NEONATAL AND PEDIATRIC TRANSFUSION MEDICINE

Dr. Lani Lieberman

Transfusion Camp Day 1

Friday September 17th, 2021

U of T

UHN Toronto General Toronto Western Princess Margaret Toronto Rehab
COURAGE LIVES HERE

Sunnybrook
HEALTH SCIENCES CENTRE
when it matters MOST

Objectives

- Highlight special considerations when ordering blood products for neonates and children

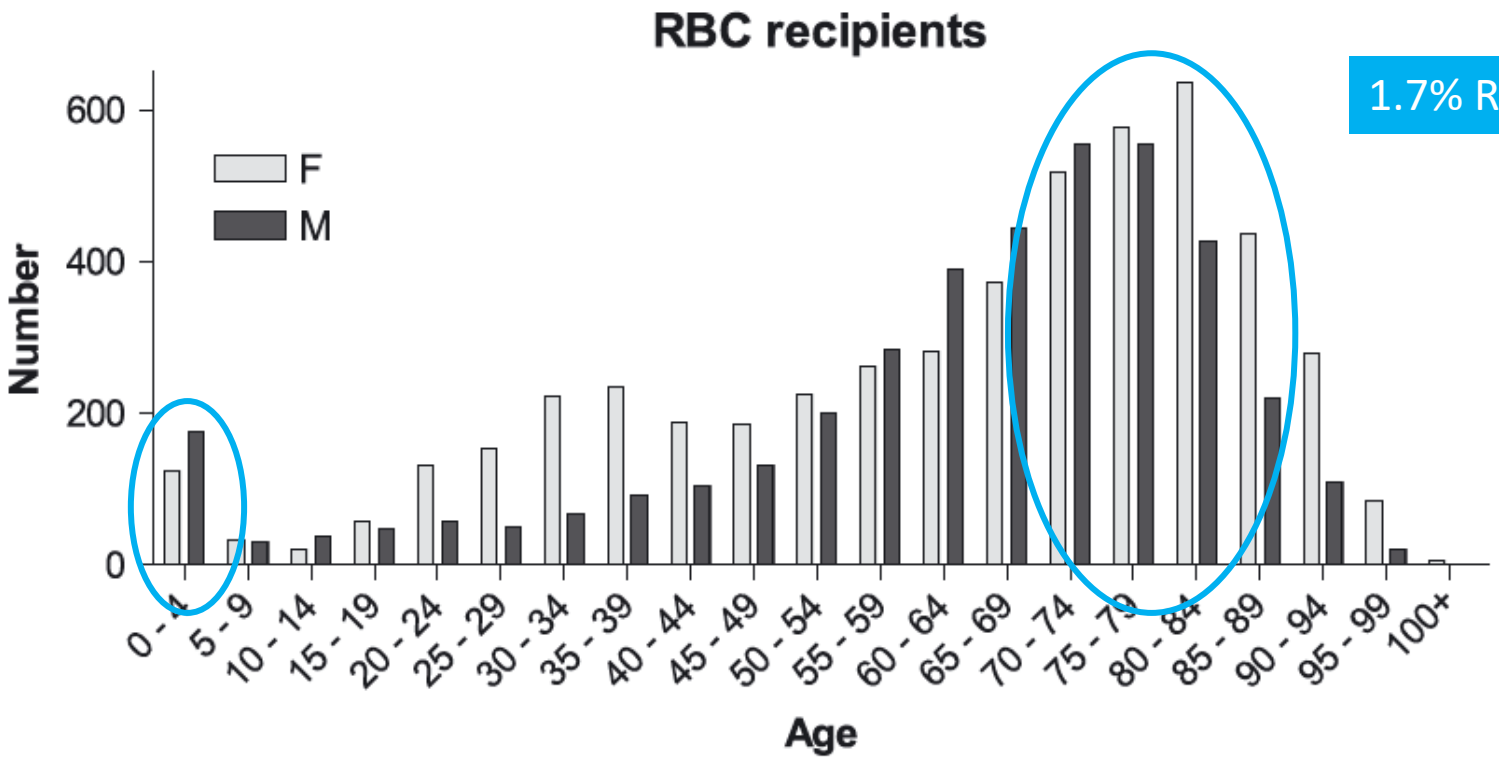
- Cases
  - PRBC
  - Platelet

- We will not be discussing
  - Use of plasma, cryoprecipitate or fractionated products
  - Intrauterine transfusions
  - Exchange transfusions
  - Blood product use in cardiac surgery

What proportion of blood supply is transfused to children?

4.2% RBC < 18 yo

1.7% RBC < 12 mo



Transfusion Medicine 2009; 19: 315–328

Evidence based pediatric transfusion

- Limited
- Guidelines
  - Extrapolated from adult data
  - Expert opinion
  - Audit data

bjh guidelines

Guidelines on transfusion for fetuses, neonates and older children

Helen V. New,[1,2] Jennifer Berryman,[3] Paula H. B. Bolton-Maggs,[4] Carol Cantwell,[2] Elizabeth A. Chalmers,[5] Tony Davies,[6] Ruth Gottstein,[7] Andrea Kelleher,[8] Sailesh Kumar,[9] Sarah L. Morley[10] and Simon J. Stanworth,[11] on behalf of the British Committee for Standards in Haematology

BJH 2016; 175: 784-828

5 things to consider prior to ordering a transfusion for a neonate or child

1. Blood recipients: similar to adult
   - Oncology, hemoglobinopathy, OR, ICU

2. Consent - should be obtained from child's legal guardian (unless the child has capacity to consent)

3. Lab reference ranges are different for children and neonates

Newborn laboratory values

Transfusion 2014; 54, 627-632
Blood 1987; 70: 165-72.
Blood 1988; 72:1651–7.

