25 Paediatric Cases

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Definition:

Paediatric cases comprise all those occurring in patients under 18 years of age. This chapter analyses the data on paediatric cases from the other chapters in this 2013 Annual SHOT Report. All the cases are also included in the data in their respective chapters. The children have been subdivided by age groups: neonates ≤28 days; infants >28 days and <1year old; and children ≥1 year to <16 years, and 16 to <18 years of age.

Table 25.1: Summary of paediatric cases 2013

Category of case	≤28 days	>28 days to <1 year	1 to <16 years	16 to <18 years	Total paediatric cases
Incorrect blood component transfused (IBCT)	11	3	11	5	**30**
Avoidable, delayed or undertransfusion (ADU)	6	1	9	1	**17**
Handling and storage errors (HSE)	4	5	4	1	**14**
Anti-D immunoglobulin related	0	0	2	7	**9**
Acute transfusion reactions (ATR)	1	2	15	4	**22**
Haemolytic transfusion reactions (HTR)	0	0	3	0	**3**
Alloimmunisation (ALLO)	0	0	2	0	**2**
Cell salvage and autologous transfusion (CS)	0	0	1	0	**1**
Unclassifiable complications of transfusion (UCT)	2	1	1	0	**4**
Total	**24**	**12**	**48**	**18**	**102**
Near miss (NM)	42	11	21	3	**77**
Right blood right patient (RBRP)	2	2	1	1	**6**

Note: There were no paediatric cases from the other chapters, so those headings are omitted from the table. NM and RBRP numbers are shown separately

Introduction and overall trends

The overall number of paediatric reports was 185, or 102 excluding 'near miss' and 'right blood right patient' incidents, where no patient harm resulted.

For 2013, paediatric cases were 102/1571 (6.5%) of total SHOT reports, and 185/2751 (6.7%) if NM and RBRP are included.

The overall pattern and number of reports were similar to previous years (Figure 25.1). Error-related reports (IBCT, HSE, ADU and anti-D) were 68.6% (70/102) of all paediatric reports, and were 83.3% (30/36) of reports from infants <1 year old. Compared to 2012, there were only half the number of IBCT-wrong component transfused (WCT) reports (8 compared to 15) but identical numbers of IBCT-specific requirements not met (SRNM). Overall IBCT reports remain a significant proportion of paediatric error reports (42.9%; 30/70). A total of 28/70 (40.0%) errors originated primarily in the laboratory (4 IBCT-WCT, 13 IBCT-SRNM, 4 HSE, 6 ADU, 1 anti-D), and the remainder (42/70 (60.0%)) were errors made in the clinical area.

The number of paediatric acute transfusion reactions (ATRs) was reduced from 28 in 2012 to 22 this year. There were no paediatric cases of transfusion-related pulmonary complications such as transfusion-related acute lung injury (TRALI). A problem previously unreported to SHOT was of high potassium levels in the supernatant of red cells used to prime a bypass circuit for infant cardiac surgery, although these were not transfused to the patient.

