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How to transfuse a neonate or a pediatric patient?

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Blood Transfusion Medicine

Nayati Medicity, NH-2, Mathura (UP)



Overview

- When to order
- How much to order
- How to transfuse and to monitor
- Liberal Vs restrictive policies



Age group

- In blood bank
 - neonate = up to 4 months of life (immunologically)
 - Infant = till 1 year
 - Older children
 - Transfusion guidelines are 'more liberal' for adults.



When to order a BT



- **Whether** to order a BT at all?
 - Utilization score for a particular category of patient
 - Probability of transfusion
- At what **'trigger'** point?
- At what **time**?



When to order a BT?

- **Whether** to transfuse at all?
 - Blood utilization survey in the institution
 - Specialty wise survey – e.g. hematoncology, pediatric cardiac surgery, emergency department, etc.
 - Benefits
 - Decreases overall cost to the organization and the patient
 - Decreases wastage of blood units
 - Patient satisfaction - Replacement donations from family
 - Rationale blood transfusion



Whether to order a RT?

Pediatric Anesthesia

Pediatric Anesthesia ISSN 1155-5645

ORIGINAL ARTICLE

Table 2 Procedures that did not require a transfusion (C : T equal to infinity)

Table 3 Procedures with a low transfusion rate and high rate of type and screen or crossmatch

Procedure	Total procedures (n)	Total type and screen (n)	Total crossmatch (n)	Number of patients transfused (n)	Transfusion probability	C : T
VP shunt revision	169	49	10	1	0.5	10
Growing rod distraction	63	26	17	4	6.3	4.25

C : T, Crossmatch/transfusion ratio; VP, ventriculoperitoneal.

Elbow open-reduction, internal fixation	88	22	1	0	0	Infinity
Lumbar puncture with chemotherapy	214	5	1	0	0	Infinity
Suboccipital craniectomy with C1 laminectomy	67	29	17	0	0	Infinity
Hip arthrogram	29	8	4	0	0	Infinity
PICC insertion	197	34	7	0	0	Infinity
Tonsillectomy and adenoidectomy	530	15	1	0	0	Infinity

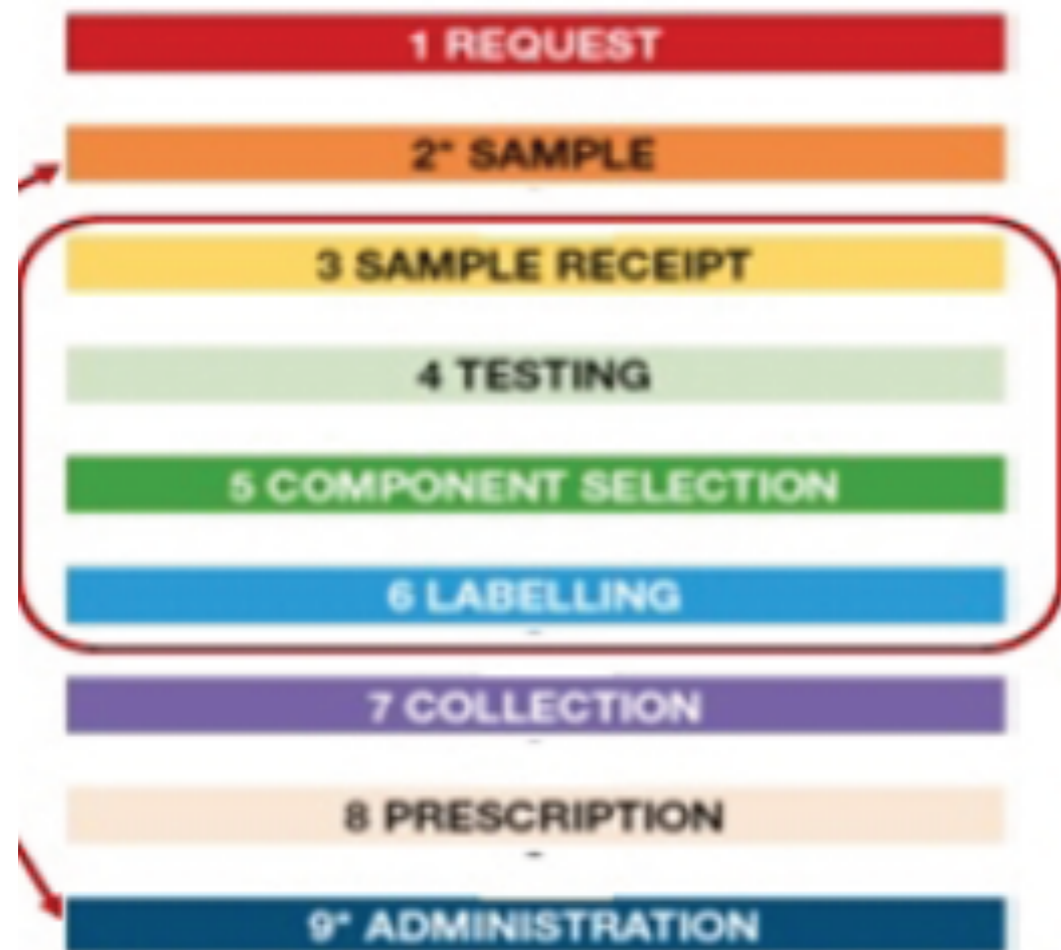
C : T, Crossmatch/transfusion ratio; PICC, peripherally inserted central catheter; VP, ventriculoperitoneal.



When to order a transfusion?

- Guidelines for “**trigger**” – to be discussed

When **(time)** to order a BT?



- BT – a multi step process
- Involves multiple HCW teams
- Consent for BT also takes time
- All HCWs may not understand emergency in BT

When **(time)** to order a BT?

- Know these essential tips for infants till 4 months of age:
 - ✓ Mother's sample is sufficient for crossmatch and antibody screening.
 - ✓ No blood sample may be required for plasma & platelet transfusion if blood group is documented.
 - ✓ If no irregular antibody present – no need for repeat crossmatch - avoid phlebotomy loss.



