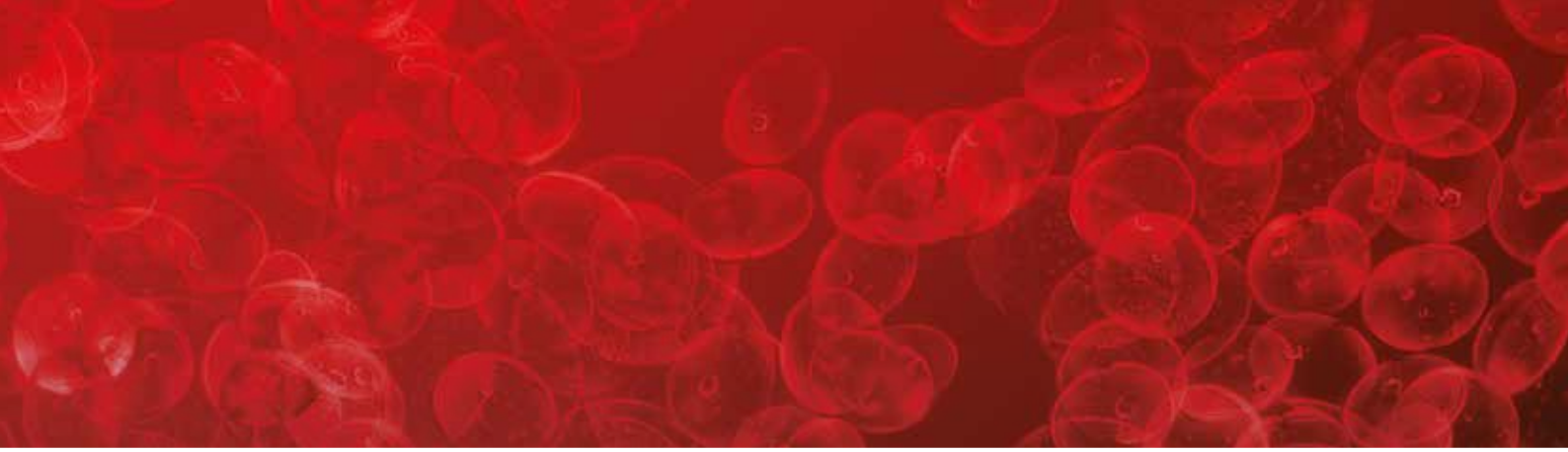

ANNUAL SHOT REPORT 2013

Affiliated to the Royal College of Pathologists

The Steering Group includes members representing the following professional bodies:

British Blood Transfusion Society
British Society for Haematology
British Society of Gastroenterology
British Committee for Standards in Haematology
Faculty of Public Health
Institute of Biomedical Science
Public Health England
NHS Confederation
Royal College of Anaesthetists
Royal College of Nursing
Royal College of Midwives
Royal College of Obstetricians and Gynaecologists
Royal College of Physicians
Royal College of Surgeons
Royal College of Paediatrics and Child Health
Intensive Care Society
Faculty of Intensive Care Medicine
The College of Emergency Medicine
Defence Medical Services
UK Forum

Serious Hazards of Transfusion (SHOT)

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Chair: Dr Dafydd Thomas

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Dr Su Brailsford	Public Health England & Faculty of Public Health
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Dr Paul Clarke	Royal College of Paediatrics and Child Health
Dr Heidi Doughty	Defence Medical Services
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Mrs Joan Jones	Institute of Biomedical Science; Clinical Advisory Group, Wales
Mr Mike Dawe	Medicines and Healthcare products Regulatory Agency
Dr Sheila MacLennan	UK Forum
Ms Joanne McIntyre	Lay Member
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Dr Kieran Morris	Royal College of Pathologists; Northern Ireland Regional Transfusion Committee
Dr Andrew Mortimer	Royal College of Anaesthetists
Dr Charles Percy	British Society for Haematology
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Mr John Saxby	NHS Confederation
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Dr Andrew Thillainayagam	British Society of Gastroenterology
Mr John Thompson	Royal College of Surgeons
Ms Nina Vinall	Expertise in Patient Safety

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Dr Elizabeth Love	Former National Medical Coordinator of SHOT
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NB. All members of the WEG are members of the Steering Group in their own right.

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Please cite this work as:

PHB Bolton-Maggs (Ed), D Poles, A Watt and D Thomas on behalf of the Serious Hazards of Transfusion (SHOT) Steering Group. The 2013 Annual SHOT Report (2014)

This work was undertaken by SHOT. The work was funded by NHS Blood and Transplant, Northern Ireland Blood Transfusion Service, Scottish National Blood Transfusion Service and the Welsh Blood Service through the UK Forum.

Published July 2014

ISBN 978-0-9558648-6-5

Contents

Foreword

1

This report is compiled from analysis of more than 3500 reports submitted during 2013. It is good to note that the number of serious reactions caused by unpredictable events (apart from allergic type acute transfusion reactions) remains very low. The risk of adverse outcomes related to transfusion is small, but it is sobering that every year the main causes are human factors (responsible overall for 77.8% of reports). This is also a main finding for the Medicines and Healthcare products Regulatory Agency (MHRA) reports.

There were 9 ABO incompatible red cell transfusions in 2013 and a death in one patient with the incompatible transfusion as a contributory factor. It is fortunate, however, that two thirds of ABO incompatible red cell transfusions are not associated with any adverse outcomes (analysis of cumulative SHOT data, details in Chapter 8 Incorrect Blood Component Transfused (IBCT)).

In this 2013 Annual SHOT Report we have analysed the events resulting in an incorrect blood component transfusion to examine both where in the transfusion process the errors occur, and also how many errors occurred. These are described in Chapter 8 Incorrect Blood Component Transfused (IBCT). The number of errors ranged from 1 to 5 with a median of 3, demonstrating that there are several potential opportunities to detect and correct an error made earlier in the process. Many of these could be detected by correct completion of the final check at the patient's side, which should include careful attention to the component and specific requirements of the patient in addition to positive patient identification. Five points could be included in the final check with an aide-memoire or checklist (see Chapter 5 Key Messages and Recommendations for an example).

Near miss reporting is very useful (James Reason's 'free lessons' – inconsequential unsafe acts that could have had a bad outcome in other circumstances [1]): this year we note that although the overall number of near miss wrong blood samples has increased to over 600, there were no transfusions where patients received wrong components due to wrong blood samples. This is an improvement over previous years and may reflect both the introduction of a check blood grouping sample as recommended by guidelines and improved quality management systems.

Human factors play a major role in medical mistakes, not only in transfusion. None of us come to work with the intention of harming our patients; rather we are highly motivated to give good care. There are now many good initiatives in the field of human factors training and research which could usefully be applied to the transfusion process in our renewed focus on putting the patient at the centre of all we do. It is time to redesign the transfusion process. SHOT advises organisations to use the recommendations and learning points within this report to begin that redesign.

Dr. Paula Bolton-Maggs DM, FRCP, FRCPath
Medical Director, SHOT

Dr. Dafydd Thomas MBChB, FRCA
Chair, SHOT Steering Group

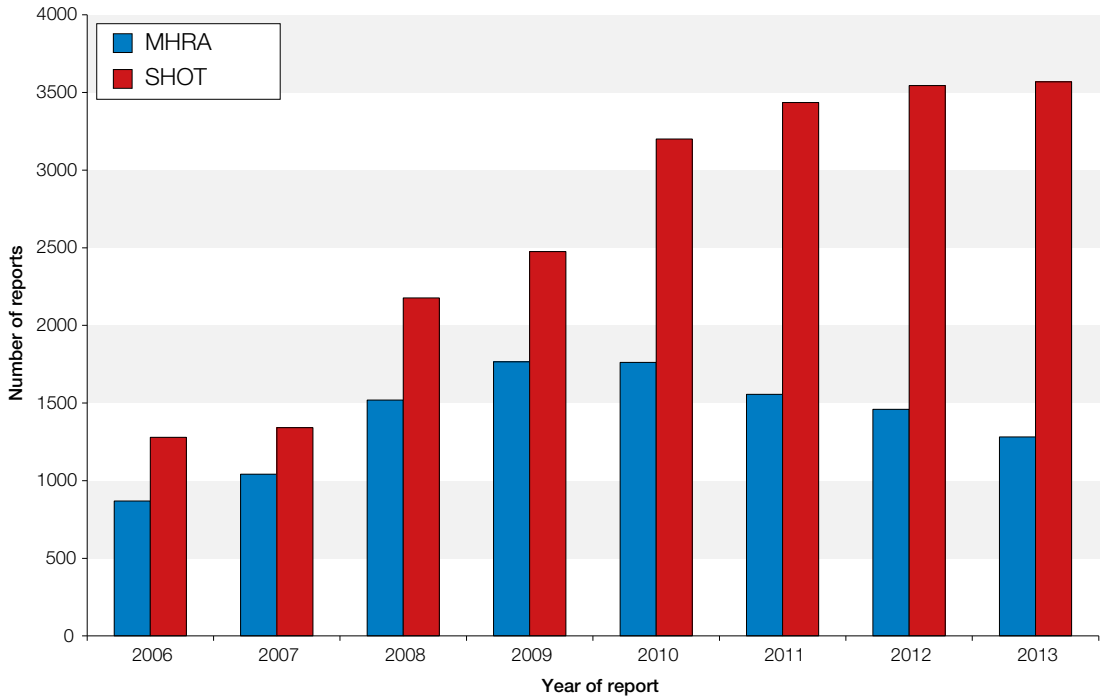
2 Participation in the SHOT Haemovigilance Reporting Scheme

Authors: Debbi Poles and Paula Bolton-Maggs

Calendar year participation 2013

The total number of reports made to the SHOT online reporting system (Dendrite) in 2013 was 3568, compared to 3545 in 2012. For the second year since reporting began in 1996, this represents a less than 5% increase in reporting numbers from the previous year. This could suggest that SHOT reporting has now reached a more stable level, similar to that seen with the Medicines and Healthcare products Regulatory Agency (MHRA) reporting over the last few years. However, the overall trend in SHOT reporting is still increasing slightly, whilst the opposite is the case for MHRA reporting. SHOT reporting includes incidents such as alloimmunisation, anti-D immunoglobulin errors and 'wrong blood in tube' errors which are outside the scope of the European Union (EU) legislation. The MHRA has identified a 29.1% reduction in serious adverse events (SAE) reports since 2009 (see Chapter 6 Medicines and Healthcare products Regulatory Agency (MHRA) Report on Blood Safety and Quality Regulation in 2013). However, there is some overlap between the two sets of data which is discussed later in this chapter (see Figure 2.3).

Figure 2.1: Reporting levels for MHRA and SHOT



Reporting organisations 2013

Registered reporting organisations are unchanged from 2012 with 99.5% (182/183) of National Health Service (NHS) Trusts/Health Boards being registered to report to SHOT either directly or indirectly.

There were 5 non-reporting NHS organisations during 2013. Four of these are low users, issued with fewer than 1500 blood components in the last year for which data at hospital level are available (2012) and the fifth organisation is currently unregistered (although may make reports via another hospital).

The number of NHS mergers and re-organisations make it increasingly complex to keep track of participation levels, as reporting arrangements can change and differ between organisations. Some hospitals that merge with other organisations prefer to keep their reporting separate from the new organisation, whereas others become completely integrated for reporting purposes. Therefore, it is quite difficult to know whether a particular hospital has made reports or not. For this reason, our participation levels are reported by Trust or Health Board rather than by individual hospitals.

Reporting by non-NHS organisations is also consistent with 2012, with 20 independent hospitals or laboratories making reports during 2013. We do not have denominator data on the number of independent organisations who would be eligible to make reports, so it is not known whether this represents full participation within the private sector. Some private hospitals are also very low users.

Number of reports by UK country

	2010		2011		2012		2013	
	Number	%	Number	%	Number	%	Number	%
England	2511	78.5	2749*	80.0	2860*	80.7	2975	83.4
Northern Ireland	154	4.8	150	4.4	156	4.4	129	3.6
Scotland	332	10.4	352	10.2	326	9.2	285	8.0
Wales	203	6.3	184	5.4	203	5.7	179	5.0
United Kingdom	**3200**	100.0	**3435**	100.0	**3545**	100.0	**3568**	100.0

**Includes reports from Ministry of Defence overseas*

Table 2.1: Total number of reports to SHOT by UK country 2010-2013

	Red cells	Platelets	FFP	SD-FFP	MB-FFP	Cryo	Totals
NHS Blood & Transplant	1,727,452	268,630	228,826	68,924	11,672	38,894	2,344,398
Northern Ireland Blood Transfusion Service	52,133	8,449	5,212	1,600	414	1,082	68,890
Scottish National Blood Transfusion Service	184,300	25,448	21,458	4,520	1461	3,697	240,884
Welsh Blood Service	79,161	9,613	10,836	4,429	0	284	104,323
Totals	**2,043,046**	**312,140**	**266,332**	**79,473**	**13,547**	**43,957**	**2,758,495**

FFP=fresh frozen plasma; SD=solvent-detergent sterilised; MB=methylene blue-treated; Cryo=cryoprecipitate

Figures contain some transfers between Blood Services, which may lead to inaccuracies in small numbers, such as MB-FFP

Table 2.2: Total issues of blood components from the Blood Services of the UK in calendar year 2013

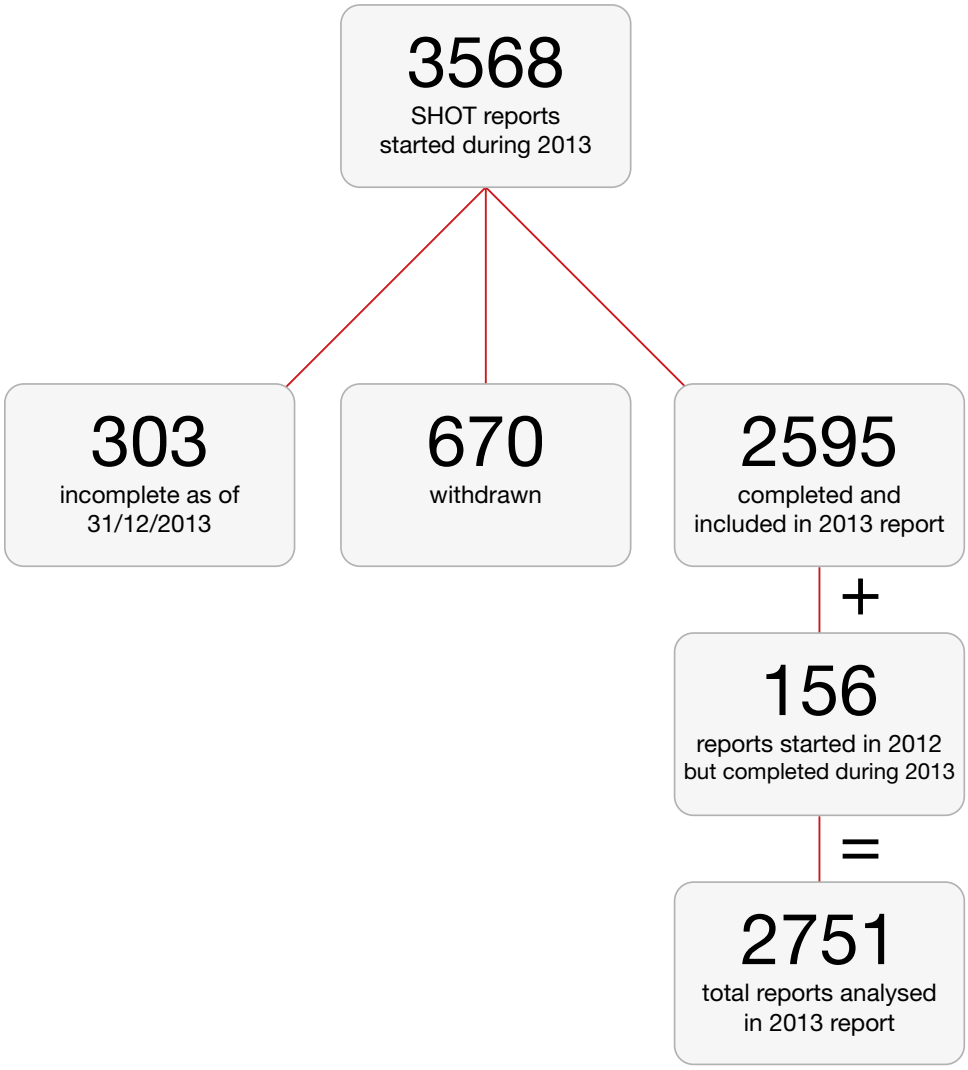
	2010	2011	2012	2013
England	10.1	10.9	11.7	12.7
Northern Ireland	20.8	21.1	21.3	18.7
Scotland	12.2	14.3	13.2	11.8
Wales	18.1	16.4	18.4	17.2
United Kingdom	**10.9**	**11.6**	**12.3**	**12.9**

Table 2.3: Total number of reports per 10,000 components by UK country 2010-2013

Cases included in the 2013 Annual SHOT Report

Cases analysed in the 2013 report include some which were reported in 2012 but not completed until 2013. Similarly some of the 3568 cases reported to SHOT in 2013 are currently incomplete and will roll over to the 2014 report. The flow chart below shows the breakdown of the reports made to the SHOT database during 2013.

Figure 2.2: Breakdown of reports to SHOT in 2013



The total number of reports analysed and included in the 2013 Annual SHOT Report is 2751. This is comparable with the 2767 reports analysed in the 2012 Annual SHOT Report. The number of reports excluding 'near miss' and 'right blood right patient' is 1571.

Data reconciliation between the MHRA and SHOT

As part of the ongoing collaboration between the MHRA and SHOT, analysis work has been undertaken to determine the level of overlap between the 2 reporting systems. Figure 2.3 shows the fate of all reports made via the Serious Adverse Blood Reactions and Events (SABRE) system during the calendar year 2013. These figures have been produced from the total cases reported to the MHRA as serious adverse events (SAE) or serious adverse reactions (SAR), combined with the total cases shared with the SHOT database or reported via SABRE as 'SHOT only'.

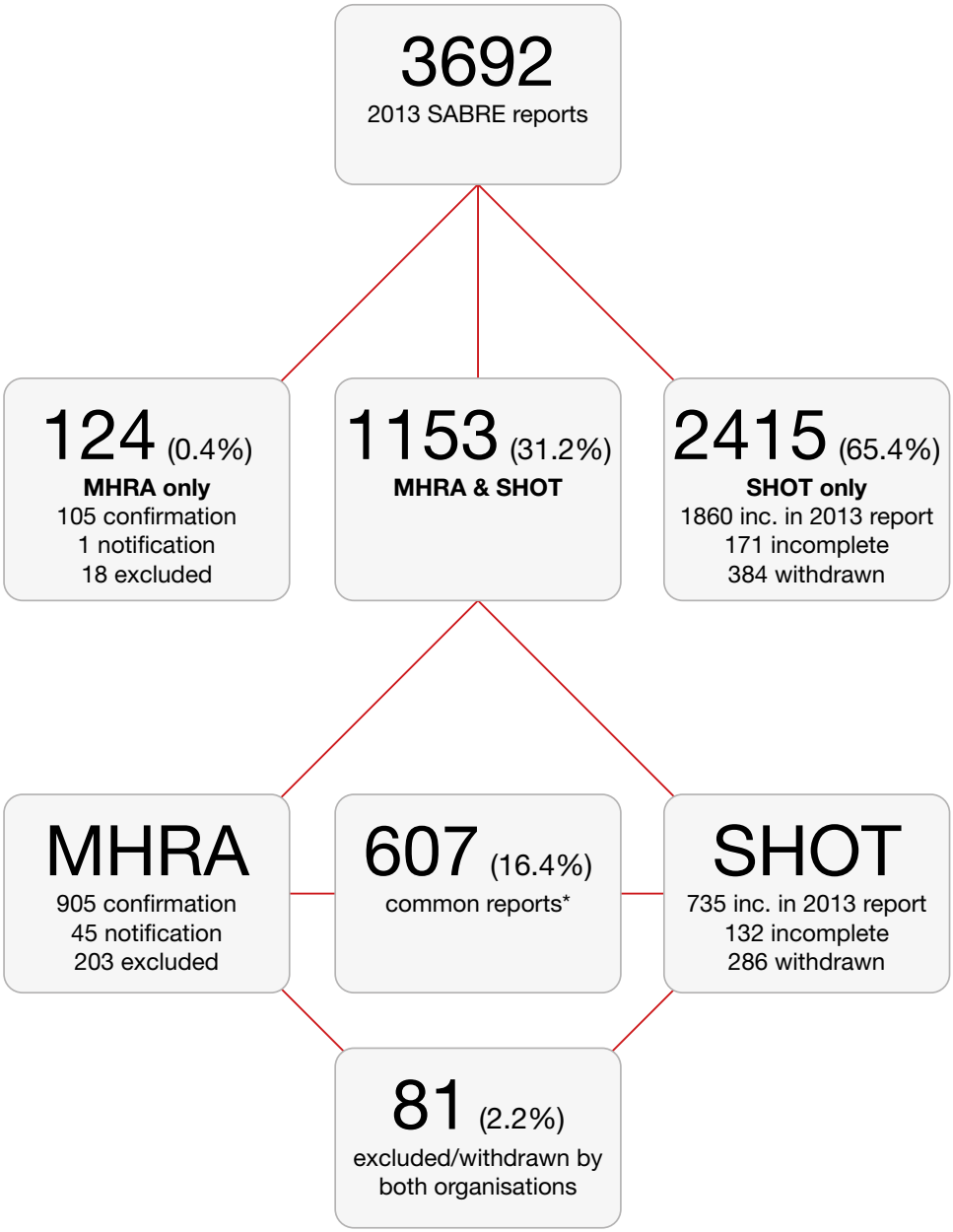


Figure 2.3: **Fate of all reports made to SABRE in 2013 (all SHOT reports are made via the SABRE entry portal where the reporters can direct their report to SHOT only as required)**

** Common reports are those completed and included in the SHOT chapters within this 2013 Annual SHOT Report and Chapter 6 Medicines and Healthcare products Regulatory Agency (MHRA) Report on Blood Safety and Quality Regulation in 2013*

There is surprisingly little overlap, with only 607/3692 (16.4%) reports being confirmed as reportable by both organisations. However, there is some potential for further overlap when the remaining 45 MHRA notifications and 132 incomplete SHOT cases are finalised during the coming year.

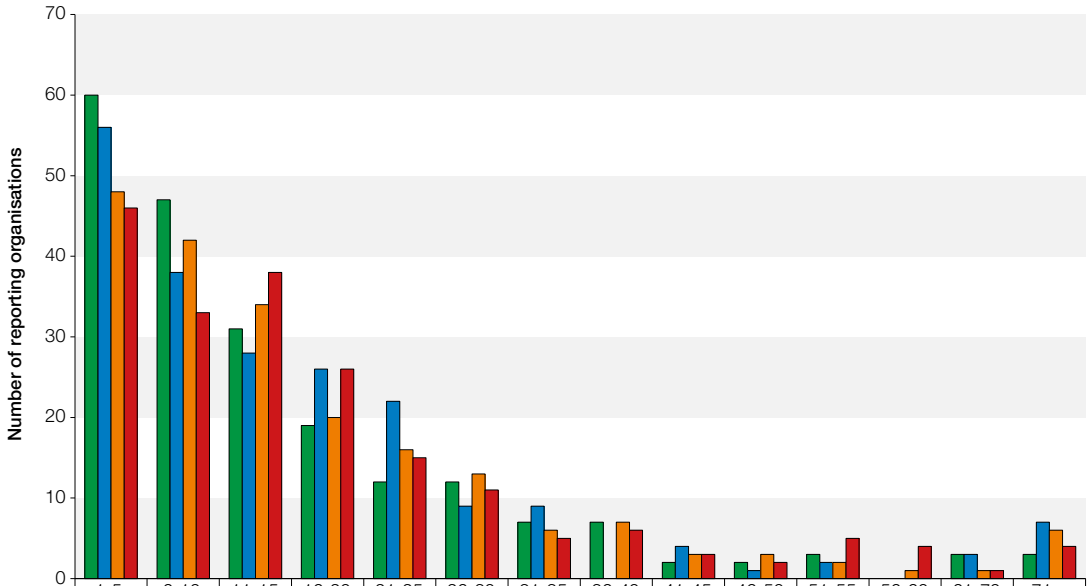
This analysis will be very useful in the continuing efforts of SHOT and the MHRA to work together towards a more unified haemovigilance system in the UK.

Benchmarking participation data

SHOT has produced participation benchmarking data for all reporting organisations since 2010, and will continue to perform this exercise for the 2013 data. In previous years, these reports have been anonymised (with the exception of data for Scotland and Wales, who have requested that this be de-anonymised). Figure 2.4 shows the number of reports per organisation for the last 4 years. Most make fewer than 10 reports but there is considerable variation with some having a very high reporting rate. SHOT has shown previously that this is not related to the size of hospital (based on blood component issue rates). The range is surprising and is unlikely to reflect actual events but rather the time available and the reporting culture of the organisation.

For the 2013 benchmarking exercise, reports will be de-anonymised and will be available on the SHOT website for all registered reporters to access. This transparency is consistent with the National Reporting and Learning System (NRLS) where individual hospital reports are open to review without restriction. (This service was previously provided by the National Patient Safety Agency but is now provided by Imperial College NHS Trust under contract to the NHS Commissioning Body.) Care Quality Commission (CQC) hospital inspection reports are also publicly available.

Figure 2.4: Number of reports per organisation for 2010-2013



	1-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	41-45	46-50	51-55	56-60	61-70	71+
2010	60	47	31	19	12	12	7	7	2	2	3	0	3	3
2011	56	38	28	26	22	9	9	0	4	1	2	0	3	7
2012	48	42	34	20	16	13	6	7	3	3	2	1	1	6
2013	46	33	38	26	15	11	5	6	3	2	5	4	1	4

Number of reports per reporting organisation

Recommendation

- These data are both interesting and useful. Reporters should use this information to ensure their organisation is participating fully across all types of incident reporting i.e. errors, pathological reactions, anti-D immunoglobulin errors and near miss events. Participation data should be made available to Transfusion Laboratory Managers

Action: Hospital Transfusion Teams with support from their Risk Managers and Chief Executive Officers

Data by location and specialty

Most SHOT questionnaires ask for information about where the event happened and what specialty the patient was under. This was analysed for the first time in the 2012 Annual SHOT Report for data collected 2010-2012, and this year the data from 2013 have been added to this cumulative analysis. The location of the transfusion or event was recorded in 5623 reports, and the specialty given in 5137 reports (excluding 'near miss', but including 'right blood right patient').

COMMENTARY

There continues to be a large number of instances of 'specific requirements not met' in haematology. This is most commonly failure to request irradiated cellular components for patients at risk (see Chapter 8 Incorrect Blood Component Transfused (IBCT)). The knowledge of haematology staff about the indications for specific requirements needs to be improved.

Emergency departments are at risk for delayed or avoidable transfusions (see Chapter 11 Avoidable, Delayed or Undertransfusion (ADU)).

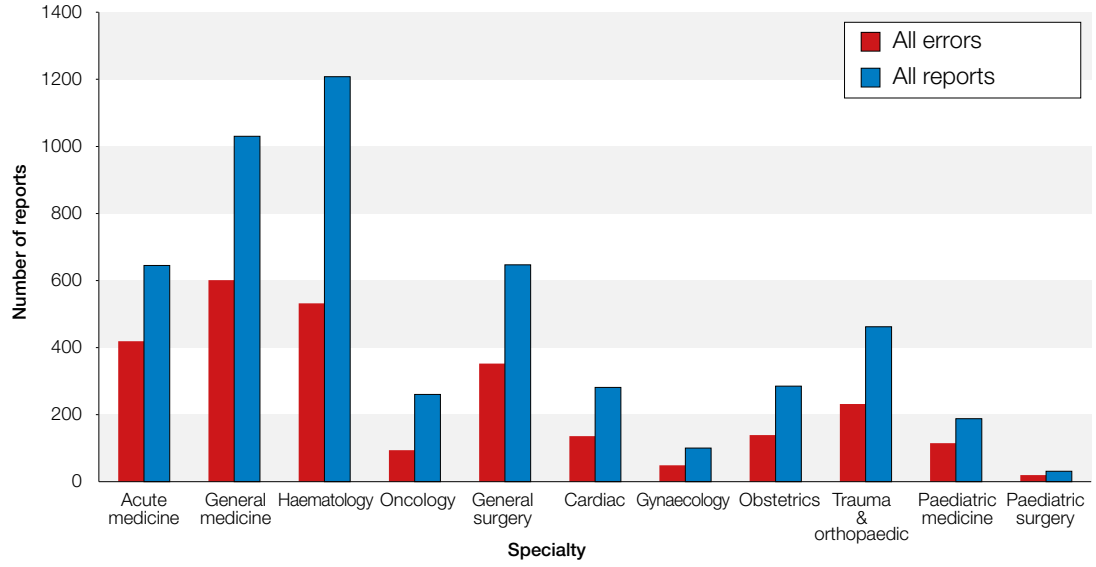


Figure 2.5: The number of incidents by specialty for the four-year period 2010 to 2013

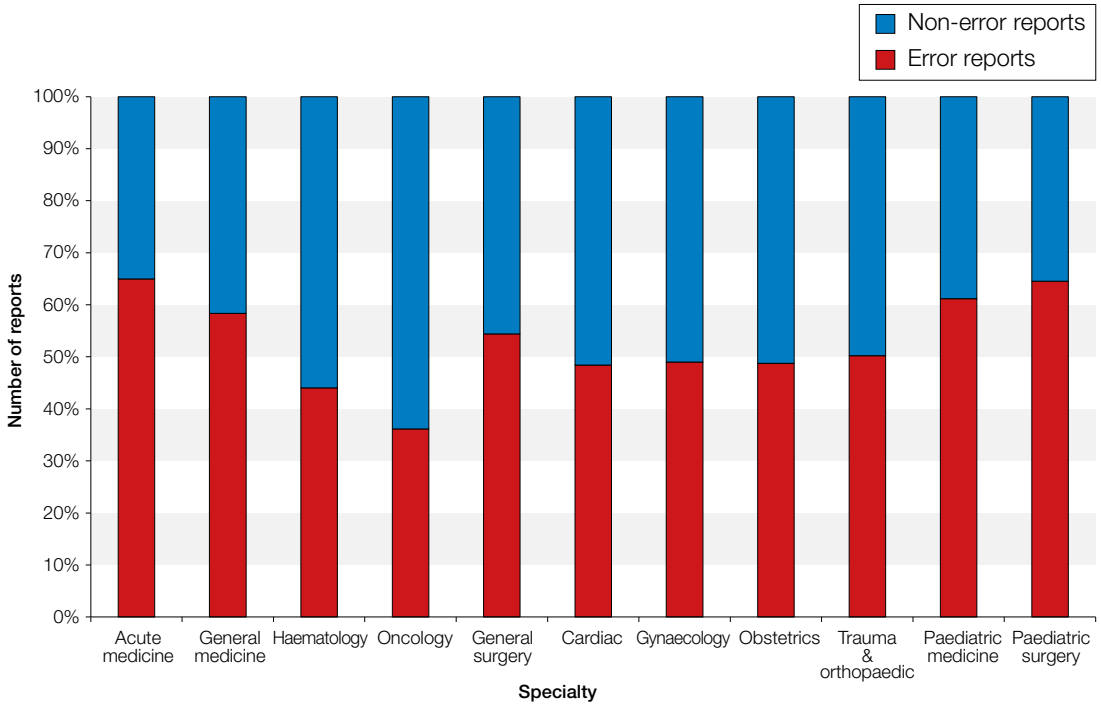


Figure 2.6: The same data as Figure 2.5 but showing the proportion of all incidents in each specialty caused by error (excluding 'near miss')