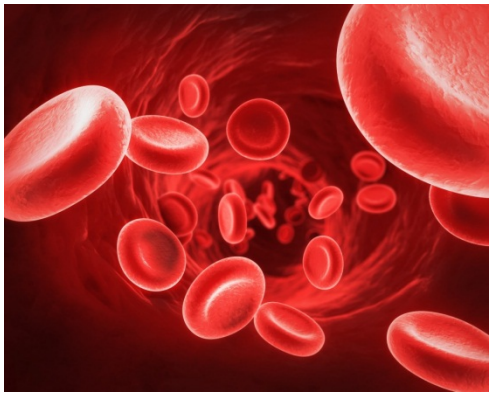


Table 1. Normal values for hemoglobin concentration and MCV in infancy and childhood. Adapted from Nathan and Orkin.[11]

	Hemoglobin (g/L)		Hematocrit		MCV (fl)	
Age	Mean	–2 SD	Mean	–2 D	Mean	–2 D
1–3 days	185	145	0.56	0.45	108	95
3–6 months	115	95	0.35	0.29	91	74
0.5–2 years	120	105	0.36	0.33	78	70
2–6 years	125	115	0.37	0.34	81	75
6–12 years	135	115	0.40	0.35	86	77

MCV, mean corpuscular volume.

HEMOGLOBIN:168 (137-201 g/dl)

MCV:110 fl/cell
(adult levels by 9 weeks)

Table 1 Infant reference ranges of common coagulation tests

Gestational age	<28 weeks[4]	28–34 weeks[4]	30–36 weeks[8]	Term infants[13]
Reference range—PT (s) 95th centile	>21	>21	>16	>16
Reference range—aPTT (s) 95th centile	>64	>57	>55	>55
Fibrinogen level (5th–95th centile, g/dL)	0.71–5.35	0.87–4.70	2.25–3.41	1.50–3.73

Reference ranges are taken from the Christensen *et al*[4] paper for neonates <34 weeks' gestation and from the Andrew *et al*[8 13] paper for those 30–36 weeks' gestation and term infants.
aPTT, activated partial thromboplastin time; PT, prothrombin time.

5 things to consider prior to ordering a transfusion for a neonate or child

1. Blood recipients: similar to adult
   - Oncology, hemoglobinopathy, OR, ICU

2. Consent should be obtained from responsible adult (unless the child has capacity to consent)

3. Lab reference ranges differ for children

4. Blood products should always be ordered by weight

Blood Products are ordered by weight (ml/ kg)

Product	Pediatric Dose (ml/kg)
RBC	10-15 ml/ kg
Platelets	10-15 ml/kg
Plasma	10-15 ml/kg
Cryoprecipitate*	1-2 U/10 kg

BJH 2016; 175, 784-828

Blood Products are ordered by weight (ml/ kg)

Product	Pediatric Dose (ml/kg)	Typical Adult Dose
RBC	10-15 ml/ kg	1 Unit ≈ 280-300 mL
Platelets	10-15 ml/kg	1 Unit ≈ 250-350 ml
Plasma	10-15 ml/kg	3-4 Units ≈ 750-1000ml
Cryoprecipitate*	1-2 U/10 kg	Adult Pool 150-200ml

Cryoprecipitate*

- Each unit = 8 -15 ml
- Adult Pool = 150 - 200 ml
- 8-10 units + 50cc NS

Maximum order for non-bleeding

- No more than adult dose

BJH 2016; 175, 784-828

5 things to consider prior to ordering a transfusion for a neonate or child

1. Blood recipients: similar to adult
   - Oncology, hemoglobinopathy, OR, ICU
2. Consent should be obtained from responsible adult (unless the child has capacity to consent)
3. Lab reference ranges differ for children
4. Blood products should always be ordered by weight
5. Irradiation guidelines – prevent TA-GVHD

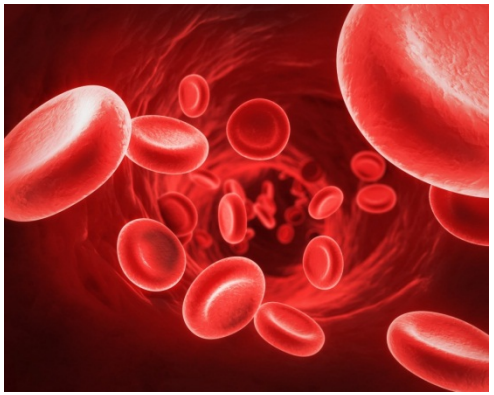
Indications for irradiation

Indications		
Neonates		
Exchange transfusion		Previous IUT until 6 month post delivery
Small volume top up transfusion		Very low birthweight infants Previous intrauterine transfusion
Congenital severe T cell immune deficiency		
Complex congenital cardiac abnormalities		*only if clinical and lab features consistent with T lymph def