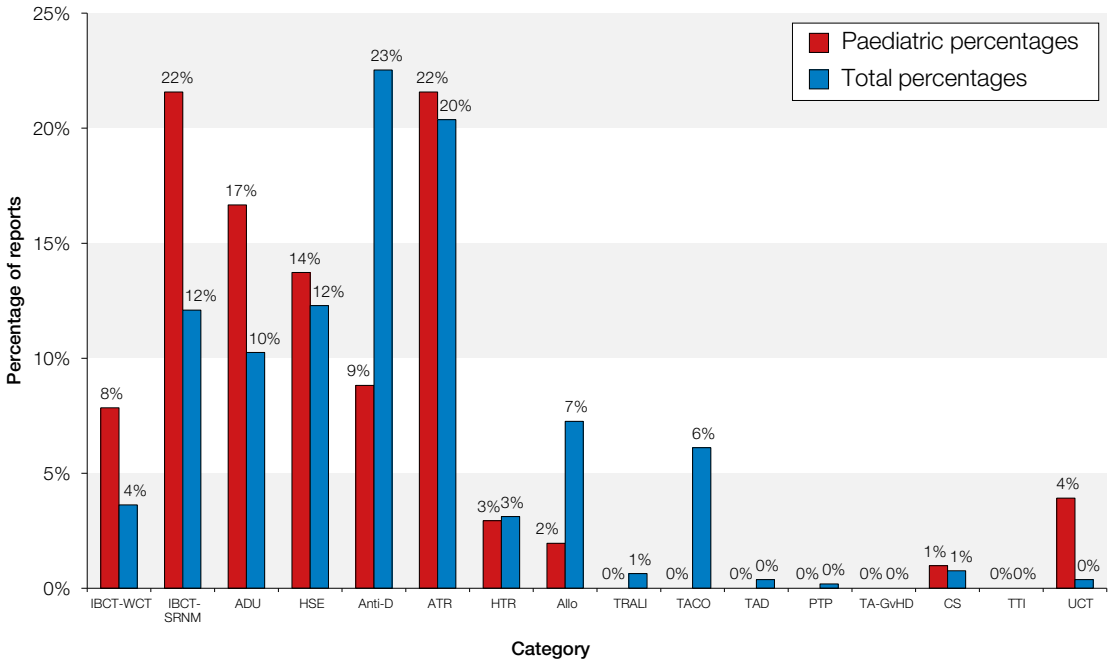


Figure 25.1: Percentages of paediatric and total reports in each category

General trends in paediatric SHOT reports over the last 7 years suggest a plateauing of overall numbers since 2009, taking into account that SHOT ceased to accept reports of minor ATRs from 2012 onwards (Figure 25.2). The overall proportion of reports to SHOT that are from children has been at its current level since 2011, having been previously higher at around 8.5% between 2008-2010 and 9.9% for the summary data from 1996-2005 [80]. Stainsby and colleagues estimated that there was a disproportionately high proportion of reports in the paediatric age group, in particular for 'incorrect blood component transfused'. However, without detailed information on numbers of paediatric transfusions it is not clear if the current trend to a decreased percentage of paediatric reports represents an absolute reduction in relation to the number of paediatric transfusions. It should be noted that specific requirements not met is a significant category of paediatric error reports, with the numbers of reports in this category not showing any overall improvement over the last few years (Figure 25.2b).

Deaths and major morbidity

Deaths due to transfusion n=2

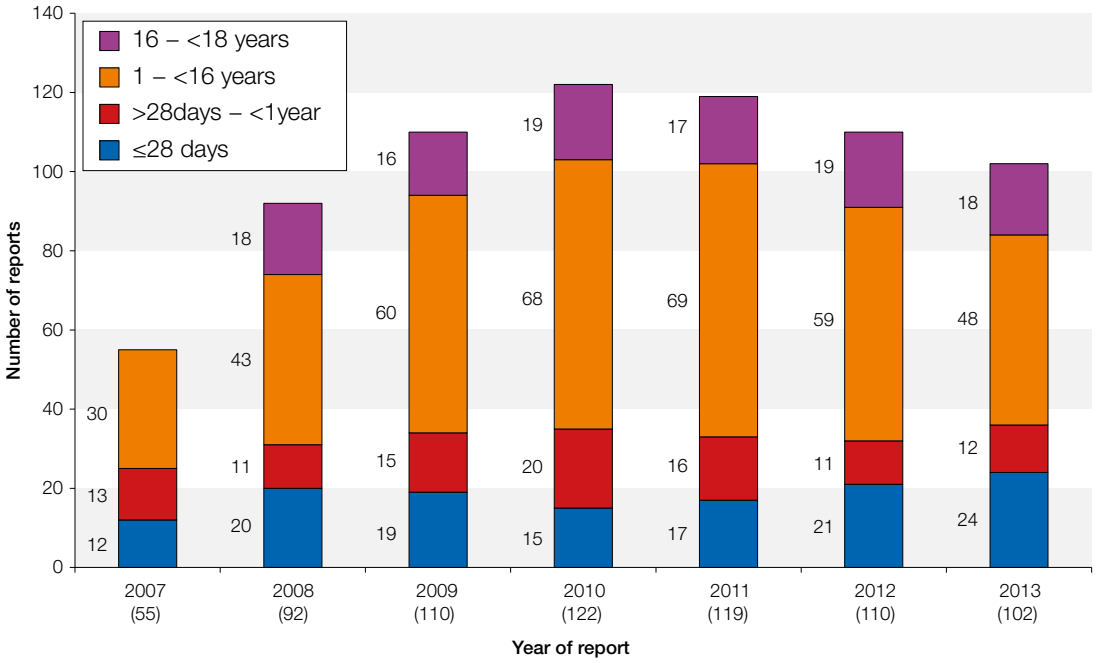
There were 13 reports where the transfused child died, but in only 2 cases was the death possibly (1) or definitely (1 delayed) related to the transfusion. A child with sickle cell disease died with severe anaemia during a delayed transfusion (see Chapter 11 Avoidable, Delayed or Undertransfusion (ADU)). A case of necrotising enterocolitis (NEC) following transfusion was classed by the reporter as 'possibly' related to the transfusion. However, it is recognised that causality between transfusion and NEC is still unproven.

Major morbidity n=3

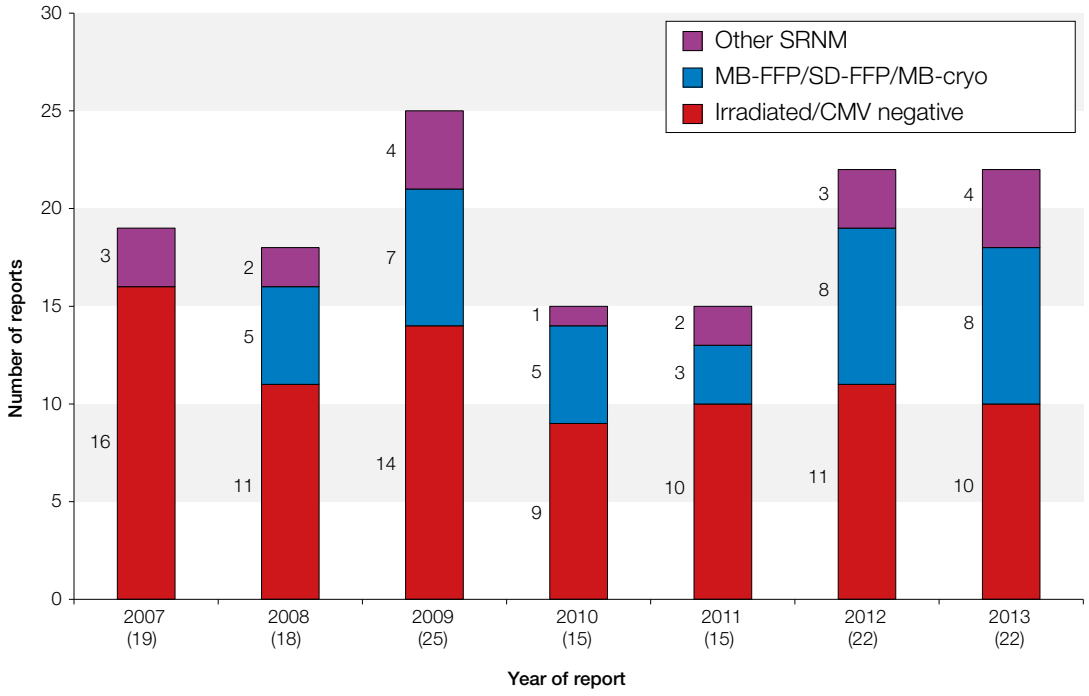
There were two severe acute transfusion reactions to platelets and one to methylene blue-treated fresh frozen plasma (MB-FFP).