Figure 2.7: Number of errors in different specialties by year of report

Figure 2.7a: Errors in haematology

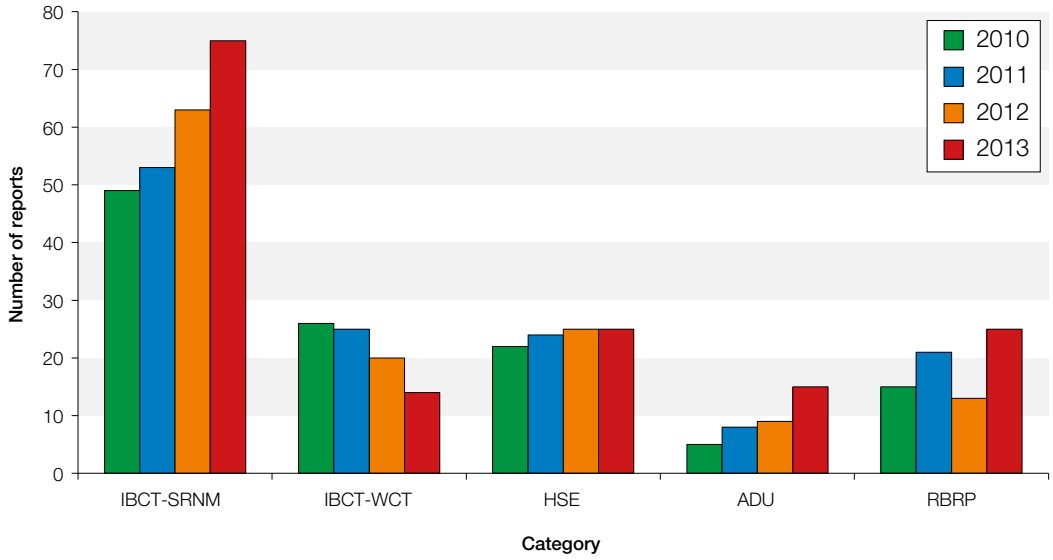


Figure 2.7b: Errors in emergency medicine

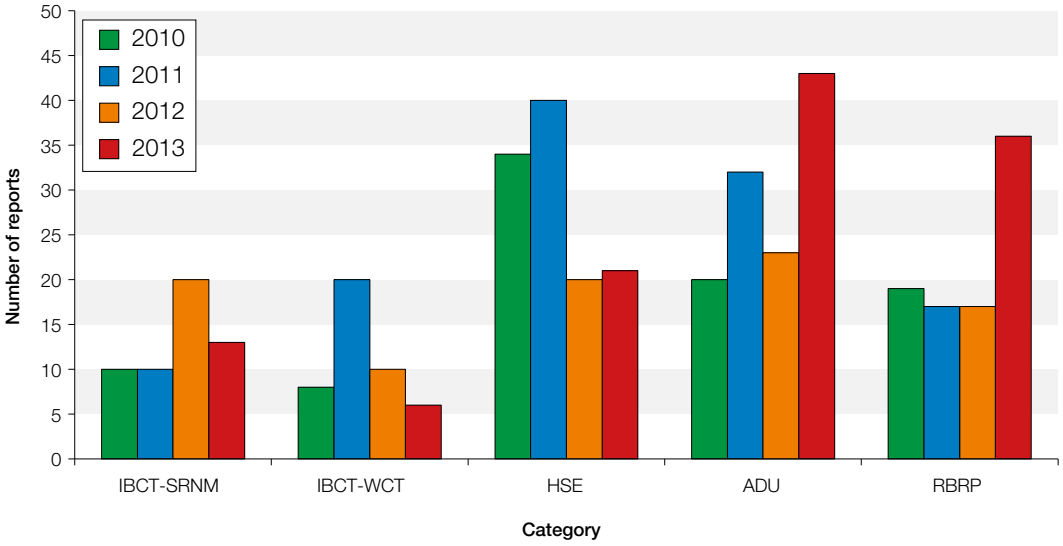


Figure 2.7c: Errors in general medicine

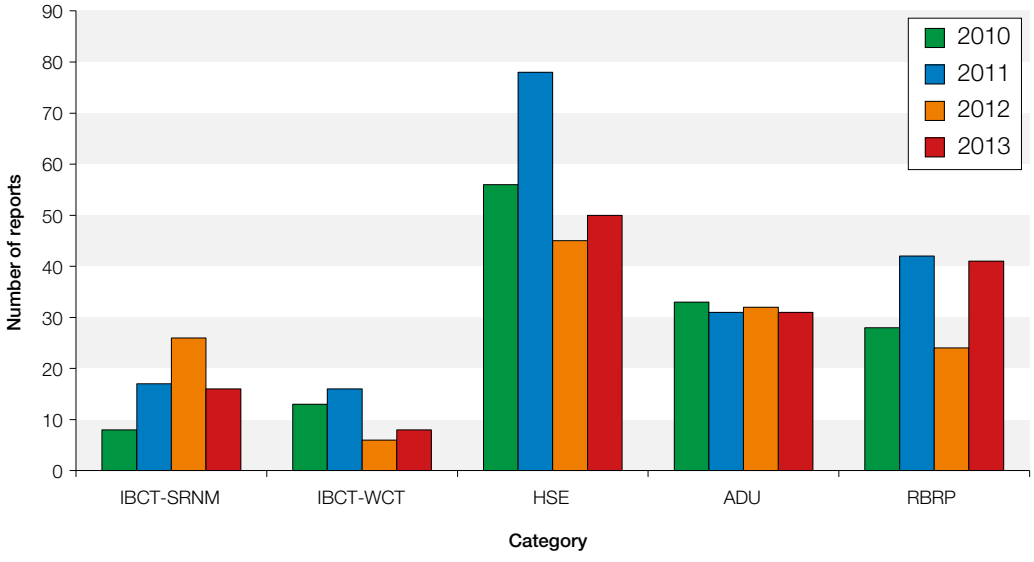


Figure 2.7d: Errors in trauma & orthopaedics

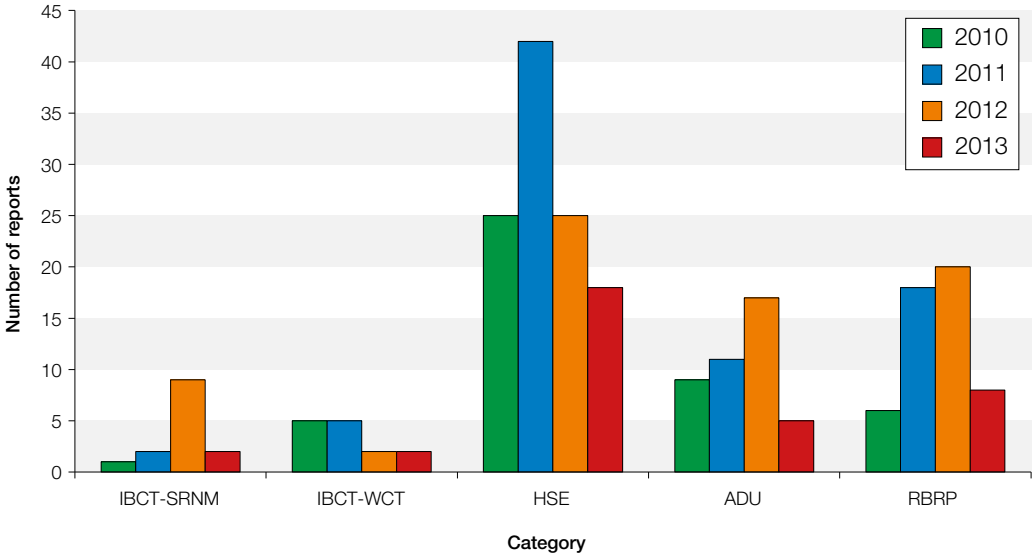
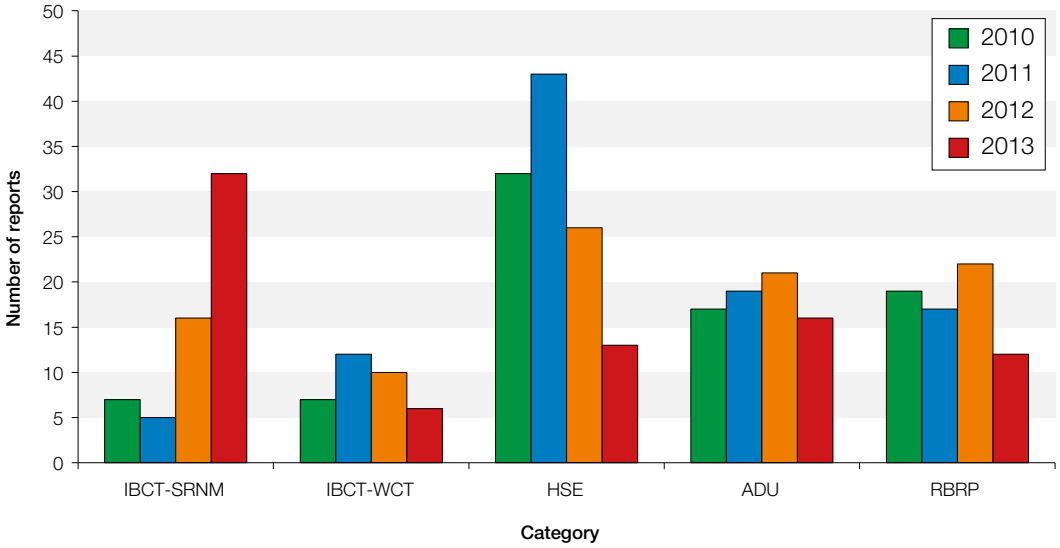


Figure 2.7e: Errors in general surgery



Key

IBCT-WCT: incorrect blood component transfused-wrong component transfused

IBCT-SRNM: incorrect blood component transfused-specific requirements not met

HSE: handling and storage errors

ADU: avoidable, delayed or undertransfusion

RBRP: right blood right patient

3 SHOT Updates and Developments

Author: Paula Bolton-Maggs

Anti-D: investigation of new sensitisation in all clinical situations

A new questionnaire has been introduced from January 2013 to collect information about women who have developed a new immune anti-D that is detected during pregnancy, at delivery or in a subsequent pregnancy. This questionnaire is currently not available on the SHOT online reporting system, but can be downloaded from the SHOT website (www.shotuk.org) and can be completed and submitted electronically. Preliminary analysis of cases reported in 2013 is discussed in Chapter 14 Anti-D Immunoglobulin – Prescription, Administration and Sensitisation.

From 2014 we are also encouraging hospital transfusion staff to report any case of alloimmunisation against RhD. The risk of alloimmunisation in RhD negative patients given donor blood that types as RhD negative but is from a donor who is DEL or other D-variant remains uncertain [2]. To date no case of anti-D immunisation after transfusion of apparently RhD negative red cells has been documented by SHOT, although there have been a small number of cases reported in other countries. In order to investigate this further we propose to collect data regarding cases of alloimmunisation in RhD negative recipients who have received RhD **negative** red cell transfusions. Hospital transfusion laboratories are ideally placed to help in this project as cases of alloimmunisation are now reportable to SHOT. Cases of apparently unexplained RhD alloimmunisation should be referred to the Blood Service reference laboratory so that the implicated RhD negative donors can be identified and samples investigated by additional serological methods and molecular typing.

In parallel with this work, SHOT is asking that all cases of RhD immunisation in both women and men are notified so that a detailed analysis of the causes of continuing immunisation (including transfusion of apparently RhD negative components) can be performed, alongside the ongoing assessment of the effectiveness (or not) of the antenatal and postnatal anti-D prophylaxis programmes.

Recommendation

- Reporters should inform the SHOT office about all cases of RhD immunisation to components using the alloimmunisation category in the SHOT online reporting system
- Reporters should continue to report immune anti-D that is detectable for the first time in the current pregnancy using the electronic questionnaire in the reporting section on the SHOT website, www.shotuk.org.

Action: Hospital Transfusion Teams (HTTs)

Investigation of cases of hyperhaemolysis

Hyperhaemolysis is a poorly understood condition most commonly (but not exclusively) reported in people with sickle cell disease. Haemolysis affects both the person's own and transfused cells resulting in a post-transfusion haemoglobin concentration lower than before transfusion. Patients might be at risk of recurrence with future transfusions and may then be subjected to restricted transfusion. There is interest from National Health Service Blood and Transplant (NHSBT) consultants to investigate these cases and to offer advice as they happen, thus a panel of experts is available for discussion (Nay Win,

Clare Milkins, Shubha Allard and Paul Telfer) and hospital haematologists are encouraged to report these cases early. The devolved countries are invited to participate in this study. Data will be entered on a new questionnaire by the expert panel and then forwarded to SHOT maintaining the patient anonymity. With improved data collection we may learn more about this difficult complication and its management. For further information please see Chapter 26 Summary of Transfusion Complications in Patients with Haemoglobin Disorders and for case reports, Chapter 16 Haemolytic Transfusion Reactions (HTR).

Recommendation

- Clinicians suspecting a case of hyperhaemolysis are encouraged to report this as early as possible via their hospital haematologist to the National Health Service Blood and Transplant (NHSBT) red cell immunohaematology (RCI) consultant (or consultant on call after 5pm). A designated RCI consultant will follow up the case and inform Dr. Nay Win who will arrange subsequent case review and forwarding of the anonymised data to SHOT

Action: Consultant Haematologists with their Hospital Transfusion Teams in collaboration with NHSBT in England

Work towards a unified haemovigilance system in the UK

Work continues between the Medicines and Healthcare products Regulatory Agency (MHRA) and SHOT towards a single haemovigilance system. A delay in the work occurred in 2013 after Judy Langham left in May until Mike Dawe took up his post at the end of September. The SHOT team is working well with Mike to establish a common set of questions. We have been surprised at the lack of overlap between SHOT and MHRA reports (see Chapter 2 Participation in the SHOT Haemovigilance Reporting Scheme, Figure 2.3) and analysis continues in order to better understand this. All are aware of the frustration for reporters of making entries on different systems, including their own hospital systems. An ideal mechanism would include a facility to upload Datix, Ulysses or other local incident reports directly. A new initiative might be to use a text analytics programme and all these ideas are currently under consideration. A recent improvement has been made for ongoing downloads from the Serious Adverse Blood Reactions and Events (SABRE) reporting system to the SHOT database (Dendrite). This permits reporters to file both MHRA and SHOT reports at the same sitting rather than having to wait for the overnight download.

Progress with recommendations from previous years

Red cells for intrauterine transfusion (IUT): following the reported infant death from TA-GvHD after an IUT with fresh maternal red cells [3]: clarification of the availability and optimal red cell component for IUT

NHSBT has updated both the service level agreement (SLA) with hospitals and the Component Portfolio (page 36 of NHSBT's Component Portfolio has full details of these components: http://hospital.blood.co.uk/library/pdf/components/SPN223_6.pdf) to clarify that while 24 hours notice is preferred for provision of Red Cells for IUT for planned procedures, in urgent situations NHSBT is able to manufacture and issue these components to hospitals with a minimum of 4 hours notice (6 hours outside normal working hours). This time includes delivery time. If required urgently, NHSBT would advise the clinical team to actively consider using an emergency 'Blue Light' delivery. If there is an unusual phenotype or any extra specific requirements these should be discussed when the order is placed as the sourcing of specific phenotypes may extend the manufacture and issue period. Any clinical concerns or difficulties can be discussed with an NHSBT consultant. Although the haematocrit varies for each component type the same testing criteria are provided for Exchange Units and for Large Volume Neonatal units, and O RhD negative units are available 'off the shelf' if required. In an emergency where time is very limited clinicians may consider the use of one of these components as an alternative. NHSBT has circulated a statement (March 2014) to this effect.

Professor Mark Kilby (President of the British Maternal and Fetal Medicine Society) has circulated the Fetal Medicine Centres with the recommendations from the SHOT 2012 report about this issue, and the

case report from 2012 has been presented at the International Society of Blood Transfusion (ISBT) (2013) [4] and at the Perinatal Medicine conference (2014).

Development of National Guidelines from NICE

The National Institute for Health and Care Excellence (NICE) is developing transfusion guidelines and Professor Mike Murphy is chair of this guideline group.

One of the outcomes of the launch of the 'Patient Blood Management' initiative by the National Blood Transfusion Committee, NHS Blood & Transplant and the Department of Health (DH) in June 2012 was a request from DH to NICE 'to develop a cross-cutting guideline on the assessment for and management of transfusion'. The NICE Guideline Development Group (GDG) for Blood Transfusion was appointed in early 2013. The scope of the guideline includes the appropriate use of blood components, alternatives to transfusion including the treatment of anaemia and the use of cell salvage and drugs to minimise blood loss, and the avoidance of harm, for example monitoring for signs and symptoms of acute transfusion reactions, and the use of electronic methods for patient identification. The guideline will not include laboratory procedures, the management of massive haemorrhage or neonatal transfusion. The GDG has met on seven occasions to date (March 2014), and is making good progress. It is planned that the guideline will be ready for consultation by the summer of 2015 and will be published in the autumn of 2015. Further information about the guideline can be found on the NICE website.

Publications and presentations

The SHOT team has been active over the past 12 months with many teaching and training presentations. If your organisation would like a presentation please contact the SHOT office. In the past 12 months (January to December 2013) SHOT staff gave a total of 58 presentations including 3 at international conferences.

A list of abstracts and publications is available on the SHOT website, www.shotuk.org under SHOT Publications.

Summary of Main Findings and Cumulative Results

4

Author: Paula Bolton-Maggs and Debbi Poles

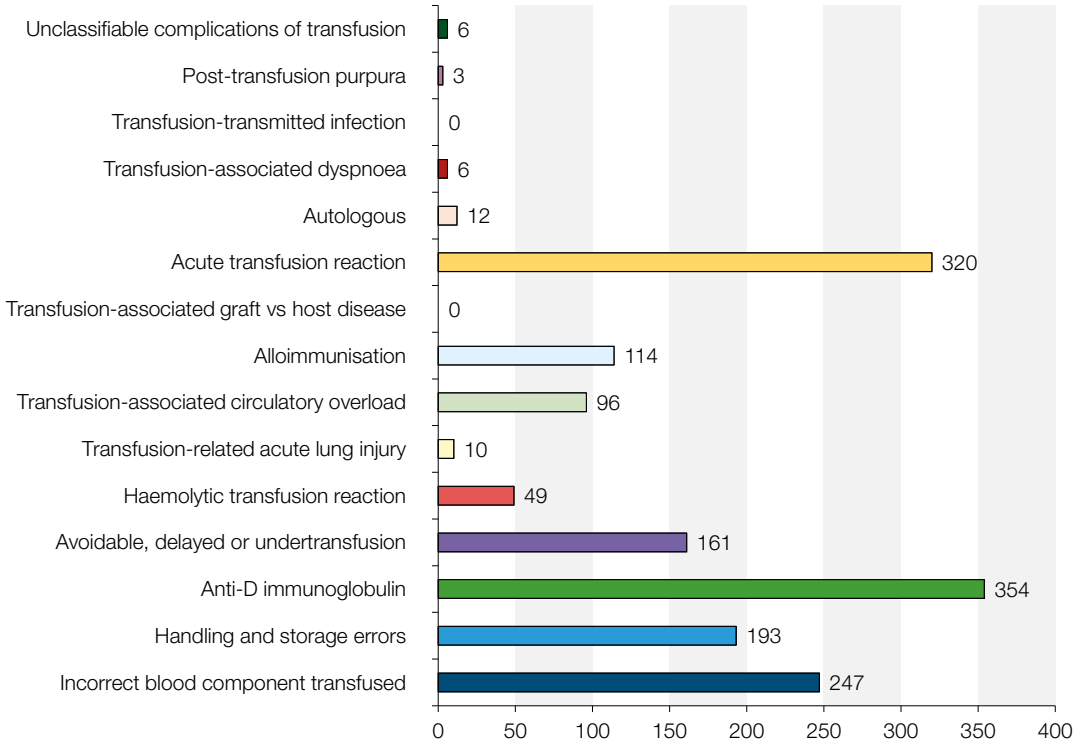


Figure 4.1: Cases reviewed in 2013 n=1571

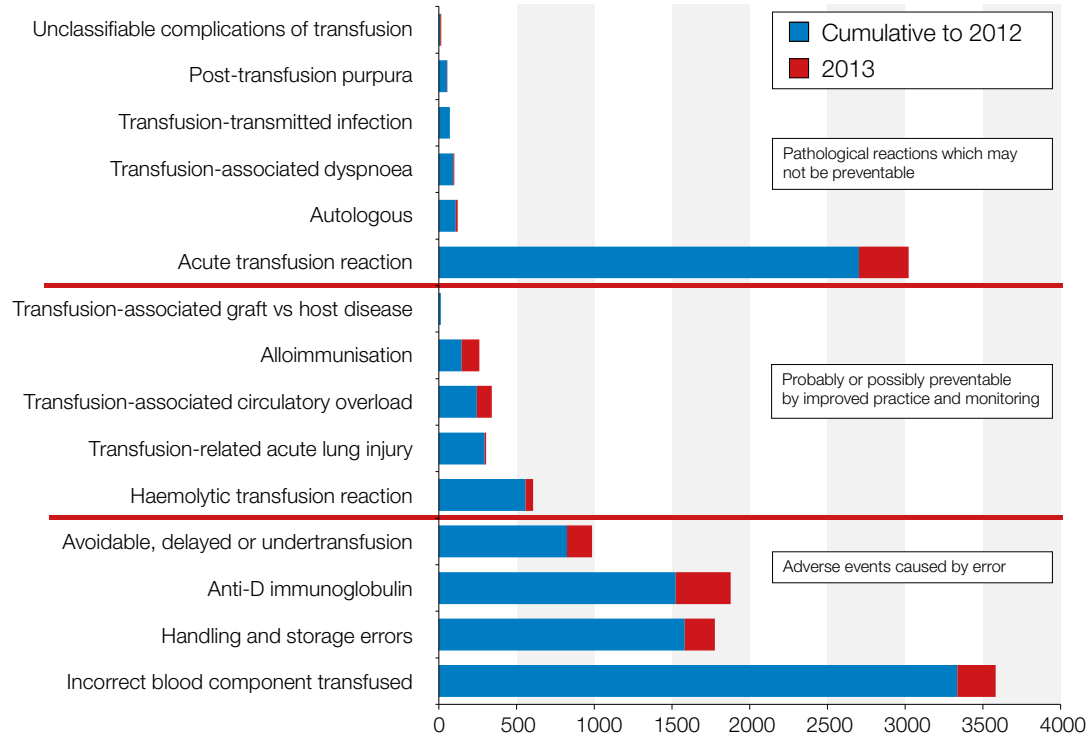


Figure 4.2: Cumulative data for SHOT categories 1996/7-2013 n=13141

Although transfusion remains very safe with low risks of serious harm or death, it is disappointing that errors continue to put patients' lives at risk, particularly from ABO incompatible red cell transfusions (9 reported to SHOT in 2013, 4 of which were classified as 'never events' i.e. the reaction resulted in serious harm or death).

In several instances, multiple errors contribute to an incident, a feature noted since the first Annual SHOT Report and analysed in some detail in the 2003 Annual SHOT Report [5]. In that year 2 errors were reported for 135/348 (38.7%) wrong transfusions, and 3 errors in 38 (10.9%). The final check at the patient's side is an opportunity to catch errors made before this step. Examples of cases compounded by multiple errors in 2013 are found in the following chapters: Chapter 8 Incorrect Blood Component Transfused (IBCT), Chapter 12 Right Blood Right Patient (RBRP), Chapter 14 Anti-D Immunoglobulin – Prescription, Administration and Sensitisation, Chapter 23 Transfusion-Associated Circulatory Overload (TACO) and Chapter 26 Summary of Transfusion Complications in Patients with Haemoglobin Disorders. These cases demonstrate the importance of correct and meticulous completion of all the steps in the transfusion process, particularly the final check at the bedside, and not making any assumptions about the safety of the steps prior to this.

Table 4.1: Relative risks of major morbidity and mortality based on data for 2013 overall and by incident group

Risk of major morbidity and mortality per 1,000,000 components issued in 2013	
Total morbidity	**51.8**
Total mortality	**8.0**

	Mortality	Major morbidity	Total cases
All errors	2.2	5.1	346.2
Acute transfusion reactions	0.0	27.6	116.0
Haemolytic transfusion reactions	0.4	2.9	17.8
Transfusion-related acute lung injury	0.4	3.3	3.6
Transfusion-associated circulatory overload	4.4	12.3	34.8
Transfusion-associated dyspnoea	0.0	0.4	2.2
Transfusion-associated graft versus host disease	0.0	0.0	0.0
Post-transfusion purpura	0.4	0.0	1.1
Cell salvage	0.0	0.0	4.4
Transfusion-transmitted infection	0.0	0.0	0.0
Unclassifiable complications of transfusion	0.4	0.4	2.2
Paediatric cases	0.7	1.5	37.0

ABO incompatible transfusions n=12 (red cells n=9, fresh frozen plasma (FFP) n=3) (12 incompatible red cell transfusions in 2012)

ABO incompatible transfusions resulted from clinical errors in 5 cases and from laboratory errors in 7. These are described in more detail in Chapter 8 Incorrect Blood Component Transfused (IBCT). Altogether 4 events were classified as 'never events' with the incompatible transfusion possibly contributing to the death of 1 patient, and major morbidity in 3 others. It is important to note that two thirds of incompatible ABO red cell transfusions are not associated with serious harm and would therefore not be reported as 'never events' to NHS England (see cumulative data and further discussion in Chapter 8 Incorrect Blood Component Transfused (IBCT)). However, each one is potentially life-threatening and should never occur.

Review of mortality and morbidity data

Definitions of imputability used in this report (see also the SHOT Definitions document in the Reporting section of the SHOT website, www.shotuk.org)

0=excluded or unlikely – when there is conclusive evidence beyond reasonable doubt for attributing the adverse reaction to causes other than the blood or blood components or where the evidence is clearly in favour of alternative causes.

1=possible – when the evidence is indeterminate for attributing the adverse reaction either to the blood or blood component or where there may be alternative causes.

2=likely/probable – when the evidence is clearly in favour of attributing the adverse reaction to the blood or blood component.

3=certain – when there is conclusive evidence beyond reasonable doubt.

Deaths n=22 (9 in 2012)

Avoidable, delayed or undertransfusion (ADU) n=5 (0 in 2012)

Imputability 3 n=1, Imputability 1 n=4

All 5 deaths resulted from delays in transfusion. A child with sickle cell disease died from anaemia with a haemoglobin level measured at 28g/L several hours earlier. A man died following late recognition of concealed postoperative bleeding and failure to recognise signs of haemorrhagic shock. Two patients died where delay was related to poor communication and labelling issues and in another case inadequate junior staffing and supervision contributed to failure to provide platelets in a timely manner.

Transfusion-related acute lung injury (TRALI) n=1 (0 in 2012)

Imputability 1 n=1

A man died 10 days after a red cell transfusion and had concordant human leucocyte antigen and antibodies. However he was already unwell with respiratory symptoms prior to transfusion. As with other transfusion-related complications this reaction may have been a tipping point.

Post-transfusion purpura (PTP) n=1 (0 in 2012)

Imputability 2 n=1 (this was the only death considered to be caused by transfusion by the MHRA reporting for their data in 2013)

A woman in her 50s with a past history of childbirth required massive transfusion including platelets after major cardiac surgery. After preliminary recovery of her platelet count there was an unexpected severe drop on the 8th day. A diagnosis of PTP was confirmed (anti-HPA-1a). Despite treatment, the following day she developed an intracranial haemorrhage and died within 24 hours.

Haemolytic transfusion reaction (HTR) n=1 (1 in 2012)

Imputability 2 n=1

A man with sickle cell disease underwent exchange transfusion but returned 11 days later with a delayed haemolytic transfusion reaction which together with ongoing sickling in the liver probably contributed to his death.

Transfusion-associated circulatory overload (TACO) n=12 (6 in 2012)

Imputability 2 n=5, Imputability 1 n=7

TACO is associated with a significant risk of death or major morbidity. One death occurred in a patient transfused for chronic iron deficiency; this and other deaths occurred in high risk elderly people.

Incorrect blood component transfused (IBCT) n=1 (0 in 2012)

Imputability 1 n=1

A patient who was already very unwell died shortly after transfusion of part of an ABO incompatible unit. This may have contributed to his death.

Unclassifiable complications of transfusion (UCT) n=1 (1 in 2012)

Imputability 1 n=1

An infant developed necrotising enterocolitis shortly after receiving a red cell transfusion and subsequently died. This was considered a possibly transfusion-related death.

Major morbidity n=143 (134 in 2012)

Acute transfusion reactions (allergic, hypotensive and severe febrile) (ATR) n=76 (68 in 2012)

These cases included 33 instances of anaphylaxis or severe allergic reactions, 22 severe febrile reactions, 5 severe hypotensive reactions and 6 severe mixed reactions. A further 10 cases were described as having severe reactions by reporters (but moderate by the Chapter authors).

Transfusion-associated circulatory overload (TACO) n=34 (29 in 2012)

This high proportion (35.4%) of major morbidity in a total of 96 reports is a reminder of the serious consequences of this complication. Fifty six patients had concomitant risk factors.

Incorrect blood component transfused (IBCT) n=6 (11 in 2012)

Three ABO incompatible red cell transfusions resulted in major morbidity and 3 women of childbearing potential were sensitised against the K antigen as a result of laboratory errors.

Haemolytic transfusion reactions (HTR) n=8 (9 in 2012)

As in previous years, patients with sickle cell disease are particularly at risk. Six of the 8 had sickle cell disease, and three of these had hyperhaemolysis. Two instances of major morbidity occurred in relation to acute haemolysis.

Transfusion-related acute lung injury (TRALI) n=9 (8 in 2012)

Consistently fewer cases are recorded since the introduction of risk-reducing measures in 2003. More cases reported in recent years have additional respiratory risk factors.

Anti-D errors n=1 (4 in 2012)

A woman developed anti-D after omission of anti-D immunoglobulin prophylaxis during pregnancy. There were also 276 women at risk for development of anti-D whose prophylaxis was delayed or omitted.

Transfusion-transmitted infections (TTI) n=0 (3 in 2012)

No new infections were confirmed from transfusions given in 2013. Two pending cases from 2012 were finalised in 2013. These are not counted in the numbers for 2013.

Avoidable, delayed or undertransfusion (ADU) n=7 (2 in 2012)

These 7 cases all resulted from delayed transfusions, 3 associated with cardiac arrest.

Unclassifiable complications of transfusion (UCT) n=1 (0 in 2012)

An infant developed major morbidity from necrotising enterocolitis shortly after receiving a red cell transfusion.

Transfusion-associated dyspnoea (TAD) n=1 (0 in 2012)

A middle aged man with underlying malignant disease, already very unwell, became more acutely distressed in relation to a transfusion. The reaction demonstrated features of an ATR, and occurred in the context of pre-existing pulmonary oedema and neutropenic sepsis, both of which could have been contributory to the patient's symptoms.

Categories of reports where no harm was done

Near miss n=996 (980 in 2012)

The majority of these, 643 (64.6%), were 'wrong blood in tube' near miss events. James Reason calls near misses 'free lessons' as no harm is done [1], but if not detected at least 125 could have resulted in ABO incompatible transfusions. Most near miss events occurred in clinical areas (n=742) with 251 errors in the laboratory and 3 in Blood Establishments.

Right blood right patient n=184 (142 in 2012)

As in previous years the majority (118/184) were minor discrepancies in patient identification and 52 were labelling errors.

Reports where incidents were caused by error n=955 (1026 in 2012)

Anti-D immunoglobulin n=354*

Handling and storage errors n=193

Avoidable, delayed or under transfusion n=161

Specific requirements not met n=190

Wrong component transfused n=57

**This number does not include the 35 cases of RhD sensitisation reported to the new study in obstetric patients – for details see the appendix to Chapter 14 Anti-D Immunoglobulin – Prescription, Administration and Sensitisation. (These cases are not necessarily a result of errors)*

Figure 4.3 shows the cumulative numbers of errors. There is some reduction in handling and storage errors, but no reduction in instances where the specific requirements were not met. This is mainly missed irradiation of cellular components for patients at risk for transfusion-associated graft versus host disease due to immune suppression. The cumulative number of instances of missed irradiation in the past 12 years is 999.

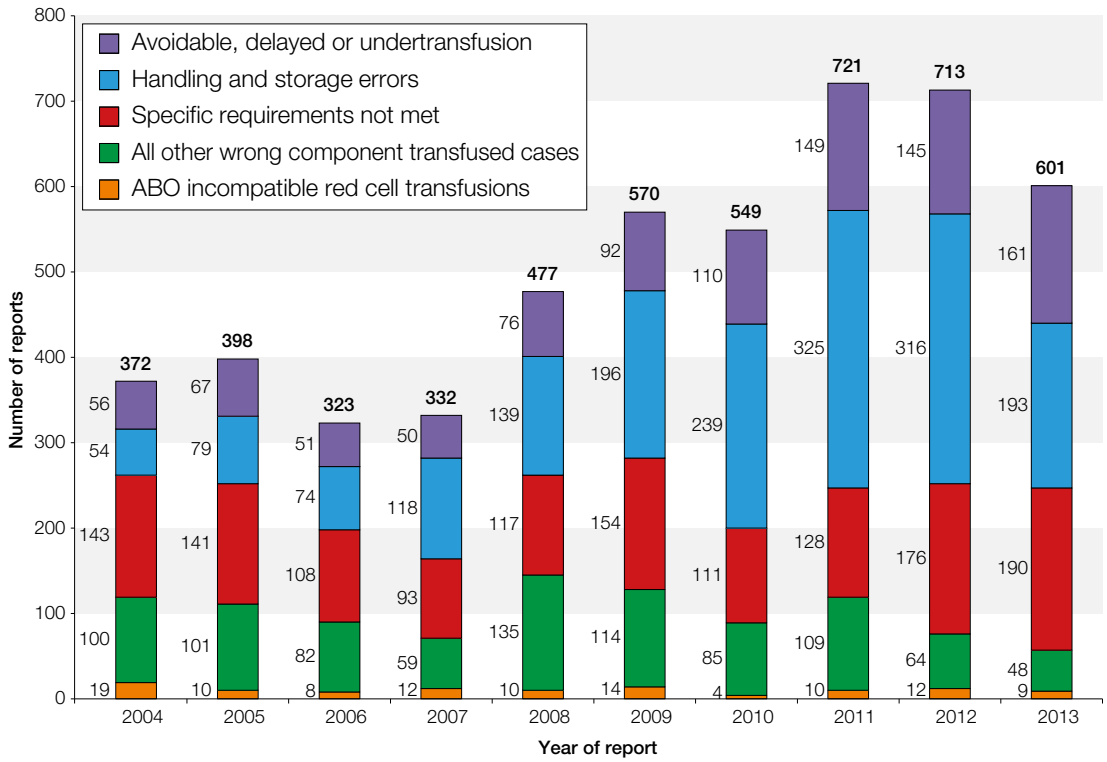


Figure 4.3: Cumulative numbers for blood component error-related reports (excluding anti-D Ig)

Where information is collected about competency-assessment, again we observe that the majority of personnel involved have passed their assessment (Table 4.2). Work continues through the National Blood Transfusion Committee subgroups to improve education and to review methods for competency-assessments that probe for better knowledge and understanding of the transfusion process.

Table 4.2: Competency-assessment in relation to errors

Competency assessment 2013	Yes	No	Not known or blank
Errors with Anti-D			
Pre-administration sample (n=15)	2	0	13
Laboratory procedures (n=51)	38	4	9
Collection of anti-D (n=47)	26	2	19
Laboratory errors where the specific requirements were not met			
Competency-assessed for procedure	39	7	6
Competency-assessed on LIMS	*36*	*10*	*6*
Incorrect blood component transfused			
Sample collection (n=1)	0	0	1
Laboratory errors (n=19)	16	2	1
Collection (n=19)	15	4	0
Total n=204*	**136** **66.7%**	**19** **9.3%**	**49** **24.0%**

**Numbers in this table include all instances where competency-assessment questions were answered regardless of the eventual categorisation of the individual report*

COMMENTARY

Transfusion remains very safe with few serious incidents or deaths related to pathological events. However, patients continue to be at risk from potentially preventable causes, particularly transfusion-associated circulatory overload. Error-related incidents continue to be the largest group, and new strategies are needed to change this, and these are discussed in Chapter 5 Key Messages and Recommendations.

Additional tables showing report types by year and the cumulative morbidity and mortality data 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.

Key Messages and Recommendations

5

Authors: Paula Bolton-Maggs and Dafydd Thomas

Human factors in hospital practice

Year on year the largest group of reports relate to mistakes made in the transfusion process. In 2013, errors contributed to 77.6% of all reports (this includes 'near miss' and 'right blood right patient' reports where, by definition, no harm was done). As illustrated in Chapter 8 Incorrect Blood Component Transfused (IBCT), errors in the 9 step multidisciplinary transfusion process are frequently multiple (median 3, maximum 5 errors). If each person in the transfusion sequence completed their part correctly, these errors would not occur and many could be detected before transfusion, especially by the final check at the patient's side.