Hematology/ Oncology indications = same as adult recommendations

http://www.nacblood.ca
National Advisory Committee

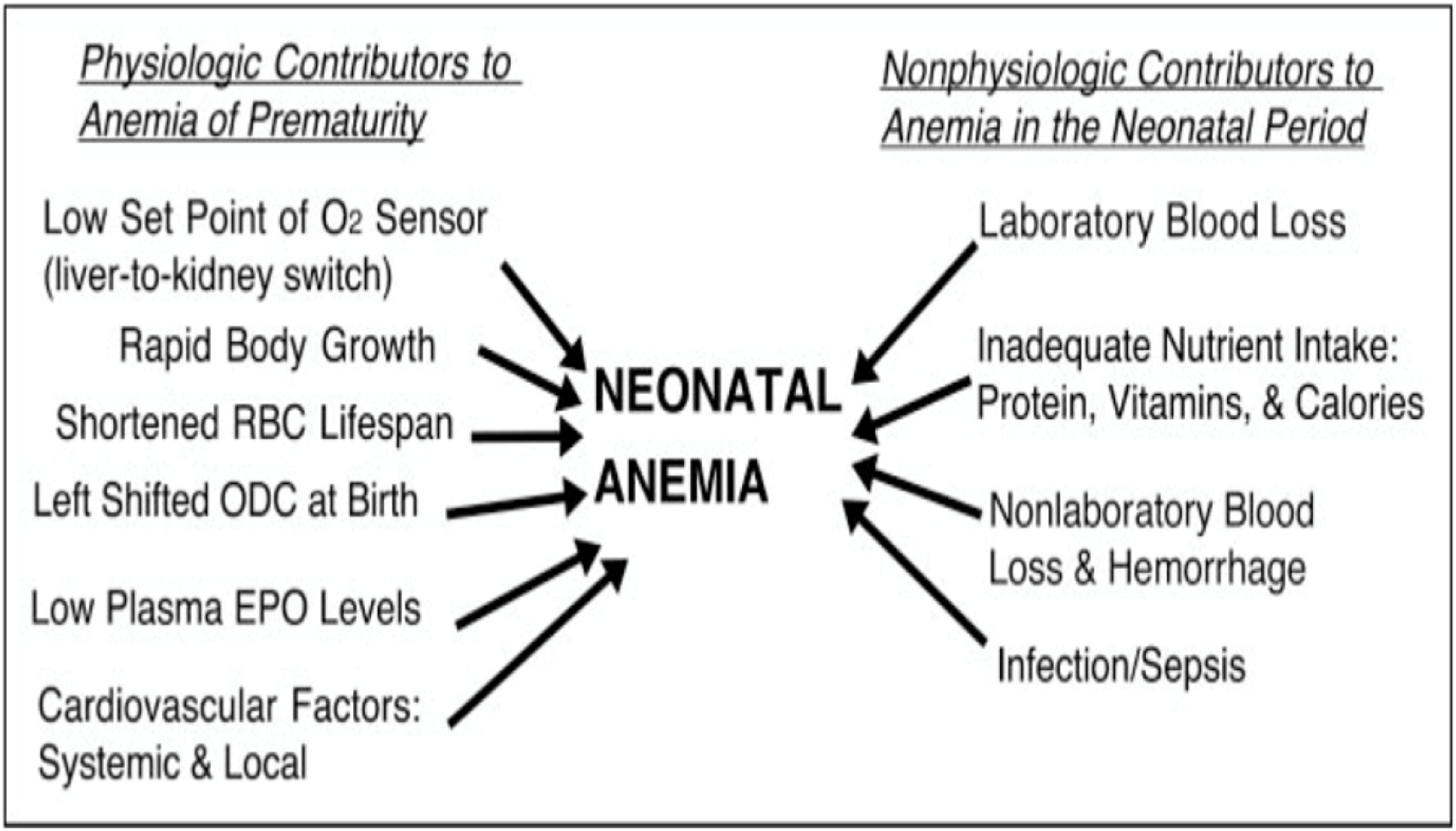
RED BLOOD CELL TRANSFUSIONS



Case: Neonatal Anemia

- 25 week premature– 10 days old
- Intubated, NG fed, antibiotics, Grade 2 IVH
- Daily bloodwork since admission
- Hemoglobin has been gradually ↓
- 150 g/L .....80 g/L

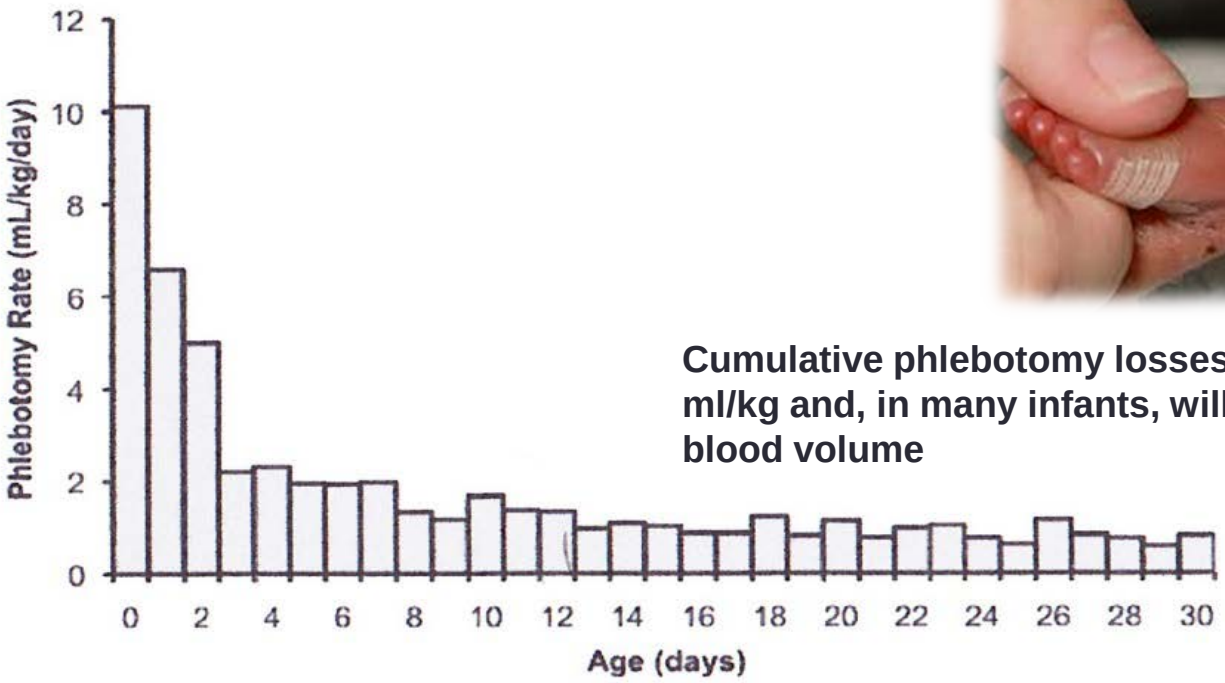
Neonatal Anemia



Widness et al. NeoReviews 2008; 9 (11) e520

Phlebotomy Blood Loss in Very Low Birth Weight (VLBW) Infants (< 1500 grams)

Phlebotomy Blood Loss in VLBW Babies



Cumulative phlebotomy losses typically reach 40-80 ml/kg and, in many infants, will exceed the infant's blood volume

Freise KJ and Widness JA, *J Pharmacol Exp Ther* 20

RBC transfusions in ELBW infants

- 50-80% of ELBW infants receive one or more RBCT during hospitalizations

Vlalieva et at. J Pediatr 2009; 155 (3): 331-337
Keir et al. Transfusion 2015; 55:1340-6

RBC Transfusion

- Increased O_2 supply to brain
- Decreased risk of apnea of prematurity frequency & severity

- Intraventricular hemorrhage
- Necrotizing enterocololitis
- Bronchopulmonary dysplasia
- Retinopathy of prematurity

Christensen et al. J Matern Fetal Neonatal Medicine. 2013; 26 (s2):60-63
Mohamed A, Shah PS. Pediatrics 2012; 129 (3): 529-540
Ghirardello S et al. Am J Perinatology. 2017; 34 (1):88-95
Slidsborg C et al. Ophthamology.2016; 123(4):796-803.