Figure 25.2: Trends in paediatric reports 2007-2013

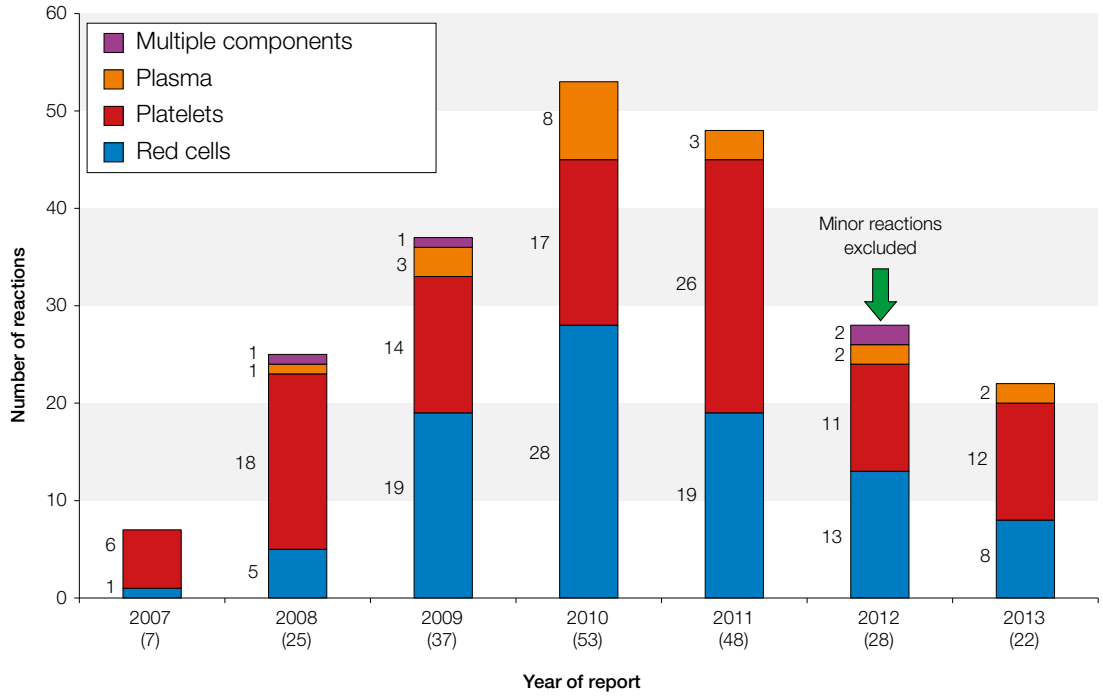
a. Total numbers of paediatric reports



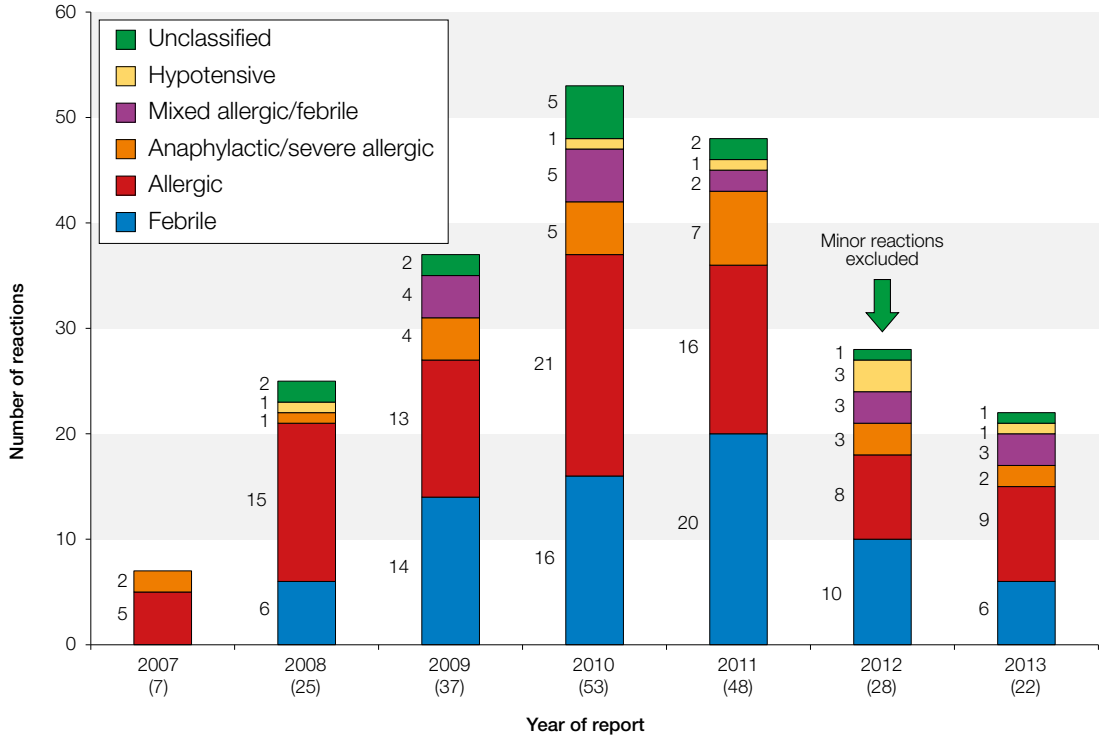
b. Paediatric SRNM reports



c. Paediatric ATR by component type



d. Paediatric ATR reports by reaction type



Note: in 2007 only cases <16 years were included

ERROR-RELATED REPORTS n=70

Incorrect blood component transfused (IBCT) n=30

Table 25.2: Breakdown of incorrect blood component transfusion reports

Category of case	≤28 days	>28 days to <1 year	1 to <16 years	16 to <18 years	Total paediatric cases
IBCT – wrong component transfused (IBCT WCT)	6	0	2	0	8
IBCT – WCT Clinical	*4*	*0*	*0*	*0*	*4*
IBCT – WCT Laboratory	*2*	*0*	*2*	*0*	*4*
IBCT – specific requirements not met (IBCT SRNM)	5	3	9	5	22
Irradiated	*3*	*1*	*3*	*1*	*8*
CMV negative	*1*	*1*	*0*	*0*	*2*
MB- or SD-Plasma	*1*	*0*	*3*	*4*	*8*
Others	*0*	*1*	*3*	*0*	*4*
Total	**11**	**3**	**11**	**5**	**30**

MB: Methylene blue-treated SD: solvent-detergent treated CMV: cytomegalovirus

IBCT – wrong component transfused (WCT) n=8

IBCT – WCT clinical error n=4

There were four cases, all in fetuses/newborn babies. An urgent intrauterine transfusion (IUT) was undertaken with neonatal red cells from the neonatal unit refrigerator rather than taking the time to order specific irradiated IUT red cells from the Blood Service. A baby requiring urgent cardiac surgery immediately post delivery, prior to grouping, was given A RhD positive red cells prepared for his mother rather than the O RhD negative blood that had been issued. Two neonates requiring emergency transfusions following delivery were given adult emergency O RhD negative units, taken instead of the available neonatal red cells.

IBCT – WCT laboratory error n=4

A neonate requiring an exchange transfusion was issued and transfused with paedipacks (over 5 days old) rather than exchange red cells. Another neonate given an emergency transfusion with group O red cells for severe anaemia at birth was incorrectly grouped as O with weak reactions with grouping reagents following emergency transfusion with group O red cells. The neonate was subsequently found to be group A but in the meantime had been transfused with group O FFP (see Chapter 8 Incorrect Blood Component Transfused (IBCT)).