In response to the first report about the tragic events at Mid Staffordshire NHS Foundation Trust a Human Factors Reference Group [6] was set up by Sir Bruce Keogh, Medical Director of NHS England. 'Human Factors is the science explaining the interrelationship of humans to their environment and to each other' or 'enhancing clinical performance through an understanding of the effects of teamwork, tasks, equipment, workspace, culture and organisation on human behaviour and abilities and application of that knowledge in clinical settings'. His report notes 'the significant role that good handover and communication has to play in delivering safe care'. The errors reported to SHOT often demonstrate failures in communication and handover that lead to adverse incidents, some life-threatening, in transfusion practice.

A House of Commons Health Committee Parliamentary Inquiry into patient safety reported in 2009 [7] making 59 recommendations including human factors training in all medical undergraduate and postgraduate courses, patient safety training covering the role of human factors in training curricula of all health care workers, and changes to the ways that hospitals assess risks and measure performance by using information about actual harm done to patients. This was a decade after the publication of 'An organisation with a memory' [8] which encouraged NHS staff to report instances of patient harm (in the context of a more open culture searching for systems failures with the intent of learning from these), and the establishment of the National Reporting and Learning System (NRLS, 2003) together with the National Patient Safety Agency (NPSA). It is estimated that up to 10% of patients admitted to hospital experience some form of potentially avoidable harm. Data from the NRLS shows that of the 1.43 million incidents reported in 2012, 68% caused no harm, 25% were 'low harm', 6% moderate harm, 1% serious harm, and <1% deaths [9]. However, these last two categories include a total of 11,452 patients. The 2009 Select Committee report notes that the NHS lags behind other safety-critical industries, such as aviation, in recognising the importance of effective teamworking and other non-technical skills. Inadequate staffing levels have been major factors in undermining patient safety in a number of notorious cases. This is unacceptable. Some of the reports of transfusion errors in 2013 recorded staffing shortages as a factor. The integration of patient safety into education and training curricula of all healthcare workers was recommended, but also more interdisciplinary training: those who work together should train together. In transfusion practice we should work as an integrated team, and more can be done to improve this (see discussion of multiple errors in Chapter 8 Incorrect Blood Component Transfused (IBCT)).

Further key publications have followed including the Berwick report on behalf of the National Advisory Group on the Safety of Patients [10], and more recently, the Human Factors Concordat [11] which is endorsed by NHS England, the Care Quality Commission (CQC), the National Institute for Health and Care Excellence (NICE), the General Medical Council, the Nursing and Midwifery Council, the NHS

Litigation Authority and others. This approach will require multiple actions at several levels across the system: from ensuring the workforce is aware of the application of Human Factors in everyday clinical practice, to embedding and understanding of human limitations and how to mitigate against their impact in the development and design of healthcare systems and processes. The Clinical Human Factors Group was founded in 2007 by Martin Bromilow, a pilot whose wife died after a 'routine' operation and this organisation now has wide support. It is a broad coalition of healthcare professionals, managers and service-users who have partnered with experts in human factors from healthcare and other high-risk industries to campaign for change in the NHS. Information and resources are available at http://chfg.org.

Although blood and blood component transfusion is very safe, the main risk to patients lies in the human factors. We have very good blood safety and need to work on transfusion safety. Helen Hughes, the Chief Operating Officer for the Parliamentary Health Service Ombudsman, has been seconded to NHS England to support the development of human factors work in association with Dr Mike Durkin, the Director of Patient Safety, NHS England.

The most dangerous steps in transfusion practice continue to be the human interventions. Many errors are multiple but could be detected at the final check at the patient's side. In addition to confirmation of the patient identity (positive patient identification), the component should be checked against the prescription to ensure it is correct and that patient-specific requirements are met. This could be done simply with an aide-memoire (or checklist) to include the following essentials:

- **Positive patient identification (ask the patient to state name and date of birth)**
- **Check identification of component against patient wristband**
- **Check the prescription: has this component been prescribed?**
- **Check the prescription: is this the correct component?**
- **Check for specific requirements – does the patient need irradiated components or specially selected units?**

The introduction of a list on its own does not solve the problem; the issue is the human behaviour and interaction. Members of the SHOT Steering Group were wary of recommending another checklist; it is important to have a better understanding of what goes wrong on the ground. This requires training in teamwork by all those involved in the transfusion pathway together so that all know they are respected and accountable [12]. The recent NHS England report on safer surgery also noted that 'where a Checklist is treated as a tick-box exercise it is of limited use'. The Checklist is not an end in itself but as a tool to promote systemic change and prompt safer behaviour'[13]. That safety review was prompted as a result of the 'never events' recorded in surgery.

Serious incidents should be reported and lessons learned from them. This is a legal requirement under Care Quality Commission regulations [14]. There are few 'never events' in transfusion because in relation to ABO incompatible transfusions, the only recordable ones relate to harm or death. However review of SHOT data in Chapter 8 Incorrect Blood Component Transfused (IBCT) shows that two thirds of ABO incompatible transfusions are not currently reportable to national surveillance as they do not result in harm. Only a third result in major morbidity or death. In addition, a significant number of ABO incompatible transfusions were averted as 'near miss' events (where the information is supplied there were at least 125 where patients of blood group O might have received group A, or patients of blood groups A or B receiving the opposite group). These prevented 'never events' provide vital warning signs that the potential for real events exists [15]. Since the death or major morbidity from actual ABO incompatible events cannot be predicted, SHOT recommends that all ABO incompatible transfusions be reported nationally as 'never events'.

As human factors (including 'absent mindedness' and 'automatic pilot') are the major factor in both SHOT and MHRA reporting, we should consider ergonomics and redesign of the transfusion process. Ergonomics fosters design of equipment and the environment to complement strengths and abilities while minimising human limitations (see www.ergonomics.org.uk/learning /what-ergonomics/). Review is needed closer to the action. An observational audit of 92 blood samplings in 13 departments across 3

hospitals demonstrated some practical difficulties in performing the process in the manner recommended by guidelines, for example, it was almost impossible to label samples at the bedside and phlebotomists were sharing trolleys increasing the risk of confusing their samples. Several inpatients did not have positive identification or wristband checks [16]. A series of wider process audits of this kind could inform how the 9 steps (see Chapter 8 Incorrect Blood Component Transfused (IBCT)) of transfusion between patient, the transfusion laboratory and back to the patient could be redesigned to reduce risks of error. Transfusion is comparatively well regulated, but these errors will also apply to other pathology samples where a result impacts on individual patient management.

Serious adverse incidents associated with death and major morbidity – transfusion-associated circulatory overload and delayed transfusion

Transfusion-associated circulatory overload (TACO) is a significant cause of death and major morbidity (Chapter 23 Transfusion-Associated Circulatory Overload (TACO)). These reports show a steady increase with 96 cases in 2013 (an increase from 82 in 2012). Half of these patients experienced death or major morbidity as a result, demonstrating that this is a serious complication. Some of these could be prevented by better pre- and post-transfusion assessment. There is a place for single unit transfusions followed by a clinical and haemoglobin check – 'Don't give two without review'. This advice is inspired by a campaign devised by NHSBT's Patient Blood Management (PBM) team with resources on the Hospitals and Science Website http://hospital.blood.co.uk.

With increasing pressure to transfuse patients as day cases there is also a risk that complications may develop after discharge as shown for TACO and acute transfusion reactions (Chapter 15 Acute Transfusion Reactions (ATR)) where 3 developed at home, but 57 reactions occurred in day case patients. It is essential that patients are informed of the possibility of later adverse events and that they are supplied with a contact telephone number.

This year again there were reports of inappropriate transfusions for iron deficiency, one of which resulted in circulatory overload and death.

The number of reports of delayed transfusion has increased year on year. This is clearly of concern as recorded in Chapter 11 Avoidable, Delayed or Undertransfusion (ADU), and these are not all in relation to massive haemorrhage. Some of these reflect the increased burden in emergency departments. These are serious incidents: review of data on delays over the past 4 years shows that 10/69 (14.5%) died, with delay playing a part. These were not all related to problems with activation of the major haemorrhage protocols but had many different causes. However, it is of particular concern that two foundation year doctors did not recognise signs of haemorrhagic shock. Contributory factors included poor supervision at nights and weekends, and confused care by a succession of clinical teams.

Key Recommendations:

- Process redesign: Annual SHOT data consistently demonstrate errors to be the largest cause of adverse transfusion incidents. In line with human factors and ergonomics research it may be better to redesign the transfusion process by process mapping and audit at local and national level, to design out the medical errors

Action: National Blood Transfusion Committees, working with Regional and Hospital Transfusion Committees in association with NHS England patient safety domain and equivalent organisations in the devolved countries and the National Comparative Audit Programme

- All ABO incompatible red cell transfusions to be included as 'never events': ABO incompatible transfusions may be fatal and are absolutely preventable. The two thirds that do not result in harm should be included as reportable 'never events'

Action: NHS England, patient safety domain

- Management of blood and blood component transfusion to be included as a specific standard by the Care Quality Commission. This should include the same subset of standards as currently apply to medicines (Outcome 9)

Action: Care Quality Commission

- Don't give two without review: Transfusion-associated circulatory overload is a significant hazard particularly when elderly or other patients at risk (renal impairment, cardiac disease, obstetric haemorrhage, gastro-intestinal haemorrhage) receive several units of blood without review and a check on the Hb level

This advice is inspired by a campaign devised by NHSBT's Patient Blood Management team

Action: Trust/Health Board Chief Executive Officers and Medical Directors responsible for all clinical staff

- Advice for patients**:** Day case or outpatient transfusions: with the increased emphasis on day case and community care, patients receiving transfusions need to be given printed advice, be advised to report any symptoms or complications and provided with a 24-hour contact number

Action: Trust/Health Board Chief Executive Officers and Medical Directors responsible for all clinical staff

Medicines and Healthcare products Regulatory Agency (MHRA) Report on Blood Safety and Quality Regulation in 2013

6

Authors: Mike Dawe and Chris Robbie

Introduction

The United Kingdom (UK) Blood Safety and Quality Regulations (BSQR) [17] require that serious adverse events (SAE) and serious adverse reactions (SAR) related to blood and blood components are reported by Blood Establishments and hospital transfusion laboratories (blood banks) to the MHRA, the UK Competent Authority for blood safety. This requirement is facilitated by the Serious Adverse Blood Reactions and Events (SABRE) reporting system. Annual summary reports are also required. The annual reporting period for the MHRA and the European Union (EU) Commission is from January to December. SABRE reports are included in the summary report for the year in which the confirmation report was submitted.

Summary

2013 SABRE data have been analysed by the MHRA haemovigilance team in order to identify common errors and to make recommendations for improvements to corrective and preventative action (CAPA) plans. In reviewing the data and analysis it is important to remember that even with 2.9 million components issued last year, only 705 SAE notification reports were submitted to the MHRA. This is a very low error rate that reflects the high standards of blood transfusion procedures and techniques in place throughout the UK.

The number of SAEs reported is now 29.1% lower than the 2009 peak. This suggests that efforts of hospital transfusion laboratories and Blood Establishment management and staff are paying dividends, local systems and procedures are improving and corrective and preventive actions are properly addressing errors seen previously.

However, 'human error' still accounts for the majority of SAE reports received. SABRE confirmation reports mostly record that individuals are aware of their local standard operating procedures (SOPs) and that those SOPs are complete and up to date. They also record that those individuals were either busy with urgent work when the error occurred (especially during 'out of hours' shifts), or were otherwise distracted. In either case the result was an error due to a lapse in concentration. Managers and staff are encouraged to make every effort to ensure that potential causes of distraction and concentration lapses are minimised and/or that appropriate resources are allocated to ensure that staff are not overstretched.

SABRE report data

Table 6.1 and Figure 6.1 below display the totals of notification reports received by the MHRA since 2006. The data show that between 2012 and 2013, the overall total fell by 12.2% from 1460 reports to 1282.

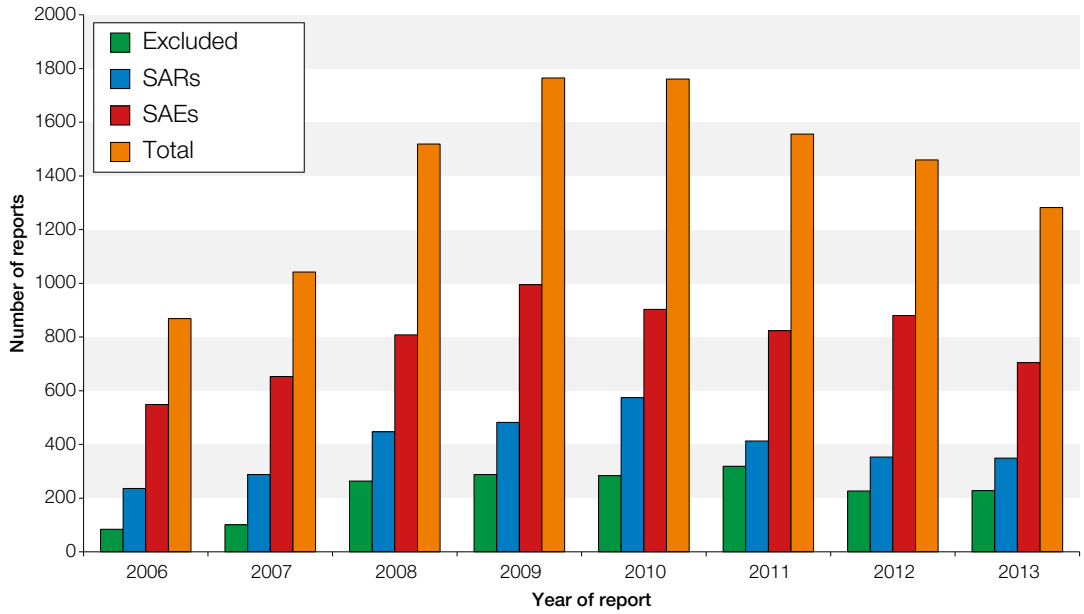
	2006	2007	2008	2009	2010	2011	2012	2013
Serious adverse events (SAEs)	549	653	808	995	903	824	880	705
Serious adverse reactions (SARs)	236	288	447	482	574	413	353	349
Excluded reports	84	101	264	288	284	319	227	228
Total	**869**	**1042**	**1519**	**1765**	**1761**	**1556**	**1460**	**1282**

NOTE: SABRE reports are routinely updated in light of additional or revised data from reporters. As a consequence, some figures may differ from those previously published

Table 6.1: SABRE notification reports 2006-2013

The number of SAE reports received in 2013 was the lowest since 2008. This may be indicative of improvements in both root cause analysis (RCA) and CAPA processes. Excluded reports show a reduction since 2011. This was expected in light of the continuing communication and personal guidance offered by the MHRA haemovigilance team. The number of SARs reported remains largely unchanged from 2012.

Figure 6.1: SABRE reports 2006–2013 (Number of reports by individual year)



Serious adverse events

Definitions

From the Blood Safety & Quality Regulations [17]

'Any untoward occurrence associated with the collection, testing, processing, storage and distribution, of blood or blood components that might lead to death or life-threatening, disabling or incapacitating conditions for patients or which results in, or prolongs, hospitalisation or morbidity.'

Reporting requirements

'Blood Establishments/the person responsible for the management of a hospital blood bank ('hospital transfusion laboratory' is used in this report for consistency with other chapters) shall notify… any serious adverse events related to the collection, testing, processing, storage and distribution of blood or blood components by the Blood Establishment which may have an influence on their quality and safety'

Deviation	Total number	Specification			
		Product defect	Equipment failure	Human error	Other
Whole blood collection	**18**	0	1	17	0
Apheresis collection	**3**	0	0	3	0
Testing of donations	**3**	0	0	3	0
Processing	**14**	0	1	13	0
Storage	**211**	0	8	203	0
Distribution	**24**	0	0	24	0
Materials	**2**	0	1	1	0
Other	**430**	0	5	425	0
Total	**705**	**0**	**16**	**689**	**0**

NOTE: *n=number of confirmation reports submitted in 2013.*

Table 6.2: SAE confirmation reports by deviation and specification

Whole blood and apheresis collection n=21

Most of these reports relate to Blood Establishment collections where donor health questionnaires have not been assessed correctly. This usually results in a failure to defer donors or take samples for additional testing.

Testing of donations n=3

These reports concern errors made in the donation testing procedure undertaken by the laboratory. Two reported errors related to red cell immunohaematology (RCI) laboratories, and a third to testing performed using an unauthorised test kit.

Processing n=14

These reports relate mostly to secondary processing, such as the irradiation of components. A common mistake is a failure of the Blood Establishment (or hospital with Blood Establishment licence) to update the expiry date of irradiated units on the laboratory record system. It is important to remember that the processing category only relates to the processing of donor units by Blood Establishments and hospitals with a Blood Establishment licence. Any other 'processing' such as sample processing should be reported under a different category.

Storage n=211

SAE reports, categorised as storage, account for 211/705 (29.9%) reports received in 2013.

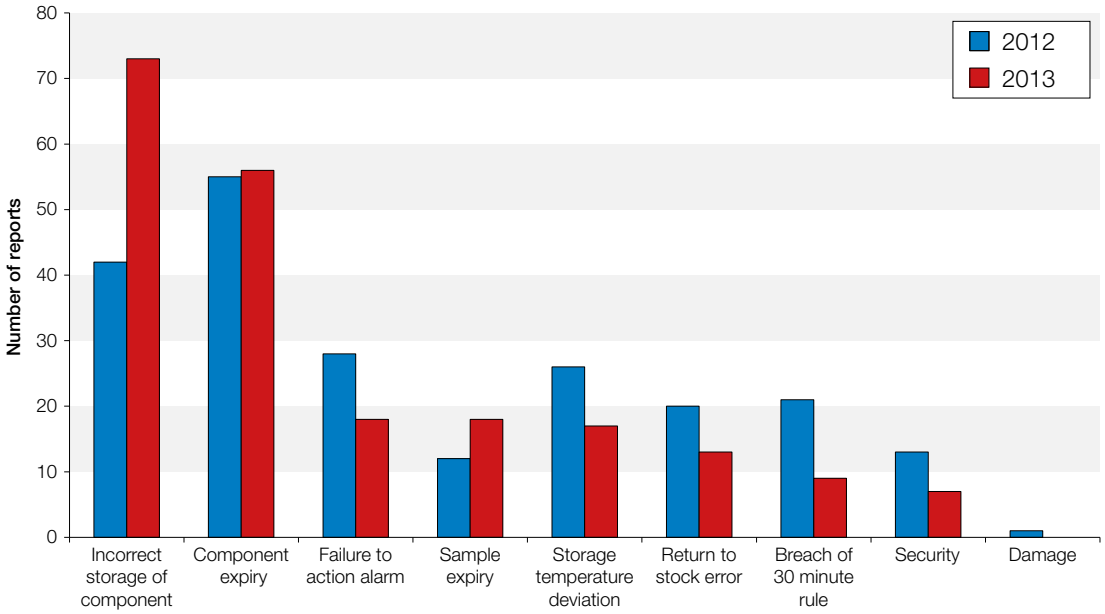
The EU Commission have recently clarified that all component storage errors, including those which occur in a clinical area (but not all clinical handling errors, e.g. putting units in the ward refrigerator), are reportable [18].

In order to further distinguish between and to better understand the range of storage errors being reported, the MHRA haemovigilance team has developed sub-categories which are used to categorise these errors more specifically.

Storage error	2012	2013
Incorrect storage of component	42	73
Component expiry	55	56
Failure to action alarm	28	18
Sample expiry	12	18
Storage temperature deviation	26	17
Return to stock error	20	13
Breach of 30 minute rule	21	9
Security	13	7
Damage	1	0
Total	**218**	**211**

Table 6.3: Numbers of storage errors 2012 and 2013, defined by MHRA sub-category

Figure 6.2: Storage errors 2012 and 2013, defined by MHRA sub-category



Storage sub-category data

a. Incorrect storage of component n=73

This sub-category includes the following, failure to remove components from transport boxes, placing components into the wrong storage location, for example, refrigerators not in use, unmonitored refrigerators, wrong temperature conditions or failure to use an appropriate transport container.

Many of these reports involve errors by nurses, healthcare assistants and porters. The increase in reports from 2012 to 2013 may be indicative of a need for additional and/or more frequent training of staff responsible for collecting and delivering blood.

b. Component expiry n=56

This sub-category covers expired components not being removed from the supply chain. It does not include components which are still in date but require de-reservation based on sample expiry (see d. Sample expiry, below).

c. Failure to action alarm n=18

These SAEs are as a result of staff in laboratories and/or the clinical areas failing to follow procedures correctly once an alarm sounds. As a consequence, compromised components may remain in the supply chain and there may be a significant loss of component stock.

In one incident components were lost because the on call biomedical scientist (BMS) muted an alarm with the intention of dealing with it once they had completed the urgent work that they were currently working on. The BMS then forgot to go back to the refrigerator to deal with the incident. By the time the BMS remembered about the alarm the components were out of temperature control and therefore had to be wasted.

d. Sample expiry n=18

Sample expiry SAEs reflect a failure in local de-reservation processes where components have remained available for transfusion after the sample time period had expired.

e. Storage temperature deviation n=17

This sub-category describes incidents where components had apparently been stored correctly, but where the storage conditions had in fact changed without being detected by the quality system. This could be as a result of an equipment failure, e.g. alarms failing to sound; existing hotspots found after routine temperature mapping. The reduction in report numbers in this area suggests that stricter controls and checks may now be in place.

f. Return to stock error n=13

SAEs in this category concern occasions where individuals incorrectly return components to the supply chain when they should have been discarded following cold chain errors. The 13 reports received in 2013 involved components that were returned to stock from a clinical area without a substantiated cold chain record.

g. Breach of 30 minute rule n=9

These reports concern failures to properly quarantine components which have breached the 30 minute rule. These components had been returned to the supply chain and therefore had the potential to be, or were, used inappropriately. The reduction in the number of reports suggests growing awareness of and adherence to this rule.

h. Security n=7

Security SAEs arise where storage locations are not adequately secured from use by unauthorised or untrained staff. The reports submitted indicate that staff who are not up-to-date with training and competency have been allowed access to issued components.

i. Damage n=0

This category concerns damage occurring during storage, where that damage could have been avoided by appropriate handling procedures being in place.

Where the problem appears to lie with the blood bag, rather than the way in which that bag was stored or handled, consideration should be given to contacting the MHRA's Medical Device Adverse Incident Centre: aic@mhra.gsi.gov.uk or 020 3080 7080.

Distribution n=24

Many reported distribution errors have occurred when clinical staff have transferred components without following the local distribution procedures or without consulting the hospital transfusion laboratory. This has resulted in components not being transferred within an appropriate and verifiable cold chain environment. Other distribution errors reported involve SAEs where components do not reach their intended destination when being sent between hospitals and Blood Establishments. Errors that occur when components are transferred from the laboratory to a ward within the hospital are not considered distribution errors but are classified under the deviation category 'storage'.

Materials n=2

Materials errors include reagent and equipment failures. There were two reports in 2013. One related to a misread barcode (due either to a faulty barcode or a faulty scanner) and the other to a test kit incorrectly stored prior to use.

Other n=430

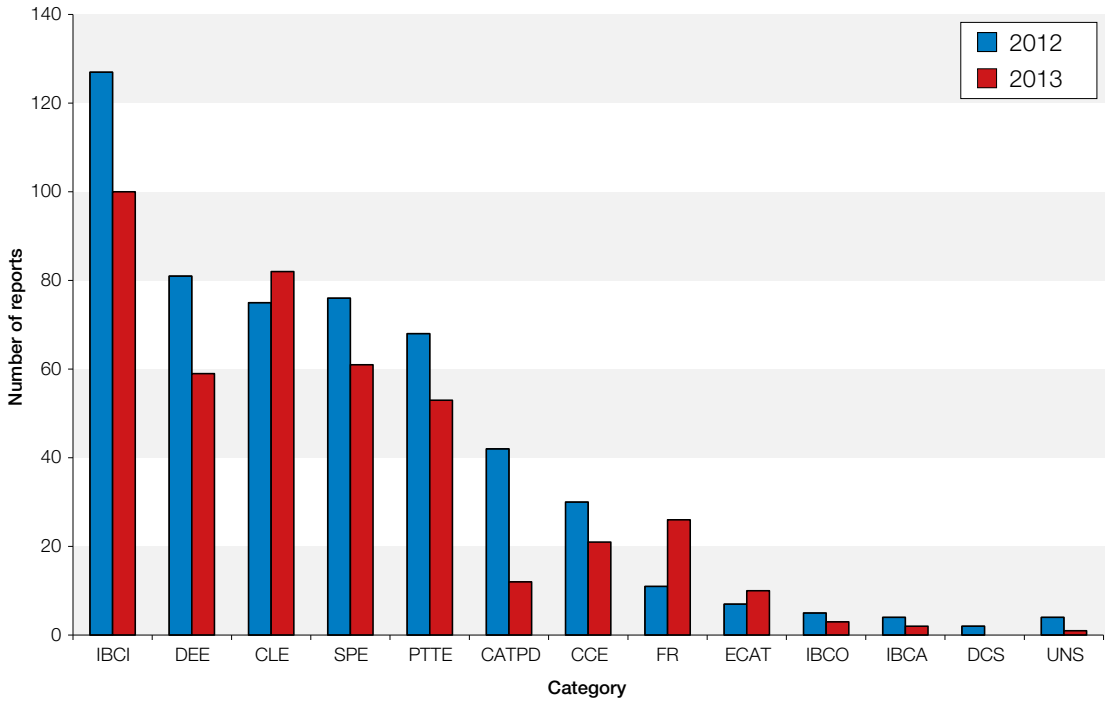
The 'other' category accounted for 430 of the 705 SAE reports submitted in 2013. Nearly all, 98.8% (425/430) of these resulted from human error. As 'other' is the single largest category of SAE reports, the MHRA haemovigilance team has created sub-categories to simplify analysis.

Table 6.4: SABRE reports, sub-category 'Other', 2012 and 2013

Sub-category 'Other'	Abbreviation	2012	2013
Incorrect blood component selected and issued	IBCI	127	100
Data entry error	DEE	81	59
Component labelling error	CLE	75	82
Sample processing error	SPE	76	61
Pre-transfusion testing error	PTTE	68	53
Component available for transfusion past de-reservation date	CATPD	42	12
Component collection error	CCE	30	21
Failed recall	FR	11	26
Expired component available for transfusion	ECAT	7	10
Incorrect blood component ordered	IBCO	5	3
Incorrect blood component accepted (from supplier)	IBCA	4	2
Delayed component supply (BE* only)	DCS	2	0
Unspecified	UNS	4	1
Total		**532**	**430**

**BE=Blood Establishment*

Figure 6.3: SABRE reports, sub-category 'Other', 2012 and 2013



SAE 'Other' sub-category

a. IBCI - Incorrect blood component selected and issued n=100

These reports relate to the issue of components which do not meet the specification requested. Despite a reduction in the number of reports received in 2013, IBCI errors remain the single largest 'other' subcategory, comprising 23.3% (100/430) of the total in this sub-category.

b. CLE - Component labelling errors n=82

CLEs mostly concern the transposition of compatibility labels and inadequate checking. This clearly remains a significant problem. Reports indicate the prime cause is a lack of concentration when labelling components. Local managers should ensure that staff are not distracted or rushed during the labelling process and that strict checking procedures are in place.

c. SPE - Sample processing errors n=61

These SAE reports arise where samples are not processed in accordance with local SOPs and/or clinical requests. They include a failure to spot labelling or request form errors. The reduction in the number of SPEs may indicate that stricter controls have been put in place.

d. DEE - Data entry errors n=59

DEEs are transcription errors and will, therefore, include laboratory information management system (LIMS) data entry errors. These may be from the sample or from the associated request form. A frequently reported error is where staff merge patient details without undertaking prescribed checks correctly. Many SAEs in this category result from a loss of concentration at the critical steps. When designing the process and the procedure, consideration should be given to minimising the distractions within the environment which could affect concentration.

e. PTTE – Pre-transfusion testing errors n=53

Pre-transfusion testing errors comprised 12.3% (53/430) of the total 'other' errors reported. The most common failures arose where pre-transfusion tests were not initiated or completed before components were issued to a patient. Specific reports have included units being issued without an antibody identification test being completed on the recipient's screening sample.

f. FR - Failed recalls n=26

The 2013 total for FR reports is more than double that for 2012. The most common failures are where a hospital transfusion laboratory has failed to react to a recall notice or where the Blood Establishment has failed to recall the component in a timely manner. These errors occurred through failures in communication between the hospital transfusion laboratory and the Blood Establishment. Local managers must ensure that a robust and flexible communication plan is in place to allow for a quick response to any recall received.

g. CCE - Component collection errors n=21

These errors occur when an incorrect component is collected from a satellite storage facility or is handed over by laboratory staff to another individual without checks being undertaken correctly. Reports suggest that, in most cases, staff have been distracted whilst issuing or collecting components. One report states that the wrong unit was taken (and transfused) because the member of staff was asked to do an additional task whilst signing a component out of a satellite refrigerator.

h. CATPD - Component available for transfusion past de-reservation n=12

This category of SAE describes the situation where a component or sample is time-expired and the laboratory staff do not carry out their de-reservation/stock control processes. The 2013 data show a significant reduction in reports of CATPD errors.

i. ECAT - Expired components available for transfusion n=10

SAEs in this category refer to components issued in advance of a planned transfusion and/or operation, but which have an expiry date or time that is before the specified date or time required.

j. IBCO - Incorrect blood component ordered n=3

This category refers to the wrong components being ordered from a Blood Establishment.

k. IBCA - Incorrect blood component accepted n=2

An IBCA occurs when a laboratory incorrectly accepts components intended for another location. In these cases a second SAE report to the MHRA is expected from the Blood Establishment to cover the erroneous issue of the wrong components.

l. UNS - Unspecified n=1

This final sub-category exists to collate reports that do not fit into other categories and which therefore remain unspecified.

MHRA human error analysis

Human error remains the largest single reported specification of SAEs received. In 2013 they accounted for 689 (97.8%) of the total 705 SAEs reported.

By categorising and analysing these errors, local quality management systems (QMS) can be modified to reduce those human behaviours that may lead to mistakes and errors occuring.

The following table shows the number of reports received that have been classified as human error in the years 2010 to 2013.

Table 6.5: SABRE reports 2010-2013, human error

	Specification – human error			
SAE deviation	**2010**	**2011**	**2012**	**2013**
Whole blood collection	54	36	24	17
Apheresis collection	0	1	3	3
Testing of donations	4	8	2	3
Processing	22	32	15	13
Storage	224	225	211	203
Distribution	48	53	58	24
Materials	1	0	1	1
Other	425	434	527	425
Total human error	**778**	**789**	**841**	**689**

The MHRA haemovigilance team has been focussing advice and guidance to reporters on this area since 2010. In that time there has been a reduction in human error reports of 11.4%.

This detailed scrutiny of report data has enabled the MHRA to develop human error sub-categories to support effective root cause analysis. The seven MHRA human error sub-catogories are shown below.

Table 6.6: MHRA human error sub-categories

Human error sub-categories	Definition
Inadequate process	The defined process does not achieve correct outcome
Incorrect procedure	The written procedure does not reflect the defined process
Lapsed or no training	Training/competency out of date or not completed
Inadequate training	Training/competency-assessment does not cover the error made
Ineffective training	Training is adequate but misunderstood
Procedural steps omitted	Procedural steps missed out or the wrong procedure followed
Concentration	The correct procedure has been followed but not performed correctly

The chart below shows that the majority of human errors relate to lapses in concentration. This accounts for 35.6% (245/689) of the total number of human error reports received.

The next largest category shows that errors have occurred when procedural steps have been omitted, or the correct procedure was not followed at all. Approximately two thirds of all SAEs could have been prevented had the correct procedures been followed accurately.

Report details show that these errors can occur when the workload is at normal levels as well as at busy times. When addressing CAPA for these incidents, it is important for managers to focus on the reasons why trained, competent members of staff make these avoidable errors.

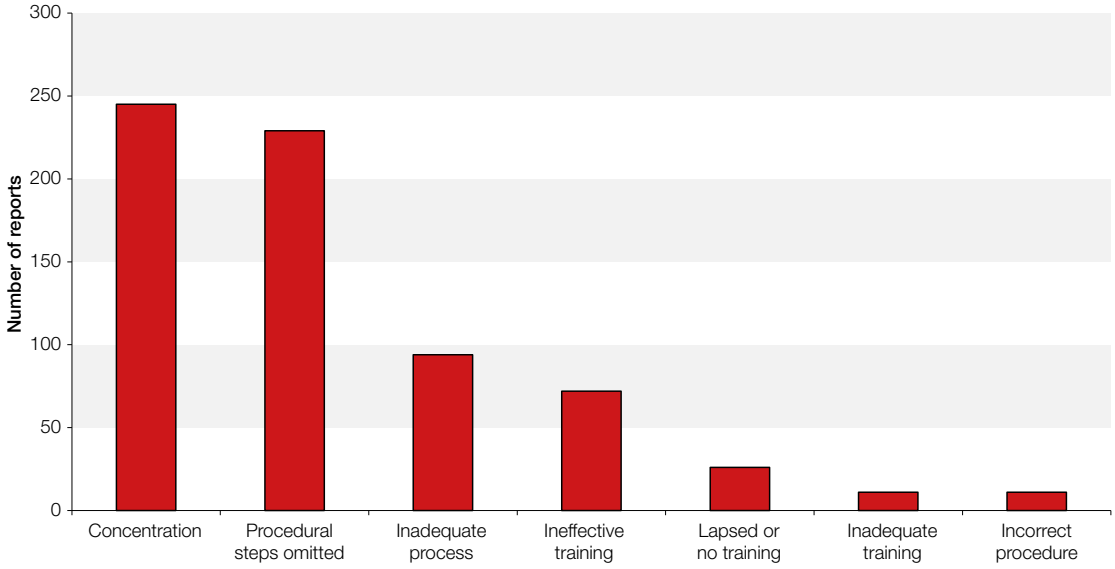


Figure 6.4: SABRE human error sub-categories, 2013

Corrective measures

Whilst local managers may propose any CAPA system to address SAEs and their contributing factors, care must be taken not to introduce too many additional changes into existing processes. Such additional tasks may be complicated, time-consuming or resource-rich, and may either fail to address the main root cause, or may introduce additional risks of errors occuring. This is particularly important as there can often be a temptation to build in secondary checks to help reduce errors. Whilst these may prevent any knock-on effects arising from an error, they will not address the cause of the initial error. Secondary checks may also stretch existing resources by lengthening processes and putting additional time pressures on staff. Indeed the involvement of another member of staff in a secondary checking process may itself be a distraction and could lead to another instance of lost concentration and a further error.

