Neonatal blood management and transfusion

Presentation by the Australian Red Cross Blood Service in collaboration with John Hunter Children's Hospital, Newcastle, The Royal Children's Hospital, Melbourne, and the Women's and Children's Hospital, Adelaide.

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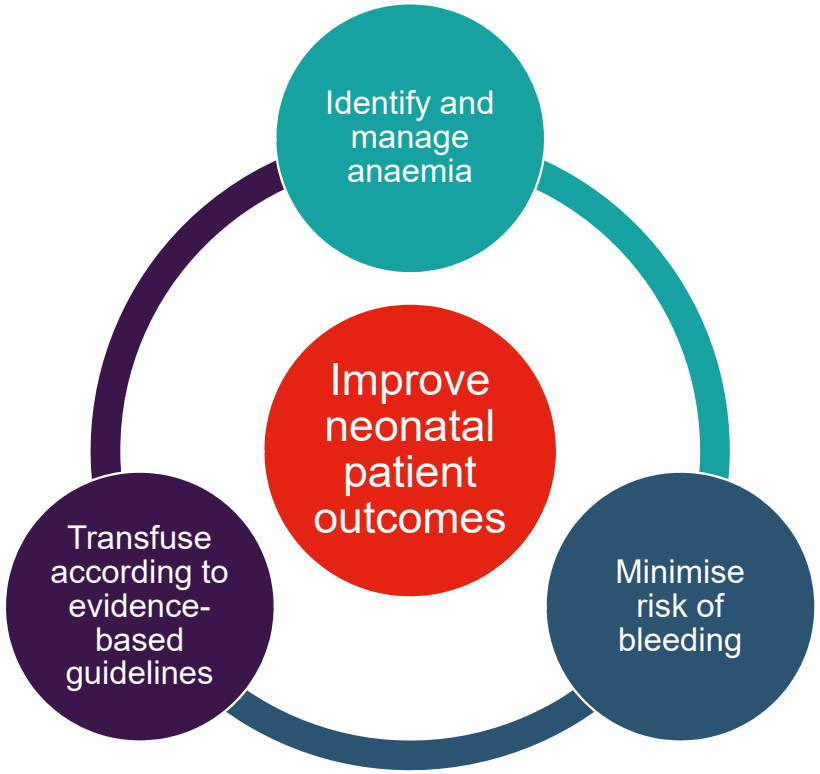
Patient blood management: Overview



Patient blood management (PBM) is a coordinated, patient-centred approach to manage and conserve a patient's own blood in order to improve health outcomes

PBM strategies:

1. Identify and manage anaemia
2. Minimise risk of bleeding
3. Transfuse according to evidence-based guidelines

Neonatal blood management: Overview

- The decision to transfuse a neonate should be carefully considered, evidence or consensus-based.
- Transfusion should improve a neonates' outcome without causing harm.
- Potential benefits and any risks or long-term implications should be considered.

What's unique about neonates?

Neonates have:

- a higher blood volume per weight
- lower tolerance to volume losses
- a physiological decline in erythropoietin (EPO) levels and red blood cells in the first few weeks of life, and
- age-related developmental immaturity including hepatic, neurological and immune systems, making them more vulnerable to organ injury and metabolic complications associated with transfusion.

What's unique about neonates?

These effects are more pronounced in preterm infants who have:

- lower Hb concentration
- relative iron deficiency
- lower EPO production
- lower cardiac reserve

= greater risk of symptomatic anaemia.

Incidence of neonatal transfusion

- 5.4/1,000 live births.
- Red cells: 4.8/1,000 live births.
- Platelets: 1.3/1,000 live births.
- 7% of transfusions occurred in a hospital without a NICU.

Risk factors for transfusion

- prematurity
- transfusion rate = 582.8/1,000 live births < 32 weeks
- transfusion rate = 1.4/1,000 live births term
- intrauterine transfusion
- congenital anomaly requiring surgery, and
- haemolysis.

PBM strategy 1: Identify and manage anaemia

- Consider delayed cord clamping (where appropriate):
  - increases neonatal red blood cell volume at birth
  - increases Hb after birth and iron stores at 3–6/12 in term neonates, and
  - reduces RBC transfusion in preterm neonates.
- Consider iron supplementation for preterm, low birth weight neonates. Dose = 2−3 mg/kg/day.
- If intravenous iron is required, administer according to a protocol relevant to the specific product.
- Acknowledge the limited role of erythropoietin stimulating agents.

PBM strategy 2: Minimise risk of bleeding

Blood conservation techniques

- Reduce laboratory ordering, rationalise and consolidate laboratory blood testing:
  - routine coagulation profile is not required for neonates, and
  - extended expiry blood group and antibody screen in neonates less than four months can be implemented.
- Remove sampling lines early.
- Consider the role of laboratory testing in minimising blood loss:
  - use paediatric collection tubes and/or tubes with fill lines
  - adhere to minimum analyte volume
  - return discard volumes
  - consider point of care testing devices, umbilical cord testing and transcutaneous instruments for Hb assessment, and
  - does your laboratory have analytical instruments capable of analysing small volumes?

PBM strategy 2: Minimise risk of bleeding

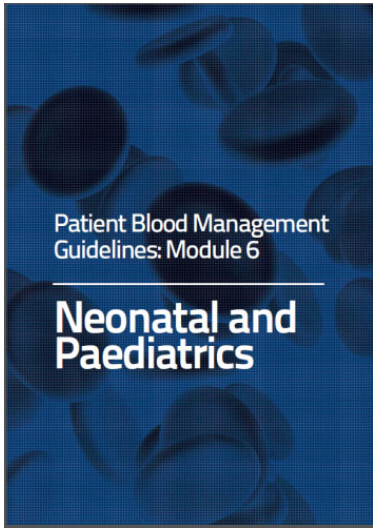
- Supplement Vitamin K at birth.