When to order a BT? – avoid

Blood Transfusion Delay and Outcome in County Hospitals in Kenya

Julius Thomas,^{1*} Philip Ayieko,¹ Morris Ogero,¹ Susan Gachau,¹ Boniface Makone,¹ Wycliffe Nyachiro,¹ George Mbevi,¹ Mercy Chepkirui,¹ Lucas Malla,^{1,2} Jacquie Oliwa,¹ Grace Irimu,¹ and Mike English^{1,2} for the Clinical Information Network

¹*KEMRI-Wellcome Trust Research Programme, Nairobi, Kenya;* ²*Nuffield Department of Medicine, University of Oxford, Oxford, United Kingdom*

* Address correspondence to Julius Thomas, KEMRI-Wellcome Trust Research Programme, P.O. Box 43640-00100, Nairobi, Kenya. E-mail: tjulius@kemri-wellcome.org

Delays in transfusion are common and associated with poor outcomes.

Despite clear transfusion policies and clinical guideline recommendations, the inability to initiate blood transfusion rapidly enough to save lives has been identified as a contributing factor to anemia deaths in sub-Saharan Africa.^{14,19} Considerable investments have been made



When to order a BT? – avoid

Annals of Tropical Paediatrics (1997) 17, 355–359

Predictors of mortality in Gambian children with severe malaria anaemia

K. A. BOJANG, M. BOELE VAN HENSBROEK*, A. PALMER, W. A. S. BANYA*,
S. JAFFAR* & B. M. GREENWOOD*

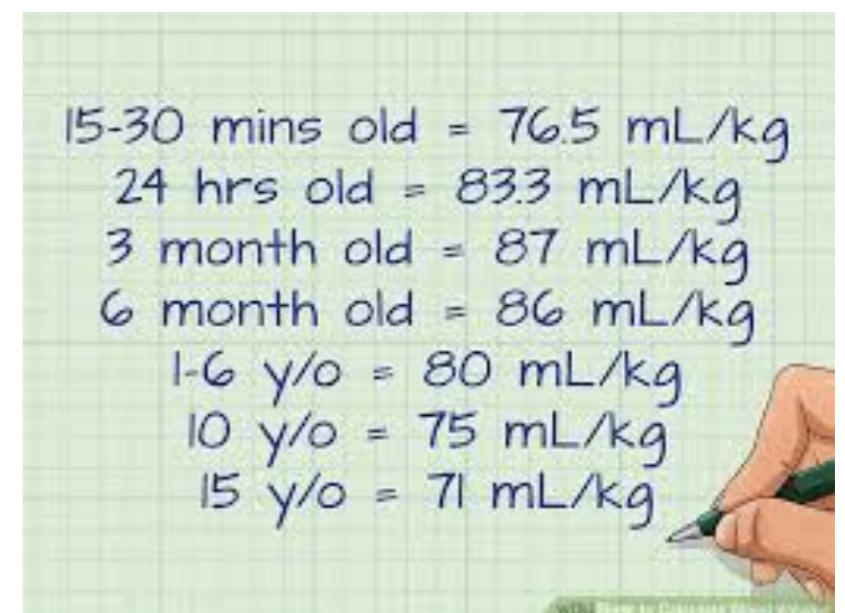
*Department of Paediatrics, Royal Victoria Hospital, Banjul, and *Medical Research Council
Laboratories, Fajara, The Gambia, West Africa*

distress. Twenty-three children died (13%); in 15 cases (65%) death occurred before blood transfusion was given. The presence of respiratory distress was found to be the most important predictor of death. Children with severe malaria anaemia and signs of respiratory distress must therefore be transfused as soon as possible.



How much (blood) to order?

- Weight based manner
 - Small volume = 5-20 ml/ kg
 - Large volume ≥ 25 ml/kg



Hand-drawn table on a green grid background showing blood volume requirements for different ages. A hand is visible at the bottom right, holding a green pen.

15-30 mins old	= 76.5 mL/kg
24 hrs old	= 83.3 mL/kg
3 month old	= 87 mL/kg
6 month old	= 86 mL/kg
1-6 y/o	= 80 mL/kg
10 y/o	= 75 mL/kg
15 y/o	= 71 mL/kg

How much (blood) to order?

- It is a good idea to know the hematocrit of the blood (unit) transfused
 - Whole blood – Hct = $45 \pm 5\%$
 - Additive solution RBC – Hct = $60 \pm 5\%$
 - Packed RBC – Hct = $70 \pm 5\%$
- In newborns –
 - ✓ not necessary to replace ml to ml
 - ✓ Adult RBCs with less O_2 affinity are transfused



How much blood?