Inappropriate use of electronic issue resulted in red cells of inappropriate group being transfused to a 1 year old post ABO mismatched liver transplant. A 16 year old male haemopoietic stem cell transplant (HSCT) patient was transfused with RhD positive instead of RhD negative platelets on several occasions (an error, not an intentional decision). These errors originated in the laboratory but could potentially have been detected by checks on the wards.

IBCT – specific requirements not met (SRNM) n=22

Cases where the specific requirements were not met made up 31.4% (22/70) of all paediatric error reports. The pattern of cases was similar to 2012. In line with the recommendations of the Advisory Committee on the Safety of Blood, Tissues and Organs [81], only paediatric reports where there was an error in providing CMV negative components for infants of less than 44 weeks corrected gestational age were included. Errors regarding irradiation were largely due to poor understanding and communication by clinicians, whereas most failures to provide pathogen inactivated plasma were due to problems with laboratory computer flagging of age-related requirements.

There were 8 cases where non-irradiated components were given in error with no adverse outcome. Two were neonates following IUT; for one the prescribing junior doctor did not know the irradiation requirements, and for the other there was poor communication following inter-hospital transfer of

the baby. Three recipients, aged between 28 days and 13 years, had either known or suspected immunodeficiency (Di George syndrome /severe combined immunodeficiency). Three were haematology/ oncology patients, including one undergoing lung transplant where no information was given to the laboratory about a preceding HSCT.

In 2 cases CMV unscreened components were erroneously given to infants. Investigation of the donor status confirmed that a 12 day neonate had received CMV positive adult apheresis platelets: the laboratory scientist did not realise they required specific neonatal platelets and the laboratory information technology (IT) system gave no age-related alert indicating the requirement for CMV negative. A 3 month old infant undergoing cardiac surgery was transfused non-CMV negative adult red cells. Having been born preterm, the baby was still only 43 weeks corrected gestational age and this was not communicated to the laboratory.

