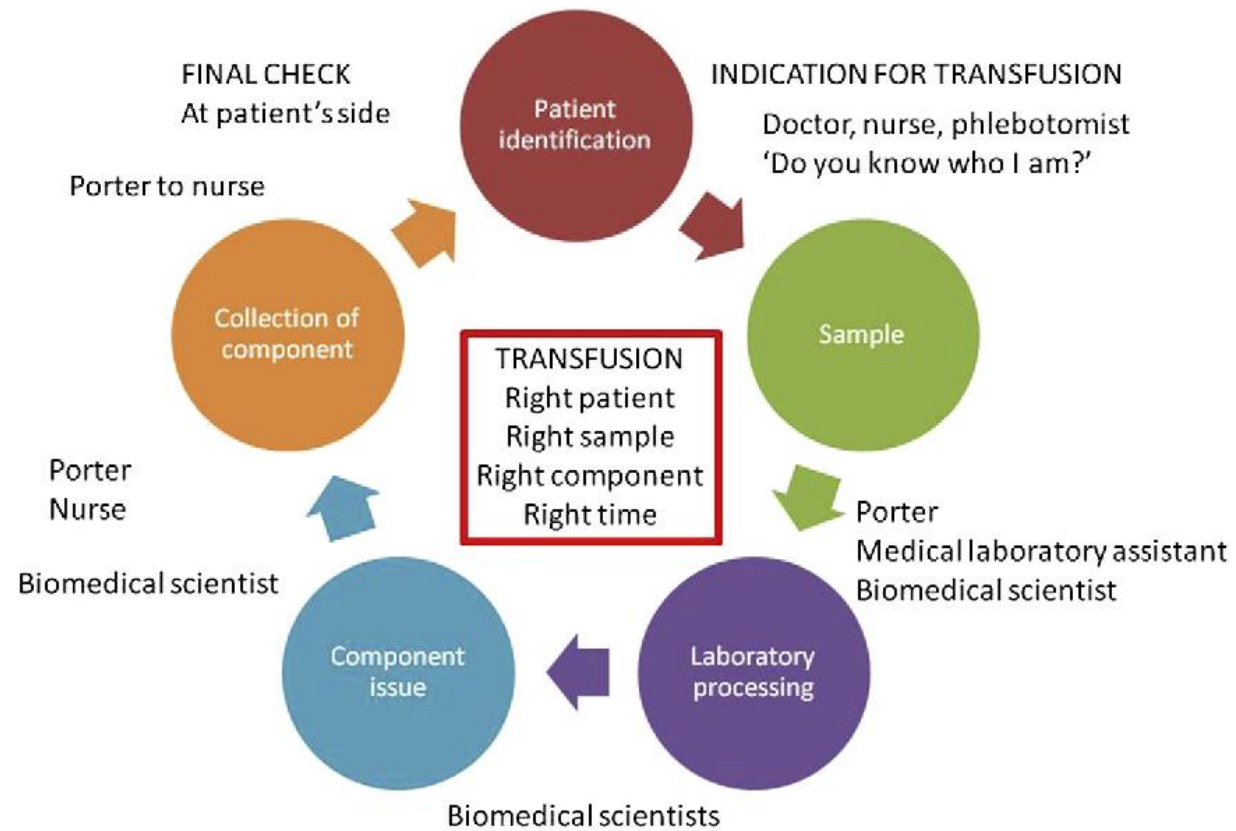
^a Division of Transfusion Medicine, Department of Pathology, New York Presbyterian Hospital, Weill Cornell Medical College, New York, NY

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^c Division of Transfusion Medicine, Department of Pathology, Johns Hopkins University, Baltimore, MD

Patient blood management (PBM) programs strive to optimize the care of patients who need transfusion support. As an adaptation of the “five rights” of medication administration, the transfusion medicine community has appropriately summarized PBM as “transfusing the right product, in the right dose, to the right patient, at the right time for the right reason” [14,15]. A hospitalwide comprehensive, multidisciplinary, and interdepartmental PBM program has the opportunity to optimize patient care, avoid unnecessary transfusions of blood products and limit adverse effects [16]. Successful adult PBM programs are rooted in evidence-based medicine and enhance patient safety and outcomes through measurable improvements [17].