**The great tragedy of science – the slaying of
a beautiful hypothesis by an ugly fact.**

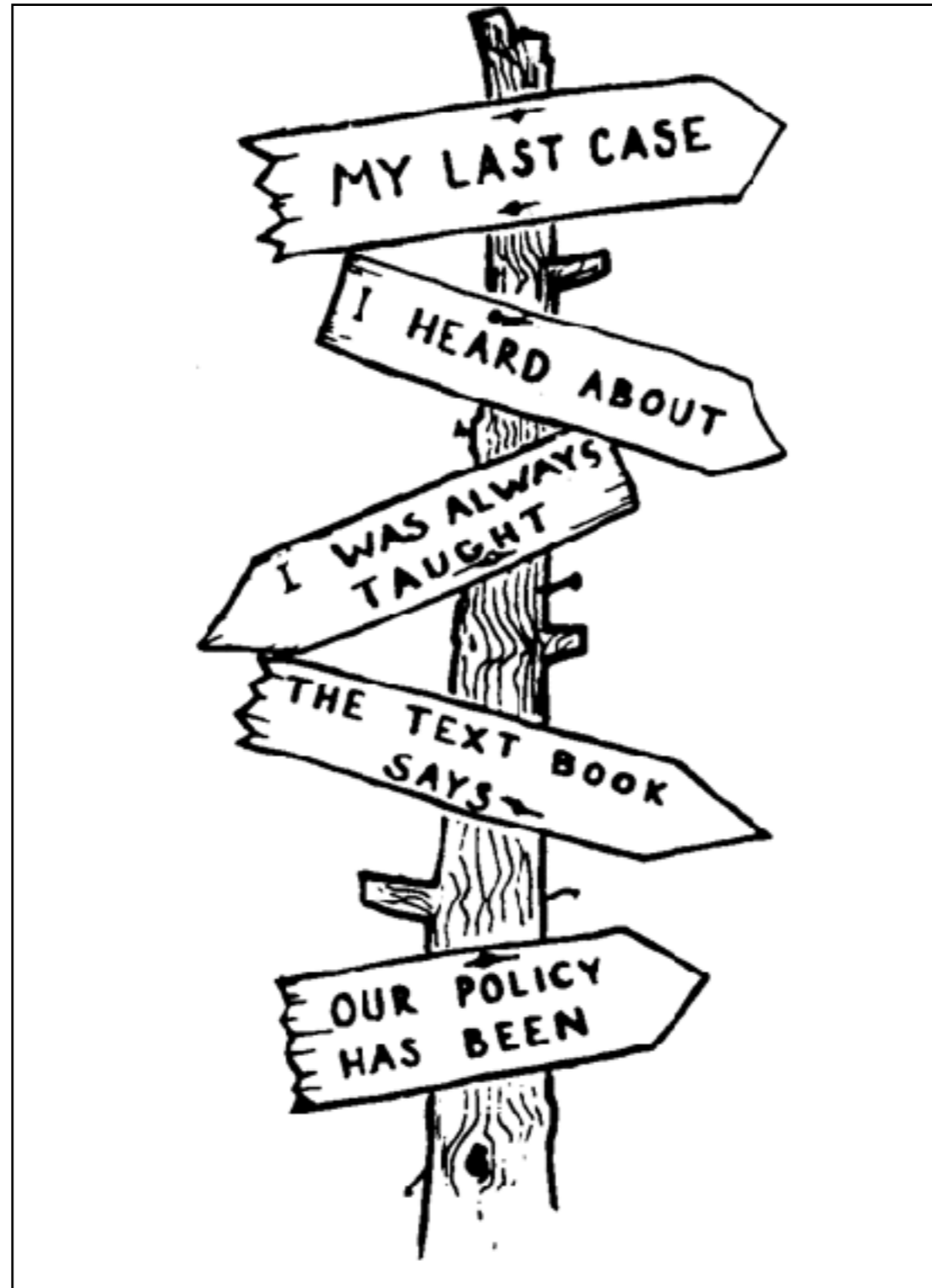
- Thomas H. Huxley



NICU



How do you decide?



How much blood?

Small volume red cell transfusions

Condition	Hematocrit
Severe cardiopulmonary disease (high volume O ₂ requirement, Congenital heart disease causing cyanosis/ CHF)	> 35 to 40%
Moderate cardiopulmonary disease	> 30 to 35%
Major surgery (esp neonates)	> 30 to 35%
Stable anemia (a/w breathing ds/ tachycardia/ poor growth)	> 20 to 25%

Source – Rossi's Principles of Transfusion
Medicine – 5th Edn - 2016



Blood aliquots

Table 46.4 Mean change in blood chemistry levels during RBC transfusions^{28,29}

Value	Change*	
	1 to 21 Days of Storage (<i>n</i> = 78)	22 to 42 Days of Storage (<i>n</i> = 42)
Hematocrit (%)	+12 ± 5	+12 ± 4
Glucose (mg/dL)	-12 ± 24	-16 ± 28
Lactate (mmol/L)	-0.6 ± 1.1	-0.2 ± 0.3
pH	0.00 ± 0.08	0.00 ± 0.06
Calcium (mg/dL)	-0.1 ± 0.5	0.0 ± 0.8
Sodium (mEq/L)	+0.3 ± 4.6	-0.4 ± 4.7
Potassium (mEq/L)	+0.2 ± 0.8	+0.2 ± 0.6



Additive solution – need to worry?

Table 46.3 Quantity (Total mg/kg) of additives infused during a transfusion of 15 mL/kg AS-1, AS-3, or AS-5 RBCs at hematocrit 60%

Additive	AS-1	AS-3	AS-5	Toxic Dose*
Sodium chloride	54.0	24.6	52.6	137 mg/kg/day
Dextrose	132.0	66.0	54.0	240 mg/kg/hour
Adenine	1.6	1.8	1.8	15 mg/kg/dose
Citrate	Trace	37.8	Trace	180 mg/kg/hour
Phosphate	Trace	16.6	Trace	>60 mg/kg/day
Mannitol	45.0	None	31.5	360 mg/kg/day

Source: Rossi's principles of Transfusion Medicine: 5th Edition



Additive solution – need to worry?

RESULTS: Twenty-eight of 47 respondents (60%) accept the use of at least one AS (AS-1, AS-3, or AS-5). Twenty-one (45%) accept the use of all three ASs for neonatal transfusions. Thirty-seven of 45 respondents (82%) do not have a policy requiring washing of RBCs used for low-volume transfusions beyond a specified number of days of storage or days after irradiation.



Age of stored blood – a concern?

- Small-volume/ top-up transfusion

–

???

- Exchange transfusion OR massive transfusion – No debate – give fresh (<5 days old) units



Age of stored blood – a concern?



With “older” blood units

- Less efficient oxygen delivery
- faster clearance of older RBCs *in-vivo*
- Toxicity/ inflammation due to hemolysis/ free iron
- Adverse events - higher infection rates, higher mortality, etc.

Age of stored blood – a

WJCP

World Journal of
Clinical Pediatrics

Submit a Manuscript
Help Desk:
DOI: 10.5406

Original Investigation

Effect of Transfusion of Red Blood Cells With Longer vs Shorter Storage Duration on Elevated Blood Lactate Levels

Dhabangi et al. *Malaria Journal* 2013, **12**:55
<http://www.malariajournal.com/content/12/1/55>



RESEARCH

Open Access

The effect of blood storage age on treatment of lactic acidosis by transfusion in children with severe malarial anaemia: a pilot, randomized, controlled trial

Aggrey Dhabangi^{1*}, Edison Mworozzi², Irene R Lubega², Christine M Cserti-Gazdewich³, Albert Maganda⁴ and Walter H Dzik⁵

ONLINE FIRST

Effect of blood storage age on treatment of lactic acidosis by transfusion in children with severe malarial anaemia: a pilot, randomized, controlled trial

The A



Age of stored blood – a

REVIEW

Red blood cell storage time and transfusion: current practice, concerns and future perspectives

María García-Roa¹, María del Carmen Vicente-Ayuso¹, Alejandro M. Bobes¹, Alexandra C. Pedraza¹,
Ataúlfo González-Fernández¹, María Paz Martín¹, Isabel Sáez², Jerard Seghatchian³, Laura Gutiérrez¹

¹*Department of Hematology, "Instituto de Investigación Sanitaria San Carlos" (IdISSC), "Hospital Clínico San Carlos", Madrid;* ²*"Servicio de Hematología y Hemoterapia", "Hospital Clínico San Carlos", Madrid, Spain;* ³*International Consultancy in Blood Components Quality/Safety Improvement and DDR Strategy, London, United Kingdom*

Blood Transfus 2017; 15: 222-31 DOI 10.2450/2017.0345-16



Age of stored blood – a concern?