Surgical and anaesthetic techniques

- Maintenance of normothermia.
- Meticulous surgical technique with trained neonatal surgical and anaesthetic expertise.

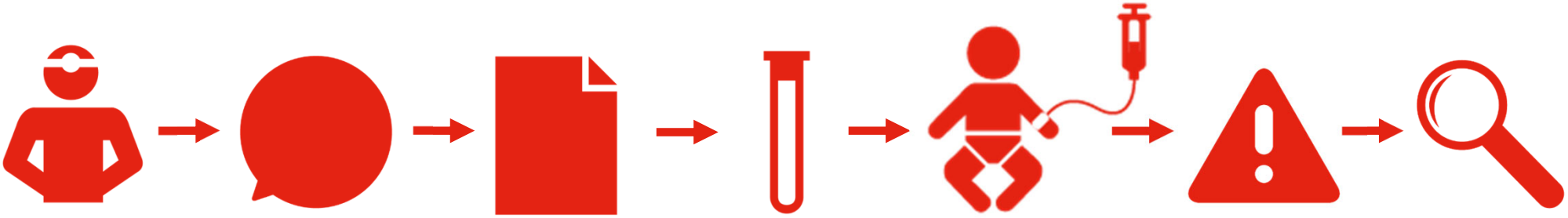
PBM strategy 3: Transfuse according to evidence-based guidelines

- Avoid unnecessary red blood cell transfusions:
  - the decision to transfuse should be based on clinical signs and symptoms of anaemia, NOT on Hb alone, and
  - adhere to age-appropriate red blood cell transfusion thresholds from evidence-based international guidelines.
- Platelets, fresh frozen plasma, cryoprecipitate may have a role in treating bleeding where thrombocytopenia and/or coagulopathy are contributing factors but have an unclear role in terms of correcting haemostatic abnormalities.
- Use appropriate neonatal vital sign observation charts.



The transfusion process

The transfusion process



Decision to transfuse → Consent → Documentation → Pretransfusion sample collection → Administration → Monitor → Response

Decision to transfuse

Question: Does the neonate really need transfusion?

Considerations:

- Transfusion should be **dictated by clinical status rather than Hb alone: tachycardia, tachypnoea, work of breathing, pallor, apnoeic events, feed intolerance and growth restriction.**
- The **degree of respiratory support including inspired oxygen concentration** should be considered. The safest range in a preterm neonate has recently been defined as 90–95%.
- Transfusion is not without risk; **patient blood management principles** should always be considered.

Decision to transfuse

Question: Does the neonate really need transfusion?

Action:

- Assess neonate.
- Document transfusion decision.
- Document any special requirements e.g. irradiated, CMV negative.

Consent and documentation

Consent:

- Obtain **informed consent from parents.**

Documentation:

- **Complete prescription** for blood product transfusion, including clinical indication, transfusion history and date and time the blood product is required.

Communication:

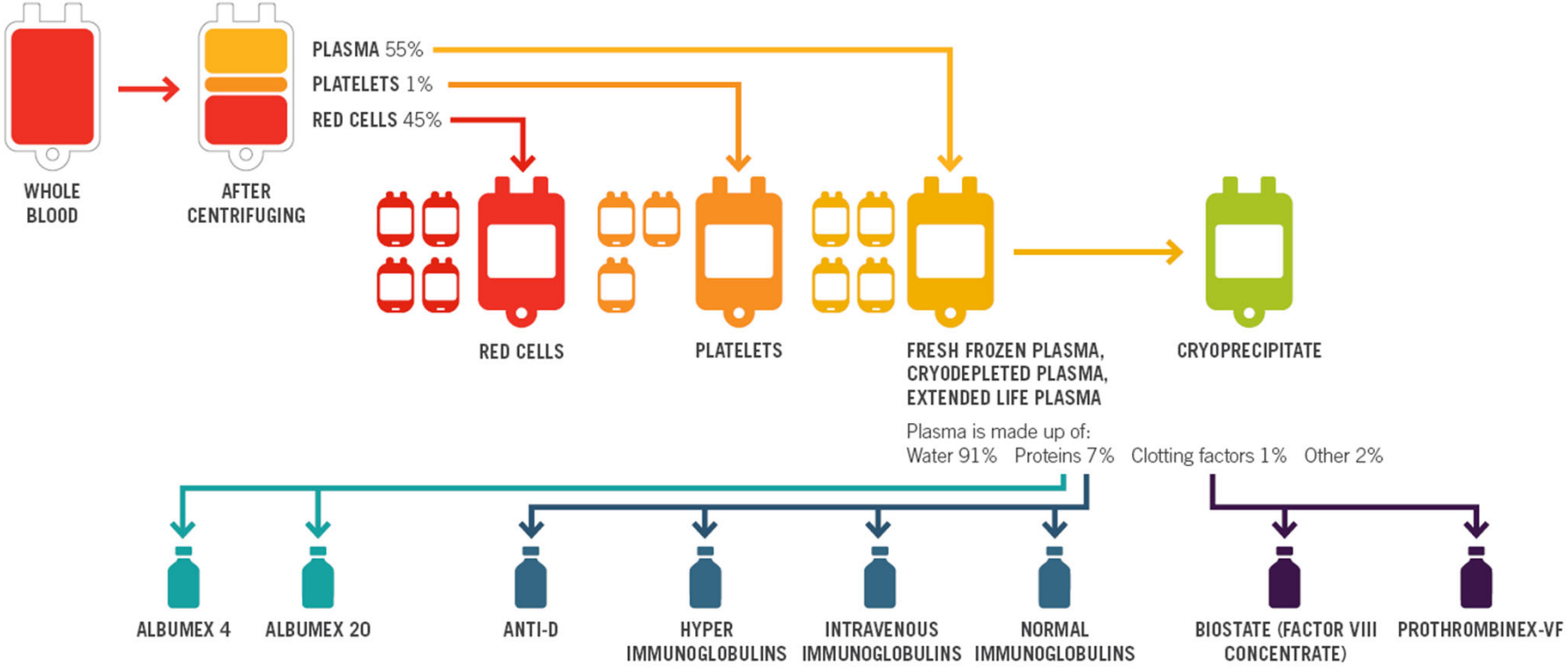
- Inform ward and clinical staff.