ESTRATEGIA DE PBM



1. COMPONENTE CORRECTO
2. DOSIS CORRECTA
3. PACIENTE CORRECTO
4. TIEMPO CORRECTO
5. RAZON CORRECTA

💡 Patient Blood Management: Improving Outcomes for Millions While Saving Billions. What Is Holding It Up?

Axel Hofmann, Dr rer medic, ME,*† Aryeh Shander, MD,‡§||¶ Neil Blumberg, MD,#
 Jeffrey M. Hamdorf, MD, PhD,* James P. Isbister, MB,** and Irwin Gross, MD††

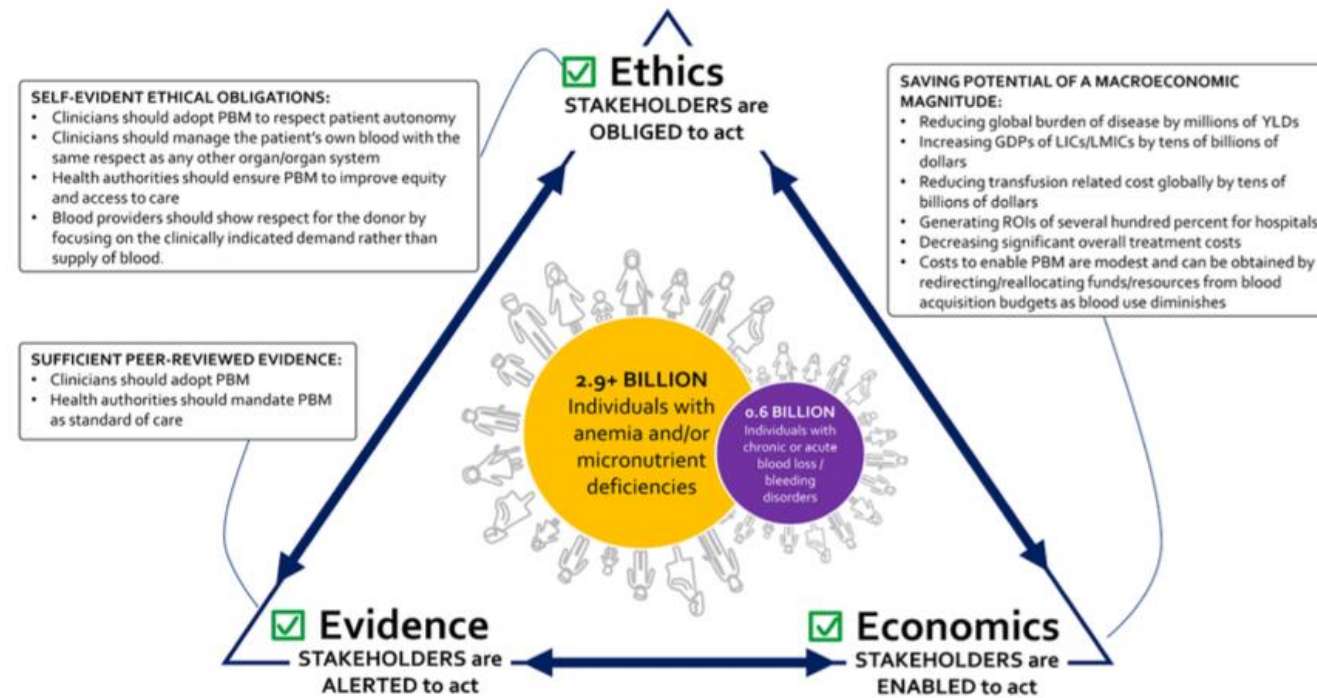


Figure 2. Evidence, economics, and ethics—the “Triple E”—call stakeholders to implement PBM to benefit billions of individuals with anemia/micronutrient deficiencies and both chronic and acute blood loss and bleeding disorders. GDP indicates gross domestic product; LIC, low-income country; LMIC, lower middle-income country; PBM, patient blood management; YLDs, years lived with disability.

**Sobre cada Niño
se debería poner
un cartel que
dijera: Tratar
con cuidado,
contiene sueños**



**Universidad
Pontificia
Bolivariana**



**EL HOSPITAL CON ALMA
Pablo Tobón Uribe**