Eight patients were transfused with standard plasma (FFP or cryoprecipitate) instead of pathogen-inactivated as specified for patients born on or after 1st January 1996. Five of the cases were the result of inadequate laboratory systems for flagging the age-related requirement and for 2 the flag was ignored. For the final case it was not initially realised that a 16 year old trauma patient was a 'child'.

The final 4 SRNM reports were all due to laboratory error. Red cells transfused to a one month old infant were crossmatched against the baby but not the mother and subsequently found to be incompatible with the mother who had multiple alloantibodies. Phenotyping errors included a failure to give appropriately phenotyped blood to a 4 year old with sickle cell disease by a rural laboratory with little experience of such patients, and failure to give K negative red cells to a 4 year old female. Finally, non-apheresis platelets were issued for a 4 year old following errors and poor communication within the laboratory.

Avoidable, delayed or undertransfusion (ADU) n=17

This was a clinically significant category of paediatric error reports, including one patient who died as a result of delayed transfusion. There were 5 cases of avoidable transfusion, four on the basis of erroneous results, normal on repeat. A 17 year old with iron deficiency anaemia (Hb 76g/L) was inappropriately transfused.

There were 6 reports of delayed transfusion, 4 in neonates. One hospital transfusion laboratory was unable to issue emergency neonatal blood due to a problem with the laboratory computer and another misunderstood the clinical urgency. For an acutely bleeding neonate there was confusion over the location of neonatal blood following breakdown of the normal storage refrigerator. A neonatal exchange transfusion for hyperbilirubinaemia caused by maternal anti-D was delayed due to poor communication between the obstetric team, the paediatricians and the laboratory in not highlighting possible haemolytic disease of the newborn requiring neonatal exchange blood. The fifth case related to miscommunication of unit size requested: six adult size units of blood were requested for an 8 year old post cardiac surgery patient being taken back to theatre for bleeding but 6 paedipack units were issued. A child with a sickle cell crisis and anaemia had a falling Hb and was only transfused when the Hb was 28g/L, and had a cardiac arrest and died during the transfusion (see Chapter 11 Avoidable, Delayed or Undertransfusion (ADU)).

Four children were overtransfused, one requiring subsequent venesection. A neonate was mildly overtransfused as a result of an incorrect weight recorded on the prescription chart. A 2 year old had a massive haemorrhage following trauma and was overtransfused in theatre as rapid transfusion continued despite control of bleeding. A 9 year old was prescribed and transfused 3 units rather than 1 unit after a locum doctor did not follow the consultant's instructions. The fourth case is described below (Case 1).

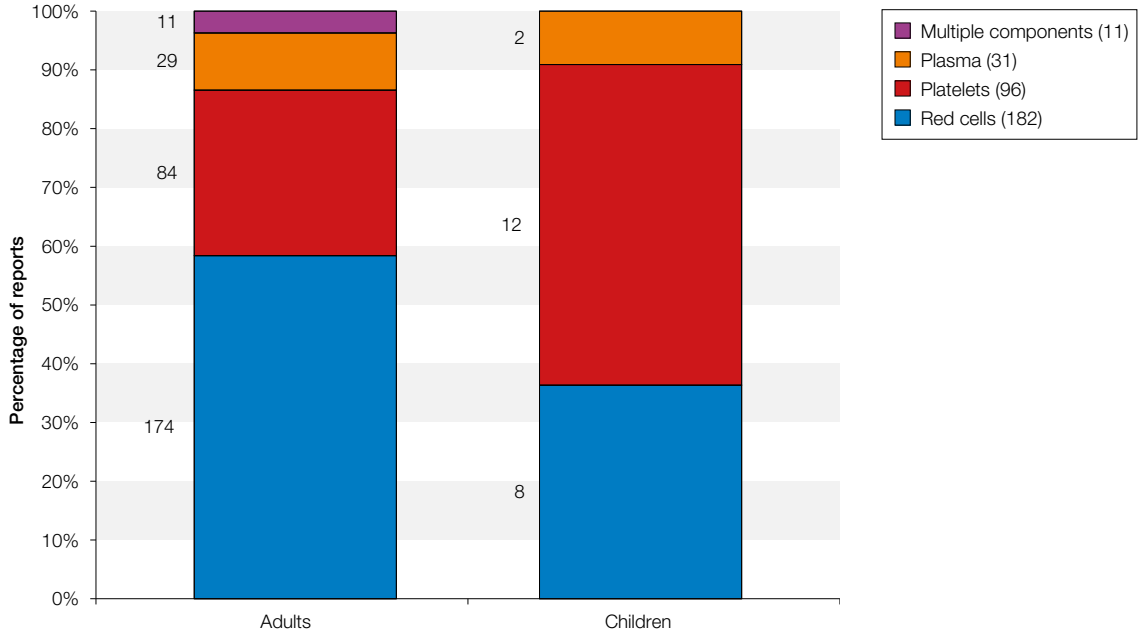
Case 1: Overtransfusion of a child with sickle cell disease

A 3 year old 15kg child with sickle cell disease and pre-transfusion Hb of 43g/L was transfused 2 adult-sized units of red cells. The post-transfusion Hb was 151g/L. A repeat blood count had been taken after the first unit but the sample was clotted and not repeated. The child required venesection.