Transfusion consent for neonates video

transfusion.com.au/neonates

Blood components and products

Blood components and products



Blood components and products

Fresh components

- Red cells
- Platelets

Frozen components

- Fresh frozen plasma (FFP)
- Cryoprecipitate
- Cryodepleted plasma

Fractionated plasma products

- Albumin
- Prothrombinex-VF
- Immunoglobulins
  - IVIg, SCIg
  - CMV Ig, HBV Ig
- Factor concentrates
  - FVIII, FIX for haemophilia

Paediatric packs

One standard size adult component is divided into four packs (red cells, FFP) or three to four packs (apheresis platelets).

Why?

- If repeated transfusions are required, multiple packs from the same donation can be transfused, reducing donor exposure.
- Reduces wastage.

These may NOT immediately be available in your hospital and will need to be ordered in advanced from the Blood Service.

Red cells – what's normal?

Normal values for haemoglobin concentration and MCV in infancy and childhood						
Age	**Haemoglobin (g/L)**		**Haematocrit**		**MCV (fL)**	
	Mean	**−2 SD**	**Mean**	**−2 SD**	**Mean**	**−2 SD**
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

Adopted from Nathan and Orkin. MCV − Mean corpuscular volume. SD − Standard deviation.

Estimated circulating blood volume (volemia) in accordance with the age of the patient	
Child age	**Volemia**
Pre-term newborn	90 mL/kg
Term newborn to 3 months	80−90 mL/kg
Over 3 months	70−80 mL/kg
Over 2 years old	70 mL/kg

Adopted from Hawtrey R.

Red cells – when to transfuse?

	British Society for Haematology			National Blood Authority Australia		Canada	
	Very preterm <32 weeks			Preterm <37 weeks		Infants with anaemia of prematurity	
Age	Ventilated	O_2 / Nasal-intermittent positive pressure ventilation (NIPPV)	No support	O_2 / high flow / Continuous positive airway pressure (CPAP) / Positive pressure ventilation (PPV)	No support	FiO_2 (fraction of inspired oxygen) >25% or mechanical increase in airway pressure	No support
First 24h (g L^{-1})	<120		<100	Not specifically stated, assumed to be Week 1		Not specifically stated, assumed to be Week 1	
Week 1 (g L^{-1})	<120	<100	<100	110–130	100–120	<115	<110
Week 2 (g L^{-1})	<100	<95	<75	100–125	85–100	<100	<85
Week 3 (g L^{-1})	<100	<85	<75	85–110	70–100	<85	<75

Red cells:
Restrictive vs liberal transfusion

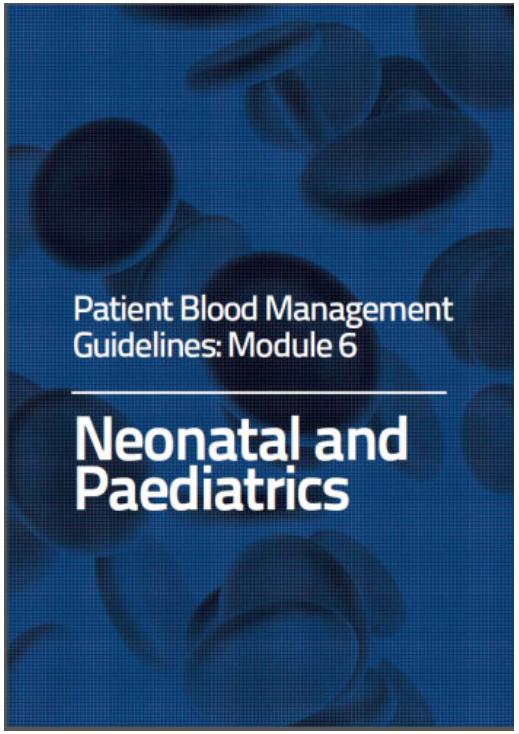
- Term neonates: restrictive transfusion strategies have not demonstrated any short-term adverse events when compared to liberal transfusion strategies.
- Preterm neonates: more liberal transfusion strategies are preferred due to the potential for improved neurodevelopment.
- The *Effects of transfusion thresholds on neurocognitive outcome of extremely low birth weight infants (ETTNO)* trial is currently underway.

Red cells paediatric

Indications: clinically significant anaemia or acute blood loss >15% of total blood volume.

Transfusion should be based on:

- the use of age-appropriate reference ranges for haematology parameters for neonatal patients, and
- clinical status.



