Paediatric Cases n=159

23

Authors: Anne Kelly and Helen New

Definition:

Paediatric cases comprise all reports for patients under 18 years of age, including all paediatric cases from the other chapters in this report. Paediatric reports have been subdivided by recipient age group: neonates ≤28 days; infants >28 days and <1 year; children ≥1 year to <16 years and young people aged 16 to <18 years.

Key SHOT messages

- Massive blood loss in children is less common than in adults and hospitals should have protocols in place for appropriate and timely management
- Communication and education regarding specific requirements and their indications remains vital
- Management of D-incompatible platelet transfusions in neonates and children should be discussed with a haematologist
- Education and training resources should be provided for those administering neonatal transfusions to reduce errors

Abbreviations used in this chapter

ADU	Avoidable, delayed and under/overtransfusion
ATG	Anti-thymocyte globulin
BMS	Biomedical scientist
BSH	British Society for Haematology
CMV	Cytomegalovirus
DHTR	Delayed haemolytic transfusion reaction
ECMO	Extracorporeal membrane oxygenation
ED	Emergency department
FAHR	Febrile, allergic and hypotensive reactions
FFP	Fresh frozen plasma
Hb	Haemoglobin
HSE	Handling and storage errors
HTR	Haemolytic transfusion reactions
IBCT	Incorrect blood component transfused
Ig	Immunoglobulin
IT	Information technology
IV	Intravenous
LIMS	Laboratory information management system
MB	Methylene blue-treated
NHSBT	National Health Service Blood & Transplant
NM	Near miss
PAS	Platelet additive solution
PICU	Paediatric intensive care unit
RBRP	Right blood right patient
SCID	Severe combined immunodeficiency
SRNM	Specific requirements not met
TACO	Transfusion-associated circulatory overload
TAD	Transfusion-associated dyspnoea
TANEC	Transfusion-associated necrotising enterocolitis
TRALI	Transfusion-related acute lung injury
TTI	Transfusion-transmitted infection
UCT	Uncommon complications of transfusion
VSD	Ventricular septal defect
WCT	Wrong component transfused

Recommendations

- Departments should ensure major haemorrhage protocols for children are available and are used (see also Recommendations in Chapter 12a, Delayed Transfusions)
- Irradiation guidelines have been revised and published recently. Local education programs should be updated to include indications for special requirements in line with national guidelines

Action: Hospital transfusion laboratory, transfusion practitioners, clinical transfusion staff

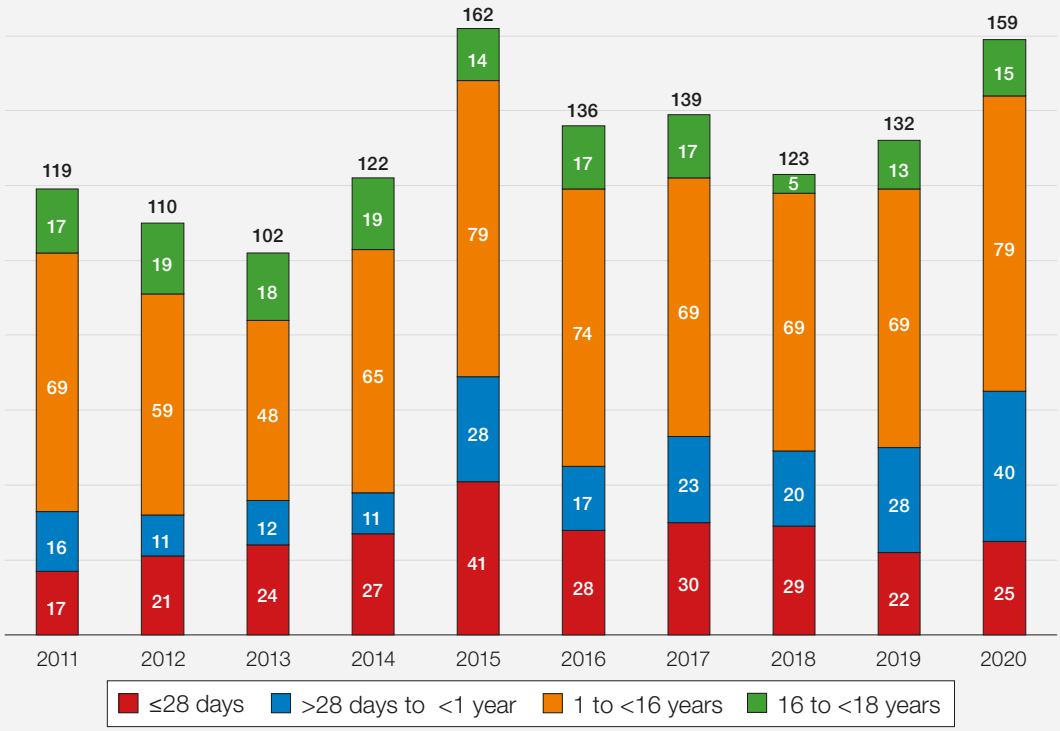
Introduction

There were more reports in 2020 compared to the previous year (159 vs 132, Figure 23.1). Paediatric cases accounted for 8.5% (159/1877) of total cases analysed excluding NM and RBRP, and 8.4% (271/3214) if NM and RBRP are included.