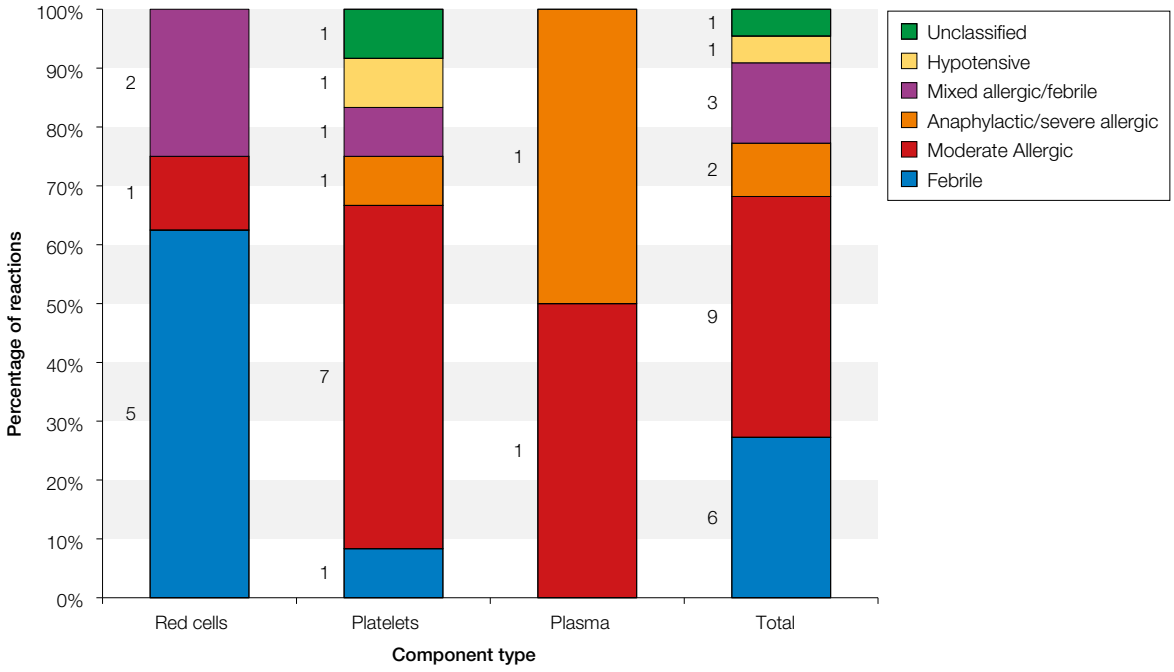
Although there were no serious adverse outcomes, a high Hb can risk neurological complications for patients with sickle cell disease and this case illustrates the need for meticulous calculation and prescription of transfusion volumes for children.

Figure 25.3: Paediatric ATR reports

a. Comparison of proportions of adult and paediatric ATRs due to different components.



b. Percentages of reaction types for each component for paediatric reports



Undertransfusion was related to the prescription in two cases. Due to difficulty in reading the prescription, a 14 year old was given a total of 145mL over 4 hours instead of 145mL/hour for 4 hrs, requiring readmission for further transfusion. A 2 year old was prescribed 20mL instead of 203mL as a result of using Hb in g/dL in a transfusion calculation formula designed for Hb in g/L.

Handling and storage errors (HSE) n=14

There were 8 cold chain errors, and two reports where the laboratory errors resulted in expired platelets being transfused to a neonate and red cells being issued to an infant on the basis of an invalid crossmatch sample. A non-blood administration set was used to prepare a transfusion for an infant. Three reports involved problems with infusion pumps. A 3 day old baby was given more red cells than prescribed due to incorrectly setting the pump, a 6 month infant was prescribed 70mL platelets but the pump was set at 700mL so the entire 140mL volume in the bag was infused. For almost an hour into a red cell transfusion to a newborn baby the blood went back into the blood bag rather than into the baby due to incorrect positioning of the 3 way tap.

Anti-D Ig errors n=9

The youngest pregnancy-related paediatric case was 14 years old, but none of the reports were related to the patients being children and they are discussed as part of Chapter 14 Anti-D Immunoglobulin – Prescription, Administration and Sensitisation. A 5 year old RhD negative girl with thrombocytopenia as a result of chemotherapy was transfused with RhD positive platelets and did not receive anti-D immunoglobulin. Her subsequent antibody screens remained negative.

TRANSFUSION REACTIONS n=32

Acute transfusion reactions (ATR) n=22

Paediatric ATRs made up 6.9% (22/320) of all ATR reports. Of the 21 where severity could be classified, 2 were severe reactions to platelets (1 severe allergic/anaphylactic, 1 severe hypotensive), 1 was a severe allergic reaction to MB-FFP and 18 were moderate reactions. Overall, 36% reactions were to red cells, 55% to platelets, and 9% to FFP (Figure 25.3a). Most red cell reactions were febrile whereas most platelet reactions were allergic (Figure 25.3b). There was only one neonatal ATR reported, a febrile reaction to red cells.

As in previous years, platelets contributed a higher proportion of reactions for children than for adults (see Figure 25.3a). The platelet reports all involved apheresis platelets (2 human leucocyte antigen (HLA)-matched), except for 1 pool to a 16 year old and one unstated. The two severe reactions to platelets both followed prophylactic platelet transfusions prior to invasive procedures/line removal. Both occurred on paediatric intensive care units: a severe hypotensive reaction in a 6 month infant with a cardiac surgery diagnosis, and a severe allergic/anaphylactic reaction in a 1 year old. Both FFP reports were allergic reactions to MB-FFP. One was a moderately severe reaction in a 7 year old transfused for a prolonged prothrombin time prior to a procedure, and the other was a severe allergic (but not anaphylactic) reaction in a 16 year old child transfused red cells and plasma following a gastrointestinal bleed (see Chapter 15 Acute Transfusion Reactions (ATR)).