Red cells paediatric

Dose: 15 mL/kg can be expected to raise the neonates haemoglobin (Hb) concentration by about 20 g/L.

Product information:

Available in Group A, B, O, AB and Rh D positive/negative.

Paediatric size volume: 60 ± 4 (25–100) mL

Storage: 2–6°C for up to 35 days with the appropriate additives

Cost: $450.55 (set of 4)

Platelets paediatric

Indications: Management of thrombocytopenia or abnormal platelet function with bleeding, or at risk of bleeding.

Platelet count	Indications for neonates
<25–30 x 10^9/L	Stable term or preterm infant with asymptomatic thrombocytopenia and no bleeding
30–50 x 10^9/L	Sick preterm infant with thrombocytopenia
<50 x 10^9/L	Term or preterm infant with symptomatic thrombocytopenia and minor bleeding, coagulopathy or prior to surgery
<100 x 10^9/L	Term or preterm infant with symptomatic thrombocytopenia and major bleeding or requiring major surgery (e.g. neurosurgery)

These indications should be used as guide only as evidence for clinical indications are rapidly evolving

Platelets paediatric

Dose: 1 unit is expected to increase platelets by $20x10^9$/L in stable 18 kg patient.

Product information:
Available in Group A, B, O or AB and Rh D positive/negative.

Apheresis platelets

Paediatric size volume: 56 ± 2 mL

Storage: Apheresis platelets are stored agitated at 20–24°C for up to 5 days
Cost: $843.79 (Set of 4)

Fresh frozen plasma paediatric

Indications: Management for acquired or congenital clotting factor deficiencies with bleeding or at risk of bleeding.

- Patients who are critically bleeding, and require massive transfusion resuscitation.
- Replacement of clotting factors where specific factor concentrates are not (readily) available e.g. FV deficiency.
- Acute disseminated intravascular coagulopathy (DIC).

Fresh frozen plasma paediatric

Dose: 10–15 mL/kg.

The volume transfused depends on the clinical situation and patient size, and should be guided by laboratory assays of coagulation function.

Product information:

Manufactured from whole blood or apheresis plasma donations and frozen (-30ºC) within 18 hours of collection.

Contains all of the coagulation factors.

Available in Group A, B, AB and O.

Volume: 67 ± 4 mL
Storage: ≤25ºC for up to 12 months
Cost: $219.61 (set of 4)

Cryoprecipitate

Indications: Management for acquired or congenital fibrinogen deficiency (or dysfunction) with bleeding or at risk of bleeding.

Dose: 5 mL/kg (whole blood), 2.5 mL/kg (apheresis).

Product information:

Manufactured from the precipitated protein product recovered during the manufacture of FFP.

Collected from whole blood or apheresis donations.

Contains Factors VIII, XIII, Von Willebrand Factor and **Fibrinogen.**

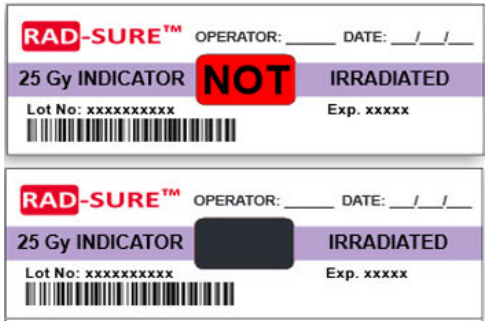
Volume: 60 ± 2 mL

Storage: ≤ 25ºC

Cost: $165−$350 per unit

Special modifications

- All cellular blood components in Australia are **leucodepleted.**
- **Irradiated** red cells and platelets.
- **CMV negative.**
- Human Leucocyte Antigen **(HLA) matched** platelets.
- Human Platelet Antigen **(HPA) matched** platelets.
- **Frozen** red cells.
- **Phenotyped** red cells.
- **Washed** red cells.
- **IgA deficient.**



Parent information handout

BABIES RECEIVING A BLOOD TRANSFUSION
A guide for parents

WHAT IS A BLOOD TRANSFUSION?

A blood transfusion involves blood being given through a tube into the bloodstream.

Transfusion has been recommended because it is the best option for your baby at this point.

WHICH BLOOD PRODUCT MIGHT MY BABY RECEIVE?

After blood is collected from a donor it is separated into parts so your baby only receives the part that they need.

RED BLOOD CELLS	PLATELETS	FRESH FROZEN PLASMA, CRYOPRECIPITATE	PLASMA PRODUCTS
Carry oxygen around the body • A low number of red blood cells results in anaemia. • Some causes of anaemia include prematurity, blood loss and increased red cell breakdown (haemolytic disease of the newborn).	**Help to stop bleeding by forming a clot** • Low platelet count can be due to too few being made, too many being used or too many being destroyed. • Some causes include infection and antibodies.	**Liquid part of blood containing important plasma proteins** • May be required in acute bleeding where proteins in the plasma are reduced.	**Concentrated blood proteins** • Albumin helps maintain fluid levels. • Immunoglobulins helps the immune system. • Clotting factors for treating specific bleeding problems.

ARE TRANSFUSIONS SAFE?

The blood for transfusion is collected by the Australian Red Cross Blood Service from voluntary, unpaid ~~Australian~~ donors.
The blood supply is one of the safest in the world and most babies will have no complications during or after their transfusion.