Neonatal pediatric RBC transfusion trials

PINT

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

HARESH KIRPALANI, MSC, FRCP(UK),[1] ROBIN K. WHYTE, MB, FRCP(C),[1] CHAD 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*

Short term
No statistically significant difference in death or morbidity

IOWA/ BELL

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. Cress, RN*; Karen J. Johnson, RN*; Irma J. Kromer*; and M. Bridget Zimmerman, PhD¶

Kirpalani et al. J Peds. 2006; 149:301-7
Bell et al. Pediatrics 2005; 115: 1685-1691

Iowa Trial: Severe IVH and Cystic (Periventricular Leukomalacia) PVL

	Liberal	Restrictive	*P*
Grade-4 IVH	0	4	0.054
Cystic PVL	0	4	0.115
Grade-4 IVH or cystic PVL	0	6	0.012

Caution: Composite outcome combining grade-4 IVH and PVL was not planned; small numbers

Long Term Follow up Data - Cognitive

	PINT	Bell (Iowa)
Age at follow up	18-21 months	8-15 years
Cognitive testing	Better in LIB group	Better in RES group

Conflicting results – leads to variability in practice

Whyte et al. Pediatrics 2009; 123(1):207-213
McCoy et al. Child Neuropsychology, 2011; 17 (4): 347–367

JAMA | Original Investigation

Effects of Liberal vs Restrictive Transfusion Thresholds on Survival and Neurocognitive Outcomes in Extremely Low-Birth-Weight Infants
The ETTNO Randomized Clinical Trial

Axel R. Franz, MD; Corinna Engel, PhD; Dirk Bassler, MD; Mario Rüdiger, MD; Ulrich H. Thome, MD; Rolf F. Maier, MD; Ingeborg Krägeloh-Mann, MD; Martina Kron, PhD; Jochen Essers, MD; Christoph Bührer, MD; Georg Rellensmann, MD; Rainer Rossi, MD; Hans-Jörg Bittrich, MD; Claudia Roll, MD; Thomas Höhn, MD; Harald Ehrhardt, MD; Stefan Avenarius, MD; Hans Thorsten Körner, MD; Anja Stein, MD; Horst Buxmann, MD; Matthias Vochem, MD; Christian F. Poets, MD; for the ETTNO Investigators

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Higher or Lower Hemoglobin Transfusion Thresholds for Preterm Infants

H. Kirpalani, E.F. Bell, S.R. Hintz, S. Tan, B. Schmidt, A.S. Chaudhary,

Methodology ETTNO

Inclusion
BWt 400-999g
GA <29 wks
Postnatal:

1013 neonates

Trigger varies by
: Postnatal age &
Critical state of
health

Liberal threshold = 492

Restrictive threshold = 521

RBC 20
ml/kg
Leucocyte
reduced

Exclusion

1. Major anomalies (cyanotic heart disease, chromosomal anomalies, syndromes) or malformations needing surgery
2. Lack of viability/comfort car
3. First neonate of multiples pregnancy

Death or Neurological impairment at 24 months

Secondary outcomes

Other measures of cognitive deficit
Measures of growth @ D/C & FU
Length of stay
Time from birth to dc respiratory support, resp stimulant gavage feeds
Complications of prematurity

Transfusion thresholds (ETTNO)

Table 1. Red Blood Cell Transfusion Hematocrit Trigger Thresholds

	Red blood cell transfusion threshold, %[a]			
	Liberal		Restrictive	
Postnatal age	Critical health state	Noncritical health state	Critical health state	Noncritical health state
From randomization to 7 d after birth[b]	<41	<35	<34	<28
8-21 d	<37	<31	<30	<24
>21 d	<34	<28	<27	<21

- Critical health
- Exceptions to guidelines were permitted

Methodology TOP

Inclusion
BWt < 1000 g
GA 22 -29 weeks
Postnatal: < 48 hours

1824 neonates

Transfusion thresholds: postnatal age & respiratory support

Liberal threshold

Restrictive threshold

Exclusion

1. Cyanotic heart disease
2. Received IUT
3. Lack of viability
4. Parent with hgbopathy or
5. congenital anemia
6. RBCtxn within 6 hours of life
7. Twin- twin transfusion
8. Isoimmune hemolytic disease
9. Concerns re: follow up
10. RBC txn within 6 hours of life
11. Congenital condition

RBC 15 ml/kg

Death +/- Neurodevelopmental impairment at 22-26 months

Secondary outcomes

Other measures of cognitive deficit
Measures of growth
Survival without complications of prematurity
Number of RBC txns
Administration of RBC as per protocol
Length of stay

Transfusion thresholds (TOP)

Table S2. Intervention Algorithm, Hemoglobin[a] RBC Transfusion Thresholds in g/dL by Postnatal Age and Received Respiratory Support

	High hemoglobin threshold		Low hemoglobin threshold	
	Respiratory support[b]	No respiratory support	Respiratory support	No respiratory support
Post-natal Age				
Week 1	13.0	12.0	11.0	10.0
Week 2	12.5	11.0	10.0	8.5
Weeks ≥3	11.0	10.0	8.5	7.0

Results: Death or neurocognitive deficits

ETTNO

Outcomes	No./total (%) Liberal threshold	Restrictive threshold	Absolute difference, % (95% CI)	Odds ratio (95% CI)	*P* value
Death or neurodevelop-mental impairment by 24 mo	200/450 (44.4)	205/478 (42.9)	1.6 (−4.8 to 7.9)	1.05 (0.80-1.39)	.72
Death by 24 mo	38/460 (8.3)	44/491 (9.0)	−0.7 (−4.3 to 2.9)	0.91 (0.58-1.45)	.70
Cognitive deficit	154/410 (37.6)	148/430 (34.4)	3.1 (−3.3 to 9.6)	1.12 (0.83-1.51)	.47
Cerebral palsy	18/419 (4.3)	25/443 (5.6)	−1.3 (−4.2 to 1.5)	0.75 (0.40-1.40)	.37

No difference
Death
Neurodevelopmental
Impairment
Fewer transfusions

TOPS

Table 2. Primary Composite Outcome and Components of the Primary Composite Outcome at 2 Years.*