Case 2: Severe allergic reaction to prophylactic platelets

A one year old on intensive care was transfused platelets prior to an invasive procedure. Within a few minutes the child had a falling blood pressure, became wheezy and developed tachycardia with swelling to the lips and face, and required treatment with adrenaline.

This case illustrates the need to balance the perceived benefit of prophylactic platelets prior to procedures against the risk of a potentially severe reaction.

Haemolytic transfusion reactions (HTR) n=3

A transfusion of group O platelets to a group AB child caused an HTR following subsequent transfusion of group A red cells (see Chapter 16 Haemolytic Transfusion Reactions (HTR) for further discussion of the HTR cases). The other two patients had sickle cell disease, both dropped their Hb several days following transfusion and no red cell antibodies were identified as the cause. Both had suspected hyperhaemolysis as the post-transfusion Hb was lower than pre.

Alloimmunisation (ALLO) n=2

There were reports of alloimmunisation to Jk^a in two 3 year olds following routine red cell transfusions, one post chemotherapy, and one postoperatively with a Hb of 74g/L.

Cell salvage (CS) n=1

A child had a reaction to a postoperative reinfusion of salvaged blood.

Unclassifiable complications of transfusion (UCT) n=4

A 13 year old girl, group B RhD negative, developed anti-D following a liver transplant from a donor who was O RhD positive (see Chapter 21 Unclassifiable Complications of Transfusion (UCT), for further details).

There were two cases of NEC reported in preterm babies following red cell transfusion, both of whom died the subsequent day. One was 25 days old, developed a distended abdomen two hours into a red cell transfusion for symptomatic anaemia with Hb 75g/L, was commenced on antibiotics, diagnosed with NEC and died. The other was a stable 10 day old extremely low birthweight preterm baby, transfused for an anaemia of 95g/L who developed NEC 10 hours post transfusion.

There were two previous cases of NEC reported to SHOT in 2011, and observational studies have shown an association between transfusion and some cases of NEC, in particular following relatively late transfusions to stable preterm babies. However it is not clear if this is a causal association. A recent meta-analysis showed that for the few randomised controlled trials of red cell transfusion in neonates where NEC was included in the outcomes, there was a tendency for more NEC in the restrictively transfused group rather than the liberal, opposite to the expectation if NEC were causally associated with transfusion [82].

Case 3: High potassium in a red cell unit used to prime a cardiac bypass circuit

A large volume unit of red cells (day 5 post donation, non-irradiated, no cold-chain errors) was used to prime the bypass circuit for a 4 month infant about to undergo cardiac surgery. According to their normal practice, the perfusionist took a blood gas sample from the circuit and found the potassium to be unacceptably high (13.76mmol/L). The potassium measured in a subsequent sample from the red cell unit itself was 41.4mmol/L. The blood was not transfused and there was no clinical impact of the incident other than a minor delay to surgery. The donor was subsequently found to have a mutation for familial pseudohyperkalaemia, resulting in increased leakage of potassium from their red cells on cold storage, and the supernatant potassium was higher than expected for red cells of this storage time [73]. The donor had previously donated multiple units without any recorded adverse events.

This report was of red cells with an unusually high supernatant potassium at day 5 post donation, but levels can be even higher following longer storage [73]. For this reason, for large volume transfusions to neonates and infants such as cardiac surgery and neonatal exchange transfusion it is recommended that fresh red cells (less than 5 days old, British Committee for Standards in Haematology (BCSH) guidelines [32]) are used in order to reduce the risk of hyperkalaemia in the recipient. Despite these precautions it is recognised that potassium levels may sometimes be high, particularly after red cell irradiation, and there have been reports in the literature of hyperkalaemia and cardiac arrest following large volume transfusions although these are rare and there are probably multiple factors involved [83, 84]. It is therefore practice in many paediatric cardiac centres to routinely check the potassium in the circuit pre-bypass, particularly when there has been irradiation of the units, and if it is high the red cells may be washed in order to achieve physiological levels.

Near miss (NM) n=77

The paediatric NM cases are included in the trends discussed in Chapter 7 Near Miss Reporting (NM). More than half (44/77) were wrong blood in tube (WBIT) reports, 29 of these from neonates. Neonatal samples are frequently mixed up with the maternal sample, and altogether SHOT received 37 reports where this occurred, 15 reported within the neonatal cases, and a further 22 as a maternal error. There were also 3 reports where samples from twins were exchanged.

Right blood right patient (RBRP) n=6

These reports included a case where blood was transfused to a twin using a duplicate patient entry on the IT system.