Approximately a third of reports are in children under the age of 1 year, highlighting the issues around transfusion in this patient group, particularly for error-related reports (Figure 23.2). The overall pattern of case reports is consistent with previous years (Figure 23.3). Children continue to be over-represented in reports in the FAHR and IBCT-WCT categories, and there was a striking increase in the number of paediatric FAHR reports following platelet transfusion. This year there were no FAHR cases reported in infants under the age of 1 year.

The proportion of error reports considered to originate primarily in the laboratory was 51.6% (48/93). This proportion increased significantly from 39.5% (34/86) in 2019, but 9 cases were from a single centre following a look back exercise. The laboratory error reports were in the following categories: ADU, 12/35 reports (34.3%); IBCT-WCT 19/23 (82.6%); IBCT-SRNM, 15/21 (71.4%) and HSE, 2/15 (13.3%).

Figure 23.1: Trends in paediatric reports from 2010-2020



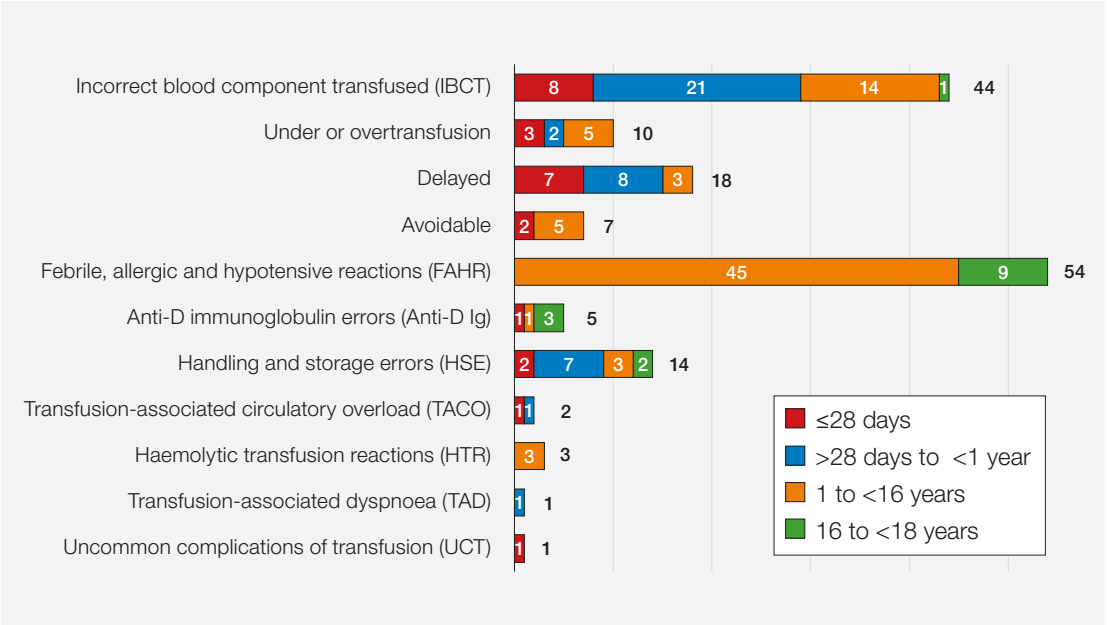


Figure 23.2: Summary of paediatric cases by category and age 2020 (n=159)