Formal re-training is often proposed as a corrective measure. This is usually only appropriate if the individual member of staff did not understand their initial training. If a trained competent member of staff has made an error it is unlikely that the root cause will be addresssed by re-training. The incident investigator should look for other reasons for the error and take measures to address all of the causes. For example, if a member of staff makes an error through a loss of concentration when rushing, investigate the reasons for that member of staff rushing. There could be a combination of factors involved relating to a member of staff working too quickly, a busy workload due to an emergency, a busy workload due to poor planning, or staff shortages due to lack of resources or poor staff management. Each of these and other causes will need to be specifically addressed.

The MHRA's key recommendations proposing corrective measures are:

- one-off and infrequent errors by individuals could be addressed through discussion and reflective statements
- infrequent errors by a small number of staff members could further be addressed by sharing learning points with the team
- frequent errors by individuals could be further addressed by additional training
- frequent errors could indicate a weakness in the QMS that may require improved processes, procedures and training material

The MHRA also recommends that local managers try to avoid CAPA that:

- demand re-writing of procedures as this can lead to an unnecessary training and the burden of re-validation
- complicate procedures with extra checking steps that do not address the root cause
- involve re-training of staff who do already know what the correct procedure is

Trend analysis

Trend analysis will help identify common error trends. A high frequency of particular error types may be indicative of underlying problems with the overall quality system, i.e. with a process, with particular equipment and/or with training arrangements.

A good QMS should incorporate**:**

- **Involvement of staff** - Staff are more likely to buy into the QMS if they have an appreciation of what it is and are included in its development
- **Well-designed work environment** - Suitable equipment and resource is available in a purpose-made or appropriately adapted location
- **Logical work flows and processes based on capacity planning** - Many incidents are the result of an individual member of staff rushing or being distracted by dealing with too many processes at the same time. Staff should be encouraged to work safely with sufficient resource and at a suitable pace. On occasion it may be appropriate simply to advise staff to slow down to ensure accuracy
- **Robust procedures (accessible, consistent, controlled)** - Procedures should also cover what to do if things go wrong. Many incidents are the result of staff improvising when something unexpected occurs
- **Good quality training and education, based on the principles of good practice** - No member of staff should complete a task without first being trained to do it. The quality of the training and competency-assessment is vital. This also applies to the education of staff in good manufacturing process (GMP). Staff often learn from their own and others' mistakes. Not only should the errors that occur and their consequences be highlighted to staff, but also the root causes. A member of staff is more likely to avoid repeating a colleague's error if they are aware of how and why that error first occurred
- **Incident reporting and trend analysis** - Work with the staff involved and encourage open and honest discussions to allow learning points to be developed leading to continuous improvement

Serious adverse reactions

Definitions

From the Blood Safety & Quality Regulations [17]

'an unintended response in a donor or in a patient that is associated with the collection, or transfusion of blood or blood components that is fatal, life-threatening, disabling or incapacitating, or which results in or prolongs hospitalisation or morbidity' 'blood establishments and the person responsible for the management of a hospital transfusion laboratory (blood bank) shall notify the Secretary of State (Competent Authority) of any serious adverse reactions observed during or after transfusion which may be attributable to the quality or safety of blood or blood components –

(i) Collected, tested, processed, stored or distributed by the Blood Establishment, or

(ii) Issued for transfusion by the hospital transfusion laboratory (blood bank)'

The European Commission DIRECTIVE 2005/61/EC of 30th September 2005 implementing Directive 2002/98/EC of the European Parliament and of the Council as regards traceability requirements and notification of serious adverse reactions and events states that:

Member States shall submit to the Commission an annual report, by 30 June of the following year, on the notification of serious adverse reactions and events received by the competent authority using the formats in Part D of Annex II and Part C of Annex III.

These schedules include the need to report the following imputability levels:

Not assessable (NA), 0, 1, 2 and 3.

Blood products

Adverse reactions involving blood products (i.e. licensed medicines such as Anti-D immunoglobulin, Octaplas®, or coagulation factor concentrates) should be reported to the MHRA via the Yellow Card scheme (http://yellowcard.mhra.gov.uk). Acute transfusion reactions to Octaplas® and errors associated with anti-D immunoglobulin should also be reported to SHOT.

Summary of SAR report data (Table 6.8)

The largest group of reports, 120 out of the total of 343, concern 'anaphylaxis/hypersensitivity' type reactions.

A total of 135 reports were submitted under the 'other' reaction type category. However only 51 of these were found to be 'probably' or 'certainly' attributable to the component transfused – i.e. Imputability levels 2 and 3.

Only one SAR confirmed in 2013 concerned a patient death that was specified as Imputability level 3, i.e. the reaction was 'certainly' attributable to the transfusion. The patient had post-transfusion purpura (PTP) confirmed by the presence of HPA-1a (see also Chapter 18, Post-Transfusion Purpura (PTP)).

MHRA haemovigilance activity in 2013

Type of meeting	Number
Competent Authority/EU working groups	2
Blood Consultative Committee meetings	2
National Transfusion Committee meetings	2
Regional Transfusion Committee meetings	5
British Blood Transfusion Society (BBTS)/ National External Quality Assessment Service (NEQAS) presentations	2
Informal site visits	12

Table 6.7: Haemovigilance team activities 2013

Issues referred by haemovigilance team to MHRA inspectors

The MHRA haemovigilance team has a responsibility to check every report submitted via SABRE for quality, timeliness and accuracy. Alongside this the MHRA operates a telephone helpdesk providing reporters with appropriate help, advice and education wherever possible.

On occasion the MHRA haemovigilance team will refer reports to the MHRA inspectors for advice or for their information. The inspectors review those reports and decide if any further action is required.

Referred cases will include:

1. Major failures in the total quality management (TQM) system
2. Reports of deaths associated with transfusion, where the imputability level is 2 or 3
3. Reports showing repeated failures in one aspect of the TQM

In 2013 the total number of referred reports was 173/1282, representing 13.5% reports received.

Table 6.8: SARs 2013 and imputability (The totals in table 6.8 include those not assessable or imputability 0)

Table 6.8: SARs 2013 and imputability

Type of reaction	Totals	Imputability Level 1 (possible)	Imputability Level 2 (probable)	Imputability Level 3 (certain)
Immunological haemolysis due to ABO incompatibility				
Red cells	**4**	0	0	**4**
Platelets	**1**	0	0	**1**
Immunological haemolysis due to other alloantibody				
Red cells	**30**	5	13	**9**
Non-immunological haemolysis				
Red cells	**2**	1	0	**0**
Transfusion-transmitted bacterial infection				
Red cells	**15**	3	0	**0**
Platelets	**4**	0	0	**0**
Plasma	**0**	0	0	**0**
Other (granulocytes)	**1**	0	0	**0**
Anaphylaxis/ hypersensitivity				
Red cells	**58**	24	27	**5**
Platelets	**38**	8	17	**11**
Plasma	**21**	7	7	**6**
Other	**3**	2	1	**0**
Transfusion-related acute lung injury				
Red cells	**12**	1	4	**1**
Platelets	**1**	0	0	**0**
Plasma	**3**	1	0	**0**
Other	**5**	2	1	**0**
Transfusion-transmitted viral infection (HBV)				
Red cells	**1**	0	0	**0**
Platelets	**0**	0	0	**0**
Plasma	**0**	0	0	**0**
Other	**2**	1	0	**0**
Post-transfusion purpura (PTP)				
Red cells	**3**	0	0	**1**
Platelets	**2**	0	0	**1**
Other	**2**	0	1	**1**
Deaths	1	0	0	**1**
Other				
Red cells	**107**	51	31	**11**
Platelets	**9**	8	0	**0**
Plasma	**4**	2	1	**1**
Other	**15**	6	6	**1**
Grand totals	**343**	**122**	**109**	**53**

(the complete table including imputability 'not assessable' or 'unlikely' may be viewed in the Annual SHOT Report 2013 Supplement, located on the SHOT website, www.shotuk.org under SHOT Annual Reports and Summaries, Report, Summary and Supplement 2013). (Reporters are reminded that these imputability levels are still a reporting requirement for MHRA).

MHRA inspection activity 2013

Following review of information provided on submitted blood compliance reports (BCR) 49 sites were selected for inspection. No control sites were chosen as the assessment process for information provided to the MHRA via the BCR had not changed from the previous year.

The number of major and minor deficiencies was comparable with the previous year.

Significant errors identified

Hospital and laboratory information technology (IT) systems (see also Chapter 10 Summary of Errors Related to Information Technology (IT)).

The main issue with patient administration systems (PAS) is that hospitals do not have secure systems in place, for example to ensure that access is restricted to appropriately trained individuals, and as the laboratories tend to use the hospital number generated from the PAS as a key identifier, if it is wrong in PAS then the patient can be misidentified at the laboratory level.

Other common IT errors include:

1. Data quality issues – merging errors and quality control of data entry and transfer between systems
2. Level of availability of technical support/knowledge
3. User requirements – not always met
4. Contingency and failure – business continuity planning

Although these errors are still prevalent the situation has improved compared with data collected in 2012.

Non-conformances

Some deviation management systems were found to be overly simplistic. This has led to a failure to provide staff with adequate guidance. These systems included SOPs that were lacking in detail and CAPA reporting methods that lacked detail about why the error had happened.

Data showed that there was an increase in the use of hospital local risk management systems for error reporting. These are not quality based and because of their broader focus do not meet the detailed requirements of the transfusion laboratory. Specifically, there is a lack of relevant record of investigation data, evidence and/or feedback for reporters.

Inspections also identified weak root cause analysis systems that did not fully identify the true root cause and therefore failed to identify appropriate corrective and preventative action.

There was also a lack of triage of incidents to determine the criticality of errors. This is important with respect to potential recalls as if components are not recalled in an appropriate time-frame the chance of them being transfused is increased. If these errors were triaged and categorised as ‘critical/major’ they are likely to be acted upon immediately.

In addition to this there is also evidence of a lack of formal feedback links between the laboratory and incident reporters in clinical areas. This feedback should include:

1. A description of the root cause of the error and why it happened
2. The corrective and preventative measures imposed
3. Evidence of implementation of these measures so that the error does not occur again

Quality management systems (QMS)

Many laboratories and Blood Establishments treat their QMS as the sole responsibility of the Quality and Transfusion Managers, i.e. treated as something the rest of the personnel do not get involved in. Sites need to invest more time in training and, by involving staff at all levels, instilling an understanding that quality systems are everybody’s responsibility.

Insufficient time is devoted to maintaining and developing the QMS. SOPs were found to be out of date and/or did not reflect current practice. Insufficient evidence for the validation of new methods and/or automation was a common finding. Dedicating more time to treating quality management as an essential element of laboratory function would avoid these issues.

Change control deficiencies

Change control remains sporadic, with systems observed that only authorise but not initiate the change.

This lack of appropriate change control systems has led to a lack of pre-'go live' authorisation and/or post-implementation review. In addition, change control requests are not always raised when significant changes take place.

Laboratory discrepancies

Dispensed and/or prepared reagents do not always have the appropriate labelling or storage conditions marked on the containers. Specifically, records do not show when containers were opened or how they were stored.

Investigation of analyser quality control (QC) failure was in some cases inadequate. Little attention was given to establishing why the QC had failed before process re-runs were initiated. Documentation was found to be weak in that where the failure happened, why it happened, what the corrective action was, is not always evidenced.

It was apparent that some staff are still not following appropriate set procedures.

These procedures include:

1. Continuous training
2. Resource management
3. SOPs
4. Any combination of the above

Storage errors

A common finding was the poor housekeeping of storage devices, e.g. icing of freezers or dirty storage units. Temperature mapping and monitoring also seemed to be problematic, with monitoring devices not being calibrated or mapped correctly. Refrigerator mapping records were also found to be out of date.

Training

Weaknesses in training were apparent where a lack of directed training to key quality systems for 'out-of-hours' staff was a common finding. This was coupled with many training records being incomplete. Evidence showed that staff were not being trained/updated following significant changes. It was being left as the responsibility of the member of staff to act on this, rather than having a system that ensured the training had been completed appropriately.

Blood compliance reports (BCR)

BCRs seem to be completed in the most optimistic light, sometimes to the extent where the BCR is not a true reflection of the location's compliance status. Statements have been made on the BCR, e.g. the percentage of staff trained, for which evidence could not found at the time of the inspection.

Post-inspection actions

Post-inspection actions have not always been completed in the agreed timeframes and the inspectors have not always been made aware of a transgression as soon as it was known by the site.

On repeat inspections sites failed to demonstrate compliance to the agreed remedial plan either in respect to the agreed timeline or the action itself. Evidence of commitments not being completed is periodically observed and the sites are reminded of the requirement not to provide false and misleading information. The Regulations are clear in that sites are to ensure that adequate resource, oversight and

priority is given to these commitments, in order to ensure that they are completed in a timely manner. In a number of cases this failure has led to the direct involvement of local Chief Executive Officers and an escalation within the MHRA.

Learning points from inspections

- Define and review all system processes regularly to ensure that they are fit for purpose
- Improve root cause analysis procedures and applications ensuring that the whole process is looked at and areas of weakness identified (including internal and external quality control (QC)) so that appropriate safeguards and corrective measures can be introduced
- Validate and perform regular audits on patient administration systems (PAS) and laboratory information management systems (LIMS) to avoid error
- Critically review all incidents so the severity of risk can be appropriately categorised and assessed and so that corrective and preventative actions can be introduced in an appropriate timeframe
- Improve and validate the quality management system (QMS) ensuring that all staff at all levels are aware of it and so that the appropriate 'buy in' from those staff can be achieved. In addition allocate time for regular reviews of the whole total quality management (TQM) system so that appropriate updates and improvements can be made
- Devise and adhere to an effective audit calendar
- Monitor system performance so that failures due to resource issues can be raised to the appropriate level
- Raise change controls in an effective and timely manner to ensure that process changes have an appropriate level of validation data
- Introduce measures that ensure effective laboratory housekeeping is undertaken and maintained. This applies particularly to reagent stock control and to the care and maintenance of storage devices
- Design and implement an achievable and effective training plan for all routine and 'out of hours' staff, and ensure that this includes the QMS
- Blood compliance reports must be completed as accurately as possible

Issues regarding implementation and execution of guidelines, such as problems with the recently introduced British Committee for Standards in Haematology (BCSH) 'group check sample' guideline [19], must be raised through the MHRA's Blood Consultative Committee (BCC). This will allow the inspectors to consider the issue and supply an appropriate response.

For further information on the **MHRA and the Regulation of Blood** please refer to the MHRA website:
http://www.mhra.gov.uk/Howweregulate/Blood/BloodConsultativeCommittee/index.htm
http://www.mhra.gov.uk/Howweregulate/Blood/index.htm

7 Near Miss Reporting (NM)

Author: Alison Watt

Definition:

A 'near miss' event refers to any error which if undetected, could result in the determination of a wrong blood group or transfusion of an incorrect component, but was recognised before the transfusion took place.

DATA SUMMARY Total number of cases: n=996							
Implicated components				**Mortality/morbidity**			
Red cells			0	Deaths definitely due to transfusion			0
Fresh frozen plasma (FFP)			0	Deaths probably/likely due to transfusion			0
Platelets			0	Deaths possibly due to transfusion			0
Cryoprecipitate			0	Major morbidity			0
Granulocytes			0	Potential for major morbidity (Anti-D or K only)			0
Anti-D Ig			0				
Multiple components			0				
Unknown			996				
Gender		**Age**		**Emergency vs. routine and core hours vs. out of core hours**		**Location of near miss event**	
Male	365	≥18 years	858	Emergency	0	Emergency Department	96
Female	579	16 years to <18 years	3	Urgent	0	Theatre	14
Not known	52	1 year to <16 years	21	Routine	0	ITU/NNU/HDU/Recovery	20
		>28 days to <1 year	11	Not known	996	Wards	403
		Birth to ≤28 days	42			Delivery Ward	0
		Not known	61	In core hours	568	Postnatal	0
				Out of core hours	143	Medical Assessment Unit	17
				Not known/Not applicable	285	Community	2
						Outpatient/day unit	37
						Hospice	1
						Antenatal Clinic	37
						Hospital Transfusion Laboratory	190
						Obstetrics	75
						Other/Unknown	104

(ITU=Intensive therapy unit; NNU=Neonatal unit; HDU=High dependency unit)

Near misses n=996

The total of 996 near misses in 2013 is similar to the total of 980 reported in 2012. However, there is a continuing large increase in reports of 'wrong blood in tube' incidents (WBIT), which have risen to 64.6% (643/996) of all near misses in 2013 from 41.9% (386/921) in 2010 (Figure 7.1). There has been a corresponding marked reduction in reports of near miss incidents other than WBIT. It is not known whether this is a true reduction of incidents, or a disinclination to report near miss incidents, other than the most serious WBIT cases. Continued reporting of near misses is strongly encouraged, as important lessons can be learnt from such errors.

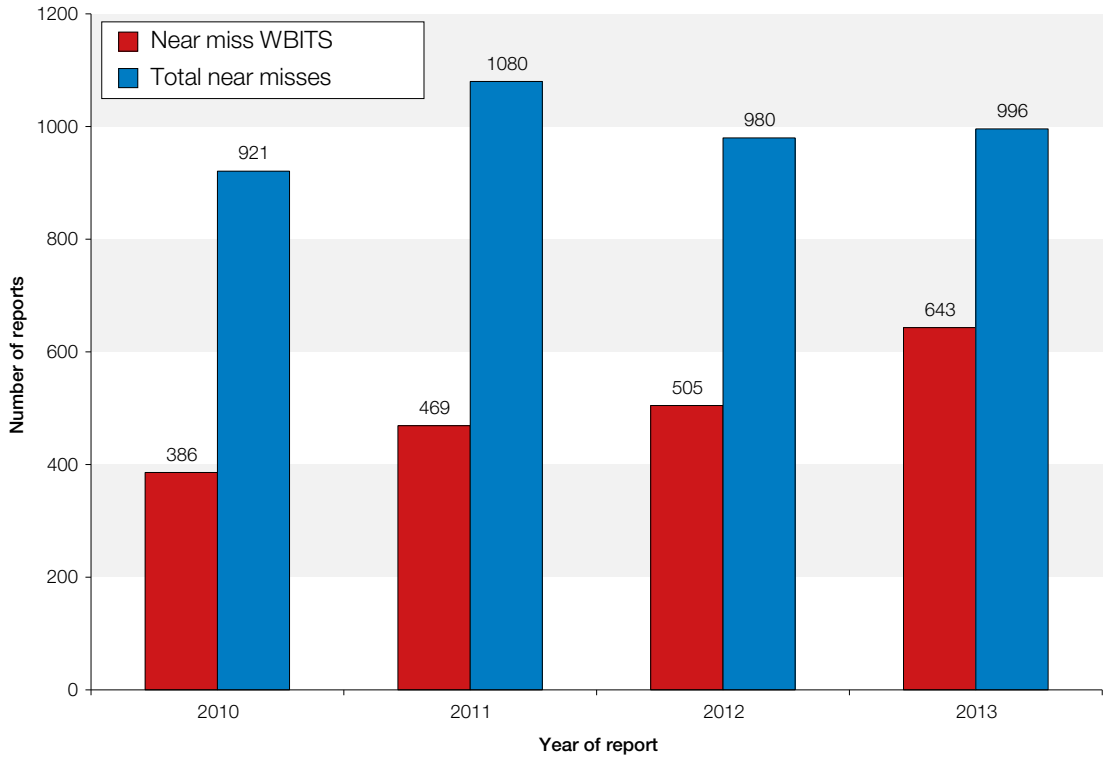


Figure 7.1: Increasing reports of near miss 'wrong blood in tube' cases compared to total near misses

Despite the increasing reports of WBIT incidents, it is likely that WBITs are still under-reported. A survey of the North East region of England in 2012 [20] showed 48 WBITs from a population of 2.6 million. The authors extrapolated that if figures are representative of the whole of the United Kingdom (UK), then over 1160 WBITs will occur each year nationwide.

Discussion of near miss errors in other chapters

In order to highlight the importance of continuing to report and learn from near miss incidents, discussions of these cases are incorporated into each relevant chapter according to the likely outcome if the near misses had progressed to full incidents and components had actually been transfused.

Categorisation of all near misses according to SHOT definitions		Discussed in	Number of cases	Percentage of cases
Incorrect blood component transfused (IBCT)	Wrong component transfused (WCT)	Chapter 8	715	71.8%
	Specific requirements not met (SRNM)	Chapter 8	72	7.2%
Right blood right patient (RBRP)		Chapter 12	97	9.8%
Handling and storage errors (HSE)		Chapter 13	62	6.2%
Anti-D immunoglobulin errors (Anti-D Ig)		Chapter 14	35	3.5%
Avoidable, delayed or undertransfusion (ADU)		Chapter 11	15	1.5%
Total			**996**	**100%**

Table 7.1: Categorisation of all near misses according to SHOT definitions

Importance of quality management systems

Good quality management systems (QMS) can detect many near miss incidents before the transfusion takes place, so a robust QMS is essential. The British Committee for Standards in Haematology (BCSH) guidelines for pre-transfusion compatibility procedures [19] state 'the transfusion laboratory must have an operational and documented Quality Management System, clearly defining the organisational structure, procedures, processes and resources necessary to meet the requirements of its users, to accepted standards of good practice.' The BCSH guidelines also include a key recommendation that 'the laboratory must identify all critical control points in pre-transfusion testing and build in security at these points.' The National Health Service (NHS) Operational Impact Group produced a specification

for a hospital transfusion laboratory QMS, which can be found in the Regulations and Implementation section of the JPAC website:
http://www.transfusionguidelines.org.uk/regulations/toolkit/mhra-process/qms-specification.

Learning point

- Quality management system (QMS) procedures should be robust and strict adherence should be promoted to ensure there is every opportunity to detect a potentially serious hazard before the transfusion actually takes place

Analysis of SHOT near miss cases shows that an error is often detected by accident, rather than by the QMS.

Case 1: Patient realises blood was not irradiated

The consultant haematologist had discussed the need for irradiated blood with the team caring for the patient and the patient himself. Non-irradiated blood was erroneously prescribed by the team and was collected for transfusion. The blood was not given, because the patient reminded staff that he needed irradiated blood.

Table 7.2: Near miss detected by quality management system or by accident (good luck)

Near miss detection	Number of cases	Percentage of cases
Error detected by quality management system (QMS)	253	25.4%
Detected by QMS, but good luck that ABO/RhD group differed	415	41.7%
Accidental detection, QMS would not have detected the error	321	32.2%
Unknown	7	0.7%
Total	**996**	**100%**

Further analysis of total near miss errors n=996

Table 7.3: Numbers of near misses originating in clinical or laboratory areas

Category of incidents	Number of cases	Percentage of cases
Clinical errors	742	74.5%
Laboratory errors	251	25.2%
Blood Establishment errors	3	0.3%
Total	**996**	**100%**

Tables showing the sub-categorisation of near miss errors consistent with those in previous SHOT Reports (2010-2012 [3, 21, 22]) 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.

COMMENTARY

The importance of following all QMS procedures is demonstrated, because over a quarter of near miss incidents (253/996, 25.4%) were detected purely by the QMS. These quality processes were also involved in revealing when grouping anomalies were detectable in WBIT samples (415/996, 41.7% of all near misses and 415/643, 64.5% of all WBIT incidents).

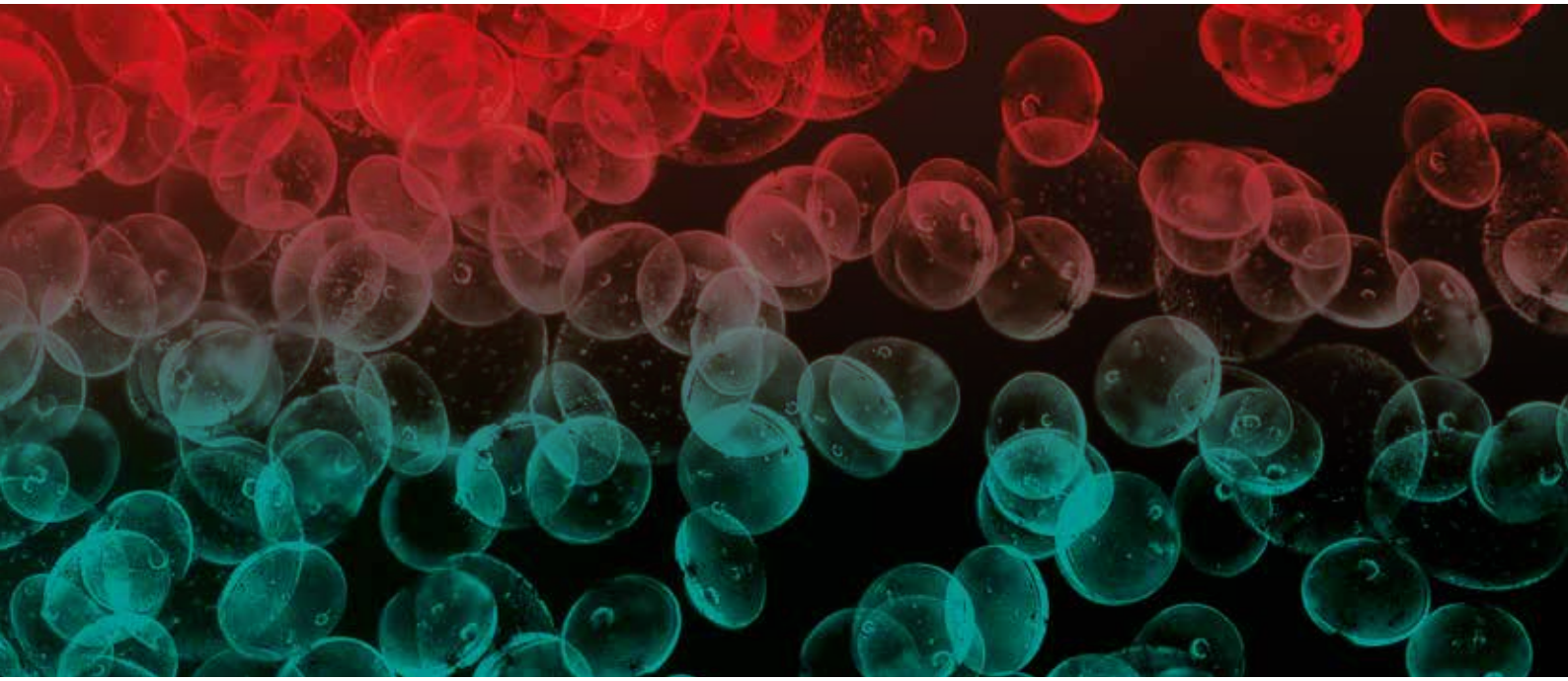
It could be said that luck played a part in a total of 736 cases, which were either detected by accident (321/996, 32.2%) or were WBIT samples detected only because of a different ABO or RhD group on a previous or subsequent sample (415/996, 41.7%). Testing for ABO and RhD on every sample and, where known, comparing it to a historical group should always part of an effective QMS. However, these WBIT incidents could not have been detected if there had never been a historical or subsequent sample to show a differing group or if the patients involved happened to be of the same group. Further discussion on WBIT incidents is in Chapter 8, Incorrect Blood Component Transfused (IBCT).

A near miss is defined as an error which was recognised before the transfusion took place, but it can be difficult to define exactly the point at which a transfusion has started. SHOT has used the International Society of Blood Transfusion (ISBT) definition, which considers transfusion to have started when the unit is spiked. That means a few cases in this and previous Annual SHOT Reports are categorised as full rather than near miss incidents, even though the reporters are quite clear that no part of the component was given to the patient. Following a discussion at the SHOT Working Expert Group in February 2014, it was decided that in future such cases should be categorised according to how the unit was fated. Therefore, from 2014 incidents will be categorised as near miss if the spiked unit is fated as wasted, rather than transfused (see also further discussion in Chapter 8, Incorrect Blood Component Transfused (IBCT)).

Recommendations

No new recommendations for this year

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.



Analysis of Cases Due to Errors

8 Incorrect Blood Component Transfused (IBCT) (clinical and laboratory errors)

Authors: Julie Ball, Hema Mistry, Christine Gallagher and Paula Bolton-Maggs

The category of incorrect blood component transfused is divided into instances where a wrong component is transfused (WCT) and those where the specific requirements are not met (SRNM).

Definitions:

Wrong component transfused (WCT):
Where a patient was transfused with a blood component of an incorrect blood group, or which was intended for another patient and was incompatible with the recipient, which was intended for another recipient but happened to be compatible with the recipient, or which was other than that prescribed e.g. platelets instead of red cells.

Specific requirements not met (SRNM):
Where a patient was transfused with a blood component that did not meet their specific transfusion requirements, for example irradiated components, human leucocyte antigen (HLA)-matched platelets when indicated; antigen-negative red cell units for a patient with known antibodies, red cells of extended phenotype for a patient with a specific clinical condition (e.g. haemoglobinopathy), or component with a neonatal specification where indicated. (This does not include cases where a clinical decision was taken to knowingly transfuse components not meeting the specification in view of clinical urgency).

DATA SUMMARY
Total number of cases: n=247

Implicated components		Mortality/morbidity	
Red cells	185	Deaths definitely due to transfusion	0
Fresh frozen plasma (FFP)	19	Deaths probably/likely due to transfusion	0
Platelets	20	Deaths possibly due to transfusion	1
Cryoprecipitate	0	Major morbidity	6
Granulocytes	0	Potential for major morbidity (Anti-D or K only)	1
Anti-D Ig	0		
Multiple components	8		
Unknown	15		

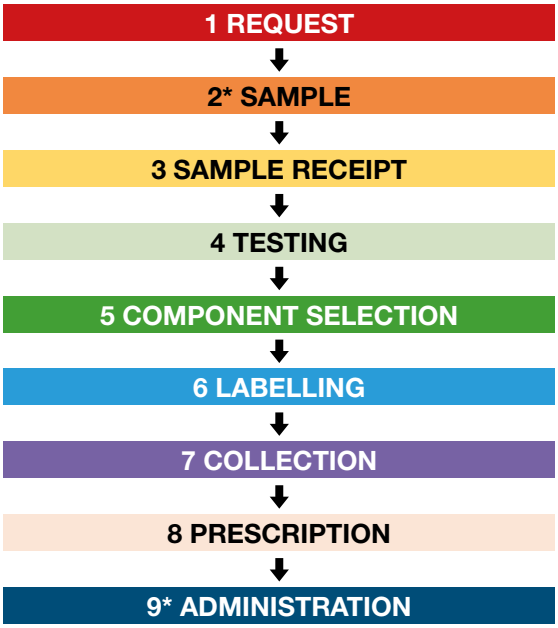
Gender		Age		Emergency vs. routine and core hours vs. out of core hours		Where transfusion took place	
Male	120	≥18 years	213	Emergency	32	Emergency Department	9
Female	125	16 years to <18 years	5	Urgent	51	Theatre	18
Not known	2	1 year to <16 years	11	Routine	132	ITU/NNU/HDU/Recovery	28
		>28 days to <1 year	3	Not known	32	Wards	137
		Birth to ≤28 days	11			Delivery Ward	11
		Not known	4	In core hours	135	Postnatal	0
				Out of core hours	35	Medical Assessment Unit	10
				Not known/Not applicable	77	Community	1
						Outpatient/day unit	19
						Hospice	0
						Antenatal Clinic	1
						Other	0
						Unknown	13

(ITU=Intensive therapy unit; NNU=Neonatal unit; HDU=High dependency unit)

This definition includes the following errors in the transfusion process:

- Phlebotomy errors leading to 'wrong blood in tube' (none reported in 2013)
- Laboratory procedural and testing errors
- Component collection and bedside administration errors
- Transfusion of components which did not meet the patient's specific requirement

Transfusion is a multidisciplinary activity with both the clinical and laboratory staff working in partnership as one integrated team. Each case that led to an incorrect blood component being transfused has been reviewed to find the steps where the error(s) could have been identified, Figure 8.1. These essential steps are clearly defined [23, 24] and should be followed using a checklist as previously recommended [21]. Each participant in the transfusion process is responsible for carrying out his/her own roles and ensuring that necessary checks are not overlooked and/or that no procedures are omitted.



** Critical points where positive patient identification is essential*

Figure 8.1: Steps in the transfusion process

The definitions of the steps in the transfusion process can be found in the British Committee for Standards in Haematology (BCSH) Guideline on Administration of Blood Components [23]. A complete summary and classification of all laboratory incidents is found in Chapter 9 Summary of Events Originating in the Hospital Transfusion Laboratory.

Overview

There were 247 reports where patients received an incorrect blood component (Table 8.1a, 57 reports where a wrong component was transfused and Table 8.1b, 190 reports where the patient's specific requirements were not met).

Patient ages ranged from birth to 95 years (median 54 years). Thirty cases were reported in children, 6 ABO/RhD errors in transplant cases, and 37 SRNM transplant-related cases. These are discussed in Chapter 25 Paediatric Cases, and Chapter 27 Summary of Incidents Related to Transplant Cases.

Table 8: An overview of incorrect blood components transfused n=247

Table 8.1a: Wrong component transfused n=57

Outcome	No. of reports	Blood component
ABO incompatible	**12***	
	9	Red blood cells (RBC)
	3	FFP
ABO non-identical	**7**	
	4	RBC
	2	Platelets
	1	FFP
RhD mismatch	**8****	
	6	RBC
	2	Platelets
Wrong component type	**17**	
	3	Cryoprecipitate
	5	RBC
	2	FFP
	7	Platelets
ABO identical	**8**	
	7	RBC
	1	FFP
Spiked prior to pre-administration checks (will be classified as 'near miss' in future)	**5**	
	4	RBC
	1	Platelets
Total wrong components transfused	**57**	

**3 ABO incompatible transfusions related to transplant cases, (2 HSCT patients and 1 liver transplant patient)*

***3 cases RhD mismatched blood components transfused to HSCT patients*

Table 8.1b: Specific requirements not met n=190

Location of error	No. of reports
Clinical	134
Laboratory	56
Total specific requirements not met	**190**

Please see Table 8.6 for a full breakdown of specific requirements not met

Deaths n=1

An ABO incompatible red cell transfusion which occurred as a result of an administration error may have contributed to the death of an already very sick patient.