Although transfusions are generally very safe, there are some associated risks. However, precautions are taken to avoid any complications. There are three key risks to be aware of:

HAVING A REACTION	CATCHING AN INFECTION	RECEIVING THE WRONG BLOOD PRODUCT
• Reactions can range from mild to severe. • Mild reactions are the most common and include a rash or slight fever. • Severe reactions include breathing difficulties, high fever and severe allergy (anaphylaxis). • Your baby will be carefully monitored. Alert the nursing staff if you have any concerns about your baby during the transfusion.	• In Australia, blood is carefully screened for infections. • This includes screening donors and testing the blood after it has been donated. • Risk of catching any diseases such as Hepatitis C or HIV is less than one in a million.	• This occurs rarely (usually a checking error). • This is prevented by multiple checks in the laboratory and at the bedside prior to beginning transfusion. • It is important that your baby is wearing an identification band throughout the process.

FOR MORE INFORMATION VISIT
MYTRANSFUSION.COM.AU

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HOW IS BLOOD GIVEN?

1. Your baby will need a small plastic tube placed into a vein
2. The blood product will be carefully checked to make sure it matches your baby's blood
3. The transfusion will begin
4. Your baby will be carefully monitored

- The transfusion should take less than four hours
- We usually observe no change in the baby during their transfusion
- If you have any concerns about your baby at any stage of the process, alert nursing staff immediately

DO I NEED TO GIVE CONSENT FOR A BLOOD TRANSFUSION?

Yes, consent is necessary prior to your baby being given a transfusion.
Consider the following statements and if you have any doubts, please ask your clinical team.

- ✓ I understand why transfusion has been recommended and other possible options for treatment
- ✓ I am aware of the expected benefits of a transfusion for my baby
- ✓ I am aware of the potential risks and side effects
- ✓ I am aware of which blood products will be transfused to my baby
- ✓ I am aware of how the transfusion will be given and how long it will take

In an emergency, there may not be time to discuss your baby's transfusion and obtain your consent. However, the reasons for the transfusion will be explained to you as soon as possible.

FREQUENTLY ASKED QUESTIONS

CAN I DONATE BLOOD TO MY BABY?	WILL THE BLOOD TRANSFUSION AFFECT THE NEWBORN SCREENING TEST?	WILL THIS TRANSFUSION AFFECT MY BABY IN THE FUTURE?
The risk of blood from donors provided by the Australian Red Cross Blood Service is extremely low, so parents' blood is not used. In addition, there are some increased risks of rare transfusion reactions when babies receive blood from relatives.	Yes, there is a chance it might. This test is usually done between 48–72 hours after birth. If the blood spot sample has not yet been taken, your baby will need it done before receiving a transfusion. They may also need a further sample after transfusion.	A transfusion will be given only if medically necessary. From what we know so far, there are limited long-term effects. If your baby needs a transfusion in the future, remember to mention that they have had one before as it may influence which blood is given.

Version 3.0 17 December 2018.
The disclaimer found at **transfusion.com.au** applies to this information sheet. This information was compiled by John Hunter Children's Hospital (Hunter New England Local Health District) in collaboration with the Australian Red Cross Blood Service and The Royal Children's Hospital, Melbourne.

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Administration

Ensure the pre-administration checklists confirms:

- ✓ Right patient
- ✓ Right blood product
- ✓ Right pack
- ✓ Right time

Reminder: *The **final check** between patient and blood product must be performed at the **bedside** prior to transfusion.*

Monitor and response

Monitor:

If suspected transfusion reaction occurs:

- **STOP** the transfusion and follow local transfusion reaction protocols.
- Activate emergency procedures, if required.

Response:

- Assess to determine if desired outcome of transfusion has been achieved.
- Assess patient for further blood product transfusion/s as necessary.
- Document assessment.

Adverse transfusion reactions

Adverse transfusion reactions

Any untoward event that occurs as a result of an infusion of blood or a blood component.

- **Immediate** (<24 hours) or **delayed** (>24 hours)
- **Immune** or **non-immune**

Acute haemolytic transfusion reaction (AHTR)

Allergy

Anaphylaxis

Bacterial contamination

Delayed haemolytic transfusion reaction (DHTR)

Febrile non-haemolytic transfusion reaction (FNHTR)