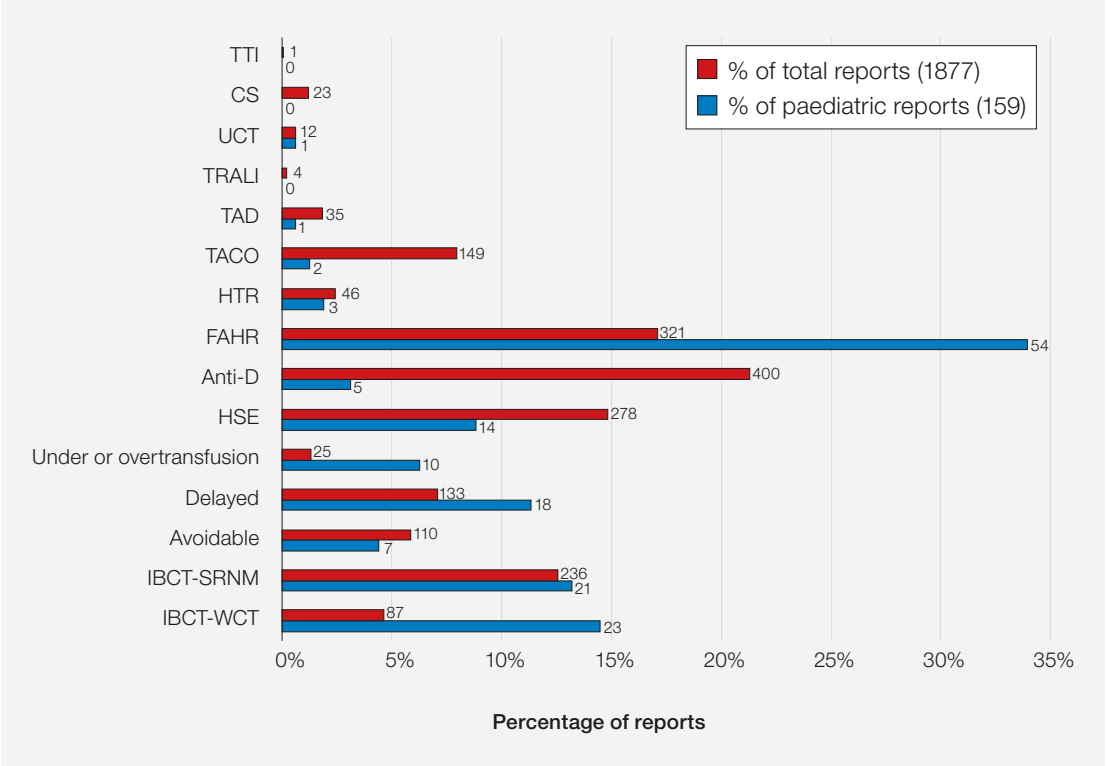


Figure 23.3: Percentages of paediatric and total reports in each category

TTI=transfusion-transmitted infection; UCT=uncommon complications of transfusion; TRALI=transfusion-related acute lung injury; TAD=transfusion-associated dyspnoea; TACO=transfusion-associated circulatory overload; HTR=haemolytic transfusion reactions; FAHR=febrile, allergic and hypotensive reactions; HSE=handling and storage errors; IBCT-SRNM=incorrect blood component transfused-specific requirements not met; IBCT-WCT=IBCT-wrong component transfused

Deaths due to transfusion n=3

There were 9 deaths, with 3 assessed as being possibly or probably related to transfusion. One of these was a case of TANEC where the imputability was only 1 (possible).

The other 2 cases involved the timely management and provision of blood components to bleeding patients following biopsies. Both were in the ADU category, with significant delays in recognition of the severity of haemorrhage and in activating major haemorrhage protocols.

Case 23.1: Transfusion delay and death due to multiple factors

A young infant had a liver biopsy performed. Post procedure they developed internal bleeding, and this was not noticed. There was then a delay activating the major haemorrhage protocol and a delay in recognising the need for the neonatal O D-negative blood, which was available. This resulted in a delay of over 3 hours before the infant received any red cells. This was partly due to communication issues. The patient did not survive.

Case 23.2: Delay in recognising major haemorrhage

A 2kg infant was admitted to the ED overnight with rectal bleeding following a suction rectal biopsy which had been performed the day before. There was history of two blood filled nappies at home and a further nappy in the ED which was filled with blood and clots. There was a nearly 2-hour delay in obtaining IV access, including a delay in escalation to intra-osseous access. The major haemorrhage protocol was not activated. The baby became significantly acidotic. During resuscitation the baby suddenly developed bleeding from the mouth and nose and had a cardiopulmonary arrest. A chest X-ray performed shortly afterwards showed a 'white out'. Overall significant volumes of red cells and Octaplas® were given. The child was transferred to PICU but did not survive.

Delays in recognising the severity of the bleeding and activation of the major haemorrhage protocol contributed to patient death.

Imputability was recorded as probable in cases 23.1 and 23.2. Both cases illustrate the need for specific paediatric major haemorrhage protocols to be available and activated in massive haemorrhage situations (see also Chapter 12a, Delayed Transfusions).

Learning points

- Protocols should be in place for the management of massive haemorrhage in infants and children. These should include guidance on the appropriate component volumes to be used in resuscitation
- If in doubt the major haemorrhage protocol should be activated

Major morbidity n=19

FAHR was the most common cause of major morbidity in the paediatric reports (16/19, 84.2%), 2 following red cells and 14 platelets.

The other major morbidity cases included:

- One in the ADU category involving a delay in transfusion with a missed opportunity to use available emergency neonatal O D-negative red cells
- A case of HTR involving a young teenager with sickle cell anaemia who developed a delayed haemolytic transfusion reaction secondary to anti-E
- A case of hyperhaemolysis in a child with sickle cell anaemia who had several alloantibodies

Error reports n=98

Incorrect blood component transfused (IBCT) n=44

IBCT-wrong component transfused (WCT) n=23

There was a significant increase in IBCT-WCT compared to last year's report (2019 n=10) due to an increase in laboratory errors, with 9 coming from the same reporting organisation.