- No, but...
- All the studies done so far had technical/ medical limitations.
- Jury is still out
- ...so, both approaches – “fresh” Vs standard – are safe and effective.
- ***Until reliable evidence is available, the use of “young” rather than “old” blood CANNOT be recommended for cardiac, ICU, surgery, trauma or PEDIATRIC patients.***



How to transfuse

MUST – SOP prepared with inputs from all the stakeholders

Essential elements of the SOP:

- ✓ Positive patient identification – most errors happen here
- ✓ TAT – Turn Around Time for blood arrangement
- ✓ Positive blood unit identification
- ✓ Infusion guidelines – vital monitoring frequency, etc
- ✓ non-emergent infusion rates/ drops per minute
- ✓ Sign and symptoms of acute blood reactions –
training

Audit of transfusion practices by blood bank



How to transfuse

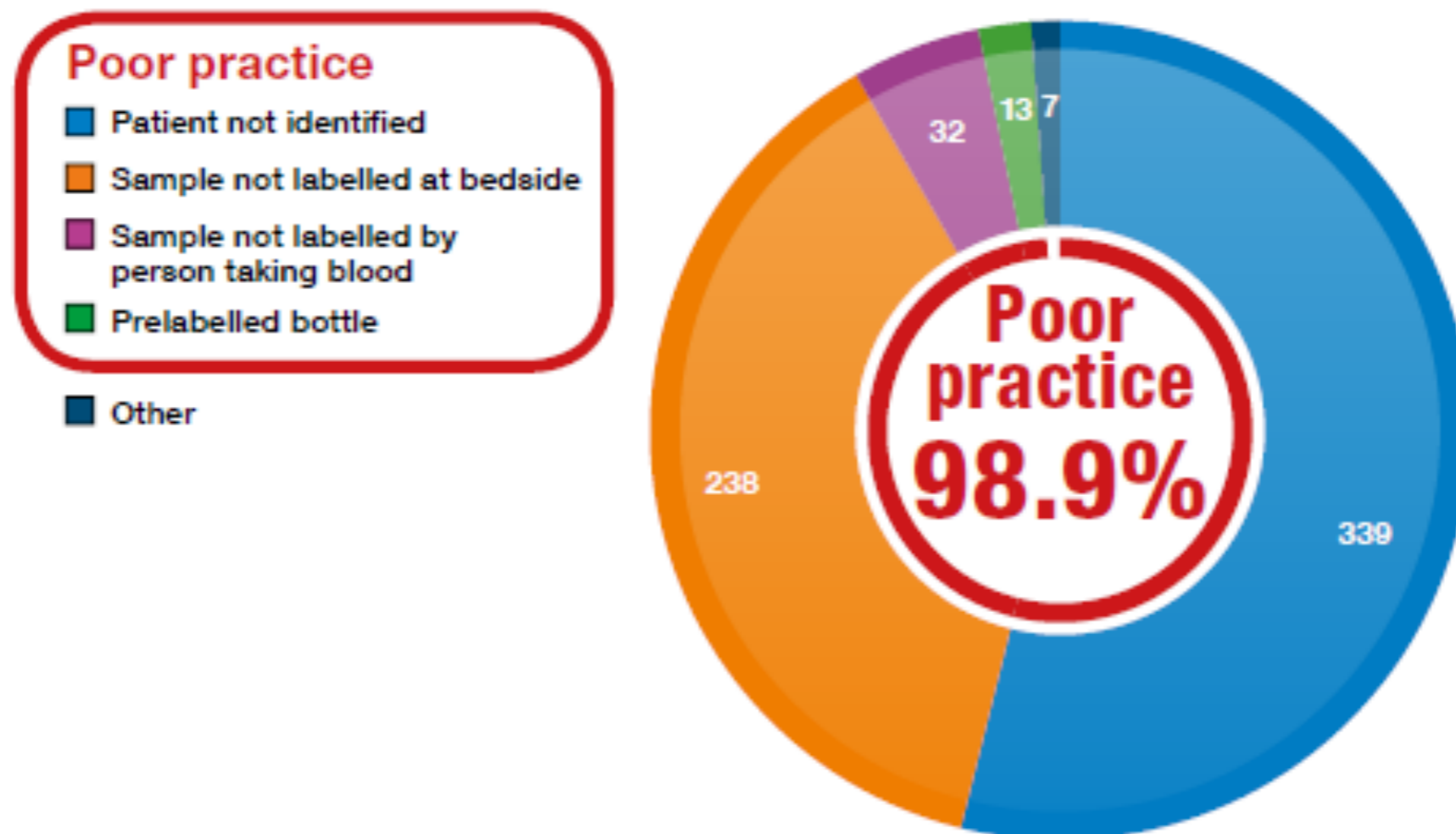
working with

SERIOUS HAZARDS OF TRANSFUSION

SHOT

Affiliated to the Royal College of Pathologists

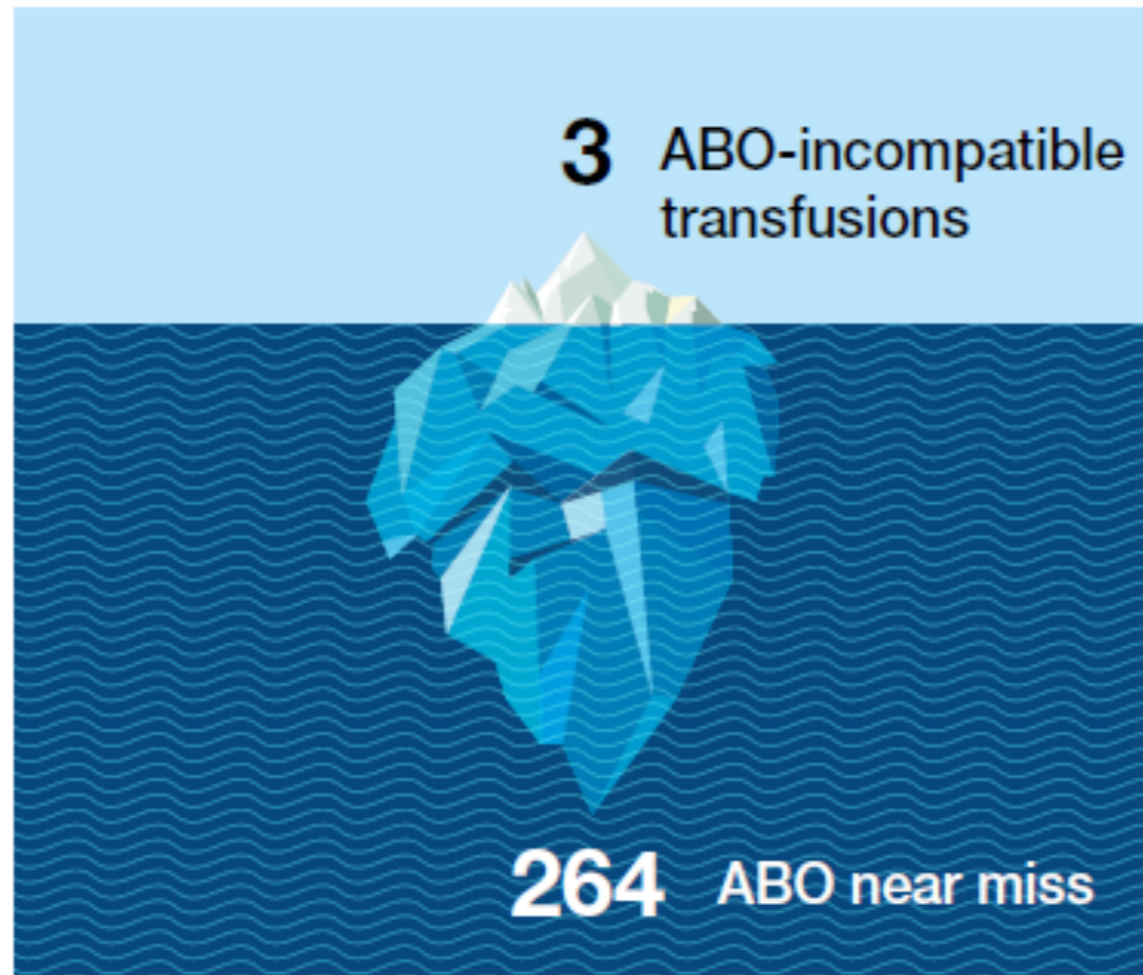
Most near miss incidents are clinical errors



How to transfuse

Key SHOT Message

ABO-incompatible transfusions are the tip of the iceberg; they most commonly result from failure to identify the patient at the time of blood sampling (wrong blood in tube) or administration to the wrong patient.



How to transfuse



Key SHOT messages