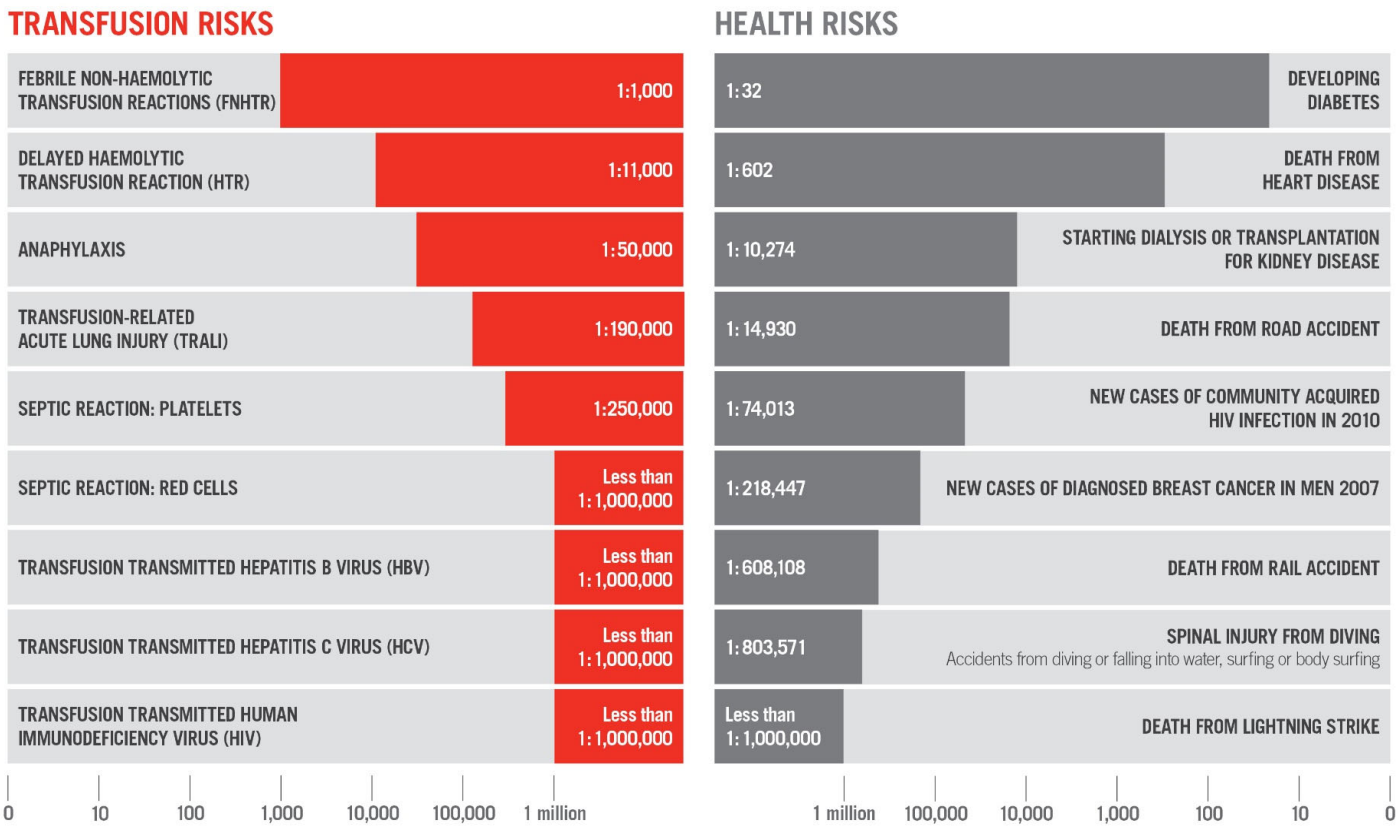
Post-transfusion purpura (PTP)

Transfusion-associated circulatory overload (TACO)

Transfusion-related acute lung injury (TRALI)

Transfusion-transmitted infection (TTI)

Relative risk of adverse transfusion reactions



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Potentially life-threatening adverse transfusion reactions

Severe fever with signs of cardiovascular shock and DIC

- Acute haemolytic transfusion reaction (AHTR) (e.g. from ABO incompatibility)
- Transfusion-transmitted bacterial infection (TTBI)

Severe dyspnoea and decreased oxygen saturation

- Anaphylaxis
- Transfusion-related acute lung injury (TRALI)
- Transfusion-associated circulatory overload (TACO)

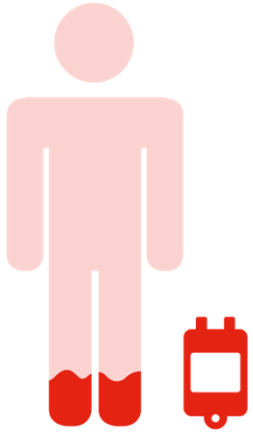
These severe reactions may require immediate support from seniors so consider calling a MET or CODE early.

Adverse transfusion reactions in neonates

- Adverse events are uncommon although neonates are 2x higher risk of transfusion reactions than adults in particular higher rates of allergic reaction and febrile non haemolytic transfusion reactions.
- Increased risk of metabolic complications of transfusion due to the larger transfusion to blood volume ratio.

A unit of red blood cells in an infant may be equivalent to its total blood volume whereas in an adult it is equivalent to only approximately 10% of total blood volume.

1 UNIT = ~100% OF BLOOD VOLUME



1 UNIT = ~10% OF BLOOD VOLUME

Adverse transfusion reactions in neonates

Hypocalcaemia

- Cardiac arrhythmias
- Ionised calcium = factor IV in coagulation cascade
- Citrate, the anticoagulant in stored blood binds to calcium to inhibit clot formation
- Rate of administration contributes

Hyperkalaemia

- Cardiac arrhythmias
- Rate of administration and age of red cells contribute

Adverse transfusion reactions in neonates

Hypomagnesaemia

- Arrhythmias
- Rate of administration contributes

Hypothermia

- Due to high surface to weight ratio of neonates
- Hypothermia can cause:
  - apnoea
  - hypoglycaemia
  - decreased drug metabolism
  - reduced oxygen dissociation at the tissues