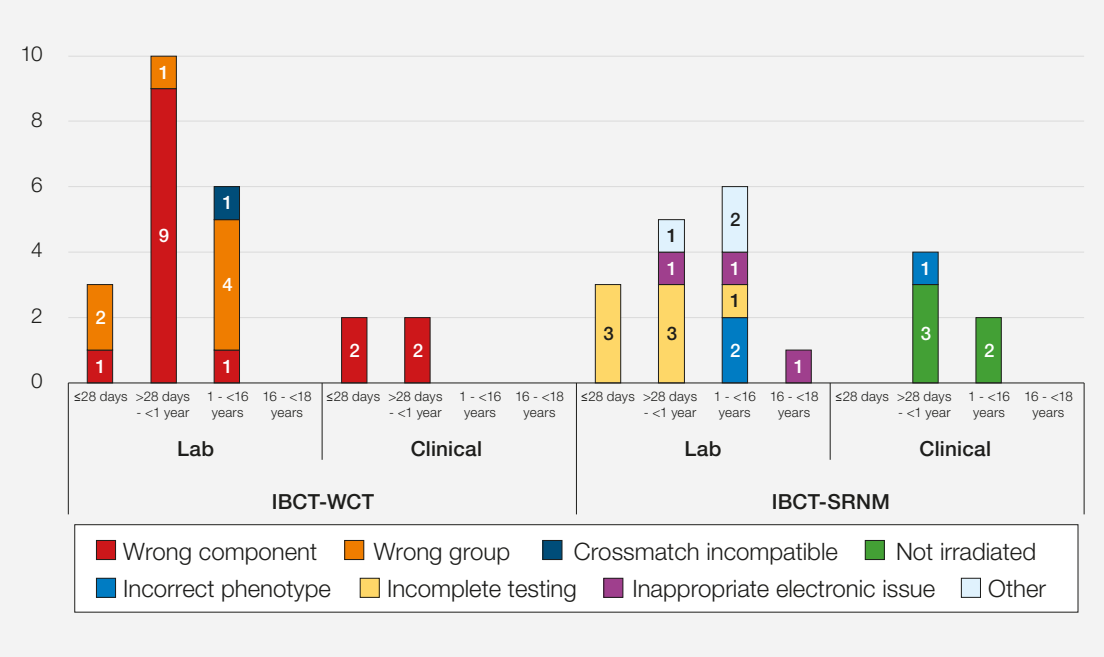


Figure 23.4: Breakdown of incorrect blood component transfused reports (n=44)

IBCT-WCT=incorrect blood component transfused-wrong component transfused; IBCT-SRNM=IBCT-specific requirements not met; MB=methylene blue-treated; SD=solvent-detergent treated

Note: Category 'other' includes invalid sample (n=1), K positive red cells to individual with childbearing potential (n=1), failure to provide washed platelets (n=1)

IBCT-WCT clinical errors n=4

Adult emergency blood given to neonates n=4

All 4 cases where the error was judged to be clinical involved transfusion of adult specification O D-negative red cells to a child under the age of 1 year. Two were newborn babies and 2 were 1 month of age. In all 4 cases the correct neonatal/infant specification red cells were available in the same blood refrigerator, but the adult component was selected in error. This is an ongoing issue, discussed in previous Annual SHOT Reports.

IBCT-WCT laboratory errors n=19

Of these, 9 reports were from the same hospital (part of a 'look-back' exercise), involving adult components issued to infants ranging in age from 1-7 months (see discussion and learning point in Chapter 10, Incorrect Blood Component Transfused (IBCT)).

There were 2 cases of D-positive platelets issued to D-negative patients, one of whom was female and subsequently given anti-D Ig. In 1 case a neonate was accidentally issued cryoprecipitate rather than FFP and one unit was transfused before the error was realised. One child received a red cell unit where the compatibility from a crossmatch was not fully confirmed. One child who was group A received a non-high titre negative group O platelet unit, with no sequelae.

Grouping errors occurred in 3 cases. In 2 of these, non-group O patients received group O red cells, 1 due to a transcription error and 1 due to a technical grouping error. There was also a case of failure to provide red cells that were compatible with both mother and baby ABO group for a baby on ECMO.

Learning point

- Laboratory staff should be fully trained and aware of procedures for pre-transfusion compatibility testing and component selection in infants under 4 months of age, including understanding the need to consider the maternal group and antibody screen. This was highlighted in a recommendation in the 2016 Annual SHOT Report (Bolton-Maggs et al. 2017)

In 1 case a young child was given multiple neonatal red cell split packs because the ward requested 'paediatric units' (instead of a standard full-sized pack as indicated for children from 1 year of age) each via a different giving set. This resulted in significant undertransfusion.

Learning points

- Imprecise terminology around different component types can be confusing, resulting in incorrect ordering and risk of either wastage of components or over transfusion
- Neonatal/infant specifications are recommended for children <1 year of age. From the age of 1 year, children are usually provided with components of the same specification as adults
- Information on the specification of components for neonates/infants and children are available in the British Society for Haematology (BSH) guidelines (BSH New at al. 2016 and 2020)
- Selection of the appropriate component should be the responsibility of the hospital transfusion laboratory taking into account information from the clinical team. This highlights the importance of communication between clinical and laboratory transfusion teams

There was 1 case of a D-positive red cell transfusion to a D-negative patient with sickle cell disease, discussed in Chapter 24, Haemoglobin Disorders (Case 24.6).