Delayed transfusions are an important cause of death, 25/115 (21.7%) 2010 to 2016

Eleven of 21 cases of overtransfusion or undertransfusion reported to SHOT (52.4%) were in paediatric cases, consistent with the complexity of transfusion administration and prescription calculations for neonates and children

How to transfuse

- COMMUNICATE with blood bank doctor for:
 - ✓ Special procedures – irradiation, customized volume, difficult phlebotomy, severe anemia, shock
 - ✓ Fresher units for sick babies – long stay anticipated
 - ✓ G6PD on donor unit
 - ✓ Decreasing cost by avoiding repeated crossmatch, dedicated units

Key SHOT messages

Many errors in transfusion, some with serious clinical consequences, relate to **poor communication** between teams, shifts and interfaces. The infrastructure needs improvement to facilitate exchange of results within and between hospitals



How to transfuse

- Key points
 - ✓ Ask only desired volume
 - ✓ Positive patient identification
 - ❖ At the time of blood sampling –avoid WBIT
 - ❖ At the time of blood transfusion
 - ✓ Two person check before starting BT
 - ✓ Careful with syringe pumps
 - ✓ Standard BT set (170 micron) is must always – even with syringe pumps. Pediatric sets are good.
 - ✓ Use in-line warmers for NICU patients
 - ✓ Do not STORE in NICU/ PICU – bacterial contamination