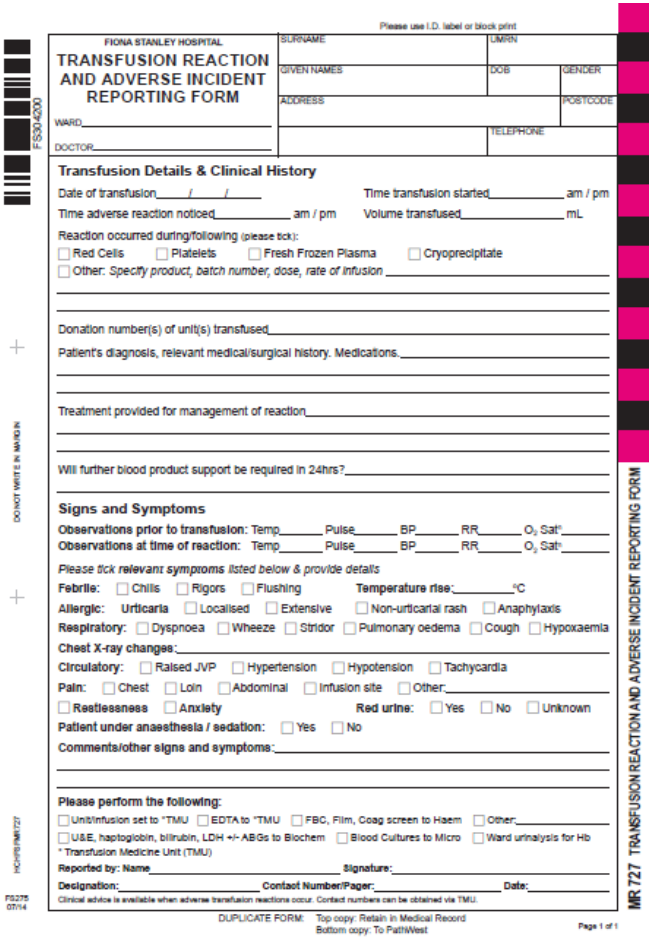
Investigation and management

RECOGNISE, REACT, REPORT

1. **Stop transfusion** and activate emergency procedures if required
2. **Check vital signs** (respiration, pulse, blood pressure, temperature and urine output)
3. **Maintain IV access**, but do not flush the existing line
4. **Repeat all clerical and identity checks** of the patient and blood product
5. **Notify** medical staff and transfusion laboratory
6. **Collect** blood and urine samples. Save the blood pack and IV line for culture if required.
7. **Commence specific clinical management**
8. **Document** reaction in patient's chart and complete incident report as per your local health service policy.

Reporting adverse transfusion reactions

RECOGNISE,
REACT,
REPORT



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FIONA STANLEY HOSPITAL

TRANSFUSION REACTION AND ADVERSE INCIDENT REPORTING FORM

SURNAME | UMRN | GIVEN NAMES | DOB | GENDER | ADDRESS | POSTCODE | TELEPHONE

WARD_____ DOCTOR_____

Transfusion Details & Clinical History

Date of transfusion____/____/____ Time transfusion started_____ am / pm

Time adverse reaction noticed_____ am / pm Volume transfused_____ mL

Reaction occurred during/following (please tick):

☐ Red Cells ☐ Platelets ☐ Fresh Frozen Plasma ☐ Cryoprecipitate

☐ Other: *Specify product, batch number, dose, rate of infusion* _____

Donation number(s) of unit(s) transfused_____

Patient's diagnosis, relevant medical/surgical history. Medications._____

Treatment provided for management of reaction_____

Will further blood product support be required in 24hrs?_____

Signs and Symptoms

Observations prior to transfusion: Temp_____ Pulse_____ BP_____ RR_____ O_2 Sat*_____

Observations at time of reaction: Temp_____ Pulse_____ BP_____ RR_____ O_2 Sat*_____

Please tick relevant symptoms listed below & provide details

Febrile: ☐ Chills ☐ Rigors ☐ Flushing **Temperature rise:**_____°C

Allergic: **Urticaria** ☐ Localised ☐ Extensive ☐ Non-urticarial rash ☐ Anaphylaxis

Respiratory: ☐ Dyspnoea ☐ Wheeze ☐ Stridor ☐ Pulmonary oedema ☐ Cough ☐ Hypoxaemia

Chest X-ray changes:_____

Circulatory: ☐ Raised JVP ☐ Hypertension ☐ Hypotension ☐ Tachycardia

Pain: ☐ Chest ☐ Loin ☐ Abdominal ☐ Infusion site ☐ Other:_____

☐ **Restlessness** ☐ **Anxiety** **Red urine:** ☐ Yes ☐ No ☐ Unknown

Patient under anaesthesia / sedation: ☐ Yes ☐ No

Comments/other signs and symptoms:_____

Please perform the following:

☐ Unit/infusion set to *TMU ☐ EDTA to *TMU ☐ FBC, Film, Coag screen to Haem ☐ Other:_____

☐ U&E, haptoglobin, bilirubin, LDH +/- ABGs to Biochem ☐ Blood Cultures to Micro ☐ Ward urinalysis for Hb

* Transfusion Medicine Unit (TMU)

Reported by: Name_____ **Signature:**_____

Designation:_____ **Contact Number/Pager:**_____ **Date:**_____

Clinical advice is available when adverse transfusion reactions occur. Contact numbers can be obtained via TMU.