IBCT-specific requirements not met (SRNM) n=21 (15 laboratory, 6 clinical)

IBCT-SRNM clinical errors n=6

One clinical communication error resulted in the failure to perform full phenotyping for a child with sickle cell disease.

The other 5 errors were failure to provide irradiated components. The indications for irradiation were: Di George syndrome, previous intrauterine transfusion, SCID, stem cell transplant and ATG therapy.

Case 23.3: Infant with Di George syndrome received non-irradiated components

A young infant was transferred to a cardiac surgical centre for repair of a VSD. Red cells were ordered in preparation for the surgery and the BMS asked the clinicians if irradiated components were required. The conclusion was that there was a low risk of Di George and so non-irradiated units were issued. The next morning the laboratory was informed that genetic testing had confirmed Di George syndrome and that the clinicians wanted components for future transfusions to be irradiated.

Case 23.4: Multiple non-irradiated components given to an infant with SCID

An infant with suspected SCID, on PICU with seizures, diarrhoea and a CMV infection, was given five red cell transfusions before the transfusion laboratory were informed of the need for irradiated blood. The intensive care medical staff were not aware of the need for irradiated components in this patient group.

This case highlights the need for education of all paediatric staff groups regarding the indications for irradiated blood components.

The UK irradiation guidelines have recently been revised (Foukaneli et al. 2020). Irradiation of cellular components for patients with diagnosed or suspected Di George syndrome is no longer required for infants and children <2 years of age *provided* immunological testing has shown sufficient T lymphocytes (both total and naïve), or for older children and adults provided there is no significant history of infection suggestive of severe T-lymphocyte immunodeficiency.

Learning points

- It is important that all clinical staff understand the indications for irradiated components or are aware of how to access this information
- Updated irradiation guidelines are available to support decision making (Foukaneli et al. 2020) and should be reflected in local procedures and policies

IBCT-SRNM laboratory errors n=15

Failure to provide antigen-negative component n=1

A preterm neonate whose mother had documented anti-c received a transfusion of O D-negative red cells (c-positive). The investigation of the mother's previous positive antibody screen had not been recorded clearly in the LIMS.

Inappropriate electronic issue n=4

These cases include an infant with no antibody screen, an infant whose mother had detectable anti-D with no current maternal or infant sample, electronic issue for a child who had had a sibling allograft (there was also no record of this in the blood transfusion laboratory) and a child with HbSD (compound heterozygous haemoglobinopathy) who had blood components issued inappropriately through electronic issue, contrary to local policy.

Failure to perform antibody screen on maternal blood (neonatal transfusion) n=3

See learning point above from IBCT-WCT regarding pre-transfusion compatibility testing.

No valid antibody screen n=2

Two infants under the age of 6 months had no antibody screen performed.

Expired reagents n=1

A young child was identified as part of cohort of patients whose samples had been tested with expired reagents.

K-positive to a female with childbearing potential n=1

A K-negative girl with sickle cell anaemia received a K-positive transfusion.

Non-phenotyped blood for patients with sickle cell disease n=2

In both cases, children received red cells with phenotypes that were not matched. In 1 case the child developed an anti-E. This child had only ever been transfused at one centre and must have received a non-phenotyped unit there.

Non-washed apheresis unit n=1

One child, known to react to platelet transfusions, was due to receive either a pooled platelet unit or a washed apheresis unit. Due to a miscommunication a standard apheresis unit was given instead.

Avoidable, delayed, under or overtransfusion (ADU) n=35

Avoidable n=7

Five of the 7 avoidable transfusions were due to staff acting on erroneous results. One was a duplicate transfusion for a neonate who had already been transfused that day and another involved avoidable use of cryoprecipitate for a child who had plasma exchange.

Delayed n=18

Two children died following multiple delays to transfusion during massive haemorrhage. These have been discussed earlier in this chapter.

In half the cases of delayed transfusion there was an element of communication failure between clinical and laboratory staff. Two delays were due to sample labelling issues, including a neonate whose name had changed from 'baby'. In 3 cases there were delays in multiple steps in the transfusion process. In 1 case there was an IT failure and in 1 case a unit of platelets was left in a taxi.

Overtransfusion n=9

Errors included 2 related to pump programming, and 1 preterm neonate who was accidentally transfused twice in the same 24-hour period. There were also errors in the volume prescribed, 1 due to a miscalculation and 2 due to failure to prescribe in mL for children. Two teenagers were transfused excessive volumes of platelets repeatedly without checking the platelet count in between. The final case is described below.

Case 23.5: Overtransfusion of solvent detergent FFP to a neonate

A bleeding neonate on cardiopulmonary bypass received 105mL of solvent detergent FFP instead of 15mL. The reporter describes that the unit was not clamped after the bolus.

Undertransfusion n=1

One neonate received an undertransfusion due to recurrent issues with a giving set.