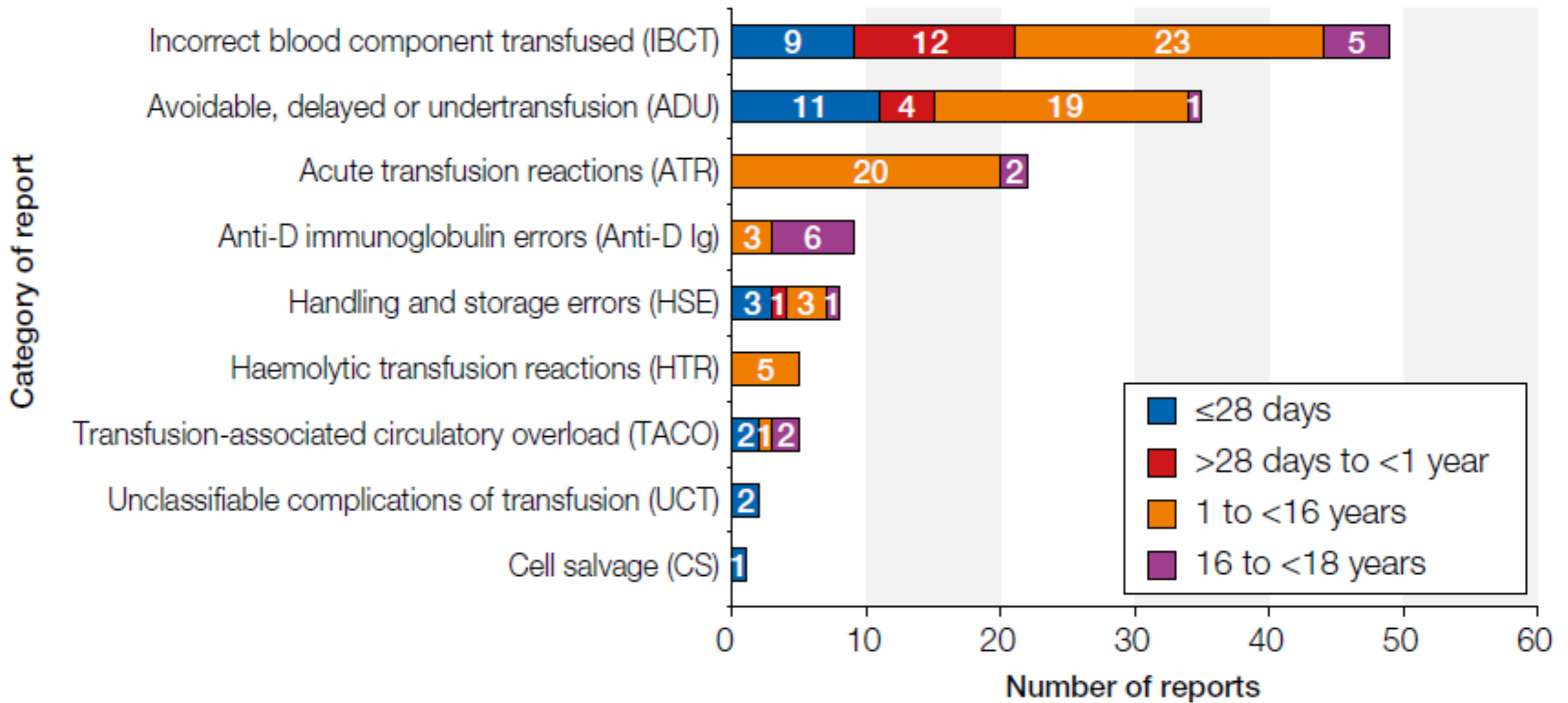


How to transfuse

- Preadministration check (must be a doctor):
 - ✓ The type of component prescribed
 - ✓ Any special requirement – irradiation, etc.
 - ✓ Any pre-medication needed – e.g. diuretic
 - ✓ Consent of parents/ guardian
 - ✓ Transfusion rate:
 - lack of clinical studies in neonates
 - Risk of IVH with rapid infusion – not proven
 - Transfuse over 2-4 hours in non-emergent cases



How to transfuse



How to monitor?

- Observe closely & have facility to resuscitate
- Monitor vitals &/ or observe patient
 - Just before asking for blood and then starting BT
 - Every 5 min for first 15 minutes
 - 30 minutes for next 1 hour
 - 60 minutes thereafter till complete BT given
 - 4 hours after completion



How to monitor?

Patient Safety Events During Pediatric Hospitalizations

Marlene R. Miller, MD, MSc*§; Anne Elixhauser, PhD‡; and Chunliu Zhan, MD, PhD*

Pediatrics 2003;111:1358–1366;

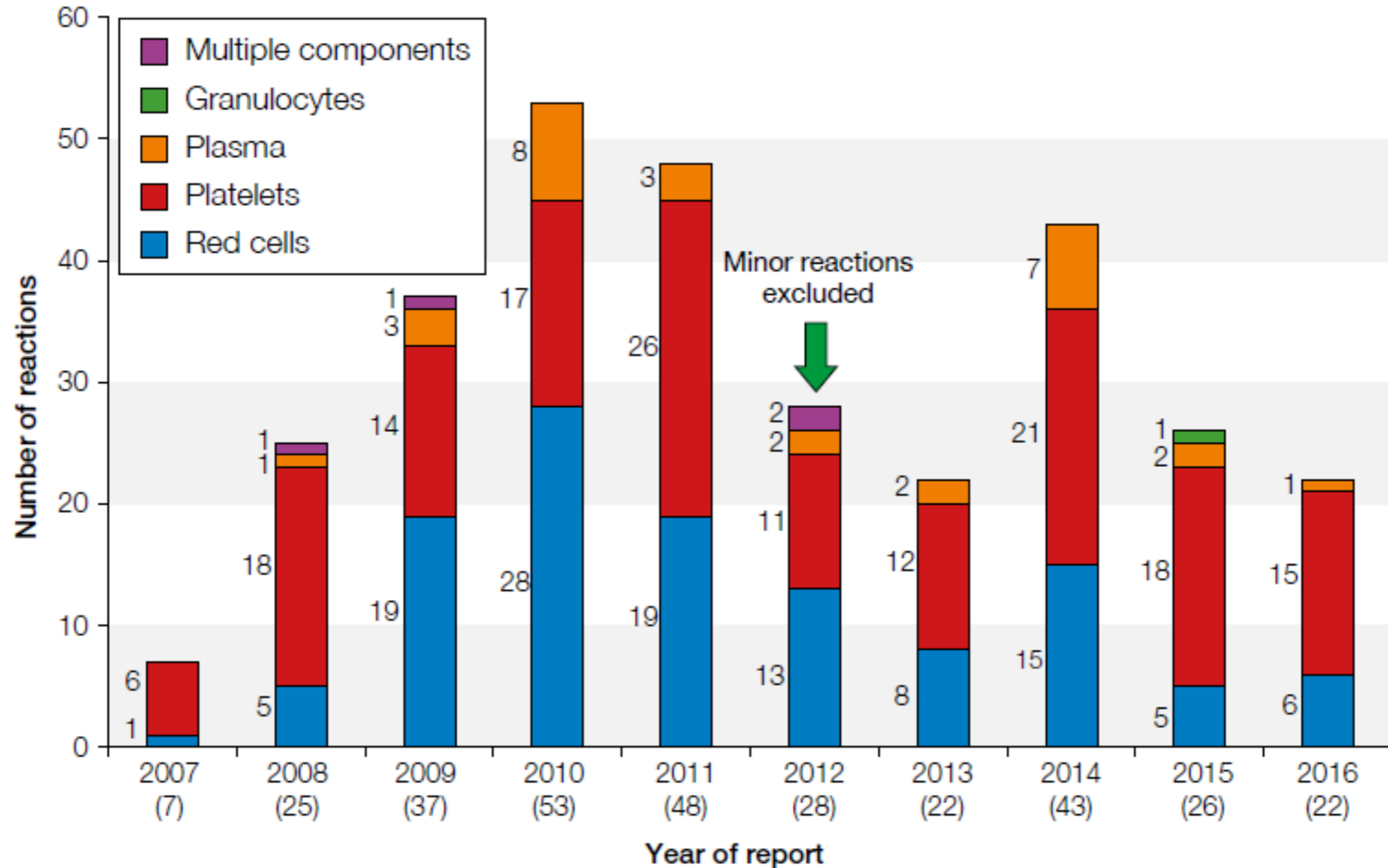
TABLE 3. Comparison of Outcomes for Records With PSI Events Versus Records Without PSI Events