Case 1: ABO incompatible transfusion which may have contributed to death

Two patients with the same surname were in adjacent beds. Blood was correctly collected for Patient M and taken to the ward. The blood intended for Patient M (patient group AB RhD negative) was checked at the nurses' station but was transfused to Patient J (patient group O RhD positive). The error was detected after infusion of 35mL and the transfusion was stopped. Patient J was already very unwell pre transfusion but deteriorated quickly with an unrecordable blood pressure, chest pain, a deteriorating conscious level and also stopped passing urine. The recipient's subsequent blood samples all showed evidence of frank haemolysis. The patient already had advanced heart failure and renal failure but died 3.5 hours after transfusion.

Learning point

- Pre-administration transfusion checks must be undertaken at the bedside. This is the final opportunity to detect a wrong transfusion. The essential steps are outlined in the British Committee for Standards in Haematology (BCSH) guideline for the administration of blood components [23] and the Handbook of Transfusion Medicine [24]

Major morbidity n=6

Three cases of ABO incompatible red cell transfusions (2 clinical, 1 laboratory error) led to haemolysis necessitating admission to the HDU, and 3 other laboratory errors resulted in K-sensitisation in women of childbearing potential.

Case 2: Collection slip error leads to a patient being transfused ABO incompatible blood labelled for a different patient

A patient was transfused blood which had been crossmatched and labelled for another patient. The error was noticed only when a second unit of blood was delivered to the ward (so missed on the first occasion at the final bedside check). The patient's blood group was O RhD positive and the red cell unit was A RhD positive. The staff nurse had put incorrect patient details on the collection slip. Staff failed to notice that the wrong unit had been collected. The patient developed jaundice and other evidence of intravascular haemolysis requiring admission to the HDU.

Learning point

- Any blood component that is delivered to the clinical area must be checked and received by a 'trained and competent member of staff' [25]

Case 3: ABO incompatible transfusion despite a robust system of warning alerts on the laboratory information management system (LIMS)

An ABO incompatible red cell unit was transfused resulting in a haemolytic transfusion reaction. The blood was issued using an emergency protocol on the LIMS, which was not appropriate for the non-urgent clinical situation, and the computer warning flag stating that the units were incompatible was overridden several times by the biomedical scientist (BMS). This incompatibility was not noted at the bedside and when the patient reacted to the transfusion, the doctor who was consulted advised that the transfusion should continue without reviewing the patient. The patient developed acute and delayed haemolysis, but no long-term sequelae.

Learning points

- Warning flags should not be overridden or ignored without laboratory staff understanding the significance of this action and the potential for harm. Use of automation and information technology (IT) can increase the security of component selection and testing but only if the displayed warning flags are heeded and acted on appropriately. If warning flags are overridden, which they may need to be in a clinical emergency, a positive response as to why they are being overridden must be entered. It should not be possible to simply 'escape' past a warning flag
- Continuation of a transfusion and clinical advice about transfusion reactions should not be given without reviewing the patient
- The laboratory information management system (LIMS) should be used as much as possible to help prevent mistakes by laboratory staff. There are many rules to remember during component selection so that a timely prompt based on, for example, the age and/or sex of a patient can be very helpful
- The Handbook of Transfusion Medicine states: p10: 'Robust identification procedures outside the laboratory at collection of blood from the hospital transfusion laboratory and administration of blood at the bedside are vital' [24]

ABO incompatible transfusions n=12

There were 9 ABO incompatible red cell transfusions and 3 incompatible FFP transfusions. In 5/12 there were clinical errors; 3/5 combined collection and administration errors and 1/5 an administration error alone. The final case in this group is discussed below (Case 4).

Case 4: Group O FFP issued on limited information available in an urgent situation

A 52 year old patient was transfused with emergency O RhD negative red cells (own group A RhD positive but not known until later) and also received group O FFP. Some emergency O RhD negative red cell units were transfused before a grouping sample was taken and sent to the laboratory. The group therefore appeared to be O by immediate spin technique because of the recently transfused group O blood. The laboratory was not informed that the sample was taken post transfusion nor that the patient had received emergency O RhD negative units. Two units of group O FFP were transfused. The true patient group was A RhD positive.

This shows the importance of communication between clinicians and laboratory staff in an emergency. There was no historical record available for the patient and laboratory staff issued FFP based on the misleading grouping result. The internal standard operating procedure (SOP) for use of group O blood in emergency situations did not stipulate what to do if the group was unclear, and also did not advise what group of FFP to give in an emergency (which should be AB or group A if AB is in short supply). It is essential to take a group and screen sample before transfusion, see learning points below.

In a further 7/12 reports, the error occurred in the transfusion laboratory. Three resulted in transfusion of an inappropriate ABO group to haematopoietic stem cell transplant and solid organ transplant patients (Chapter 27 Summary of Incidents Related to Transplant Cases). In the remaining 4/12 cases (non-transplant patients), 2 were due to errors in component selection (Case 3 described earlier) and 2 in testing. In 3 of 4 cases the error occurred over a weekend and involved staff who do not routinely work in blood transfusion. In 2 of 4 cases the error could have been detected during the final pre-administration checks.

Location of error	Error	Patient group	Unit group
Clinical	Collection & administration	O RhD positive	A RhD positive
Clinical	Collection & administration	O RhD positive	A RhD positive
Clinical	Collection & administration	B RhD positive	A RhD positive
Clinical	Collection & administration	O RhD positive	AB RhD negative
Laboratory	Component selection	O RhD positive	A RhD positive
Laboratory	Testing	A RhD positive	AB RhD positive

Table 8.2: ABO incompatible red cell transfusions 2013 n=9 (6 discussed here and 3 in Chapter 27 Summary of Incidents Related to Transplant Cases) (4 clinical, 5 laboratory errors)

Three additional laboratory cases (summarised below) are discussed in Chapter 27 - Summary of Incidents Related to Transplant Cases.

Transplant cases		Patient group	Donor group	Unit group
Laboratory	Component selection	B	O	B
Laboratory	Component selection	A	O	A
Laboratory	Component selection	A	O	A

**A group compatible with both patient and donor should be transfused, usually group O*

In two of the laboratory cases group O FFP was selected during an emergency, one for transfusion to a premature baby born at 29 weeks' gestation who was critically ill (group A RhD positive) and the second to an unknown male (group B RhD positive). In both cases no pre-transfusion sample was available. Group O FFP is only compatible for patients who are group O.

Good communication between clinicians and the laboratory is essential, particularly in an emergency.

Learning points

The following learning points have been extracted from the British Committee for Standards in Haematology (BCSH) Guidelines for pre-transfusion compatibility testing [19]

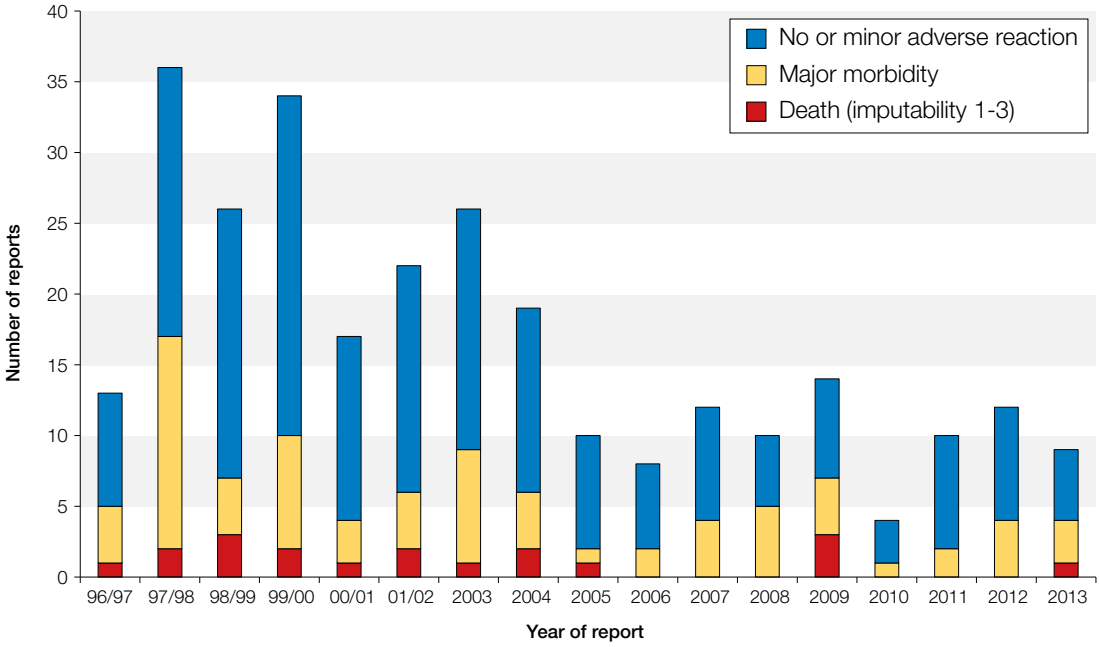
- Emergency groups performed MUST include a test against anti-A, anti-B and anti-D with appropriate controls or reverse group, if there is insufficient time for this level of testing then group O red cells must be issued
- In an emergency, or if the group is unclear, the safe group of fresh frozen plasma (FFP) to give is group AB or group A (because AB is often in short supply), but not group O. Group O FFP should be reserved for patients confirmed to be group O and is not suitable for use in the emergency setting where the blood group is unknown. Laboratory protocols for emergencies should clearly state this
- The ABO and RhD group should be verified against historical patient results
- If it is not possible to obtain a reliable reverse grouping result and there is no historical group against which to validate, the cell group must be repeated
- A second, group check sample should be sought and tested as soon as possible

ABO incompatible red cell transfusions are one of the most feared outcomes of errors in the transfusion process. Review of cumulative data from SHOT reports shows a reduction after 2004 but a relatively constant number since then (Figure 8.2). There were a total of 14 deaths in the years before 2005, but 5 in the following 9 years.

It is interesting that overall, 66.3% (187/282) of these transfusions had no, or very minor, adverse effects, although every ABO incompatible transfusion carries the risk of death or major morbidity. Death occurred in 6.7% (19/282) and major morbidity in 27.0% (76/282). ABO incompatible blood component transfusions are defined as 'never events' when causing death or severe harm which means that only a third (95/282, 33.7%) will be reportable to National Health Service (NHS) England. Only 2 such incidents are recorded in the National Reporting and Learning System (NRLS) for the period 1 April 2013 to 30 September 2013 (one case of group A to a group O patient, and one case of group A

given to a group B patient), and 2 incidents in 2012 (which do not quite match SHOT data). NHS England are planning to publish more detailed information on never events starting in April 2014 (see http://www.england.nhs.uk/ourwork/patientsafety/never-events/ne-data).

Figure 8.2: Most ABO incompatible transfusions are not associated with serious outcomes



Note: from 1998/99 to 2003 the SHOT reports do not specify whether the deaths and major morbidities were caused by red cells or other component types

All incidents resulting in death or severe harm should be reported to the NRLS who then report them to the Care Quality Commission (CQC), and most incidents are submitted to the NRLS electronically from local risk management systems. Recent data for England and Wales from the NRLS in 2012, show that most events were 'patient accidents' (347,172) accounting for about 25%, and the groups 'medication' (154,895) and 'treatment, procedure' (143,150) for about 10% each. (Total events 1,293,843). NRLS Quarterly Data workbook up to September 2012 (http://www.nrls.npsa.nhs.uk/resources/collections/quarterly-data-summaries/?entryid45=135212).

Potential for major morbidity n=1

Case 5: Inadequate bedside check leads to potential RhD sensitisation of a woman of childbearing potential and a near miss ABO incompatible transfusion in a second patient

Two units of red cells were delivered to the ward for 2 patients requiring transfusion; Patient X (A RhD negative) and Patient Y (O RhD positive). Nurse 1, caring for Patient X, asked Nurse 2 to check a unit of red cells with her. They both went to Patient X with the unit (labelled for Patient Y) and the case notes of Patient X. They asked the patient to state her name and date of birth. Nurse 2 checked the patient identification (ID) on the wristband but not on the compatibility label attached to the unit. Nurse 2 (as co-checker) took the unit of blood from Nurse 1 and checked the expiry date. Nurse 1 caring for Patient X then attached the bag of red cells for Patient Y to Patient X. The error was discovered by Nurse 3 during the bedside checks for Patient Y. This nurse realised that the wrong bag of blood had been attached to Patient X. The 2 nurses involved in the incident were up to date with their mandatory transfusion training but out of date with their competency-assessments (as were all the staff on this ward). The patient received 4500IU of anti-D immunoglobulin to cover this sensitising event.

There were two errors: only 1 component should be collected from the laboratory at one time, and there was failure to correctly identify the patient - at no point did either nurse check that the patient details (Y) on the attached compatibility label matched the identity details given by the patient or the wristband.

RhD mismatches n=8

In 2 cases patients were transfused RhD mismatched components due to errors in the clinical area. One is Case 5 above. In the second case, the result from a pre-admission clinic sample (O RhD negative) was discrepant with the historical record (O RhD positive, together with a record of a transfusion in 1999 with three O RhD positive red cell units). It was concluded that the 1999 sample was probably a 'wrong blood in tube' incident but the sample was grouped manually at that time without any duplicate testing therefore there can be no conclusive proof that the original was a 'wrong blood in tube'. The recent O RhD negative result was confirmed by a further sample from the patient.

In 3/8 the wrong RhD group was given to transplant patients, two due to failure to consult the patient's historical record at the time of sample receipt and registration and 1 due to component selection. In the remaining 3/8 cases (2 females of childbearing potential and 1 male) the patients received RhD mismatched red cells, 2 due to RhD grouping errors during testing and 1 due to a component selection error.

Wrong component type transfused n=17

In 17 cases an incorrect component type was requested, issued or administered to the patient. In 5 cases the error originated in the laboratory, but only 1 of 5 could reasonably have been expected to have been identified in the clinical area (the BMS issued FFP instead of cryoprecipitate). In 2 of 5 instances cryodepleted plasma was issued instead of cryoprecipitate, and in 1 of 5 an inappropriate component was selected for neonatal exchange transfusion. In the 5th instance the BMS failed to follow procedure and placed uncrossmatched O RhD negative blood in the issue refrigerator as a temporary measure due to the pressure of dealing with several emergencies. A porter then collected the uncrossmatched units thinking they were 'emergency O RhD negative units'.

Urgency	Required	Administered
Emergency	Platelets	FFP
Emergency	Platelets	FFP
Emergency	RBC paediatric emergency O RhD negative	RBC adult emergency O RhD negative
Emergency	Platelets	FFP
Emergency	RBC paediatric emergency O RhD negative	RBC adult emergency O RhD negative
Emergency	RBC for intrauterine transfusion	RBC paediatric O RhD negative
Urgent	Platelets	FFP
Routine	Platelets	RBC emergency O RhD negative
Routine	Platelets	RBC
Routine	Platelets	RBC
Routine	FFP	Platelets
Routine	FFP	Platelets

Table 8.3: Wrong component type transfused due to collection and administration errors n=12

In 12 cases a combination of collection and administration errors contributed to the incorrect component type being administered, confusion between platelets and FFP being the most common mistake. The component that was collected had not been prescribed in 7 of 12 cases. In 4 of 12 cases, the collector selected a component type other than the one intended and in 1 of 12 cases, a paediatric emergency red cell unit was collected and transfused when there was time to order and receive a unit specific for intrauterine transfusion.

Case 6: Lack of component knowledge leads to the incorrect component type being transfused

The patient was prescribed two units of platelets before surgery. Red cells were also reserved because he had irregular red cell antibodies. The staff gave two units of red cells thinking that the 'optimal additive solution' meant that the bag contained platelets. They tried to give each bag of red cells over 30 minutes as this is the time stated on the prescription for transfusion of platelets. The error was detected by a doctor when taking a blood sample to measure the platelet increment.

The two nurses did not recognise that incorrect component had been collected and transfused. This demonstrates inadequate training for transfusion practice.

Learning point

- All members of staff who participate in blood transfusion must know how to identify all the component types (illustrated in [26]) and know their individual storage requirements

Units spiked before pre-administration checks - wrong transfusion or near miss? n=5

There were 5 instances where a blood component was 'spiked' prior to the completion of pre-transfusion checks at the patient's side.

It can be difficult to define exactly the point at which a transfusion has started. SHOT has used the International Society of Blood Transfusion (ISBT) definition, which considers transfusion to have started when the unit is spiked. That means a few cases in this and previous Annual SHOT Reports are categorised as IBCT incidents, even though the reporters are quite clear that no part of the component was given to the patient. Following a discussion at the SHOT Working Expert Group in February 2014, it was decided that in future such cases should be categorised according to how the unit was fated. Therefore, from 2014 incidents will be categorised as near miss if the spiked unit is fated as wasted, rather than transfused.

These 5 cases would then be classified as 'near miss' rather than 'wrong component transfused'. This decision was made after the numbers of cases were collated for 2013 and so, for this report, remain in IBCT.

In 4/5 reports a collection error led to the wrong unit reaching the bedside. This was then compounded by failure to complete the pre-administration checks before 'spiking' the unit. In one case an ABO incompatible red cell transfusion would have occurred had the error not been detected just in time.

Case 7: A patient nearly receives an ABO incompatible transfusion

Staff on the day unit requested a unit of red cells for a patient attending the following day. The night porter collected the unit and delivered it to the ward. Two patients shared the same first name but all other identifiers were unique to each patient. The porter was distracted by the bleep during the collection and stated that the collection form was poorly printed and difficult to read. The error was missed when the red cell unit was received on the ward but the discrepancy was detected by the second checker at the bedside. The blood collected was group A RhD positive but the patient's group was O RhD positive. When the error was detected the giving set had already been inserted into the unit.

Learning point

- Components should not be 'spiked' until the patient is ready to receive the transfusion and the pre-administration checks have been completed at the patient's side

Near miss WCT cases n=715

Point in the process	Type of error made	Number of cases	Percentage of cases
Sample taking	Wrong blood in tube (WBIT)*	637	89.1%
Sample receipt	Entered to incorrect patient record	5	0.8%
	Incorrect patient administration system (PAS)/ LIMS merge	1	
Testing	Misinterpretation	5	2.2%
	Incomplete testing prior to issue	4	
	Manual group error	3	
	Transcription	3	
	Unknown ABO testing error	1	
Component selection	RhD+ issued to RhD- patient	3	1.0%
	Incorrect component type	2	
	Wrong ABO group selected	2	
Component labelling	Transposition labels between patients	7	1.4%
	Component mislabelled	3	
Collection	Collection incorrect unit	20	4.8%
	Wrong details on collection slip	7	
	Wrong units sent to ward	7	
Administration	Attempted admin wrong patient	4	0.6%
Other	IT bug in LIMS system	1	0.1%
Total		**715**	**100%**

Table 8.4: Near misses that could have led to incorrect blood component transfusions n=715

** 6 other WBIT incidents could have led to avoidable transfusions and are discussed in Chapter 11, Avoidable, Delayed or Undertransfusion (ADU)*

Wrong blood in tube near miss errors potentially leading to incorrect blood components transfused n=637 (6 near miss avoidable transfusions, total WBITS n=643)

Definition of wrong blood in tube incidents:

- Blood is taken from the wrong patient and is labelled with the intended patient's details
- Blood is taken from the intended patient, but labelled with another patient's details

If the transfusion process begins with a sample of the wrong patient's blood, there is no guarantee that the error will be detected, so there is a potential risk of an incorrect blood component transfusion. This includes the risk of death or severe harm as a result of an ABO incompatible red cell transfusion, which is a Department of Health 'never event' [27]. There has been an increase in the number of reported near miss WBIT incidents which are 64.6% (643/996) of all near misses in 2013 compared with 51.5% in 2012 (505/980) and 43.4% (469/1080) in 2011. It is likely this increase is due to a number of factors:

- A group check sample being taken more often, either as a result of compliance with the BCSH compatibility guidelines [19] or to enable electronic issue
- Increased awareness of both the danger of WBIT incidents and the requirement to report them to SHOT

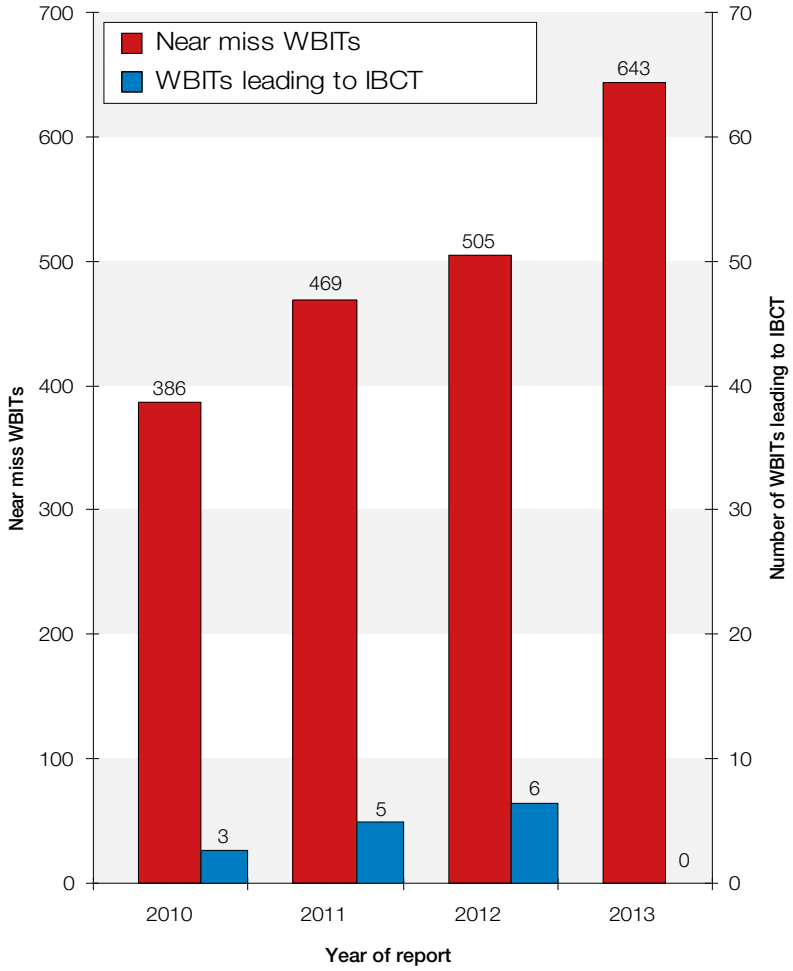
In 2013 there were no proven cases of WBIT (one possible, see RhD mismatch above) that actually resulted in an incorrect blood component being transfused, which is a change from previous years. Reports to SHOT between 2010 and 2012 indicated approximately one incorrect blood component transfused due to a WBIT error for every 100 near miss incidents. However, in 2013 there were 643 reported WBIT near misses, but no confirmed transfusions of an incorrect blood component (Figure 8.3). The 2012 BCSH pre-transfusion compatibility guidelines [19] recommend that a group check sample should be requested for confirmation of the ABO group of a first time patient, but a single year's data

are not sufficient to know if this important patient safety measure has been responsible for the absence of incorrect transfusions as a result of WBIT.

Case 8: Group check sample was also WBIT

Two samples were received on a first time patient in the emergency department. Both samples were taken by same person but at different times. Both grouped as A RhD negative. The patient was about to be listed for trauma surgery (fractured neck of femur), so a further sample was received from the ward, but this grouped as O RhD positive. It was suspected that the O RhD positive sample was wrong, as there had been two previous A RhD negative samples, but two further samples grouped as O RhD positive. Group checks on haematology and chemistry samples confirmed all original samples were WBIT. The patient was due to go to theatre in the morning, but was delayed until the group could be confirmed.

Figure 8.3: Cumulative comparison of near miss WBIT and those leading to IBCT



Detection of WBIT incidents:

The point of detection of WBIT incidents and the manner by which they were discovered show the importance of the quality processes and checks undertaken by all staff involved in transfusion, both laboratory and clinical. Unfortunately, it is also inevitable that many similar incidents will remain undetected.

Point in the process	How was WBIT error detected	Number of cases	Percentage of cases
Sample receipt	Error discovered prior to testing	38	13.6%
	Sample taker realised error	36	
	Detected by chance before booking in	12	
Testing	At authorisation of results	242	83.5%
	Unknown point during testing	198	
	Sample taker realised error*	34	
	Further sample differed	32	
	Other colleague realised error	15	
	Alerted by a non-transfusion sample	11	
Collection	Attempted collection with different patient's details	2	0.3%
Administration	Pre-administration checks	7	1.7%
	Sample taker realised error	4	
Other	After report issued	4	0.9%
	Patient realised	2	
Total		**637**	**100%**

Table 8.5: Point in the transfusion process where the wrong blood in tube incident was detected

** In 1 wrong blood in tube case the sample taker alerted the laboratory before testing, but the sample was erroneously tested anyway and the error was detected at authorisation*

Case 9: Pre-labelled tubes for maternal and paternal samples lead to WBIT detected during testing

A mother and father were bled at the same time for fetal blood group genotyping. A midwife pre-labelled tubes with letters 'M' and 'F' to indicate 'male' and 'female', but no other identifying details. These were interpreted as 'M' for 'mother' and 'F' for 'father' at the point of sampling. Tubes marked 'F' were labelled by the consultant with 'female' (mother's) details. The midwife labelled the remaining tubes marked 'M' with 'male' (father's) details. The error was detected when it was apparent from chromosome testing that the male and female karyotypes did not correspond with the sample labelling. Further checks against historical blood groups for both individuals indicated the samples had been transposed.

IT-related WCT cases n=8

There were 8 IBCT-WCT cases that also had an IT element and these are described below. The numbers are included in tables above where appropriate, so these are not additional cases.

Warning flags not in place, not heeded or not used (n=7 for laboratory WCT)

There were 2 cases where a warning flag was in place but not heeded. In one of these an IT flag was overridden several times, but could have prevented a wrong blood incident had it been heeded, Case 3.

Five incidents of incorrect blood component transfusion occurred in haemopoietic stem cell transplant patients. On three occasions an apparently robust flagging system was overlooked because there were too many separate flags in place and one of the requirements was missed and on two other occasions the LIMS was not updated to reflect the current status of the patient.

Learning points

- Training and competency-based assessment must include appropriate actions on receipt of alerts/warnings on the laboratory information management system (LIMS) or other analyser
- Where a computer warning system designed to prevent wrong blood incidents does not work in the way it was intended, an audit of the system should be undertaken to highlight any other cases that might have been missed in a similar way

Electronic blood management systems n=1 (clinical WCT)

There was a blood collection error during downtime of the blood-tracking system.

Case 10: Wrong blood collected from a satellite refrigerator during the downtime of a blood-tracking system

A porter who was aware that the blood-tracking system was down delivered blood for two patients to a satellite refrigerator. Only one of the wards was aware that the system was down and familiar with the procedure to follow when collecting blood under these circumstances. The staff member from the other ward was not familiar with the paper log, which did not contain the full patient ID, only the donation number, and collected the wrong blood. This was not detected at the bedside because the wrong checking procedure was followed.

Learning point

- Downtime procedures for all information technology (IT) systems should be validated so that they are sufficiently robust and staff should be trained to use these procedures

Specific requirements not met

There were 190 cases where patients received blood components that did not meet their specific requirements.

Table 8.6: Specific requirements not met n=190

Type of specific requirement	Number of laboratory reports	Number of clinical reports	Total
Specific phenotype of red cells	25	6	31
Irradiated units	8	111	119
Cytomegalovirus (CMV) negative units	1	7	8
Both irradiated and CMV negative units	1	2	3
K negative units to female of childbearing potential	7	0	7
Pathogen-inactivated FFP or cryoprecipitate	7	1	8
HLA-matched platelets	1	1	2
Human platelet antigen (HPA-1a)-matched platelets	0	1	1
Apheresis platelets	1	0	1
Inappropriate use of electronic issue (EI)	5	0	5
Blood warmer required	0	5	5
Total	**56**	**134**	**190**

Failure to provide irradiated cellular components remains the most commonly missed specific requirement. Most of these (113) are due to clinical staff failing to indicate this specific requirement on the request form. A further 9 cases occurred because laboratory staff failed to heed the information for irradiated components at sample receipt and registration.

Learning point

- Prior to collection of a blood component for transfusion, the prescription should be checked by the staff who will be setting up the transfusion to ensure that the components have been authorised or prescribed for transfusion to that patient and they are of the correct specification for the patient

Case 11: The patient identifies the need for specific requirements during transfusion

A patient with chronic lymphatic leukaemia and chronic anaemia was admitted to the emergency department and required an urgent transfusion of two units of red cells and platelets. The specific requirement box was not ticked on the request. The sample was processed and components issued.

The first unit of blood was in progress when the patient asked if the blood was irradiated. The nurse said 'no' and stopped the transfusion. The nurse contacted the transfusion laboratory who had no notification for irradiated components. The units were recalled to the laboratory and irradiated components were issued.

The patient knew of his specific requirement and this information should have been noted when obtaining consent. The requirement for irradiated components was also omitted from the prescription and therefore it was not noted during the final pre-administration checks until the patient alerted the nurse.

Learning points

- It is the requesting clinician's responsibility to identify the patient's specific requirements (if any) and communicate them by the request form to the laboratory and also on the prescription for the administering staff to ensure these needs are met
- The patient should be asked if he/she knows of any specific requirements at the time of giving consent for transfusion

SHOT has previously recommended [3] (page 76) that hospital transfusion teams should risk-assess the methods that clinicians use for informing the transfusion laboratory about both specific requirements, and any relevant previous history provided by the patient to clinicians. For example, there should be a robust process to inform the laboratory when treatment with purine analogues starts, rather than waiting until blood is requested.

Case 12: A patient with Hodgkin lymphoma received non-irradiated red cells

An IT prompt displayed on screen alerting the BMS to activate a flag for irradiated components was not added to the patient record at sample registration. At crossmatch the BMS did not consider the clinical details or check legacy data prior to selection of red cells. Staff on the ward noticed that red cells were not irradiated during the final pre-administration checks and bleeped the doctor and the laboratory to confirm whether the patient did require irradiated blood. The laboratory staff checked the LIMS and stated that no special requirements were recorded on the system (as the BMS had not set up the flag following a request), so the transfusion was started. The doctor arrived later on the ward and confirmed the patient did need irradiated blood. The transfusion was immediately stopped but more than 200mL had been transfused.

Learning points

- Training and competency-based assessment must include appropriate actions by the biomedical scientist (BMS) on notification of requests for alerts/warnings to be put onto the laboratory information management system (LIMS) or other analyser
- Qualified BMS crossmatching red cells or issuing components must take responsibility for checking **all** the relevant laboratory history on a patient to ensure that they issue components of the correct specification, for genuinely unknown patients the minimum identifiers are gender and a unique number

Incorrect phenotype

In 25 cases the BMS issued components of the incorrect phenotype. Most of these were due to testing errors (13/25), but in a third, opportunities were missed for detection of the error later in the process. In 8/25 the BMS missed requests for specific requirements at sample receipt and registration which led to an incorrect component being issued. There were 2 due to an error in component selection and in the remaining 2/25, there was 1 where the BMS removed the flag from the patient records that indicated the specific requirements and 1 where the patient's transfusion history was not forwarded onto the receiving hospital transfusion laboratory. Testing errors are discussed in Chapter 9, Summary of Events Originating in the Hospital Transfusion Laboratory.

Case 13: Patient transfused units of inappropriate phenotype despite LIMS alert

Red cells were requested for an elderly female who was known to have had alloantibodies. These were flagged in the computer system noting that the patient must receive D-, C-, Fy(a-) and K negative units. An antibody panel and serological crossmatch were performed. The antibody panel confirmed anti-D and anti-C and a very weak reaction that could have been due to anti-Fy^a; but this was not further investigated or identified. The crossmatch appeared compatible; the units were issued and transfused. The units selected and transfused were C-, D negative but the Fy^a status was unknown. The transfused units were investigated and both were found to be Fy(a+). The patient had no ill effects. A flag on the patient record stated the specific requirements. The BMS was confused about the significance of anti-Fy^a believing it to be a crossmatch-compatible antibody not requiring antigen-negative blood.

This case involved several errors that all occurred in the laboratory and resulted in an incorrectly phenotyped unit being selected and transfused to the patient. The initial error was not heeding patient history at sample receipt and registration. Weak reactions identified in the antibody panel were not investigated and there was a lack of basic knowledge from the BMS about a clinically significant antibody.

Blood warmers n=5

There were 5 cases where a blood warmer was not used in a routine transfusion for patients with cold agglutinin disease.

Case 14: Blood warmer not used despite clear prescription

A patient with cold agglutinin disease and Hb of 67g/L was prescribed red cells. The prescription stated that a blood warmer was required. The nursing staff did not adhere to/notice this requirement and administered the blood without a blood warmer. This was noticed by the patient's consultant on review towards completion of the second unit.

Near miss SRNM cases n=72

The near miss incidents relating to patients' specific requirements show similar learning points to the full incidents described above, which led to a transfusion of components where specific requirements were not met.

Table 8.7: Near misses that could have led to IBCT-SRNM n=72

Point in the process	Type of error made	Number of cases	Percentage of cases
Request	Irradiated	15	22.2%
	CMV negative	1	
Sample receipt	Failure to notice request for irradiated	7	9.7%
Testing	Incomplete testing prior to issue	8	12.5%
	Transcription	1	
Component selection	Failure to issue irradiated	20	55.6%
	Failure to issue red cell phenotyped	12	
	Failure to issue CMV negative	4	
	Failure to issue HLA-matched	3	
	Incorrect component type	1	
Total		**72**	**100%**

IT-related SRNM cases n=117

There were 117 SRNM cases that also had an IT element and these are described below. The numbers are included in tables above where appropriate, so these are not additional cases. There were 81 clinical errors, and 36 laboratory errors.

Use of the historical computer record (n=5 laboratory and n=5 clinical)

There were three laboratory cases where the historical record was not consulted, or not linked to the current record, when selecting suitable red cells for transfusion. This resulted in the issue of non-irradiated blood to two patients and antigen-positive blood to patients with red cell antibodies, one of whom had sickle cell disease.