Handling and storage errors (HSE) n=14

The most common errors involved time-expired units (n=6). There were issues with pump programming or rate of transfusion in 4 cases. One infant had a 3-way tap turned the wrong way so that the red cells were not entering the patient's circulation but instead going back into the blood pack. There were 3 clinical administration errors; 1 due to concomitant administration of parenteral nutrition, 1 due to an incorrect giving set and 1 due to use of gravity to transfuse (discussed below).

Case 23.6: Use of gravity for red cell transfusion in an infant

A neonate received an emergency red cell transfusion. The unit was administered by gravity rather than via an infusion pump and the child was transferred to another hospital with a nurse escort who had no paediatric training.

Learning points

- Education and training resources should be provided for those administering neonatal transfusions to reduce errors. For example, the SHOT paediatric video which is available on the SHOT website (https://www.shotuk.org/resources/current-resources/videos/, Figure 23.5)
- It is inappropriate to transfuse blood components to neonates by gravity due to the risk of overtransfusion
- Neonatal blood administration sets are available which allow blood transfusions to be delivered by a syringe driver (BSH Robinson et al. 2018)

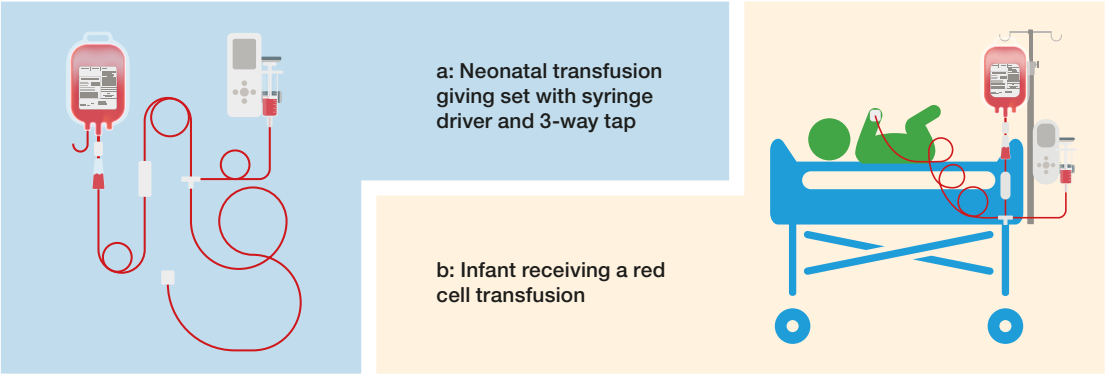


Figure 23.5 (a and b): Transfusion set up for neonates and infants

Anti-D immunoglobulin (Ig) n=5

There were 4 errors of anti-D Ig administration in teenage patients (2 delays, 1 omission and 1 anti-D to a D-positive patient). There was also 1 report of excessive anti-D Ig used for an incompatible platelet transfusion in a neonate.

Case 23.7: Use of anti-D Ig in a D-negative neonate who had received a D-positive platelet unit

A 500g neonate received a transfusion from an adult-specification unit of D-positive platelets due to clinical urgency. Multiple discussions took place regarding the requirement for anti-D Ig for the baby. The baby received 500IU of anti-D Ig via two intramuscular injections. The neonatal team had given the standard adult prophylactic dose of anti-D Ig and the message that haematology and transfusion experts had been consulted had not reached the treating consultant. No harm occurred; however, the team were not aware of the window of time that could be taken before administration and also that an IV formulation was available.

It is likely that the child would have received a maximum of 10mL of platelets, which is approximately 1/5 of a standard neonatal platelet pack volume. However, the anti-D Ig dose given was 10 times the dose that would be advised by the Blood Service to neutralise the red cells in a neonatal platelet pack.

Learning points

- 250IU of anti-D Ig will cover up to five adult therapeutic doses of platelets (approximately 1000mL; BSH Qureshi et al. 2014)
- NHS Blood and Transplant guidance advises 50IU subcutaneous or intravenous (IV) anti-D Ig per neonatal platelet pack transfused (https://nhsbtdbe.blob.core.windows.net/umbraco-assets-corp/14875/inf272v14.pdf)
- Advice from a haematologist regarding prophylactic anti-D Ig dosage should be sought following a D-positive transfusion to a D-negative paediatric female

Transfusion reactions n=61

Febrile, allergic and hypotensive reactions (FAHR) n=54

There was a notable increase in the number of FAHR paediatric reports from 38 in 2019 to 54 in 2020 (Figure 23.6). This is largely due to an unexplained increase in paediatric platelet reactions from 23 in 2019 to 38 in 2020. Paediatric FAHR involving platelets accounted for 38/112 (33.9%) of all platelet reactions reported to SHOT but there has not been a similar increase in platelet reactions in adult recipients (74 for both 2019 and 2020). In the absence of denominator data on the number of paediatric transfusions, we do not know if there has been a change in the rate of paediatric platelet reactions. There were no FAHR cases in patients less than 1 year of age.