PSI Group	Median Length of Stay (Days)			% Inhospital Mortality			Median Total Charges (Dollars)		
	With PSI	No PSI	<i>P</i>	With PSI	No PSI	χ^2 <i>P</i>	With PSI	No PSI	<i>P</i>
Transfusion reaction§	4.0	2.0	.0001	3.6	.4	.0001	9517	1704	.0001
Postoperative infection‡	10.0	2.0	.0001	2.4	.3	.0001	22 445	6409	.0001
Transfusion reaction§	4.0	2.0	.0001	3.6	.4	.0001	9517	1704	.0001
Foreign body§	8.0	2.0	.0001	1.3	.4	NS	16 897	1704	.0001
Infection attributed to procedure§	9.0	2.0	.0001	1.1	.4	.035	19 855	1704	.0001
Iatrogenic conditions§	9.0	2.0	.0001	7.2	.4	.0001	40 285	1702	.0001
Wound disruption§§	13.0	2.0	.0001	4.1	.4	.0001	30 831	1663	.0001
Miscellaneous misadventures§	6.0	2.0	.0001	6.1	.4	.0001	20 026	1703	.0001
Obstetrical misadventures¶	4.0	2.0	.0001	.4	.0	.0001	7719	3837	.0001
Birth trauma**	2.0	2.0	.0001	1.0	.4	.0001	1107	1061	.0001
E codes††	4.0	2.0	.0001	2.3	.4	.0001	10 267	1807	.0001



How to monitor?

b. Paediatric acute transfusion reactions by component type



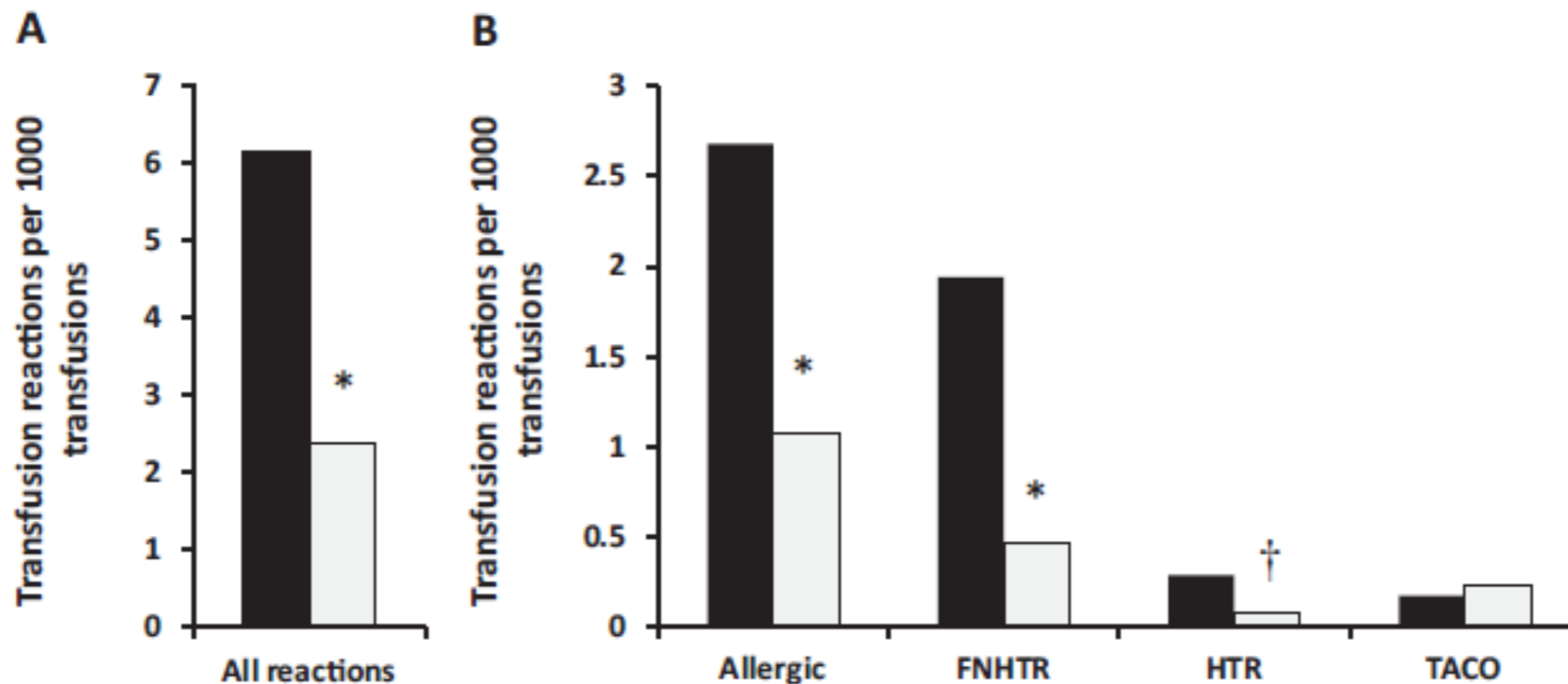
How to monitor?

TRANSFUSION COMPLICATIONS

Transfusion reactions in pediatric compared with adult patients: a look at rate, reaction type, and associated products

Volume 55, March 2015 TRANSFUSION

Fredrick D. Oakley,¹ Marcella Woods,² Shanna Arnold,^{1,3} and Pampee P. Young^{1,3}



How to monitor?