There were four clinical cases where irradiated blood components should have been provided. On two occasions, records were not linked because of different hospital numbers and on one occasion the flag was not transferred from a legacy system to the current LIMS. A neonate was not given irradiated blood following an intrauterine transfusion (IUT) because the information in the mother's record was not linked to that of the neonate. A patient with HLA antibodies was not supplied with HLA-selected components because two hospitals' LIMS systems were not linked. In these cases IT flags could have prevented the omission of special requirements but the primary fault was the lack of information provided to the laboratory by the clinical area.

Warning flags not in place, not heeded or not used (n=30 laboratory, n=76 clinical)

There were 11 cases where a warning flag was in place on the LIMS but was not heeded. This resulted in 2/11 patients not getting irradiated components, 2/11 not getting methylene blue-treated (MB) or virally-inactivated plasma components and 7/11 patients who did not receive appropriate antigen-negative blood.

In a further 12 cases a warning flag was not activated, or updated with current information. This resulted in the issue of two wrong blood components and one issue of non-irradiated red cells. In 6 cases antigen-negative requirements were not met and 2 patients with positive direct antiglobulin tests (DAT) were not highlighted as unsuitable for electronic issue (EI) according to local policy. One patient was not given HLA-matched components because the HLA antibody report had not been entered into the LIMS.

There were 7 cases where flags were not used. Four patients were transfused non MB (or non virally-inactivated) plasma because the age-specific flag for this component was not in use. A neonate was supplied with adult platelets which did not meet the CMV negative specification for this age group. A patient with sickle cell disease was not given extended matched and HbS-negative blood because the diagnosis was not flagged and another patient was not flagged as unsuitable for EI.

Case 15: Failure to provide irradiated blood because the warning flag was not set on LIMS

The request form for a newly diagnosed patient with acute leukaemia clearly documented the need for irradiated components but the on-call BMS did not have the authority to put a flag on the LIMS and forgot to handover to the senior BMS the following day. As a result, non-irradiated components were supplied on more than one occasion until this was picked up when a further request came to the laboratory.

In 74 of the 76 patients who did not receive the correct specific requirement for primarily clinical reasons, a large number of cases (68) occurred because the laboratory was not informed of the specific requirement and therefore could not set up a warning flag. The majority (64/68) received non-irradiated components, three should have had antigen-negative blood and one CMV negative components. In four cases there was miscommunication between the ward and the laboratory and the flag was not updated correctly so non-irradiated components were given. On one occasion a flag stating irradiated components were required was not heeded and on another occasion human platelet antigen (HPA) selected components were not provided despite a warning flag.

Case 16: Failure to check the notes or the LIMS to confirm special requirements

A doctor requested HLA-matched platelets out-of-hours for a patient on the basis of verbal information given by a nurse but did not check the notes. The laboratory BMS requested HLA-matched platelets from the Blood Service without checking the LIMS. These were issued without checking the LIMS. The patient had a mild reaction to the platelets, which should have been HPA-1a negative, not HLA-selected.

Case 17: Removal of a flag on the LIMS leads to antigen-positive units being transfused to a patient

A BMS inadvertently removed a specific requirements flag indicating the patient required C negative red cells, therefore the BMS who issued the blood was not aware of this requirement. The patient was consequently transfused two units of red cells that were C positive.

Learning point

- Computers can support the provision by laboratories of the right blood component and correct specific requirements but effective communication between laboratories and clinicians is still essential. Patient records should be accurately linked and merged, and updated in a timely way

Scanning errors n=1 (n=1 in the laboratory)

There was one error related to the scanning of barcoded information on the blood component bag.

The scanning error resulted in a unit being booked in as K negative when in fact it was K positive and transfused to a female child in error.

Learning point

- Transfer of information using barcodes is quick and accurate but incorrect use of barcodes can lead to errors

Inappropriate use of electronic issue

In 6 of the IT cases already described above, blood was issued electronically but criteria for EI were not met.

There were two errors where manual editing of the ABO/RhD group had taken place but EI was still possible. It is more robust if manual editing prevents EI without the need for a flag to be set manually.

There were cases with no current antibody screen (n=1) and a positive antibody screen (n=1) where EI was not prevented. There were two further cases with a positive DAT where local policy excluded these from EI but again, this was not prevented.

There were 2 cases where there was a discrepancy between the patient ID on the historical and current LIMS record (date of birth in one and name in the other) that meant that EI should have been prevented but was not.

Learning points

- Electronic issue (EI) should be under the control of the laboratory information management system (LIMS) with no manual interventions and logic rules and flags should be set up to support this
- EI must be prevented if the criteria are not met and these algorithms should be tested to ensure they are robust and corrected when errors are identified

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.

Incorrect Blood Component Transfused: Serial Errors and Multiple Missed Opportunities to Detect an Earlier Error

The transfusion process is a series of interlinked steps which require laboratory and clinical staff to work together. Safe transfusion practice depends on every step being carried out correctly and staff should not assume that or rely on previous steps having been completed properly. Correct patient identification is an integral part of each step with particular emphasis on positive patient identification at the two key stages indicated in Figure 8.1. Positive patient identification is the use of open ended questioning ('What is your name? What is your date of birth?') to verify the patient's 4 unique identifiers (first and last name, date of birth, unique identification number, gender in Scotland and first line of the address in Wales) whilst checking against the patient identity band and the relevant documentation [23].

A review of errors resulting in incorrect blood components transfused and missed opportunities for detection n=547 (220 reports)

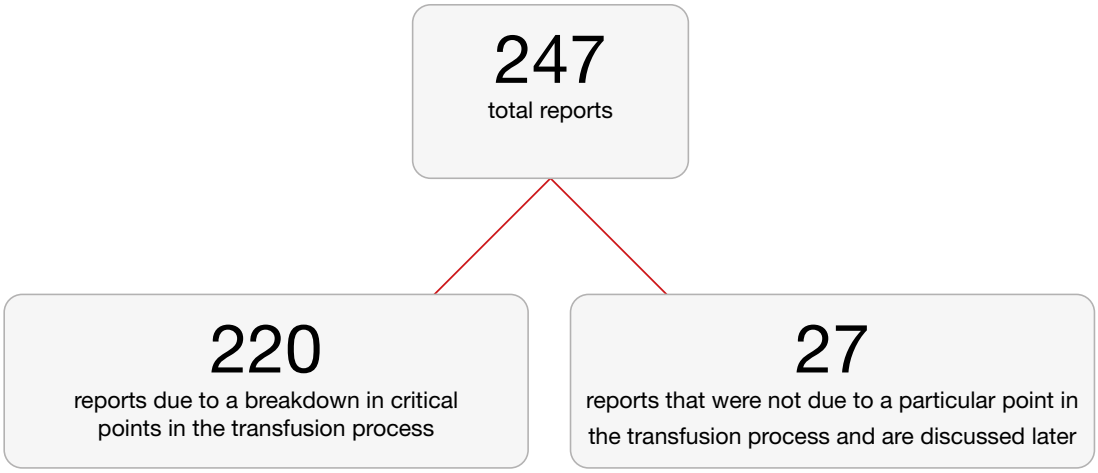


Figure 8.4: Number of reports due to failure of correct steps in the transfusion process

Figure 8.5 illustrates the number of cases that were analysed and the number of missed opportunities to detect an error (e.g. if a case has 3 missed opportunities, this means that there were 2 subsequent opportunities for the initial error to be detected).

The steps where errors are most likely to occur are shown in Table 8.8, but the opportunity to detect these is maximal at the time of checking against the prescription and before administration (Figure 8.6).

Learning point

- The process of checking each component against the prescription and patient identity before administration are key points when earlier errors could be detected and so prevent administration of a wrong component or one not suitable for that patient's specific requirements

Figure 8.5: Number of steps where there was a critical point breakdown in the transfusion process n=220 reports

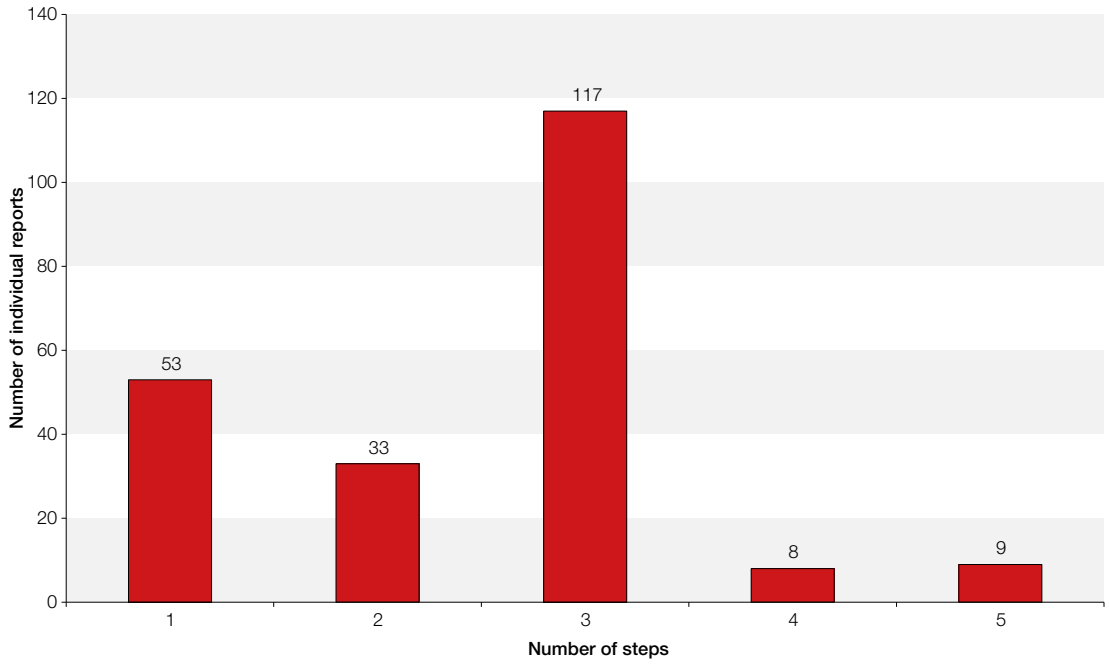
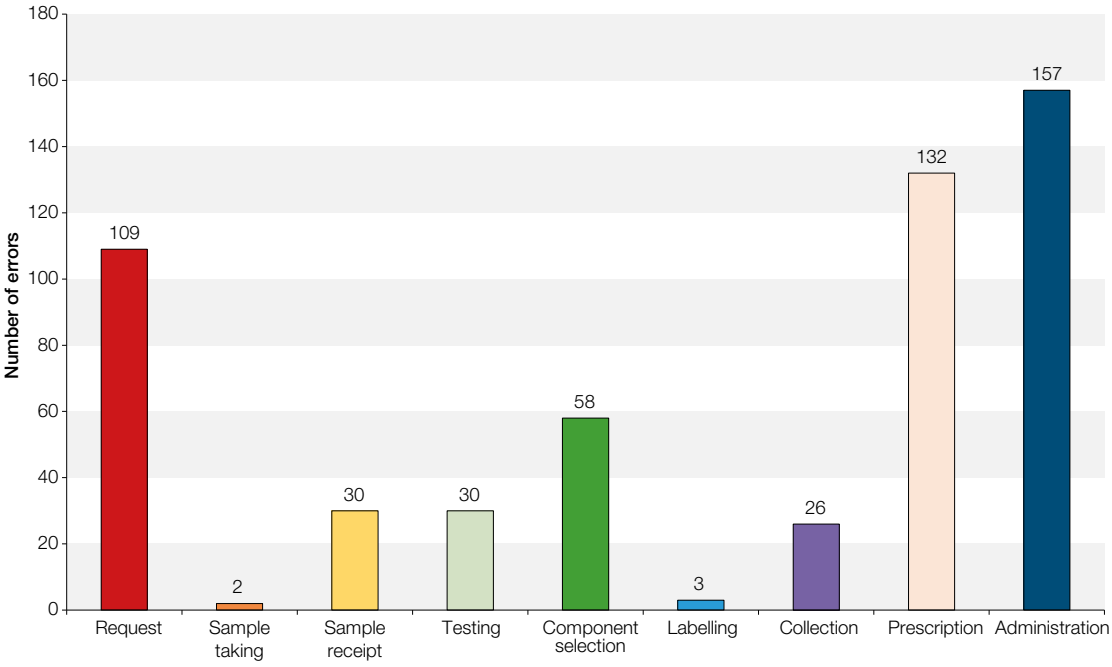


Figure 8.6: Steps in the process where an error was made or an opportunity was missed to detect the primary error n=547



SHOT has noted in the past that many incident reports are compounded by more than one error. In some cases, 31/220 (14.1%), errors could have been detected in both laboratory and clinical areas. Many primary errors, 155/220 (70.5%), could have been detected at the final pre-administration checks at the bedside. It is crucial that this step is done properly.

Step in the transfusion process	Number of reports by step of primary error	Missed opportunities to detect the primary error	Total steps in the process where an error was made or an opportunity was missed to detect the primary error
Request	109	0	109
Sample taking	1	1	2
Sample receipt	20	10	30
Testing	28	2	30
Component selection	28	30	58
Labelling	2	1	3
Collection	23	3	26
Prescription	7	125	132
Administration	2	155	157
Total	**220**	**327**	**547**

Table 8.8: Comparison of primary error and missed opportunities for detection

The request is the first step in the transfusion process. It is the clinician's responsibility to inform the transfusion laboratory of patients whose clinical condition requires components of a particular specification.

Case 18: Failure to provide units of appropriate specification due to poor communication

A pregnant woman (gestation 36/40) was admitted to the delivery ward with chronic anaemia and received two units of red cells at that were not CMV negative. Clinical details on the request form stated 'Low Hb prior to delivery' but no estimated date of delivery was recorded. Laboratory staff would expect that a patient in the delivery suite was giving birth unless told otherwise. Routine practice is to use non-irradiated components at delivery so 2 random CMV status units of red cells were issued.

Learning points

- Clinical staff should provide full information to laboratory staff with regard to specific requirements
- Age and gender-related specific requirements are a laboratory responsibility. Laboratory information technology (IT) systems should be used to their full potential to prompt staff about specific requirements either through logic rules or algorithms based on date of birth and/or gender, or by warning flags. If this is not possible with the existing system then these development requirements must be raised with the laboratory information management system (LIMS) supplier

Missed opportunities to detect the primary error

Multiple errors in the transfusion process are common (the median number is 3 – Figure 8.5). How and where can they be detected?

Five steps – Cases where there were 4 opportunities to detect the primary error n=9

There were 9 cases where the primary error in the request was followed by 4 further missed opportunities to detect the error. All 9 cases were instances resulting in specific requirements not being met where there was the same combination of primary error and opportunities for detection:

Request, sample receipt, component selection, prescription and administration.

Case 19: Failure to add the need for irradiated components to the request form leads to specific requirements not being met

A pharmacy list is updated monthly for patients who have been started on drugs that require a patient to have irradiated components. The list was e-mailed to the transfusion laboratory nine days into the next month. A renal transplant patient was on the list but the laboratory had not been informed in time. The patient had already been transfused non-irradiated red cells on three occasions. The

request form for the second transfusion had been marked for irradiated components but had not been noticed by the BMS and the flag was not on the computer to alert them.

1 Primary error: Request – Specific requirements were not documented on the 1st request form so the transfusion laboratory were not informed of the need for irradiated components.

2: Sample receipt – The need for irradiated components had been noted on the 2nd request form but the BMS had failed to notice it.

3: Component selection – Irradiated units were not selected.

4: Prescription – Specific requirements for irradiation were not indicated on the prescription chart/not followed as required.

5: Administration – Need for irradiated components was not noted at the bedside check and non-irradiated components were transfused.

There may have been a misconception that the laboratory staff would be alerted by the pharmacy notification and it was therefore not necessary to follow this up with a formal request. This case illustrates the need for effective communication and the importance of each individual's role within the team involved in the care of the patient from both a clinical and laboratory perspective.

Learning point

- Pharmacy notifications are a useful back up to ensure the laboratory know about patients who have been receiving treatment that requires provision of irradiated components. However, these systems should be used to support the information supplied on the blood request form and not relied upon as the sole communication to the laboratory as they are often not delivered until after transfusion support has started

Four steps – Cases with 3 opportunities to detect the primary error n=8

In 8/220 (3.6%) reports the patient's specific requirements were missed at 4 steps. In 7/8 cases the primary error occurred in the laboratory.

Case 20: Failure to heed request for irradiated units results in a patient receiving non-irradiated units despite 3 opportunities to detect the error

The 'irradiated red cells' box was ticked on the request form. This was missed by both the medical laboratory assistant (MLA) booking in the request and the BMS issuing the blood component and later not noticed by the clinical staff. This resulted in the transfusion of one unit of non-irradiated red cells to a patient on fludarabine.

1 Primary error: Sample receipt and registration – The need for irradiated red cells was indicated on the request form. This was missed at booking in the sample.

2: Component selection – It was then missed again when the BMS issuing the component did not notice the ticked box for irradiation on the request form either.

3: Prescription – Another opportunity was missed at the time of transfusion when nursing staff did not check for specific requirements on the prescription.

4: Administration – The need for irradiated components was not noted at the bedside check and a non-irradiated component was administered.

The consultant haematologist had not informed the transfusion laboratory about this specific requirement on a previous occasion.

Three steps – Cases with 2 opportunities to detect the primary error n=117

This was the largest group, 53.2% (117/220). Most result from errors in requesting which were not then detected at prescription or administration. Most of these resulted in specific requirements not being met.

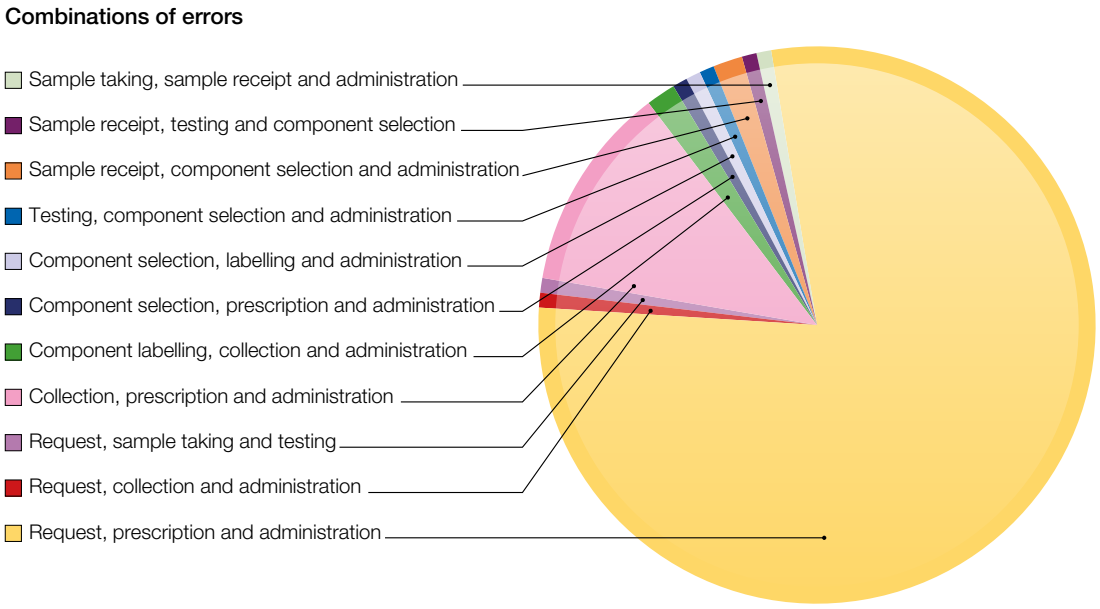


Figure 8.7: Combinations of primary error and opportunities for detection – 3 steps n=117

The slices show the different combinations of opportunities to find the errors and demonstrate that 'request, prescription and administration' is the most common combination of 3 steps (primary error and 2 missed opportunities to detect the primary error) n=92/117 (78.6%).

Case 21: Haematology registrar overlooks the need for irradiated components

When completing the blood transfusion special requirements notification form the haematology registrar circled 'No' in response to the question 'Does this patient require irradiated components?' even though the patient had been on fludarabine in 2010. Non-irradiated platelets were issued to the patient.

1 Primary error: Request – The doctor failed to identify the need for irradiated components on the request form despite the history of fludarabine treatment.

2: Prescription – The person authorising the components also failed to note this on the prescription chart.

3: Administration – Not picked up at the final bedside check.

Failures to authorise/adhere to a prescription and the subsequent administration of an incorrect component are two individual steps where an earlier error could have been detected. In this group there were 13 instances of wrong component transfused and 99 of specific requirements not met. Staff in particular areas such as haematology should have a better working knowledge of the indications for specific requirements and ensure that these are communicated to the laboratory. The needs of these patients are more likely to be overlooked when cared for in another clinical area or hospital.

Learning point

- Patients with specific transfusion requirements may be treated anywhere within the health service including different departments in a hospital, different hospitals or in the community. All staff caring for a patient requiring transfusion have responsibility for knowing what constitutes specific requirements. Staff in haematology departments in particular should be adequately trained to know when these are indicated

Case 22: Miscommunication and assumption leads to incorrect transfusion

The ambulance service contacted the emergency department (ED) about a patient being brought in following an accident. She was assigned the name 'Delta Red'. The patient was unstable, with suspected intra-abdominal injuries and required activation of the major haemorrhage protocol ('code red'). Another unidentified patient from the same accident had also been brought to the ED and assigned the name 'Charlie Red'. This patient arrived first and blood samples were sent to the laboratory.

1 Primary error: Request – When the transfusion laboratory received the 'code red' call from the ED, the caller did not pass on patient details before ending the call. As the staff member in the transfusion laboratory had, at that point, received samples for 'Charlie Red' she assumed the call was for this patient and issued the pre-thawed FFP to this patient.

2: Collection – The FFP was collected by the porter even though it was for the wrong patient (perhaps he was not given sufficient patient ID information).

3: Administration – These units were subsequently transfused to 'Delta Red' despite being issued for 'Charlie Red'. One unit of FFP was given in the resuscitation area and a further unit of FFP was given in the radiology department. Various members of staff checked the blood components. The serial numbers on the units of FFP were checked against the serial numbers on the tags; however the patient name on the FFP was not checked against the patient wristband. On return from radiology a further unit of FFP was checked at which point the team became aware that the FFP was labelled 'Charlie Red'.

There were at least 3 points where a wrong transfusion could have been prevented but each person made assumptions about the preceding step. There has to be an element of trust in these situations but this must not override clear communication and basic checking.

Learning points

- Safe transfusion is dependent on teamwork with good communication and an appreciation of each person's roles and responsibilities
- Communication between staff and other departments must be clear at all times but especially in emergency situations. Poor communication can lead to errors

Two steps – Cases with 1 additional opportunity to detect the primary error n=33

There were 33 cases where the primary error could have been detected at a second point in the process.

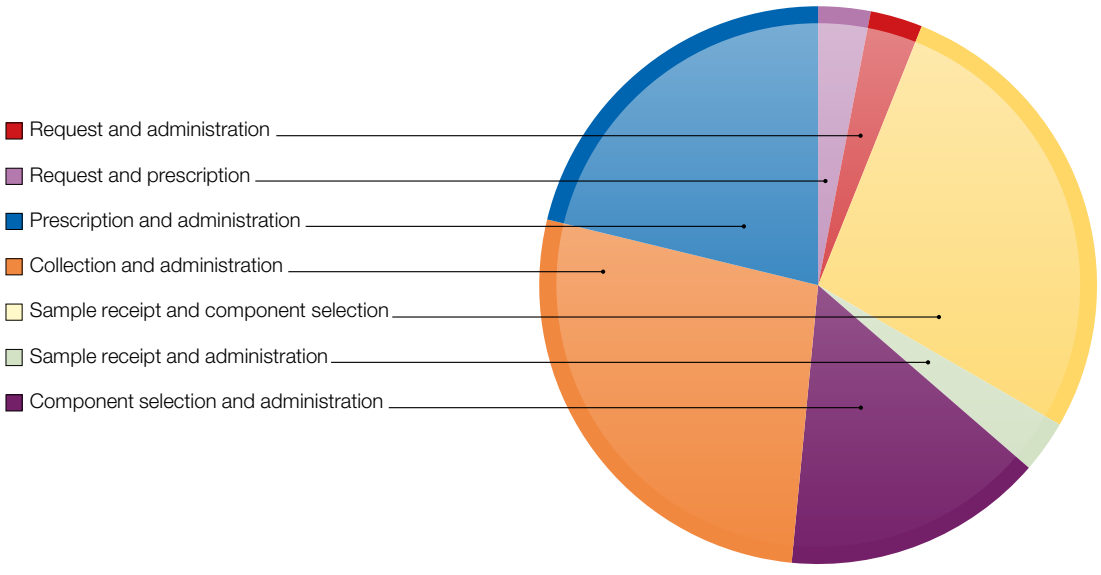


Figure 8.8: Combinations of primary error and opportunities for detection, 2 steps n=33

Case 23: A patient known to have anti-C was transfused with units of blood which were C positive

A known patient with a computer alert noting the need for C negative, and E negative red cells was issued three units of blood which were all C positive. The patient received the whole of the first unit and two thirds of the second before the error was detected. The second unit was stopped and the third was not transfused. The patient was admitted in order to monitor for signs of a delayed transfusion reaction.

1 Primary error: Sample receipt and registration – The BMS failed to heed patient historical records and the computer alert flagging the requirement for C negative, E negative red cells.

2: Component selection – Suitable units had already been put to one side for this patient and there was documentation in the laboratory for the shift handover. However, the units were not found and instead C positive units were selected from stock.

Learning point

- Handover templates should be improved to provide information about diagnosis, irregular antibodies and specific requirements. Patients are vulnerable particularly between shifts in the laboratory as well as in the clinical areas

Single opportunity to prevent a wrong transfusion n=53

In 53/220 (24.1%) reports, a single error was made. These occurred at several different stages in the process: the request, testing, component selection, and administration. However, laboratory errors were responsible for 48/53 (90.6%) of these cases. All laboratory errors are discussed in more detail in Chapter 9 Summary of Events Originating in the Hospital Transfusion Laboratory.

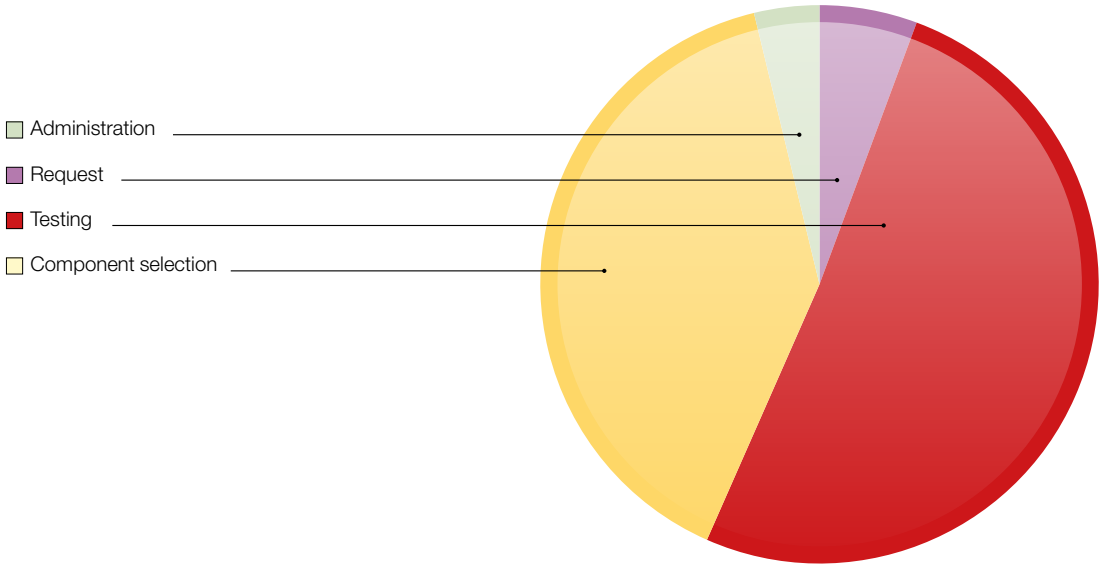


Figure 8.9: Primary errors where there were no further opportunities for detection, 1 step n=53

Case 24: A patient receives transfusion prior to testing being completed

Two units of blood were collected and the transfusion started for a patient before the immediate spin grouping results were read. The immediate spin tubes were found in the centrifuge by another BMS and read retrospectively. The patient was group A, and the units transfused were also group A, but this was not confirmed by reading the immediate spin crossmatch before the transfusion began. Additionally it transpired that the results of the current group (historical group on file) and negative antibody screen results had been transmitted to the patient file but not authorised prior to collection of the first unit.

1 Primary error: Testing – The components were issued prior to completion of testing

Other cases where errors occurred outside the steps of the transfusion process n=27

Communication failures n=9

In 9/247 instances errors occurred as a result of communication failures from sources outside the reporting hospital. Examples include shared care patients where important information about the patient's medical history and treatment was not communicated to the clinical and laboratory teams at the receiving hospital.

Conflicts in professional practice n=16

In 16 cases there were differences in professional practice between hospitals. Irradiated components are recommended for any patient who receives alemtuzumab (anti CD52, a marker for mature B-lymphocytes). This was risk-assessed and considered unnecessary at the transplant unit. However, the local hospital where the majority of the patients' care took place followed product and current national guidelines which state that patients treated with alemtuzumab should receive irradiated blood components for life [28].

These cases are discussed in more detail in Chapter 27 Summary of Incidents Related to Transplant Cases.

Miscellaneous cases n=2

There were 2 further cases which could not be categorised in this process. The first of these is discussed in the RhD mismatch section where the investigation into the incident could not establish the root cause of the error. In the second case a BMS deleted a flag that informed staff about a specific requirement for a patient who required irradiated components.

COMMENTARY

In 155/220 (70.5%) of cases, the errors could have been detected at the final pre-administration check at the patient's side, but this is increasingly difficult with fragmentation of medical care so that doctors in different teams are likely to be involved and they may not know the patient's specific requirements. Effective communication and a solid foundation of transfusion knowledge, including patient specific requirements, are necessary for all staff involved in the transfusion process.

Recommendation

- The majority of episodes resulting in an incorrect component transfusion result from multiple errors in the multidisciplinary transfusion process. All professional staff participating in transfusion must perform independent and careful checks. A simple 5-point aide memoire at the final step would remind staff to check for the correct patient identifiers, and the prescription for the correct component and confirmation of specific requirements

Action: Hospital Transfusion Teams

Summary of Events Originating in the Hospital Transfusion Laboratory 9

Authors: Hema Mistry and Christine Gallagher

This chapter includes all errors that originated in the laboratory associated with:

- Sample receipt and registration – information missed or not heeded during the 'booking in' stage
- Testing – pre-transfusion testing and procedural errors
- Component selection – selecting an unsuitable blood component
- Component labelling, availability and handling and storage of blood components – labelling errors, availability surrounding blood components and their correct storage conditions
- Miscellaneous – cases that are difficult to assign to a particular stage within the transfusion process described above

Analysis of all cases reported to SHOT (excluding 'near miss' events) in 2013 shows that 1139/1755 (64.9%) were adverse events caused by error and of these 284/1139 (24.9%) originated in the laboratory, Table 9.1. There were a further 251/996 (25.2%) laboratory-related 'near miss' cases, Table 9.2.

Analysis of laboratory errors derived from data in other chapters in this 2013 Annual SHOT Report shows:

- 84/284 (29.6%) reports where the right patient was given the right blood and transfused correctly despite one or more serious laboratory errors (RBRP)
- 56/284 (19.7%) reports of errors which resulted in the transfusion of components that did not meet the patient's specific requirements (SRNM)
- 55/284 (19.4%) reports of errors in the administration of anti-D immunoglobulin (Ig) to women of childbearing potential (Anti-D)
- 51/284 (18.0%) reports of transfusion episodes in which, during the transfusion process, inappropriate handling and/or storage errors (HSE) may have rendered the component less safe
- 24/284 (8.4%) reports of errors resulting in the transfusion of an incorrect blood component (IBCT)
- 14/284 (4.9%) reports of avoidable, delayed, or undertransfusion (ADU)

Table 9.1: Laboratory errors n=284

Laboratory categories	Total	Percentage	Chapter					
			IBCT	SRNM	HSE	RBRP	ANTI-D	ADU
Sample receipt and registration	84	29.6%	4	16	8	35	21	0
Testing	51	18.0%	8	19	0	0	18	6
Component selection	36	12.6%	9	19	0	1	7	0
Component labelling, availability, handling and storage	104	36.6%	3	0	43	48	9	1
Miscellaneous	9	3.2%	0	2	0	0	0	7
Total	**284**	**100%**	**24**	**56**	**51**	**84**	**55**	**14**

There were 251 'near miss' cases where an error was detected prior to transfusion. This illustrates that when procedures are followed and when staff involved in the transfusion process perform their role effectively errors can often be detected. A more detailed summary of all the 'near miss' laboratory

cases shown in Table 9.2 is 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.