The 38 platelet FAHR reports were mostly allergic (31) or mixed (5), with only 2 febrile alone. Of these, 14/38 (36.8%) caused major morbidity, including one of the febrile reactions. The majority (26/38, 68.4%) involved apheresis platelets, with 10 pooled and 2 not known. The proportion of paediatric reactions to apheresis platelets is lower than in the past, consistent with anticipated changes to transfusion practice: since September 2019 it is no longer recommended that patients born after 1995 receive apheresis platelets where possible (BSH New et al. 2020). This change in practice was expected to reduce the total number of paediatric FAHR reports because pooled platelets suspended in PAS are associated with a reduction in allergic response (BSH Estcourt et al. 2017). SHOT has previously recommended that hospitals should consider preferential use of pooled platelets in PAS for patients with a history of allergic reactions (see Chapter 17, Febrile, Allergic and Hypotensive Reactions (FAHR)), and this is the case for children as well as adults.

For red cells, 10/14 reactions were febrile (1 causing major morbidity), 3 allergic, and 1 was a moderate hypotensive reaction. Seven of the patients had sickle cell disease or thalassaemia and all these patients had febrile reactions.

There were 2 moderate plasma reactions: 1 to MB-FFP during a plasma exchange procedure, and 1 to MB-cryoprecipitate for a teenager following major trauma.

Figure 23.6: Trend in paediatric FAHR reports 2011-2020

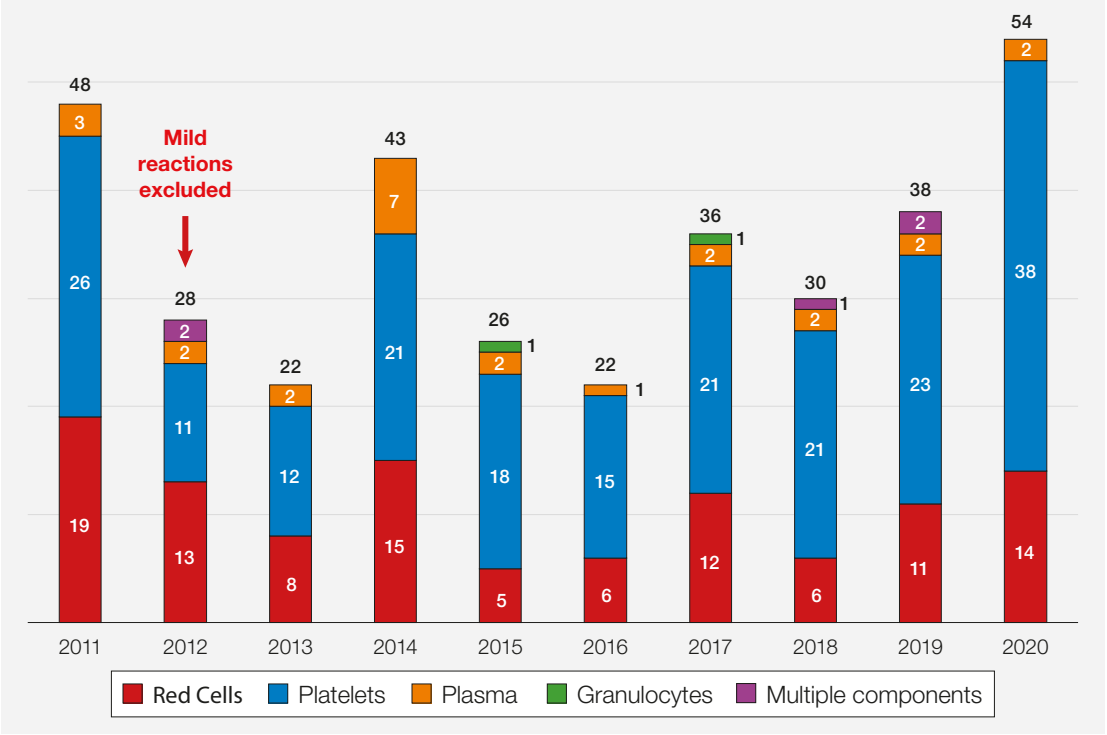
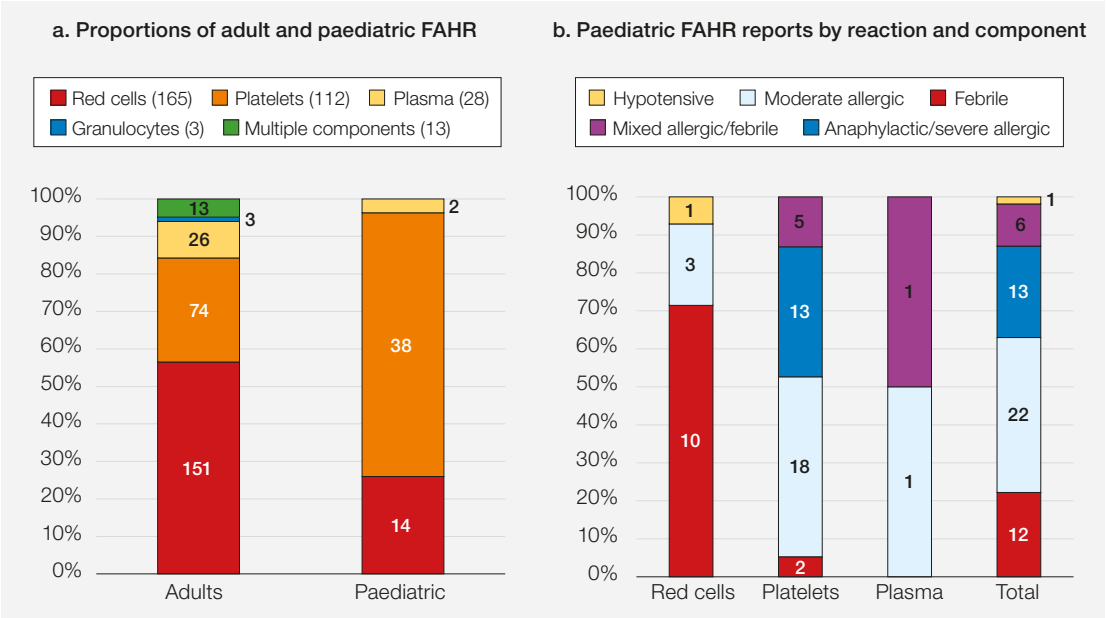