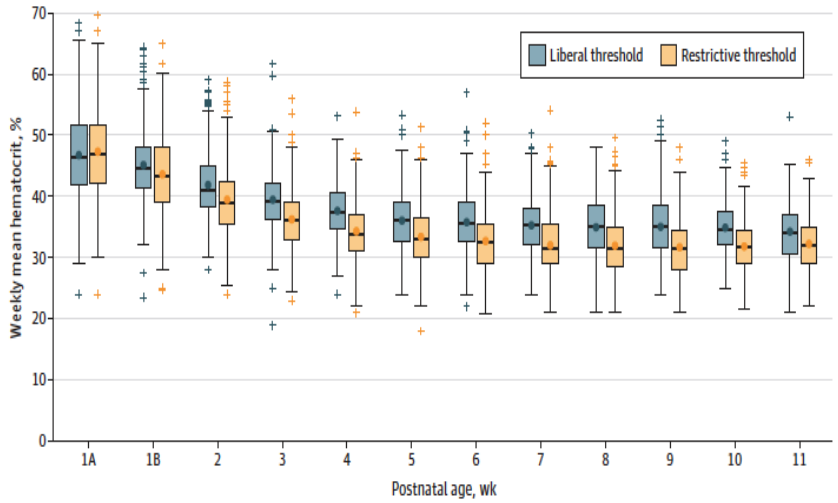
Outcome	Higher Hemoglobin Threshold (N=845)	Lower Hemoglobin Threshold (N=847)	Adjusted Relative Risk (95% CI)	P Value
	no. of infants/total no. (%)			
Primary outcome: death or neurodevelopmental impairment	423/845 (50.1)	422/847 (49.8)	1.00 (0.92–1.10)	0.93
Components of primary outcome				
Death†	146/903 (16.2)	135/901 (15.0)	1.07 (0.87–1.32)	
Neurodevelopmental impairment	277/699 (39.6)	287/712 (40.3)	1.00 (0.88–1.13)	
Cognitive delay‡	269/695 (38.7)	270/712 (37.9)	1.04 (0.91–1.18)	
Moderate or severe cerebral palsy§	48/711 (6.8)	55/720 (7.6)	0.87 (0.60–1.26)	
Severe vision impairment	5/713 (0.7)	6/720 (0.8)	0.83 (0.25–2.76)¶	
Severe hearing impairment	14/710 (2.0)	25/715 (3.5)	0.56 (0.29–1.07)¶	

Results

ETTNO

Weekly median pre-transfusion Hct was 3% higher in liberal group

Figure 2. Treatment Effect on Hematocrit and Number of Red Blood Cell Transfusions (RBCTs)



	1A	1B	2	3	4	5	6	7	8	9	10	11
No. of RBCTs (No. of patients)												
Liberal threshold	159 (121)	219 (171)	196 (165)	235 (194)	120 (113)	133 (128)	97 (88)	81 (78)	75 (68)	45 (42)	30 (29)	20 (19)
Restrictive threshold	156 (123)	131(104)	138 (114)	163 (140)	104 (88)	118 (107)	73 (55)	66 (57)	40 (38)	22 (22)	22 (20)	19 (16)
No. of patients with hematocrit data												
Liberal threshold	472	463	461	443	411	407	385	350	298	240	193	124
Restrictive threshold	494	505	489	468	445	436	399	365	325	258	189	124

Fewer transfusions

Pre-transfusion mean Hgb different by 1.9 g/dL

TOPS

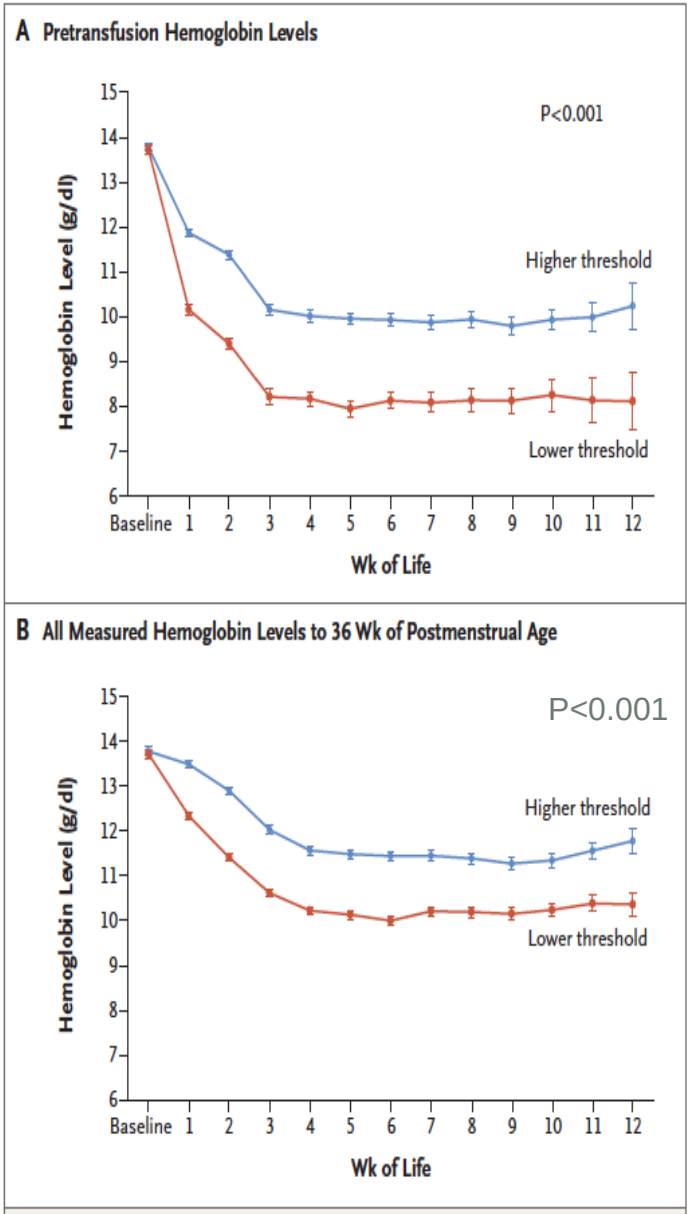


Figure 2. Separation of Hemoglobin Levels between the Treatment Groups.