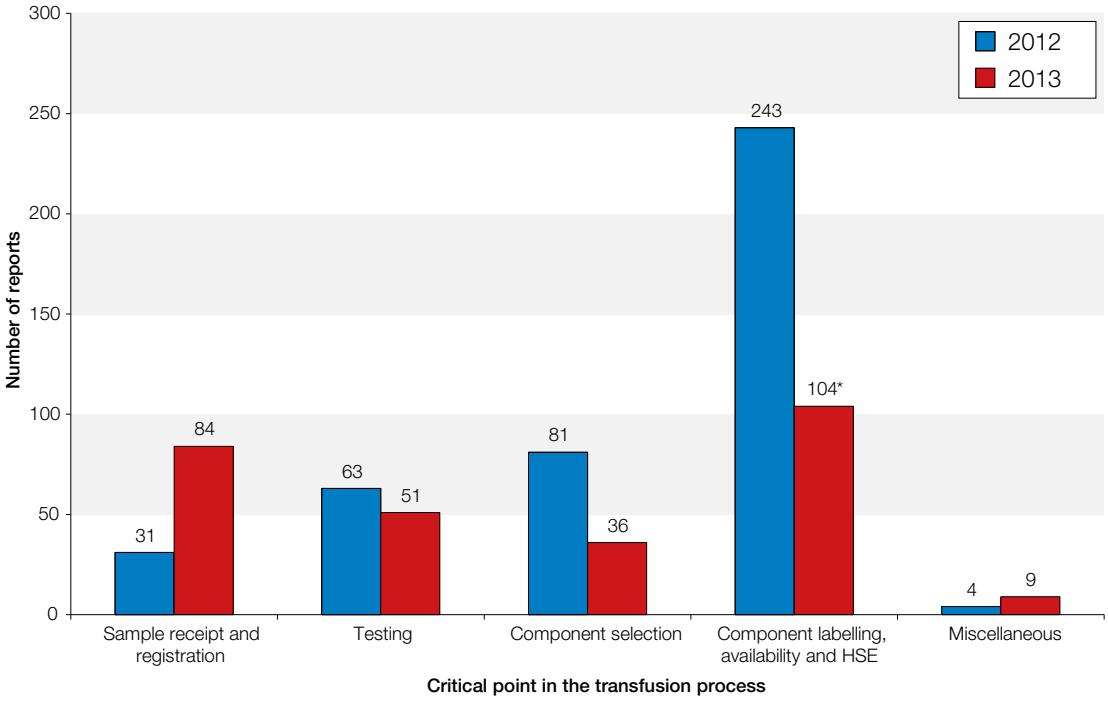
Table 9.2: Near miss laboratory errors n=251

Near miss laboratory categories	Total	Percentage	Chapter					
			IBCT	SRNM	HSE	RBRP	ANTI-D	ADU
Sample receipt and registration	26	10.4%	6	7	0	10	3	0
Testing	32	12.7%	16	9	0	0	4	3
Component selection	61	24.3%	6	39	3	0	13	0
Component labelling, availability, handling and storage	131	52.2%	17	0	38	72	4	0
Other = LIMS* bug, failed to detect group mismatch	1	0.4%	1	0	0	0	0	0
Total	**251**	**100%**	**46**	**55**	**41**	**82**	**24**	**3**

**LIMS = laboratory information management system*

This is the 2nd year that SHOT has provided a laboratory summary chapter. Figure 9.1 shows the 2 year trend and demonstrates the critical points in the laboratory process where errors occur.

Figure 9.1: Critical points in the transfusion process, two year trend 2012-2013



**There has been a decrease in errors related to component availability. This may be attributable to a single report in 2012 that involved 86 patients*

This year's chapter focusses on sample receipt and registration, testing and 9 miscellaneous cases. Most errors in component selection resulted in patients being transfused incorrect blood components and are described in Chapter 8 Incorrect Blood Component Transfused (IBCT). Most of the component labelling, availability and handling and storage errors (HSE) resulted in transfusion of the right blood component to the right patient despite a HSE that may have rendered the component less safe (HSE) or one or more serious identification/prescription errors which in other circumstances may have led to an IBCT (RBRP) [29]. These are discussed Chapter 12 Right Blood Right Patient (RBRP) and Chapter 13 Handling and Storage Errors (HSE).

A more detailed summary of all the laboratory cases shown in Table 9.1 is 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.

Sample receipt and registration errors n=84

Figure 9.1 shows an increase in 2013 in the number of errors at sample receipt and registration. Most of these are similar to those in 2012. Further analysis shows that failure to consider available historical information accounts for 39/84 (46.4%), demographic data entry errors 35/84 (41.7%) and missed information present on the request form 10/84 (11.9%), Figure 9.2.

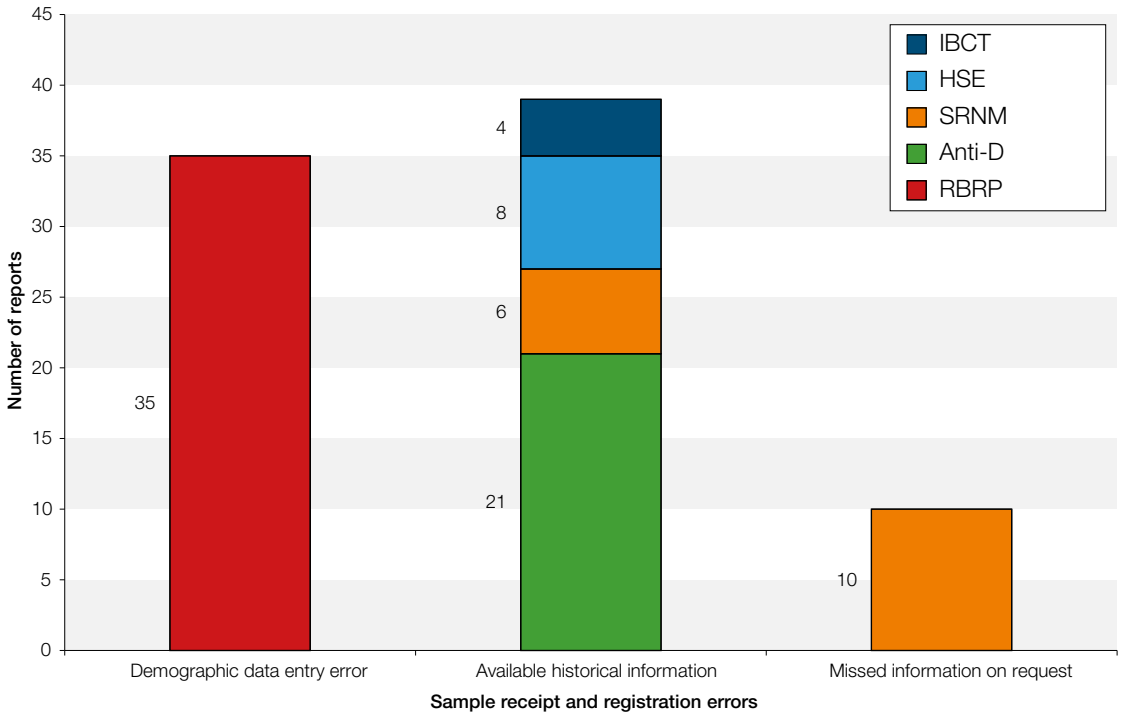


Figure 9.2: Sample receipt and registration errors with their outcome n=84

Most cases resulted in the right blood being given to the right patient despite a demographic data entry error. Further information on these reports by sub-category shown in Figure 9.2 is given below. A full analysis (where these errors are detailed under their SHOT categories so that they can be linked to outcome) of all the sample receipt and registration cases reported to SHOT in 2013 is available on 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.

Demographic data entry error	Number of reports
Patient's name	15
Date of birth (DOB)	10
Hospital number	8
Sample number	1
Address	1
Total	**35**

Table 9.3: Demographic data entry error n=35

Learning point

- Maintaining correct patient identification throughout the process is essential and must always be ensured at each critical point of the laboratory process starting with entry of correct patient demographics onto the laboratory information management system (LIMS)

Table 9.4: Available historical information missed on the LIMS n=39

Available historical information missed on the LIMS	Number of reports
Anti-D Ig inappropriately administered to women who had known immune anti-D	14
Samples that had exceeded BCSH* sample timing guidelines [19]	8
Specific requirements on patient's historical record missed/not heeded	6
Anti-D Ig inappropriately administered to women who had delivered an RhD negative infant as the cord RhD status was not checked and was assumed to be RhD positive	4
Incorrect ABO/RhD to known haemopoietic stem cell transplant (HSCT) patients	4
Anti-D Ig inappropriately administered to a known RhD positive woman	3
Total	**39**

**BCSH = British Committee for Standards in Haematology*

Case 1: A failure to consult historical records results in a patient with multiple antibodies receiving a red cell transfusion of incorrect phenotype

A patient had a positive antibody screen in 2002 which was flagged under the patient A&E (accident and emergency) number. The patient had received red cell transfusions on two occasions (2007 and 2013) that were not of the correct phenotype due to a failure to consult historical records. On these occasions the samples were booked in using the NHS/Hospital number, the antibody screens were negative and the patient was transfused red cells that had been electronically issued on both occasions. When a further request was received by the laboratory the patient's historical record under the A&E number was found and it was noted the patient had previously detectable anti-K, anti-Jk^a and anti-Kp^a in 2002.

Learning points

- Qualified biomedical scientists (BMS) crossmatching red cells and any member of staff issuing components must take responsibility for checking **all** the relevant laboratory history on a patient to ensure that they issue components of the correct specification
- Duplicate patient records must be avoided to prevent essential transfusion and/or antibody history being overlooked. There should be a policy to identify and link separate records that exist for each patient at the time of the transfusion request [19]

Table 9.5: Information provided on request form but missed n=10

Information provided on request form but missed by laboratory staff	Number of reports
Request for irradiated components	7
Request for RhD/K matched and HbS negative for sickle cell patient	2
Request for irradiated and cytomegalovirus (CMV) negative	1
Total	**10**

Learning points

- Maintaining an accurate patient database is a critical safety measure in the treatment of patients. Transfusion laboratories must have a robust search protocol in place to identify historical patient records in order to find details of known antibodies, haemoglobinopathies and previous relevant treatments, such as haemopoietic stem cell transplant or use of purine analogues
- The age and gender of a patient are required to determine some specific requirements

Testing errors n=51

Testing errors include misinterpretation of results 11/51 (21.6%), technical errors 11/51 (21.6%) and transcription errors 6/51 (11.7%). The remaining cases were due to procedural errors resulting in incomplete testing in 23/51 (45.1%), see Figure 9.3.

ABO/RhD grouping errors

There were 10 grouping errors (3 ABO, 7 RhD), all associated with manual interventions: transcription errors (6), interpretation errors (2) and technical errors (2).

Pre-transfusion testing is an essential part of the transfusion process: accurate ABO/RhD grouping is the most important serological test. Despite recommendations for fully automated grouping some laboratories continue to perform manual ABO/RhD grouping for example in emergencies or out-of-hours. SHOT supports recommendations published by the UK Transfusion Laboratory Collaborative (UKTLC) for routine use of full automation whenever possible for all samples throughout 24 hours, to eliminate manual errors [30].

Learning points

- Successive Annual SHOT Reports have demonstrated that manual intervention is prone to human error. SHOT error reports demonstrate a continuing need for appropriate serological knowledge and understanding by all blood transfusion laboratory staff to underpin the safety provided by automation and information technology (IT)
- The UK Transfusion Laboratory Collaborative (UKTLC) [30, 31] recommends that all laboratories should have full walk away automation which is in use 24 hours, 7 days a week, with bidirectional interfaces to the laboratory information system

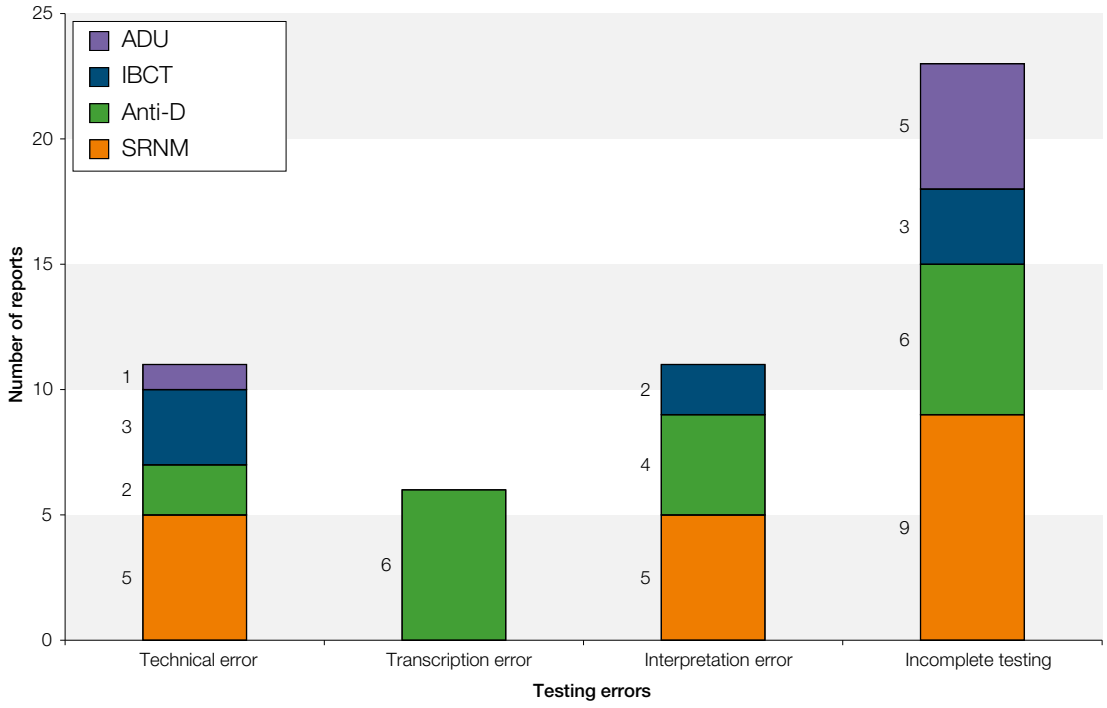


Figure 9.3: Testing errors with their outcomes n=51

Further analysis, where these testing errors are categorised under their main chapter headings, so that they can be linked to outcome is 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.

Table 9.6: Procedural error n=23 These all resulted from laboratory staff failing to follow standard operating procedures (incomplete testing)

Procedural errors	Number of reports
Omission or late administration of anti-D Ig because Kleihauer test was: a) not performed within 72 hours post delivery b) performed within 72 hours but anti-D Ig was not administered within 72 hours (Case 2)	6
Erroneous low platelet counts that were reported for patients whose platelets were known to 'clump' in ethylene diamine tetraacetic acid (EDTA)	4
Antibody identification not performed following a positive antibody screen	4
Red cells issued and transfused before crossmatch results had been confirmed	3
Group and antibody screen not performed prior to issue of crossmatched red cells	2
Antibody screen not performed	1
Red cells transfused to neonate not crossmatched against the maternal sample which contained multiple alloantibodies	1
Non–human leucocyte antigen (HLA)-matched platelets transfused due to failure to enter available HLA results into the computer system	1
Erroneous full blood count due to clotted sample	1
Total	**23**

Learning point

- Inappropriate transfusions could be avoided if laboratories did not transmit results they know or suspect to be inaccurate, but instead requested a second sample

Case 2: Delay in reporting positive Kleihauer caused by a laboratory processing error

A standard dose of 500IU anti-D Ig was given to a woman after delivery, but there was an estimated 9mL bleed by Kleihauer testing. The sample was referred to the Blood Service reference laboratory to confirm the result by flow cytometry. Further anti-D Ig was required to cover the fetomaternal haemorrhage (FMH) and was not administered within 72 hours, because the flow cytometry result was reported 60h after delivery leaving only 12 hours (overnight) to achieve administration of anti-D Ig which was to be given in the community.

Learning point

- A robust service should be in place to allow fetomaternal haemorrhage (FMH) testing to be completed with sufficient time to allow for referral for flow cytometry if required so that administration of a full dose of anti-D Ig can be completed within 72 hours of delivery, particularly where administration will take place within the community

Case 3: Incomplete testing results in a neonate receiving a red cell transfusion that did not meet their specific requirements

Compatibility testing was performed against a neonatal sample and not the maternal sample as required [32]. The mother had multiple antibodies including anti-D, anti-Fy^a, anti-Jk^b, anti-M and anti-S and subsequent testing showed that the unit issued to the neonate was incompatible with the mother.

While this may have been a short cut it is important to establish that all members of staff have appropriate knowledge and that they follow a correct standard operating procedure (SOP).

Learning points

- Omission of steps (taking short cuts) leads to errors, so processes must be followed according to a robust standard operating procedure (SOP). This is a primary principle of good manufacturing practice (GMP)
- Competency-assessment must include understanding and knowledge as well as simply the ability to follow a standard operating procedure (SOP). An SOP cannot cover every scenario and the ability to apply knowledge and recognise personal limitations are essential requirements of a qualified biomedical scientist (BMS)

Table 9.7: Interpretation errors n=11

Interpretation errors	Number of reports
Antibody identification results	5
ABO grouping errors	1
RhD grouping errors	1
Inappropriate administration of anti-D Ig to a woman with immune anti-D	1
Omission of anti-D Ig to a woman with 'partial D'	1
Inappropriate administration of anti-D Ig to an RhD positive woman	1
Anti-D Ig inappropriately administered to a woman who had delivered an RhD negative infant but the manual cord group was misinterpreted as RhD positive	1
Total	**11**

Table 9.8: Technical errors n=11

Technical errors	Number of reports
Inappropriate use of electronic issue	6
Anti-D Ig administered inappropriately as a result of incorrect estimation of fetomaternal haemorrhage (FMH) by Kleihauer testing	1
Anti-D Ig administered inappropriately as a result of a Kleihauer test that was mistakenly performed on the maternal sample of a woman who had delivered a RhD negative infant	1
No grouping reagents were added to manual ABO tube group	1
ABO grouping error due to possible contamination with incorrect antisera	1
Erroneous abnormal clotting results were reported on a sample suspected to have clotted prior to testing where a repeat test showed normal results	1
Total	**11**

Case 4: Manual ABO grouping error in an emergency

Group-specific red cells had been requested for a patient with a ruptured aortic aneurysm. A manual emergency blood group result was recorded as AB RhD positive but the confirmatory automated blood group result was A RhD positive. This was possibly caused by a contamination from the anti-A,B in the tube labelled anti-B. One unit of group AB RhD positive red cells had been transfused before the error was detected.

Learning points

- When emergency groups are performed they MUST include a test against anti-A, anti-B and anti-D with appropriate controls or reverse group, if there is insufficient time for this level of testing then group O red cells must be issued [19]
- The ABO and RhD group must, wherever possible, be verified against historical patient results
- If it is not possible to obtain a reliable reverse grouping result and there is no historical group against which to validate, the cell group should be repeated [19]

Table 9.9: Transcription error n=6

Transcription errors	Number of reports
Cord samples tested post delivery incorrectly reported as RhD positive resulting in inappropriate administration of anti-D Ig	4
Cord samples tested post delivery incorrectly reported as RhD negative resulting in omission of Anti-D Ig to RhD negative women	2
Total	**6**

Learning point

- The laboratory should have a policy with respect to the manual editing and authorisation of test results [23]

Component selection n=36

Most of these errors resulted in patients receiving an incorrect blood component (9/36) or one not of the correct specification (19/36). More information can be found in the Annual SHOT Report 2013 Supplement for Chapter 9 located on the SHOT website, www.shotuk.org under SHOT Annual Reports and Summaries, Report, Summary and Supplement 2013.

Component labelling, availability and HSE n=104

Most errors in this group resulted in the correct blood being given to the correct patient despite a handling and storage error (43/104) or an error associated with patient identification resulting in 'right blood right patient' (48/104). More information can be found in the Annual SHOT Report 2013 Supplement for Chapter 9 located on the SHOT website, www.shotuk.org under SHOT Annual Reports and Summaries, Report, Summary and Supplement 2013.

Miscellaneous n=9

There were 9 miscellaneous cases that highlight a lack in communication and knowledge by laboratory staff.

Avoidable, delayed and undertransfusion n=7

There were delays caused by equipment failures or insufficient communication between the laboratory staff and clinical teams about the clinical urgency in 5/7 cases. In one case surgery was delayed until a new sample had been received in the laboratory following an initial enquiry when theatre staff were incorrectly informed that the previously sent preoperative sample was invalid.

Inappropriate use of O RhD negative red cells occurred in 2/7 cases because of inadequate communication between the clinical team and laboratory staff. There was a delay in provision of compatible units for patients with positive antibody screens.

Learning point

- In an emergency, laboratory staff can help clinical teams by providing clear timelines for expected component availability, particularly when further testing is required i.e. when a patient has irregular antibodies. Clinical teams can help laboratory staff by providing them with a clear assessment of the urgency of the situation and an assessment of when components are required without delay

Specific requirements not met n=2

Laboratory errors contributed to a failure to meet a patient's specific requirements due to erroneous removal of specific requirements flags (see Case 17 in Chapter 8 Incorrect Blood Component Transfused (IBCT)) and incomplete follow up of a transferred patient's previous hospital for records of known antibodies.

IT-related laboratory cases n=95

There were 95 laboratory cases that also had an IT element and these are described in their main chapters: Chapter 8 Incorrect Blood Component Transfused (IBCT), Chapter 11 Avoidable, Delayed or Undertransfusion (ADU), Chapter 12 Right Blood Right Patient (RBRP), Chapter 13 Handling and Storage Errors (HSE) and Chapter 14 Anti-D Immunoglobulin – Prescription, Administration and Sensitisation.

COMMENTARY

This chapter has focussed on sample receipt and registration, testing errors and miscellaneous cases. These reports highlight key areas that have still not been addressed, such as effective communication and poor serological knowledge and understanding by laboratory staff. During the 'booking in' process it is essential to take into account any historical patient information and ensure all previous results and any specific requirements have been taken into consideration. National guidelines define the minimum dataset required for samples and requests [25, 33].

As in previous years, all ABO and RhD typing errors occurred as a result of manual interventions. Manual testing is known to carry a high risk of error and should only be used when urgent clinical situations dictate. Reporters expressed concern over laboratory staff shortages and pressures associated with heavy workload and distractions were cited as contributory factors in a number of cases. Pre-transfusion testing has potential for error at a number of critical points and must be performed according to robust SOPs.

In addition to serological testing, historical records may influence the selection of the most appropriate components for the patient, so must be consulted and any necessary actions taken. In clinical emergencies clear timelines on the availability of requested components need to be communicated effectively to the clinical team. If crossmatched red cells are required for patients with known antibodies, delays in provision need to be discussed and agreed before crossmatching can be completed, as group specific units of appropriate phenotype should be selected when possible and the associated risks should be agreed with clinicians.

The modern transfusion laboratory is critically dependent on IT and automation. Common causes of wrong blood errors in this report are the failure to use warning flags on the LIMS properly, either because they have not been heeded or have not been set up or updated in a timely manner. Maintaining correct patient identification throughout the process is imperative and must always be ensured at each critical point of the laboratory process starting with entering correct patient demographics onto the laboratory information management system. Electronic issue (EI) must be under the control of the LIMS with no manual interventions. Logic rules and flags should be set up to support this.

Supplementary information, including further details of all laboratory cases reported to SHOT in 2013 can be found 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.

Please note the updated SHOT Laboratory Lessons published 2013 are also available under the Current Resources section of the SHOT website www.shotuk.org.

UK Transfusion Laboratory Collaborative (UKTLC)

The members of the UKTLC have revised their recommendations and have produced updated standards [31] based on the findings from 2 national surveys performed in 2011 and 2013. These standards focus on 3 key areas: adequate staffing, adequate levels of knowledge and skills and technology. The laboratory accreditation organisation, Clinical Pathology Accreditation (UK) Ltd (CPA) has agreed to consider these standards when auditing compliance against their own standards. The Medicines and Healthcare products Regulatory Agency (MHRA) also confirmed that where circumstances have warranted it, inspectors have asked why a Trust/Health Board/Hospital does not work in line with the recommendations from a professional body. SHOT encourages all laboratories to comply with the UKTLC standards to improve patient safety.

Recommendation

- All blood transfusion laboratories should be familiar with and comply with the UK Transfusion Laboratory Collaborative (UKTLC) standards. Accrediting and regulatory organisations have supported this initiative, therefore compliance with these standards is strongly recommended

Action: Trust/Health Board Chief Executive Officers, Transfusion Laboratory Managers, 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.

Summary of Errors Related to Information Technology (IT) 10

Author: Megan Rowley

This chapter covers transfusion adverse events that relate to laboratory information management systems (LIMS) as well as other information technology (IT) systems and related equipment that are used in the delivery of hospital transfusion services.

The cases included are drawn from the other chapters of this report as shown in Table 10.1. The selected cases included events where IT systems may have caused or contributed to the errors reported, where IT systems have been used incorrectly and also includes cases where IT systems could have prevented errors but were not used. The corrective and preventative action suggested by hospitals in response to a few errors included IT solutions and therefore these have been included where they illustrate an important point.

In 2013 there were 187 (excluding Anti-D) reported incidents of errors related to IT systems (see Table 10.1) compared with 80 in 2012, 74 in 2011, 56 in 2010, 61 in 2009 and 44 in 2008. The breakdown of the 2012 figures is shown for comparison: there was a reduction in laboratory wrong component transfused (WCT) errors but a large increase in specific requirements not met (SRNM) errors, particularly relating to those where the primary error was outside the laboratory. Cases were included this year if it was considered that specific requirements might have been met if IT flags or alerts had been used in the laboratory. Similarly, right blood right patient (RBRP) cases increased because of the inclusion of any cases where incorrect data was recorded on one or more computer systems.

Error	2012	2013
Wrong component transfused (WCT)	21	8
Specific requirements not met laboratory (SRNM)	31	36
Specific requirements not met clinical (SRNM)		81
Right blood right patient (RBRP)	8	51
Avoidable, delayed or undertransfusion (ADU)	3	2
Handling and storage errors (HSE)	15	9
Haemolytic transfusion reaction (HTR)	2	0
Total	**80**	**187**
Anti-D immunoglobulin (Anti-D Ig)	13	16
Total including Anti-D Ig	**93**	**203**

Table 10.1: Source of cases included in the IT chapter

In 2013, 80/187 (42.8%) of the component-related incidents originated in the transfusion laboratory and 107/187 (57.2%) originated in the clinical area. A total of 157 cases involved red cells, 23 platelets and 7 related to plasma components. An additional 16 cases were anti-D-related, 15 of which were laboratory errors. The total of 203 IT-related errors includes 95 laboratory and 108 clinical errors.

A small number of cases, 22/187 (11.8%), occurred in children (including 9 infants below the age of one year).

Where the timing of the error was known (125 cases) 96/125 (76.8%) occurred during core working hours and, of the 29/125 (23.2%) out of hours, 18/125 (14.4%) took place after midnight.

Where the urgency of the request was available (173 cases) 114/173 (65.9%) of the transfusions were considered routine, 42/173 (24.3%) urgent and 17/173 (9.8%) were emergencies. In 14 cases the urgency of the request was not stated.

Deaths n=0

There were no transfusion-related deaths where IT systems contributed.

Major morbidity n=1

Use of an age- and gender-specific flag was not used to prevent sensitisation to the K antigen.

Minor morbidity

There were four cases where incorrect use of IT systems contributed to minor morbidity.

Three involved overriding warning flags resulting in the transfusion of ABO incompatible red cells, non-phenotyped units to a patient with red blood cell (RBC) antibodies and antigen-positive blood to a non-sensitised patient that resulted in alloimmunisation.

In the fourth case the timely setting of a warning flag would have prevented the transfusion of non-human leucocyte antigen (HLA)-selected platelets to a patient with HLA antibodies.

No harm

All the other cases (182/187, 97.3%) did not result in any harm to the recipient of the components transfused.

IT events are added to the appropriate chapters, and further information is also 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.

Avoidable, Delayed or Undertransfusion (ADU)

11

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Definition:

- **Where the intended transfusion is carried out, and the blood/blood component itself is suitable for transfusion and compatible with the patient, but where the decision leading to the transfusion is flawed**
- **Where a transfusion of blood/blood component was clinically indicated but was not undertaken or was significantly delayed**
- **Avoidable use of emergency O RhD negative blood where group-specific or crossmatched blood was readily available for the patient**

DATA SUMMARY
Total number of cases: n=161

Implicated components		Mortality/morbidity	
Red cells	136	Deaths definitely due to transfusion	1
Fresh frozen plasma (FFP)	11	Deaths probably/likely due to transfusion	0
Platelets	11	Deaths possibly due to transfusion	4
Cryoprecipitate	0	Major morbidity	7
Granulocytes	0	Potential for major morbidity (Anti-D or K only)	0
Anti-D Ig	0		
Multiple components	3		
Unknown	0		

Gender		Age		Emergency vs. routine and core hours vs. out of core hours		Where transfusion took place	
Male	71	≥18 years	144	Emergency	31	Emergency Department	14
Female	90	16 years to <18 years	1	Urgent	57	Theatre	14
Not known	0	1 year to <16 years	9	Routine	66	ITU/NNU/HDU/Recovery	16
		>28 days to <1 year	1	Not known	7	Wards	76
		Birth to ≤28 days	6			Delivery Ward	3
		Not known	0	In core hours	65	Postnatal	1
				Out of core hours	44	Medical Assessment Unit	21
				Not known/Not applicable	52	Community	1
						Outpatient/day unit	5
						Hospice	0
						Antenatal Clinic	0
						Other	0
						Unknown	10

(ITU=Intensive therapy unit; NNU=Neonatal unit; HDU=High dependency unit)

What to report:

- Prescription of components that are not required or are inappropriate as a result of erroneous laboratory results, transcription errors or faulty clinical judgement
- Prescription for an inappropriate indication
- Prescription at a dose or rate inappropriate for the patient's needs, excluding those cases which result in transfusion-associated circulatory overload
- Failure to transfuse when indicated, undertransfusion and significant delays in transfusion, whether caused by the laboratory or the clinical area

Overview

A total of 161 reports were included in this analysis, 71 reports relate to male patients and 90 to females. The age range was 0 to 95 years (median age 68) with 17 of these patients less than 18 years of age. Five patients died, and 7 suffered major morbidity as a direct or partial result of delayed transfusion.

Delayed transfusions n=34

The transfusions were 'emergency' in 19 cases, 'urgent' in 12 and 'routine' in 2. In 1 the urgency was not stated. The most common elements identified were communication and logistic failures.

Haemovigilance schemes focus on adverse reactions and events in recipients following transfusion of blood and its components. However, patients may also suffer adverse consequences if transfusion does not take place in a timely manner or is inadequate. The UK National Patient Safety Agency (NPSA) was set up in 2001 to identify trends and patterns in patient safety problems through a National Reporting and Learning System (NRLS) [34]. Hospitals were encouraged to report any unintended or unexpected incident that could have or did lead to harm. This scheme issued national warnings and alerts from sentinel events. Between 2005 and 2010 reports were received of 11 deaths and 83 incidents in which patients were harmed as a result of delayed provision of blood in an emergency. A 'Rapid Response Report' followed in October 2010 [35] with immediate action by hospitals to be completed by April 2011, including review of major haemorrhage protocols (MHP) and reporting any incidents of death or harm to the NPSA and SHOT. SHOT has therefore included reports of delays from 2010.

Hospitals were advised to review their local practices for requesting and obtaining blood in an emergency. This should include training and regular drills similar to training for cardiac arrest calls. The protocol should be activated using an easily recognised trigger phrase, and a local team member nominated to co-ordinate communication. Hospital transfusion committees are recommended to review all incidents to ensure activation is appropriate and effective. Some of these issues are apparent in the cases reported below.

Although the NPSA recommendation related only to emergency transfusion, SHOT will accept any report where the clinician noted 'delay', for example delay resulting from reluctance to transfuse overnight despite clear clinical indications for earlier transfusion. Emergencies are also associated with other SHOT-reportable adverse events such as sample mix-ups, poor labelling and ultimately, wrong components transfused including incompatible ABO red cells.

Reports to SHOT of delayed transfusion have increased each year, Figure 11.1 (ages ranged from birth to 86 years). These are seriously ill patients with a high mortality (21/69, 30.4%) and in some cases 10/69 (14.5%) this was related to the delayed transfusion. The majority of these events were emergencies. In 2 instances reported in 2013 the foundation year doctors did not recognise signs and symptoms of acute haemorrhage so that resuscitation and transfusion were delayed (Cases 2 and 6 below). Both these cases were compounded by serial handovers at weekends and no consistent consultant ownership or a lack of senior leadership.

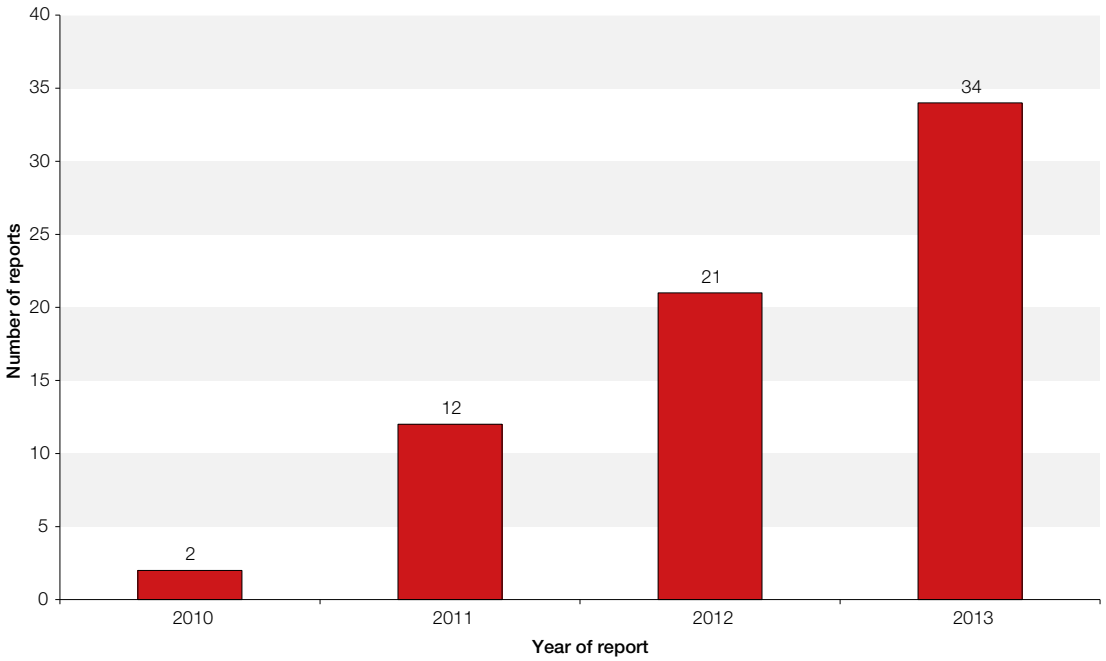


Figure 11.1: Number of reported delays by year, 2010 to 2013 n=69

Examples of the reasons or contributory factors to some of the delayed transfusions

- Poor knowledge leading to failure of or inappropriate activation of the MHP
- Incorrect trigger phrase used to activate the MHP
- Failure by foundation year doctors to recognise clinical signs of haemorrhage and shock
- Poor continuity of patient care with no adequate consultant ownership or leadership
- Poor communication between teams and departments (including failure to inform the laboratory of the emergency)
- No contingency plan for major haemorrhage during fire alarms
- Refusal to transfuse overnight despite clinical need
- Mistakes and omissions in patient identification and sample labelling requiring repeat samples with the resultant delays
- Delays in samples reaching laboratory (e.g. inappropriate use of pneumatic tube system instead of hand delivery as is required by this hospital's emergency protocols)
- Delay due to presence of alloantibodies (some samples needed to be sent to Blood Service laboratories for crossmatch)
- Patient transferred from ED to ward with no wristband, unable to identify herself and with a new shift of nursing staff who could not identify her
- Unable to release electronically as quarantined by the system (mixed field result/uncrossmatched units placed in issue refrigerator)
- Delayed collection and delivery of components
- Lack of clear communication between teams and departments regarding the urgency of the situation
- Laboratory attempts to determine the urgency of the situation misinterpreted as refusal to provide emergency components
- Components not delivered to the correct location due to unclear instructions (by both internal and external sources)
- Failure to appreciate the extent of blood loss due to the patient being treated in different areas by different clinical teams

- Delay in patient assessment leading to a delay in treatment
- Failure to provide a comprehensive handover in both laboratory and clinical areas
- Equipment failures (e.g. printers, laboratory system upgrade)
- Emergency units not able to be issued without a patient identification (ID) number

Deaths n=5

These deaths were all linked to delays in transfusion, one was 'definitely' related, Case 1 below, and 4 'possibly' related.