DUPLICATE FORM: Top copy: Retain in Medical Record
Bottom copy: To PathWest

Page 1 of 1

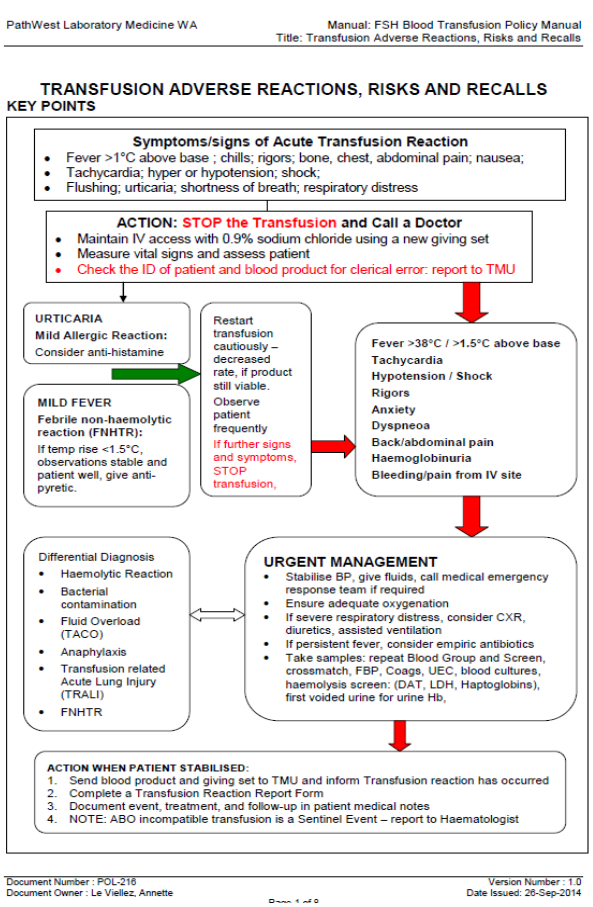
MR 727 TRANSFUSION REACTION AND ADVERSE INCIDENT REPORTING FORM

DO NOT WRITE IN MARGIN

FS0420

HCHPS/MR727

FS275 07/14



PathWest Laboratory Medicine WA

Manual: FSH Blood Transfusion Policy Manual
Title: Transfusion Adverse Reactions, Risks and Recalls

TRANSFUSION ADVERSE REACTIONS, RISKS AND RECALLS

KEY POINTS

Symptoms/signs of Acute Transfusion Reaction

- Fever >1°C above base ; chills; rigors; bone, chest, abdominal pain; nausea;
- Tachycardia; hyper or hypotension; shock;
- Flushing; urticaria; shortness of breath; respiratory distress

ACTION: STOP the Transfusion and Call a Doctor

- Maintain IV access with 0.9% sodium chloride using a new giving set
- Measure vital signs and assess patient
- Check the ID of patient and blood product for clerical error: report to TMU

URTICARIA
Mild Allergic Reaction:
Consider anti-histamine

MILD FEVER
Febrile non-haemolytic reaction (FNHTR):
If temp rise <1.5°C, observations stable and patient well, give anti-pyretic.

Restart transfusion cautiously – decreased rate, if product still viable.
Observe patient frequently
If further signs and symptoms, STOP transfusion,

Fever >38°C / >1.5°C above base
Tachycardia
Hypotension / Shock
Rigors
Anxiety
Dyspneoa
Back/abdominal pain
Haemoglobinuria
Bleeding/pain from IV site

Differential Diagnosis

- Haemolytic Reaction
- Bacterial contamination
- Fluid Overload (TACO)
- Anaphylaxis
- Transfusion related Acute Lung Injury (TRALI)
- FNHTR

URGENT MANAGEMENT

- Stabilise BP, give fluids, call medical emergency response team if required
- Ensure adequate oxygenation
- If severe respiratory distress, consider CXR, diuretics, assisted ventilation
- If persistent fever, consider empiric antibiotics
- Take samples: repeat Blood Group and Screen, crossmatch, FBP, Coags, UEC, blood cultures, haemolysis screen: (DAT, LDH, Haptoglobins), first voided urine for urine Hb,

ACTION WHEN PATIENT STABILISED:

1. Send blood product and giving set to TMU and inform Transfusion reaction has occurred
2. Complete a Transfusion Reaction Report Form
3. Document event, treatment, and follow-up in patient medical notes
4. NOTE: ABO incompatible transfusion is a Sentinel Event – report to Haematologist

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Document Owner : Le Viellez, Annette

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Date Issued: 26-Sep-2014

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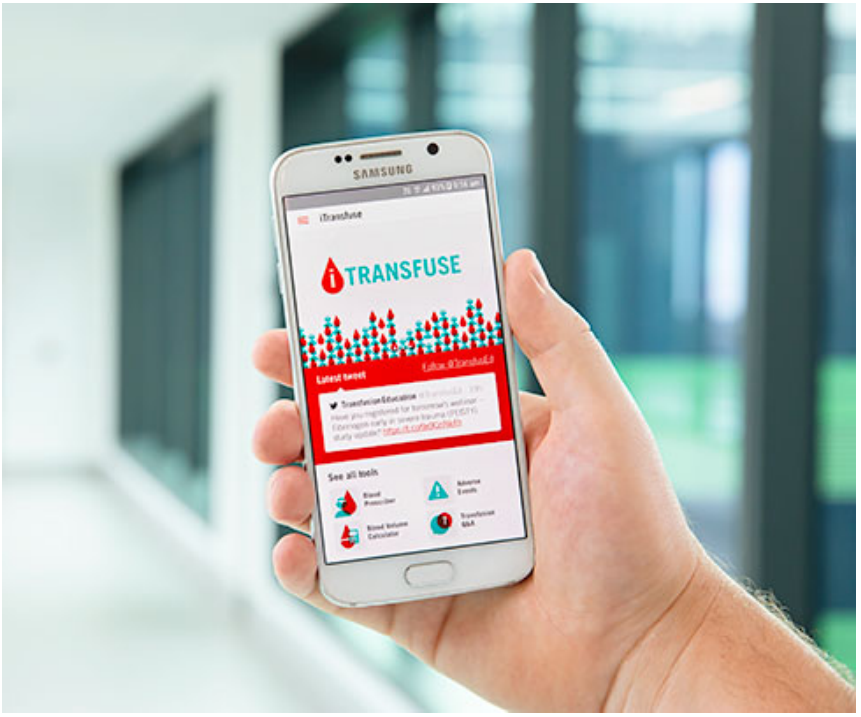

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