Neonatal RBC thresholds

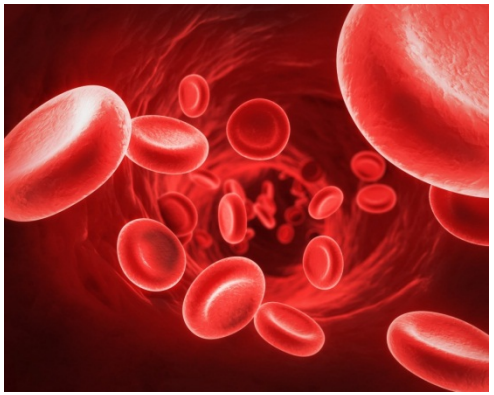
Bottom line

- No difference in cognitive outcome in neonates receiving RBCT in restrictive or liberal group
- Decreased transfusions for neonates in restrictive group

NICU RBC Transfusion Threshold (TOPS)

Age of neonate	Respiratory Support	No respiratory support
Week 1	110 g/L	100 g/L
Week 2	100 g/L	85 g/L
Week 3	85 g/L	70 g/L

RBC TRANSFUSIONS IN OLDER CHILD



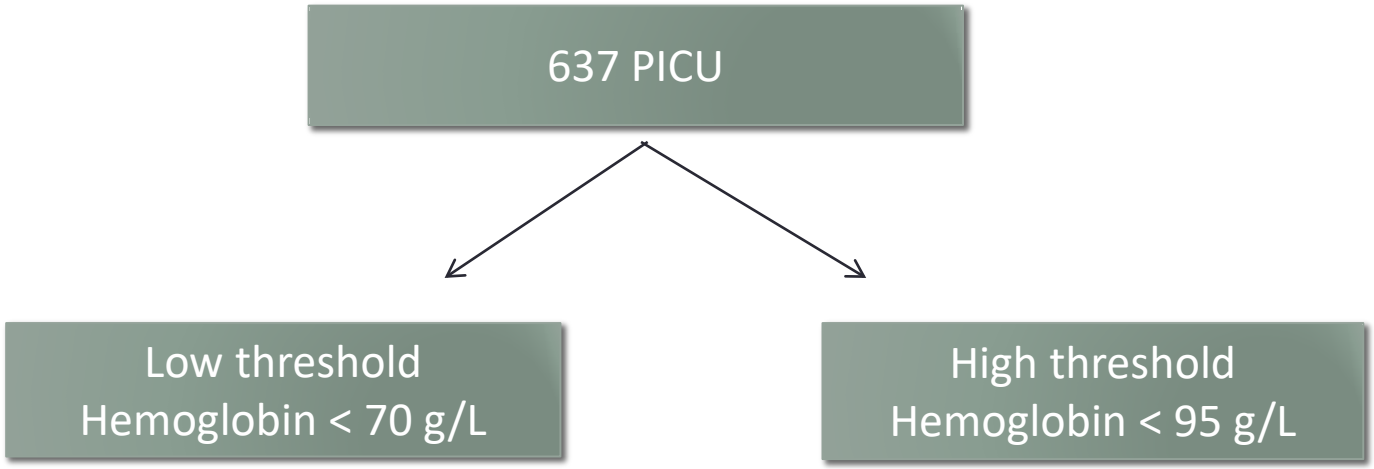
The NEW ENGLAND JOURNAL of MEDICINE

ESTABLISHED IN 1812 APRIL 19, 2007 VOL. 356 NO. 16

Transfusion Strategies for Patients in Pediatric Intensive Care Units

Jacques Lacroix, M.D., Paul C. Hébert, M.D., James S. Hutchison, M.D., Heather A. Hume, M.D., Marisa Tucci, M.D., Thierry Ducruet, M.Sc., France Gauvin, M.D., Jean-Paul Collet, M.D., Ph.D., Baruch J. Toledano, M.D., Pierre Robillard, M.D., Ari Joffe, M.D., Dominique Biarent, M.D., Kathleen Meert, M.D., and Mark J. Peters, M.D., for the TRIPICU Investigators,* the Canadian Critical Care Trials Group, and the Pediatric Acute Lung Injury and Sepsis Investigators Network

TRIPICU



No difference in primary (multi organ dysfunction)
Or secondary outcomes
44% fewer transfusions

NEJM 2007; 356:1609-19

RBC Threshold Guidelines for Children

Pediatric Patient type	Threshold	Evidence grade
PICU (stable, non-cyanotic)	70 g/L	1B
Oncology	70 g/L (typical practice) Insufficient literature	2C
Perioperative non-cardiac surgery (stable, non-bleeding)	70 g/L	1C
Chronic anemia (Diamond Blackfan anemia)	80 g/L Consensus based	2C

* Hemoglobinopathies

The following should be considered for children undergoing surgery with significant risk of bleeding:

Tranexamic acid (1B)

Red cell salvage (2C)

BJH 2016; 175: 784-828

Case: Pediatric anemia

- 22 month old healthy boy
- Symptoms
  - Pale
  - Eating paper
  - Otherwise active and energetic
- Diet history – drinks 48 oz of homo milk / day; picky eater
- PE: Patient alert, interactive and chasing brother in ER, VSS
- Hemoglobin = 52 g/L ; MCV = 62

What is the etiology of the microcytic anemia?

TAILS

- Thalassemia
- Anemia of chronic disease
- **Iron deficiency**
- Lead poisoning
- Sideroblastic anemia

Iron deficiency anemia (IDA)

Who? 3.5-11% of Canadian children- COMMON

Why? Multifactorial

- Increase needs due to rapid growth
- Inadequate intake of iron rich foods
- Malabsorption

Outcome

- Impairs physical functioning, infant growth & development and immune function
- Clear association between IDA and impaired neurocognitive development

Prevention and treatment are essential

Abdullah, 2011, Canadian Pediatric Society

How do we treat it?

- Oral iron
  - 3-6 mg/kg/day ELEMENTAL iron
  - ☺ inexpensive
  - ☹ 10% absorption, poor compliance due to GI side effects

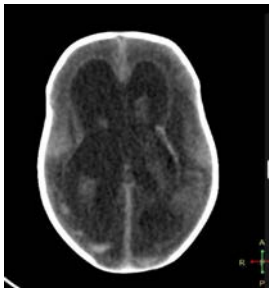
- IV iron
  - Failure of oral iron therapy
  - Iron intolerance
  - Need for quick recovery
  - Iron sucrose (venofer) = 7 mg/kg (max 300 mg dose)
  - Safe but $$

- PRBC Transfusion – should not be used in stable patient

NEJM 2015; 372(19):1832-43.