Figure 23.7 (a and b): Paediatric FAHR reports in 2020 (n=54)



Haemolytic transfusion reactions (HTR) n=3

There were 3 HTR in children. One was a case of possible hyperhaemolysis in a child who had antibodies to S, Jk^b and e antigens identified prior to transfusion. The other 2 were DHTR; 1 involving anti-S in a child who historically had an anti-Fy^a and the other was a child who had an exchange transfusion with non-phenotyped red cells and subsequently developed an DHTR due to anti-C and anti-E. This caused major morbidity.

Pulmonary complications of transfusion in neonates and children

There were no cases of TRALI in patients <18 years reported in 2020.

Transfusion-associated circulatory overload (TACO) n=2

There were 2 cases which met the criteria for TACO, 1 in a child and 1 in a neonate. The neonatal case is discussed below.

Case 23.8: Incorrect blood results viewed for a child resulting in overtransfusion and TACO

A stable neonate whose Hb had been between 140g/L and 160g/L for several days was accidentally given a 10mL/kg transfusion based on the Hb results from a different child. Following the transfusion, the neonate became hypertensive and desaturated. The Hb post transfusion was 211g/L on the gas machine and 177g/L in the laboratory. The child underwent venesection/dilutional exchange and recovered. During incident investigation, it was noted that the electronic records of several neonates were open at the same time, the hospital uses an electronic system which means a laptop on wheels is taken to each cot space. The margin of error for looking at the wrong screen for the wrong patient is therefore quite high.

Every effort must be made to avoid patient identification errors. This case of TACO highlights some of the issues around accurately accessing electronic patient records. Having multiple electronic patient records open at the same time can potentially increase the risk of misidentification.

Learning point

- When using electronic patient records, only a single patient record should be displayed on the screen at once to avoid misidentification and prevent serious transfusion errors. Patient records should be closed when leaving the bedspace and the new patient record opened when entering the next bedspace
- In the event that multiple patient records are open, care should be taken that the correct record is viewed when using electronic patient record systems. This may be a particular risk on neonatal units

Transfusion-associated dyspnoea (TAD) n=1

One case of TAD was noted in an infant under 6 months of age following a red cell transfusion.

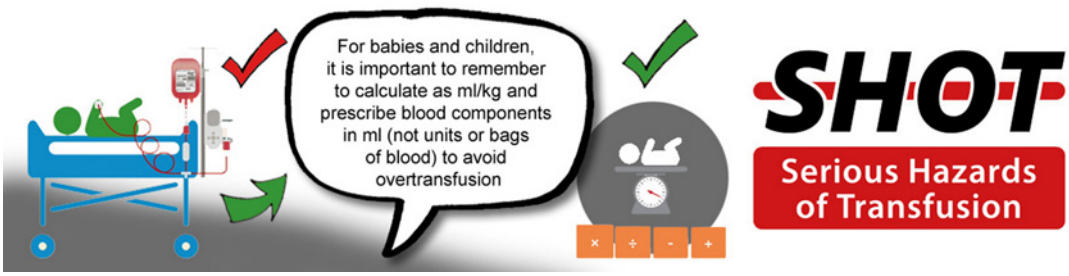
Uncommon complications of transfusion (UCT) n=1

There was 1 case of TANEC in a young infant who had been born at 26-weeks gestation. The baby had multiple co-morbidities. NEC, with pneumatosis on X-ray, developed 6.5 hours after the red cell transfusion was completed.

There were no cases of TTI or cell salvage errors in patients <18 years reported in 2020.

Near miss cases n=52, NM-wrong blood in tube (WBIT) n=44, right blood right patient (RBRP) n=15

The number of cases of near miss/no harm reported to SHOT were the same as last year.



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