COMMENTARY

Incorrect blood component transfused

Wrong component transfused

- Every year there are reports of adult blood being used for neonates, either adult emergency O RhD negative blood or red cells intended for the mother. Blood for emergency neonatal transfusions should be available in maternity and specialist neonatal units. Hospitals need to ensure robust local procedures to separately identify red cells for neonatal vs maternal emergency transfusions
- As in 2012, there was a case where non-irradiated neonatal red cells were used for urgent IUT. While this may be appropriate in life-threatening emergency, there should be local protocols in place to specify the transfusion pathways for urgent IUT, and where possible specific red cells for IUT should be ordered from the Blood Services as recommended last year (see SHOT 2012 Paediatric recommendations [3]). The Blood Services (in England) have reviewed their procedures and an update is included in Chapter 3 SHOT Updates and Developments
- For neonatal exchange transfusions, hospital transfusion laboratories should ensure that blood of the correct specification is issued, and laboratory staff should be trained to understand the requirements. Local neonatal exchange protocols should include information on the type of blood for exchange transfusion so that ward staff are aware of what to expect
- If emergency O RhD negative blood is transfused before a grouping sample is taken, laboratory staff should be aware that the transfusion may affect subsequent blood grouping. If there is uncertainty as to the neonate's own blood group then O RhD negative red cells and AB plasma should be transfused if possible. This may be a particular problem for severely anaemic neonates

Specific requirements not met

- Reports of failure to provide irradiated units mostly resulted from clinical errors where paediatricians did not consider specific requirements, with the risk sometimes exacerbated by transfer of patients between hospitals. Clinicians must inform the laboratory where there is a need for clinical specific requirements such as irradiation
- The need for CMV negative components can be missed for neonates who are born preterm unless the laboratory is given information regarding gestational age. Cellular components provided by the UK Blood Services with neonatal/infant specification are CMV negative, and if used up to 6 months post delivery this would include even very preterm babies up to 44 weeks corrected gestational age
- The majority of reports of non-pathogen-inactivated plasma transfusions to children were due to inadequate laboratory IT systems. Laboratory IT systems must be set up to give an automatic flag based on the date of birth for age-related specific requirements. Moreover, once clinical specific requirements have been communicated to the laboratory there should be robust systems to ensure that IT flags are set up as soon as possible and staff should not ignore them once in place

Learning points

- There is a need to raise awareness of specific requirements for children among paediatricians, to encourage communication with haematologists for advice, and for the hospital transfusion laboratory to be informed of any patients who might need irradiated blood even if transfusion is not currently envisaged
- Patients having intrauterine transfusions (IUTs) are a small group who have had very specialised care during fetal life and it is not unexpected that some may need postnatal transfusions. Fetal medicine units should review protocols to ensure that there is good communication of the irradiation requirement with all professionals and with the parents in order to reduce the number of reports where irradiation was missed in the future

Avoidable, delayed or undertransfusion, handling and storage errors

- Protocols for major blood loss should be developed for paediatrics in parallel to adults in order to reduce misunderstandings between clinicians and laboratories in emergency situations. Great care should be taken when calculating and prescribing paediatric transfusion volumes, particularly since the change in reporting of Hb units from g/dL to g/L, as significant over or undertransfusion can occur following miscalculation. It is recommended that transfusions for children are prescribed in mL in order to reduce the risk of transfusing an inappropriate volume [23] (BCSH 2009). Recommendations regarding paediatric transfusion prescribing have been made in previous Annual SHOT Reports [3, 22, 85]
- Problems with neonatal transfusion giving sets and pumps are repeatedly reported to SHOT and can again lead to significant over or undertransfusion

Unclassifiable complications of transfusion

- Cases of NEC following red cell transfusion have been reported previously to SHOT and there are likely to be others that have not been reported. Prospective studies are needed in order to understand if this recognised association may be causal. Neonatologists are encouraged to report to SHOT cases of NEC occurring within 48 hours following a red cell transfusion
- The case of high potassium levels measured in a bypass circuit, a type of event previously unreported to SHOT, was included in the main cases to highlight the learning points even though the blood was not transfused. The red cell unit had an unusually high supernatant potassium as the result of a mutation in the donor that increased potassium leakage during red cell storage in the cold. 1:500 donors may have this mutation so although only two isolated cases have so far been reported there are likely to be more in the future [73]

Learning points

- Perfusionists and anaesthetists and those involved with rapid large volume transfusion to children should be aware of the risk of transfusion-associated hyperkalaemia (particularly for infants or those with co-morbidities) [83]. For patients undergoing cardiac bypass, potassium levels should be measured in the circuit before connecting to the patient and local units should have protocols giving guidance on the maximum acceptable levels in the circuit
- Potassium levels should **not** be routinely measured in red cell units themselves pre transfusion as the levels may be misleading, not accurately predictive of potassium levels following dilution in bypass circuits or patients, and can cause confusion and delay in patient treatment
- If there are clinical concerns about high levels of red cell supernatant potassium this should reported immediately to the UK Blood Services for further advice and investigation as appropriate

Near miss events

- There were many reports of 'wrong blood in tube' samples resulting from mixing up mother and baby samples. This highlights that safety recommendations such as the 'group check rule' are appropriate for neonates as well as older recipients [19]

Recommendation

- Laboratory information technology (IT) systems should be set up so that they are able to automatically flag up age-related specific requirements such as the need for imported pathogen-inactivated plasma for patients born on or after 1st January 1996

Action: Hospital Transfusion Laboratories, Hospital Transfusion Teams

Recommendations still active from previous years are available in the 2013 Annual SHOT Report Supplement located on the SHOT website, www.shotuk.org under SHOT Annual Reports and Summaries, Report, Summary and Supplement 2013.