NEONATAL PLATELET TRANSFUSIONS

Neonatal Thrombocytopenia



Premature infants

- Thrombocytopenia occurs frequently
  - 73% < 1000 g

- Bleeding is common
  - 30% will develop intraventricular hemorrhage (IVH)
  - Leading cause of death & disability

- Because of increased risk, neonatologists have been liberal with respect to platelet transfusion thresholds

Pediatrics 2009;124:e826–e834

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Randomized Trial of Platelet-Transfusion Thresholds in Neonates

Anna Curley, M.D., Simon J. Stanworth, F.R.C.P., D.Phil., Karen Willoughby, B.Sc., Susanna F. Fustolo-Gunnink, M.D., Vidheya Venkatesh, M.D., Cara Hudson, M.Sc., Alison Deary, M.Sc., Renate Hodge, M.Sc., Valerie Hopkins, B.Sc., Beatriz Lopez Santamaria, M.Sc., Ana Mora, Ph.D., Charlotte Llewelyn, Ph.D., Angela D'Amore, M.D., Rizwan Khan, M.R.C.P.I., Wes Onland, M.D., Ph.D., Enrico Lopriore, M.D., Ph.D., Karin Fijnvandraat, M.D., Ph.D., Helen New, F.R.C.Path., Ph.D., Paul Clarke, M.D., and Timothy Watts, M.D., for the PlaNeT2 MATISSE Collaborators*

Curley et al. NEJM 2018; 380(3):242-251

PLANET 2: Methodology

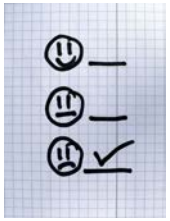
634 neonates < 34 wk GA

Head US
< 6h
No IVH

Low threshold
Platelet < 25 x 10^9/L

High threshold
Platelet < 50 x 10^9/L

Bleeding assessment daily x 14 d



Head ultrasound weekly

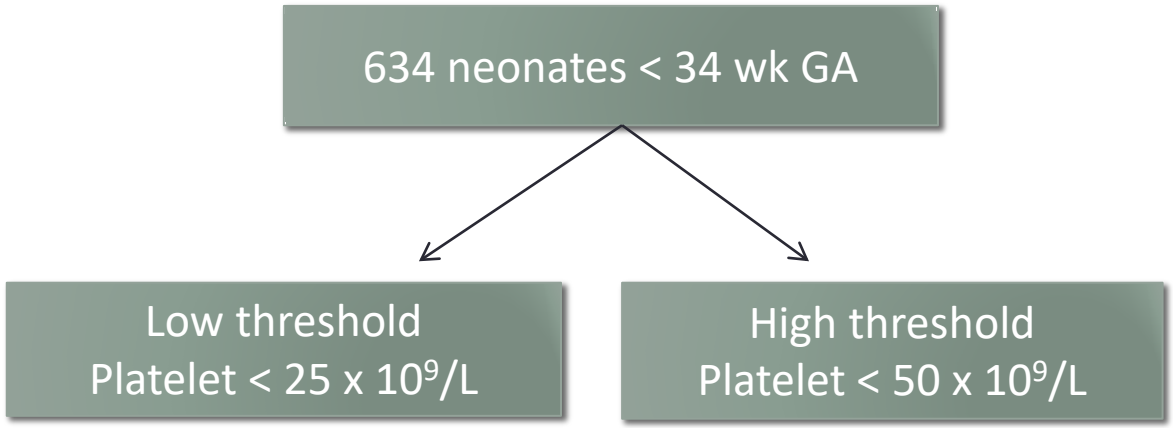
Bleeding or Death at 28d

Secondary outcomes

- Survival after bleeding episode
  Proportion surviving DC home
- Rate/ timing of bleeding
- # platelet units used
- Time to discharge
- Adverse events to discharge
- Neurodevelopment up to 2 yrs

Curley et al. NEJM 2018; 380(3):242-251

PLANET 2: Results



Outcome	N = 331 (%)	N = 329	Odds ratio or hazard ratio (95% CI)
Death to day 28(N, %)	33/330 (10)	48/326 (15)	OR = 1.57 (0.95-2.55)
New major bleeding episode (N, %)	35/330 (11)	45/328 (14)	HR 1.32 (1.0-1.74)
Adverse events	92 in 74 infants (22%)	94 in 81 infants (25%)	OR 1.14 95% CI (0.78-1.67)
At least one platelet txn (N, %)	177/331 (53)	296/328 (90)	HR 2.75 (2.36-3.21)

Curley et al. NEJM 2018; 380(3):242-251

Overall conclusions

- More deaths and major bleeding occurred when a higher prophylactic platelet count was used

Bottom line

- In neonates, a prophylactic threshold of 25x 10^9/L should be used prior to transfusing platelets

Proposed NICU Platelet Transfusion Thresholds

Clinical status	Platelet threshold	Grade Comment
Major bleeding or requiring major surgery (e.g. neurosurgery)	< 100 x 10^9/L	No RCT in prems
Bleeding, current coagulopathy, sx, exchange transfusion	< 50 x 10^9/L	
No bleeding (including NAIT if no bleeding and FHx of ICH)	< 30 x 10^9/L	Grade 2C

Special considerations for NAIT – neonatal alloimmune thrombocytopenia

BJH 2013; 160: 421–433
BJH 2019; 185(3):549-562,

PLATELET TRANSFUSIONS FOR CHILDREN

Pediatric platelet transfusions

- Who receives platelet transfusions?
  - Critically ill in the PICU, Hematology/oncology, Stem cell transplant, cardiac surgery

- Systematic review assessed effect of platelet transfusions on platelet count increment, bleeding and morality (only 1 study)
  - Prospective cohort (N = 138) found no difference in mortality between transfused and non- transfused critically ill children

- Oncology and procedural recommendations
  - Based on adult studies
  - Expert opinion