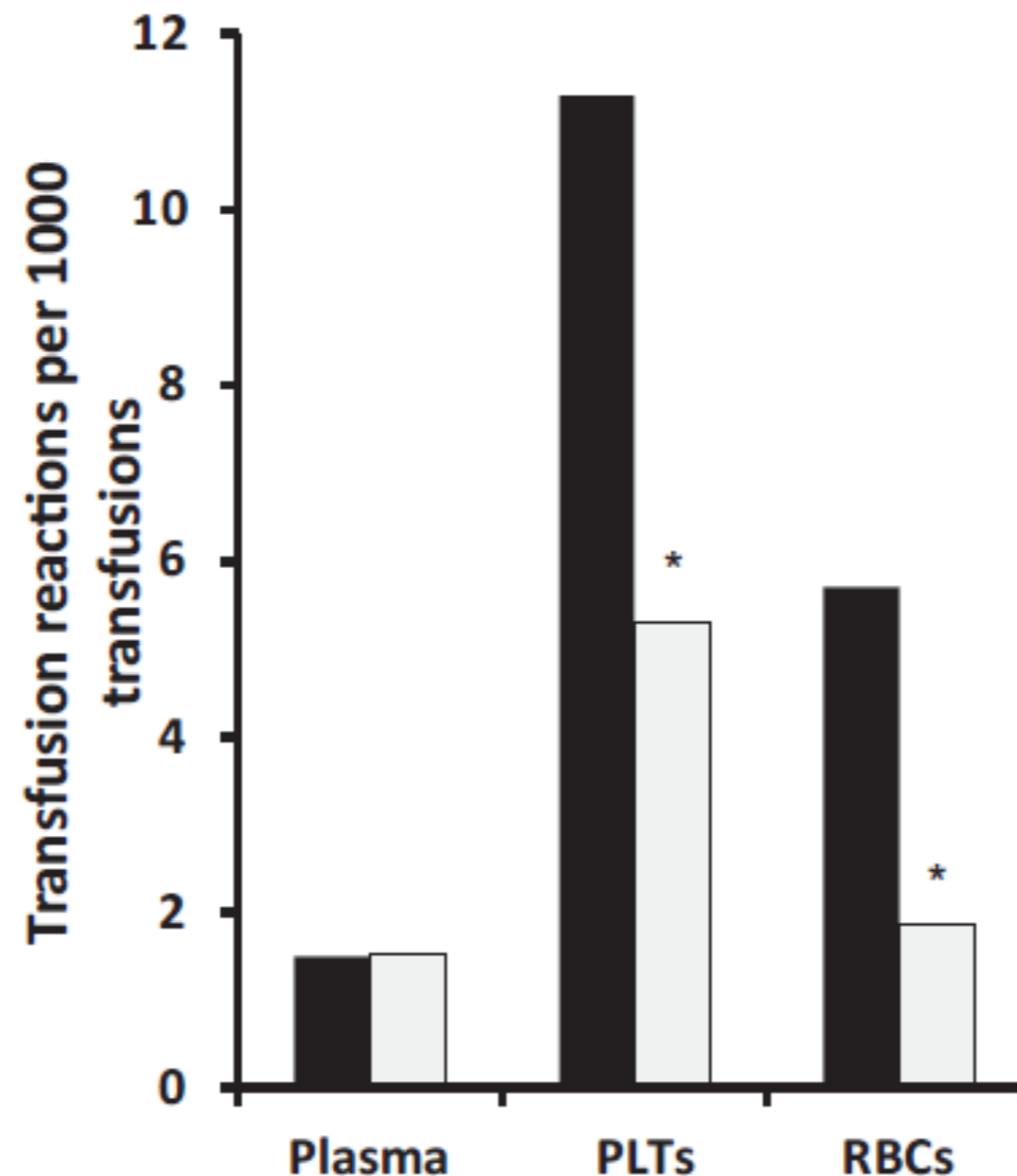
TRANSFUSION COMPLICATIONS

Transfusion reactions
a look at r

Fredrick D. Oul

In adult patients:
all products

Wesley P. Young^{1,3}



Pediatric
Adults



Liberal Vs restrictive transfusion policies

Randomized Trial of Liberal Versus Restrictive Guidelines for Red Blood Cell Transfusion in Preterm Infants

Edward F. Bell, MD*; Ronald G. Strauss, MD*‡; John A. Widness, MD*; Larry T. Mahoney, MD*;
Donald M. Mock, MD, PhD§||; Victoria J. Seward, MD*; Gretchen A. Cross, RN*; Karen I. Johnson, RN*.

THE PREMATURE INFANTS IN NEED OF TRANSFUSION (PINT) STUDY: A RANDOMIZED, CONTROLLED TRIAL OF A RESTRICTIVE (LOW) VERSUS LIBERAL (HIGH) TRANSFUSION THRESHOLD FOR EXTREMELY LOW BIRTH WEIGHT INFANTS

HARESI KIRPALANI, MSc, FRCP(UK),¹ ROBIN K. WILYTE, MB, FRCP(C),¹ CLAUD ANDERSEN, MBBS, FRACP,
ELIZABETH V. ASZTALOS, MSc, FRCP(C), NANCY HEDDLE, MSc, MORRIS A. BLAJCHMAN, MD, FRCP(C),
ABRAHAM PELIOWSKI, MD, FRCP(C), ANGEL RIOS, MD, MEENA LACORTE, MD, ROBERT CONNELLY, MD, FRCP(C),
KEITH BARRINGTON, MB, FRCP(C), ROBIN S. ROBERTS, M.TECH, FOR THE PINT INVESTIGATORS*



Liberal Vs restrictive transfusion policies

Journal of Tropical Pediatrics, 2017, 0, 1–8
doi: 10.1093/tropej/fmx037
Original paper



ORIGINAL PAPER

Comprehensive Analysis of Liberal and Restrictive Transfusion Strategies in Pediatric Intensive Care Unit

by Basak Akyildiz^{1*}, Nazan Ulgen Tekerek¹, Ozge Pamukcu², Adem Dursun¹, Musa Karakukcu³, Nazmi Narin², Mehmet Yay⁴ and Ferhan Elmali⁵

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Liberal Vs restrictive transfusion policies

Methods: A total of 180 children requiring packed red blood cells (PRBCs) were randomized into two groups: the liberal transfusion strategy group (transfusion trigger < 10 g/dL, Group 1) and the restrictive transfusion strategy group (transfusion trigger ≤ 7 g/dL, Group 2). Basal variables including venous/arterial hemoglobin, hematocrit and lactate levels; stroke volume; and cardiac output were recorded at the beginning and end of the transfusion. Oxygen saturation, noninvasive total hemoglobin, noninvasive total oxygen content, perfusion index (PI), heart rate and systolic and diastolic blood pressures were assessed via the Radical-7 Pulse co-oximeter (Masimo, Irvine, CA, USA) with the Root monitor, initially and at 4 h.

Results: In all, 160 children were eligible for final analysis. The baseline hemoglobin level for the PRBC transfusion was 7.38 ± 0.98 g/dL for all patients. At the end of the PRBC transfusion, cardiac output decreased by 9.9% in Group 1 and by 24% in Group 2 ($p < 0.001$); PI increased by 10% in Group 1 and by 45% in Group 2 ($p < 0.001$). Lactate decreased by 9.8% in Group 1 and by 31.68% in Group 2 ($p < 0.001$).

Conclusion: Restrictive blood transfusion strategy is better than liberal transfusion strategy with regard to the hemodynamic and laboratory values during the early period. PI also provides valuable information regarding the efficacy of PRBC transfusion in clinical practice.

no relationship between mortality and transfusion





NICU
300



Take home message

- Order blood judicious and ascertain timely transfusion – delay can be fatal.
- Follow BT guidelines – think global act local
- Formulate and stick to BT SOPs. Errors are on rise and can be fatal.
- BT reaction frequency is higher in pediatric pts
- Restrictive transfusion is equally good
- What's in age! - Blood units are ever young.





Thank you