Indian Journal of Critical Care Medicine, 2008; 12: 102-108
NEJM 1997;337:1870–1875
JCO 2001;19:1519-1538
http://www.c17.ca

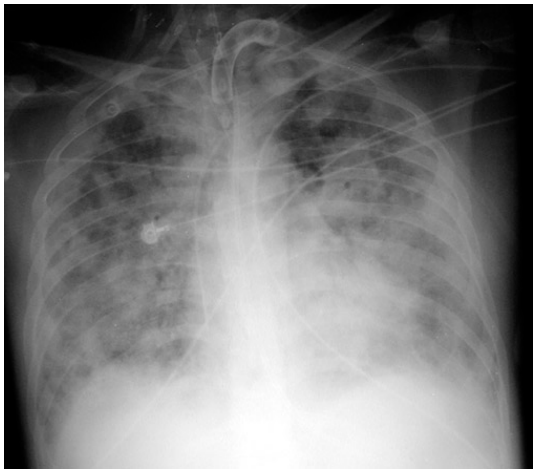
Suggested platelet thresholds for platelet transfusion in children

Platelet threshold (x 10^9/L)	Clinical situation
< 10	Irrespective of signs of hemorrhage (excluding ITP, TTP/HUS, HIT)
< 20	Severe mucositis Sepsis Laboratory evidence of DIC in the absence of bleeding Risk of bleeding due to a local tumour infiltration
< 40	Prior to lumbar puncture
< 50	Moderate hemorrhage (e.g. GI bleeding) Surgery, unless minor (except at critical sites)
< 75-100	Major hemorrhage or significant post-op bleeding Surgery at critical sites: CNS including eyes

** expert opinion

BJH 2016; 175, 784-828

What is the harm?



$1158

Adverse reactions

Supply

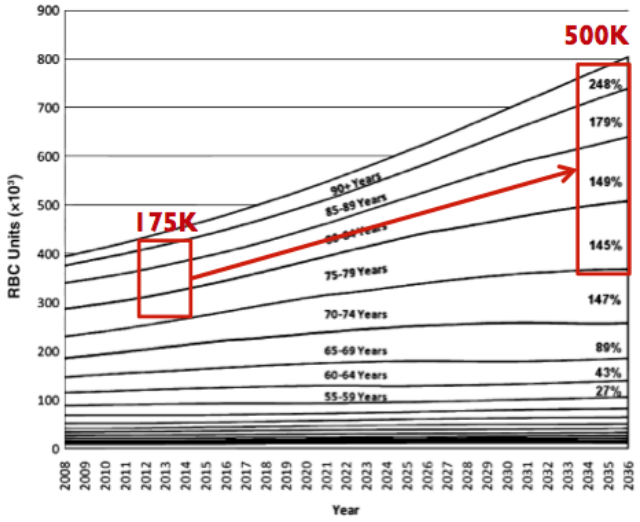


Fig. 7. Demand forecast stratified by 5-year age cohort: Ontario, 2008 through 2036.

TRIM
Transfusion related immunomodulation

Pediatr Blood Cancer 2011;57:217–223

Is the Number of Blood Products Transfused Associated With Lower Survival in Children With Acute Lymphoblastic Leukemia?

Iron overload

Pediatr. Blood Cancer 2011;56:368–371

Insidious Iron Burden in Pediatric Patients With Acute Lymphoblastic Leukemia

Transfusion Associated Necrotizing Enterocolitis: A Meta-analysis of Observational Data

Adel Mohamed and Parkesh S. Shah

Pediatrics 2012;129;529; originally published online February 20, 2012;

TA-NEC

Teaching points

- Laboratory reference ranges (hematology and coagulation) specific for neonates and children should be used
- Always consider the etiology of the anemia and thrombocytopenia prior to ordering a transfusion
- Order blood products using child's weight

Neonatal transfusion thresholds

NICU RBC Transfusion Threshold (TOPS)

Age of neonate	Respiratory Support	No respiratory support
Week 1	110 g/L	100 g/L
Week 2	100 g/L	85 g/L
Week 3	85 g/L	70 g/L

RBC Threshold Guidelines for Children

Pediatric Patient type	Threshold	Evidence grade
PICU (stable, non-cyanotic)	70 g/L	1B
Oncology	70 g/L (typical practice) Insufficient literature	2C
Perioperative non-cardiac surgery (stable, non-bleeding)	70 g/L	1C
Chronic anemia (Diamond Blackfan anemia)	80 g/L Consensus based	2C

* Hemoglobinopathies

The following should be considered for children undergoing surgery with significant risk of bleeding:

Tranexamic acid (1B)
Red cell salvage (2C)

BJH 2016; 175: 784-828

Proposed NICU Platelet Transfusion Thresholds

Clinical status	Platelet threshold	Grade Comment
Major bleeding or requiring major surgery (e.g. neurosurgery)	< 100 x 10^9/L	No RCT in prems
Bleeding, current coagulopathy, sx, exchange transfusion	< 50 x 10^9/L	
No bleeding (including NAIT if no bleeding and FHx of ICH)	< 30 x 10^9/L	Grade 2C

Special considerations for NAIT – neonatal alloimmune thrombocytopenia

BJH 2013; 160: 421–433
BJH 2019; 185(3):549-562,

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** expert opinion

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Questions

Key recommendations re: Fresh Frozen Plasma (FFP) transfusions in neonates

Neonatal

1. FFP should NOT be used to correct abnormal coagulation testing in non-bleeding neonates(1C)
2. FFP may benefit neonates with clinically significant bleeding or prior to invasive procedures (high risk of bleeding) if the neonate has an abnormal coagulation profile (2C)
3. FFP should not be used for simple volume replacement or routinely to prevent IVH(1B)

BJH 2016; 175, 784-828

Key recommendations re: Fresh Frozen Plasma (FFP) transfusions in Children

- Prophylactic FFP should NOT be administered to non-bleeding children with minor coagulation abnormalities including prior to surgery (2B) although it may be considered for surgery to critical sites (2C)

- Prophylactic cryoprecipitate should NOT be used routinely in non bleeding patients with low fibrinogen including prior to surgery (2C).

- Prophylactic cryoprecipitate may be considered if fibrinogen < 1g/L for surgery at risk of significant bleeding or to critical sites (2C)

BJH 2016; 175, 784-828