Case 1: Death attributed to delayed transfusion in a child with sickle cell disease

A young child with sickle cell disease was admitted with a sickling crisis. His Hb was 57g/L on admission. This was rechecked later the same day when it was 50g/L. The Hb was not checked the following day (a Sunday). On Monday the Hb was 28g/L (reported at midday). It was stated in the report that there was a delay of more than 4 hours in requesting red cells and starting the transfusion – the child suffered cardiac arrest and died during the transfusion in the evening.

The clinician who reviewed the case attributed death to untreated anaemia.

Case 2: Death follows failure to recognise and act on shock 4 days after major surgery in a patient on anticoagulants

A 66 year old man had spinal surgery on a Thursday. He was at high risk of complications (ischaemic heart disease with previous coronary artery stenting, was on long-term warfarin for recurrent thromboembolic disease).

Surgery was uneventful and he was returned from a planned overnight stay in the high dependency unit to the ward on Friday on a heparin infusion. His warfarin was restarted on this day. On Saturday his Hb was stable and international normalised ratio (INR) was 1.1. He was apparently well until the middle of Sunday night when he developed hypotension and had a temporary loss of consciousness. The possibility of occult bleeding was raised early on Monday morning. He continued to have hypotension; later tachycardia and poor urine output were noted, but the suspected and then confirmed diagnosis of a large retroperitoneal bleed was made several hours later at 17:00. The resuscitation was slow (two units of blood between 14:00 and 17:00 on Monday) and he died later the same day.

The detailed root cause analysis (RCA) identified many areas of concern particularly the failure to recognise symptoms and signs of shock, poor anticoagulant management over the weekend during which time his heparin dose was excessive (there were no clinical notes made on Sunday) and poor leadership.

Case 3: Delayed provision of red cells as a result of poor labelling and communication confusion

An elderly man required an emergency transfusion during massive gastrointestinal haemorrhage (Hb fell from 88 to 47g/L) complicated by a warfarin-related high INR of 11.5. Group-specific red cells were issued but were unlabelled for the patient and could not be transfused. The samples were sent by the incorrect route (pneumatic tube rather than hand-delivered), there were communication failures between the clinical area and the laboratory. The patient arrested and died, and the delay in transfusion may have contributed (3 errors).

Case 4: Failure to prepare for predictable thrombocytopenia contributes to death

A 62 year old man died from haemorrhage and sepsis. He was receiving chemotherapy for malignant disease resulting in a falling platelet count. A group and screen sample was not sent in a timely manner despite the predictable fall in count so that platelets were not available and prophylaxis was not given when indicated at the threshold platelet count (<10x10^9/L) (2 errors).

Inadequate junior medical staffing levels and supervision were cited as contributory factors.

Case 5: More haste less speed – wrong date of birth

A 66 year old man with a ruptured aortic aneurysm had delayed provision of major haemorrhage packs as the ambulance staff transferring him from one hospital to another gave the wrong date of birth to the emergency department. This was entered into the Trust information technology (IT) system. In addition, the blood sample was delayed reaching the laboratory and had not been marked as urgent (2 errors).

Major morbidity n=7

Seven cases of delayed transfusion were associated with major morbidity.

Case 6: A woman with pneumonia developed gastrointestinal bleeding with failure to recognise signs of bleeding and role of medication

A 44 year old woman was admitted with bacterial pneumonia. In addition to antibiotics, on the following day, Tuesday, she was prescribed a nonsteroidal anti-inflammatory agent (NSAID) for pain. On the third day of admission (Wednesday) she had a large haematemesis – Hb was 94g/L having been 124g/L on admission. Endoscopy took place on Friday and showed 3 gastric ulcers which were not actively bleeding, but she had a tachycardia of 116bpm. She was prescribed intravenous (IV) omeprazole but had no cannula for some hours at the weekend. No medical notes were recorded for the weekend which was interpreted in the RCA as a failure to review the patient.

Late on Sunday night she had repeated further episodes of haematemesis with melaena, Hb was 73g/L, blood pressure (BP) 88/55mmHg. The NSAID was stopped. She received one unit of blood; 2 hours later Hb was 52g/L, pulse rate 132 and she was distressed. The major haemorrhage protocol was then activated. She suffered a cardiac arrest with at least 15 minutes without an output with successful resuscitation but suffered hypoxic brain injury.

The root causes were identified as a failure to recognise haemodynamic compromise with delay in activation of the MHP, and a lack of awareness of adverse effects of NSAIDS during acute illness. There should be a clearly defined escalation policy to ensure the delivery of basic and essential medical and nursing care at night and the hospital should ensure that trainee medical staff on duty at night are competent to deal with all relevant acute medical conditions.

Delayed transfusion associated with cardiac arrest

In 3 cases the delay resulted in cardiac arrest from which the patients recovered, one only partially (Case 6 above). One patient who arrested had delayed admission following collapse at home. Admission to the ED was delayed for 3 hours while the ambulances were ‘stacking’. A further delay of 2 hours occurred in assessment in the ED. A Hb done 2 hours after admission was 38g/L and the patient then suffered a cardiac arrest with evidence of gastrointestinal bleeding (melaena). The MHP was then activated and she was successfully resuscitated. If the blood sample had been taken in a timely manner the use of emergency O RhD negative units might have been avoided. Over-capacity in the emergency department was identified as a contributory factor to the delayed admission and assessment.

In a further 2 cases the patients were already in cardiac arrest when the blood was urgently requested. Delay in one of these cases resulted from an incorrect trigger phrase for the MHP (Case 7 below) In another case a patient with alloantibodies bled unexpectedly after surgery and poor planning meant that appropriate units were not available on standby.

There were 2 additional cases in this group. In the first, the clinical staff were unable to access the remaining crossmatched units in the electronic satellite refrigerator. The blood had inadvertently been fated as used when the transfusion administration record was returned to the laboratory. The patient had to be managed with colloid infusion until the transfusion laboratory could reissue the units. In the final case, the patient arrested due to hypoglycaemia (originally thought to be due to a transfusion reaction) These cases are a reminder that poor management of transfusion is often one factor amongst many contributing to deterioration in seriously ill patients.

Case 7: Confusion about the trigger phrase for massive haemorrhage leads to the wrong emergency team being alerted and a delay in receipt of components

A patient was admitted to a maternity hospital with pulseless electrical activity due to hypovolaemia from a ruptured uterus. The MHP was triggered by the clinical staff at 23:40 using an incorrect trigger phrase. This was not recognised by the hospital switchboard who consequently activated only the cardiac arrest team in error.

The caller from the clinical area did not realise he had not been connected to the transfusion laboratory to discuss the requirements for the patient. At 00:55 the clinical area called the transfusion laboratory to ask where the platelets were. The laboratory had not been advised of the activation of the MHP, but was able to prepare and rapidly issue appropriate components. Three emergency O RhD negative units were transfused before group specific blood became available. The patient required admission to ITU.

The clinical staff were reminded of the importance of using the correct trigger phrase to activate the massive haemorrhage protocol to ensure the correct teams are alerted. The switchboard staff were given examples of other phrases that clinical staff may inadvertently use to try to ensure there was no delay/confusion in the future. The patient was admitted to intensive care in the short term but she made a full recovery.

Learning point

- All staff members involved in transfusion must be trained to know the correct trigger phrase for the massive haemorrhage protocol. Drills should be regularly run in high risk areas such as obstetrics and vascular surgery

Case 8: Delayed transfusion as patient is transferred three times

A patient with acute myeloid leukaemia was admitted with a Hb of 40g/L, but the unit of blood prescribed in the emergency department was not administered for 28 hours because the ward and the tertiary hospital to which he was transferred assumed that it had been given.

This case shows a failure of communication and raises questions about consultant ownership when patients are transferred between teams.

Avoidable transfusions n=120

The following section describes the errors associated with avoidable transfusion. These are similar each year.

Sample errors n=21

Table 11.1: Causes of full blood count sample errors n=21

Error	Number of cases
Dilute	8
Inadequate	4
Clotted	7
Wrong blood in tube	1
Pre-dialysis sample	1
Total	**21**

Case 9: Poor sample-taking leads to unnecessary hospital admission and transfusion

An elderly woman was reviewed at home because of a swollen leg. The general practitioner (GP) took a full blood count sample. However, having no sample tube with him, the GP walked 10 minutes from the patient's house to the surgery with the blood still in the syringe and then decanted the sample into a tube, labelled it with the patient's details and sent it to the laboratory. The sample is likely to have clotted in the syringe and given an erroneous result.

The laboratory phoned the out-of-hours medical service to report the Hb 76g/L. The out-of-hours medical service contacted the patient and arranged for immediate admission to the medical assessment unit (MAU).

On admission samples were taken for group and antibody screen, crossmatch and repeat full blood count and 2 units of red cells were subsequently issued and prescribed. The patient had no symptoms of anaemia.

The hospital full blood count sample result was Hb of 114g/L, authorised at 06:38. However, blood was issued at 07:14 and the 1st unit was started at 09:55, before the result, which had been accessible for more than 3 hours, was checked by the staff on the ward. The transfusion was stopped at 11:20 (after 100mL had been given) when the doctor realised the Hb result from the GP was probably spurious.

This root cause error in blood sampling led to an elderly patient having a needless admission to hospital at night and exposure to a blood component she did not need. However, there was a series of errors. First the GP should know that a delay between blood sampling and decanting into the anticoagulant tube is likely to produce an unreliable result. Secondly the patient, who had no symptoms of anaemia, should have been assessed by a doctor before being admitted to hospital. Thirdly, the patient should have been fully assessed in hospital prior to the transfusion to ensure that transfusion was indicated, in particular, the repeat Hb result should have been reviewed before transfusion started. Emergency admission to hospital at night is very distressing and disruptive for the patient.

Potentially avoidable use of emergency O RhD negative red cells n=10

Emergency O RhD negative red cell units are a precious resource reserved for emergency use. Whilst most of the situations here may have required immediate treatment with blood components, better preparation and communication with laboratory staff could have resulted in more appropriate crossmatched blood. In 5/10 cases crossmatched blood was already available in the laboratory.

In 2 further cases the patients had known alloantibodies and in 1 of these cases emergency blood was transfused in a non-emergency situation.

In 3 instances, there were problems with the samples. In 1 of these the non-availability of a suitable patient sample meant that emergency O RhD negative blood was used, in a second case there was a valid sample for electronic issue, but this was disregarded and a mismatch between a request form and sample resulted in sample rejection and emergency O RhD negative red cells had to be used in the interim.

In the third case (Case 13 cross-referenced below) lack of training in use of a point of care testing device led to a patient receiving emergency O RhD negative red cell components.

Failure to review results n=11 and failure to follow instructions n=4

Failure to review prior to transfusion n=11. In one case a patient with a preoperative Hb 202g/L bled 1500mL during surgery. Two units were prescribed and one was given. The patient had polycythaemia and a Hb 173g/L 20 hours post transfusion.

Failure to follow instructions n=4. Three patients were transfused despite clear instructions that transfusion was not necessary. There was an additional case of communication failure during handover.

Haematinic deficiency n=9

There were 8 cases with iron deficiency anaemia and one patient with an asymptomatic macrocytic anaemia (B12 deficiency).

Table 11.2: Red cell transfusions in patients with haematinic deficiency n=9

Number	Deficiency	Indication for transfusion	Symptoms Y/N	Hb pre transfusion	No. of red cell units given	Hb post transfusion
8	Iron	Iron deficiency anaemia	N	76g/L (MCV 63.9fL)	2	Unknown
		Anaemia	N	Hb 67g/L	600mL	Hb 93g/L
		Menorrhagia (lethargy)	N	Hb 46g/L (MCV 60fL)	3	Hb 102g/L
		'felt unwell'	N	Hb 58g/L	3	Hb 76g/L
		Shortness of breath on exertion	Y	Hb 65g/L	3	Hb 125g/L
		Menorrhagia (lethargy)	N	Hb 50g/L	3	Hb 88g/L
		Menorrhagia (acute blood loss)	N	unknown	3	Unknown
		? gastrointestinal (GI) bleed (iron tablets)	N	Hb 83g/L	3	Hb129g/L
I	B12	Admitted via GP B12 <30pg/mL Known macrocytic anaemia	N	Hb 58g/L	3	Unknown

The majority of these patients were transfused in acute settings, either in the ED (1), MAU (6) with a further 2 on the ward.

Case 10: Inappropriate transfusion of red cells to an asymptomatic iron deficient patient

A 78 year old man felt unwell and had a Hb 58g/L. He was otherwise asymptomatic and was known to have iron deficiency anaemia. The attending doctor authorised a 3 unit red cell transfusion. The post-transfusion Hb was 76g/L.

The error was detected by the anaemia nurse specialist. The patient should have been put onto the hospital's iron deficiency anaemia pathway and immediate management discussed with the consultant haematologist.

Learning point

- Transfusion is not the most appropriate management for iron deficiency anaemia especially if the patient is asymptomatic. These patients should be discussed with a consultant haematologist before arranging transfusion

Erroneous results n=20

Cause unknown n=8

The cause of the wrong blood results contributing to unnecessary transfusion could not be established in 8 patients.

Failure to consult correct/most recent results n=12

In 5 cases the result from a previous admission was viewed and acted on, and in a further 3 cases, transfusion was based on earlier results (recognised as likely to be wrong) instead of waiting for the results of the repeat sample.

In four additional cases, the results of another patient were used as the basis for transfusion.

Case 11: Error when consulting patient blood results puts a woman at risk of TACO

A woman attended the delivery suite in early labour. One month prior to this the Hb was 97g/L and she was taking iron tablets. She was discharged home and advised to return when labour was established. The midwife took a repeat full blood count to check the response to oral iron.

The midwife accessed results and noted that the Hb was 74g/L, printed this out not noticing it was from a previous admission. She discussed this wrong result with the consultant who advised proactive management when in labour. The midwife filed the incorrect result in the patient's notes and documented the consultant instructions.

The woman returned to the delivery suite in advanced labour 4 hours later. Based on the earlier wrong result a 4 unit crossmatch for immediate transfusion was requested – 'each unit over 2 hrs and for rapid transfusion if there was excessive bleeding' (the actual blood loss was 300mL in total). During the second unit, the patient became hypertensive and there was a concern that she was developing pregnancy-induced hypertension (and at risk for transfusion-associated circulatory overload (TACO)). A repeat Hb taken at this time was 110g/L and the transfusion was stopped. The correct Hb result from earlier in the day was 108g/L not 74g/L.

Learning point

- Care must be taken when reviewing patient blood results to ensure that the correct record is viewed

Prescription errors n=13

Ambiguous prescribing or misinterpretation of other instructions can result in unnecessary transfusions or transfusion of excessive duration. In 5 cases the component was not prescribed at all, in 3 cases red cell units were prescribed and administered to patients despite instructions to only have units in reserve for surgery. There were 2 patients with 'rolling prescriptions' who were repeatedly transfused without review of the Hb for each transfusion episode.

Case 12: Platelets prescribed to run over 4 hours

A patient was receiving a platelet transfusion which was commenced at around 08:30. The platelets were wrongly prescribed to infuse over 4 hours. Standard practice is for platelet transfusion to be given over 30 minutes.

Inappropriate components prescribed n=5

In one case platelets were prescribed for a patient who had suffered an intracranial haemorrhage following thrombolysis but whose platelet count was normal. Three patients were given FFP inappropriately, 2 were on warfarin and the other patient was intended to receive platelets not FFP. In the 5th case an elderly man with massive gastrointestinal bleeding received 8 units of red cells when the intention was for him to receive 6 units of red cells with 4 of FFP. This error occurred due to ambiguous prescribing and poor handover at a shift change.

Errors related to blood gas analysers and point of care testing devices n=9

Point of care testing devices are helpful to guide transfusion however, they must be quality assured and validated for haemoglobin measurements [21]. In addition all users must be properly trained in their use. A full blood count should be sent to the laboratory as soon as possible to confirm any abnormal results and prevent unnecessary transfusion.

Case 13: A doctor's lack of training to use a point of care testing device contributes to avoidable use of emergency O RhD negative red cells

A 35 year old woman with a suspected upper gastrointestinal bleed was transfused emergency O RhD negative red cells following a point of care testing result. The Hb from the laboratory was 140g/L. The device required a user code but the doctor operating the device had not been trained. The investigation could not establish whose user code had been used to enable the doctor to access the device. A check full blood count on a pre-transfusion sample was normal and the use of emergency blood was not indicated.

Learning point

- Clinical staff are reminded that passwords, user codes or log in details must not be shared with other staff members. Limited access is designed to ensure that only trained personnel can use such testing devices

Low body weight patients n=6

There were 2 paediatric cases in this group. Issues with overtransfusion of children are discussed in Chapter 25 Paediatric Cases in more detail. In the other 4 cases the prescribers did not take into account the patient's low body weight leading to excessive volumes which can put patients at risk of developing transfusion-associated circulatory overload.

Inappropriate transfusions to patients with an objection to transfusion n=2

Patients who have an objection to transfusion whether for personal or religious reasons may carry a written 'advanced directive' to advise of their wishes, however clear consent or not can prove difficult to achieve in confused or incapacitated patients.

In one of these cases the patient had a clear directive in place but lacked capacity meaning she did not raise an objection at the time. In the second case it was not clear from the case notes and the patient had not made their wishes clear.

An additional case is discussed below where a Jehovah's Witness nearly received an inappropriate transfusion (Case 16).

These cases are a reminder that consent for transfusion should be sought wherever possible and not simply assumed.

Units spiked before pre-administration checks avoidable transfusion or near miss? n=3

In 3 cases a unit of blood was spiked without ensuring that the pre-transfusion bedside checks had taken place.

It can be difficult to define exactly the point at which a transfusion has started. SHOT has used the International Society of Blood Transfusion (ISBT) definition, which considers transfusion to have started when the unit is spiked. That means a few cases in this and previous Annual SHOT Reports are categorised as avoidable transfusions, even though the reporters are quite clear that no part of the component was given to the patient. Following a discussion at the SHOT Working Expert Group in February 2014, it was decided that in future such cases should be categorised according to how the unit was fated. Therefore, from 2014 incidents will be categorised as near miss if the spiked unit is fated as wasted, rather than transfused.

These 3 cases would then be classified as 'near miss' rather than 'avoidable transfusions'. This decision was made after the numbers of cases were collated for 2013 and so, for this report, remain in ADU but next year such cases will be classified as 'near miss' events.

Case 14: FFP nearly transfused to a baby based on wrong indication

FFP was issued (although challenged by transfusion staff) based on an erroneous coagulation screen result because the baby had a diagnosis of necrotising enterocolitis (NEC) and was to be transferred to a specialist unit. The component was taken to the ward and drawn into a syringe ready to administer, which is equivalent to spiking the unit, but a repeat coagulation screen showed the clotting to be normal so the component was not administered.

Case 15: Emergency O RhD units taken for a patient inappropriately

A unit of emergency O RhD negative red cells was collected and taken to the ward. The patient had been found on the previous day to have a 'non-specific' cold antibody. A sample was available in the laboratory but no units had been requested. The prescription chart was seen by laboratory staff who noted that this emergency unit was to be transfused over 2 hours.

This was not an emergency and is an inappropriate and potentially unsafe use of emergency O RhD negative blood. The staff nurse had run the unit through the giving set but had not yet connected the unit. The unit was not given but was wasted. A 2 unit crossmatch was performed manually (the patient was not suitable for electronic issue of red cells due to the antibody) on the sample from the previous day.

Case 16: Platelets set up for transfusion before the patient refused

A platelet bag was spiked and about to be administered when the patient declared that he was a Jehovah's Witness and did not want a platelet transfusion. No evidence of consent or discussion was documented in the medical notes.

In all these examples the units were fated as wasted and not as transfused.

Transcription of results n=4

Incorrect transcription of results led to unnecessary transfusion in 4 patients.

Unnecessary transfusions result from poor assessment of symptoms by inexperienced junior doctors n=2

Case 17: A junior doctor misinterpreted a panic attack for symptoms of severe anaemia

The patient had Hb 72g/L due to iron deficiency; the transfusion was stopped and the patient was treated with intravenous (IV) iron.

Case 18: Misinterpretation of symptoms leads to unnecessary transfusion

A post-delivery mother with Hb 84g/L was transfused because the junior doctor thought her symptoms were due to anaemia. This was above the trigger threshold of 70g/L and was unnecessary.

Miscellaneous n=1

Case 19: Patient in theatre receives unnecessary red cells in order to prevent wastage of unit

A woman was undergoing an emergency procedure to stop her bleeding and 3 units of blood were taken into theatre for her. The bleeding stopped before the third unit was transfused. The anaesthetist decided the patient did not need the third unit and attempted to return it to stock. The unit had been out of the controlled environment for more than 30 minutes and could not be returned. The anaesthetist decided to administer the unit rather than waste it. The post-transfusion Hb was recorded as 122g/L.

Undertransfusion n=7

In 5/7 cases the undertransfusion was due to incomplete transfusions of FFP despite prescription of a full adult therapeutic dose. The other 2 cases were red cell transfusions for paediatric patients which are discussed in Chapter 25, Paediatric Cases.

Near miss ADU cases n=15

Similar lessons can be learnt from near miss cases that were detected before the patient received an avoidable or inappropriate transfusion.

Table 11.3: Near misses that could have led to avoidable or unnecessary transfusions n=15

Point in the process	Type of error made	Number of cases
Request	Requested by inappropriate person	3
	Requested on the basis of erroneous results	2
	Requested for incorrect patient	1
Sample taking	Wrong blood in tube full blood count (FBC) sample	6
Testing	Misinterpretation of FBC results	3
Total		**15**

Case 20: Alteration by a patient's friend could have lead to inappropriate transfusion

A patient's friend who was a retired doctor, altered the patient's request form from a 'group and antibody screen' to a two-unit crossmatch. A nurse noticed the alteration and a potentially inappropriate transfusion was averted.

IT-related ADU cases n=2

There were 2 ADU cases that also had an IT element and these are described below. The numbers are included in tables above where appropriate, so these are not additional cases. There was 1 clinical error, and 1 laboratory error.

Both of these cases exemplify different aspects of IT systems that can lead to patient-related problems.

Case 21: Inappropriate transfusion because incorrect electronic patient record was selected

A patient was transfused 2 units of red cells with a pre-transfusion Hb of 106g/L, which is above the recommended threshold Hb level for the patient's condition. The wrong patient had been selected for crossmatch by using an outpatient department computer screen that was logged into another patient's electronic record by a previous user of the terminal.

Learning points

- Always log out of an information technology (IT) system when the task is finished. Individuals are personally responsible for any work that is carried out under their username and logging off when leaving the system ensures that no one else can use an incorrect account
- Always check that the correct patient has been identified when ordering tests or looking at results by checking the name, date of birth and patient hospital number

Case 22: Laboratory standard operating procedure (SOP) not adequate to allow issue of emergency blood to a neonate

A premature baby developed intracerebral bleeding and required emergency transfusion followed by transfer to a specialist unit. The biomedical scientist (BMS) could not override the computer alert screen that required a blood group on the baby before issuing blood. There was no laboratory SOP to cover this scenario and the transfer of the baby was delayed waiting for the blood.

Learning point

- All emergency procedures should be subject to practice drills both in clinical and laboratory areas. Include common and less common scenarios and include the laboratory in the drills

COMMENTARY

The number of delayed transfusions reported to SHOT has increased year on year. While the NPSA Rapid Response Report was concerned mainly with instances of major haemorrhage, the evidence here shows that there are other instances of delay that put patients at risk. In 2 cases foundation year doctors did not recognise classic signs of haemorrhagic shock (tachycardia and falling blood pressure). Both these instances and another where the patient died were also associated with weekend periods with shift changes and poor record-keeping. Such cases reinforce the need to achieve better consultant supervision and cover at weekends. Other problems arise when patients are transferred several times ('patients are shunted like parcels in the night' – the Times, March 19, 2014), and not only is the handover incomplete, but consultant responsibility becomes unclear. Issues with the implementation of the European Working Time directive have been identified in a recent report from the Royal College of Surgeons leading to 'negative effects' with long intense shifts and junior staff losing contact with their trainers and feeling unsupported [36].

Nine patients with haematinic deficiencies were treated with transfusion rather than replacement of iron/B12, and a death in a patient with iron deficiency from transfusion-associated circulatory overload is reported in Chapter 23 Transfusion-Associated Circulatory Overload (TACO).

As more patients are treated with transfusion as day cases and community care is encouraged, it is important that General Practitioners are more familiar with transfusion practice and the indications and risks.

Recommendations

- The curriculum for Foundation Year training needs to be amended to include specific teaching on the recognition and urgent management of haemorrhagic shock

Action: Chair Foundation Programme Committee, Academy of Medical Royal Colleges and National Director UK Foundation Programme Office (UKFPO) in association with the General Medical Council

- Patients with iron or B12 deficiency should be carefully assessed and treated with haematinic replacement therapy and only with transfusions of red cells when there are clear indications

Action: Chief Executive Officers and Medical Directors of Hospitals/Trusts/Health Boards and the Royal College of General Practitioners

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.

12 Right Blood Right Patient (RBRP)

Authors: Alexandra Gray and Hema Mistry

Definition:

Incidents where a patient was transfused correctly despite one or more serious errors that in other circumstances might have led to an incorrect blood component being transfused (IBCT).

DATA SUMMARY Total number of cases: n=184							
Implicated components		**Mortality/morbidity**					
Red cells	147	Deaths definitely due to transfusion	0				
Fresh frozen plasma (FFP)	9	Deaths probably/likely due to transfusion	0				
Platelets	18	Deaths possibly due to transfusion	0				
Cryoprecipitate	0	Major morbidity	0				
Granulocytes	0	Potential for major morbidity (Anti-D or K only)	0				
Anti-D Ig	0						
Multiple components	9						
Unknown	1						
Gender		**Age**		**Emergency vs. routine and core hours vs. out of core hours**		**Where transfusion took place**	
Male	97	≥18 years	171	Emergency	33	Emergency Department	20
Female	80	16 years to <18 years	1	Urgent	41	Theatre	15
Not known	7	1 year to <16 years	1	Routine	87	ITU/NNU/HDU/Recovery	15
		>28 days to <1 year	2	Not known	23	Wards	75
		Birth to ≤28 days	2			Delivery Ward	4
		Not known	7	In core hours	75	Postnatal	2
				Out of core hours	43	Medical Assessment Unit	21
				Not known/Not applicable	66	Community	3
						Outpatient/day unit	3
						Hospice	3
						Antenatal Clinic	0
						Other	13
						Unknown	10

(ITU=Intensive therapy unit; NNU=Neonatal unit; HDU=High dependency unit)

This category currently includes errors associated with labelling and patient identification (ID), for example:

- Administration with incorrect or incomplete/missing patient details on the label
- Transposition of labels between units that are all intended for the same patient
- Absence of a patient ID wristband
- Transfusion of a blood component that was intended for the patient, but was not formally prescribed/authorised

As in previous years reporters have been given the opportunity to submit incidents separately where the right blood was transfused to the right patient despite a number or errors that may have led to the unit being rejected or an incomplete documentation trail being available for that transfusion episode. These errors do not fit into the definition of incorrect blood component transfused (IBCT) because the blood component was intended for the patient receiving the transfusion, but have been included to inform practice.

There were 184 cases analysed in 2013, representing a 29.6% increase from 142 in 2012; the biggest increase in RBRP reports (111.1%) is in the labelling category in transposed labels (18 in 2012, 38 in 2013). Further discussion of labelling errors can be found in Chapter 6 Medicines and Healthcare products Regulatory Agency (MHRA) Report on Blood Safety and Quality Regulation in 2013. Table 12.1 describes the findings from 184 completed questionnaires. There were also 97 near miss cases of RBRP where the error was detected prior to transfusion, see Table 12.2.

Table 12.1
RBRP episodes
n=184

Elements that were wrong on blood packs, documentation and identity bands	2012	2013
Patient identification errors	**102**	**118**
Name alone or with other elements	49	51
Date of birth (DOB) alone or with other elements	28	28
Wristband* missing/wrong wristband in place at final bedside checking procedure	9	14
Hospital or National Health Service (NHS) number	14	21
Address alone or with other elements	1	3
Patient ID details missing on sample tube/request form	1	1
Labelling errors	**31**	**52**
Transposed labels	18	38
Other labelling errors	13	14
Miscellaneous errors	**9**	**14**
Prescription error	5	9
No final patient ID check undertaken prior to administration of component	2	1
Issue procedures errors	2	2
False identity		2
Total	**142**	**184**

**'Wristband' refers to identification wristband (or risk-assessed equivalent) as defined in the British Committee for Standards in Haematology (BCSH) Guideline on the Administration of Blood Components (2010) [23]*

Case 1: Collection error leads to wrong component being transfused

The porter was requested to collect the final 2 units of a 6 unit fresh frozen plasma (FFP) transfusion. Laboratory staff handed the porter 2 pools of platelets that had also been issued for the same patient. Neither the porter nor the nursing staff involved noticed it was a different component; it was only noticed whilst the second unit of platelets was still running. The patient was due to receive the 2 pools of platelets following the FFP.

Case 2: Scanning error leads to two patients appearing to have the same unit transfused

The transfusion laboratory had a stock of apheresis platelets consisting of pack 1 and pack 2. Two patients in the ward required a platelet component each. The staff member working on the stock bench issued the two apheresis platelets packs for the two patients; however they scanned one platelet barcode twice resulting in both patients receiving components labelled with the same donation number on the traceability label. No harm was caused to either patient.

The RBRP reports continue to provide an insight into how errors persist across the transfusion process: root cause analysis has identified a number of key practices that caused the primary error. These include a variety of errors involving both clinical and laboratory staff, examples include transcription errors at admission and sample registration, patient ID errors at sampling, component labelling errors, failure to check the component at issue, collection and/or receipt in the clinical area and during pre-administration checks of both the component and the associated documents. The final opportunity to recognise the error is then missed at the patient identity check prior to the transfusion commencing. It is notable that these errors, and the opportunity to catch them at the final bedside check, are also common causes of incorrect blood components actually being transfused (Chapter 8, Incorrect Blood Component Transfused (IBCT)).

There were however 2 unusual cases this year where two young male patients were admitted using a false identity which was only uncovered during the admission (Case 3).

Case 3: False identity resulted in incorrect information being recorded on the hospital transfusion laboratory information system and in the patient case notes

Patient X gave a false name and date of birth (DOB) when admitted to the ward. He was under the care of several directorates during this time. Patient Y, whose identity was used, was also being seen in outpatients during this time but did not have a group and antibody screen on his record. Patient X eventually confessed to a doctor that he was using false identification details, the patient's manual medical records were changed, however, the hospital transfusion laboratory were not informed at any stage. Somebody inadvertently overheard a conversation reporting the problem and notified the laboratory. Patient X was transfused with red cells while he was acting as Patient Y. Patient Y was also being treated for a haematology condition at the same time, therefore both episodes were recorded in Patient Y's notes.

Near miss RBRP cases n=97

There were 97 cases of RBRP that were detected during the final bedside check and prior to transfusion of the component. These errors have been reported as near miss incidents. The largest category of near miss cases related to labelling errors 72/97 (74.2%) associated with transposition of labels or incorrect patient ID on labels (Table 12.2). These near miss cases have the same causes as those that resulted in a transfusion. Laboratory staff are making errors when labelling components, especially where there is more than one component being issued for the same patient, 38/184 transfused cases and 38/97 near misses. Patient ID is clearly enhanced by robust information technology (IT) systems however, laboratory staff need to ensure that patient information is being input correctly into the system. Errors associated with patient ID are sometimes not detected in the laboratory, but in the near miss cases are fortuitously being detected by clinical staff during the final pre-administration checks. This shows the importance of the final bedside check.

Table 12.2: Near misses that could have led to RBRP n=97

Point in the process	Type of error made	Number of cases	Percentage of cases
Sample receipt	Sample labelling error not rejected	15	15.4%
	Wrong identifiers entered in LIMS*	8	8.2%
	Entered on to patients' duplicate record	2	2.1%
Component labelling	Transposition of labels for same patient	38	39.2%
	Incorrect patient information on label	34	35.1%
Total		**97**	**100%**

**LIMS = Laboratory information management system*

IT-related RBRP cases n=51

There were 51 RBRP cases that also had an IT element and these are described below. The numbers are included in tables above where appropriate, so these are not additional cases. There were 21 clinical errors, and 30 laboratory errors.

Use of the historical computer record n=19 (n=9 laboratory, n=10 clinical)

There were 12 cases where there was a discrepancy in the DOB, ID number or patient name and the LIMS record could have resolved the discrepancy but was not consulted.

There were four cases where incorrect merging of LIMS records for the same patient resulted in a discrepancy in the DOB, ID number or patient name. This occurred on two occasions because the patient was allocated an emergency number.

On one occasion the wrong record was selected on LIMS to issue the platelet unit but the platelets were transfused to the patient they were intended for, not the patient they were issued for. Three further errors occurred in the laboratory when the wrong platelet pack unit was scanned into the LIMS but as these were from the same donation they were still traceable to the right patient.

Errors related to data entry n=26 (n=18 laboratory, n=8 clinical)

There were 17 cases where incorrect manual data entry either at the time of request using ordercomms or at the time of booking in the sample resulted in a discrepancy in the DOB, ID number or patient name. There were cases where the NHS number was used rather than the hospital ID number and in one case this resulted in the compatibility tag having a missing patient ID number because the LIMS was not able to handle NHS numbers.

On one occasion the wristband printer failed and a handwritten wristband contained incorrect patient details and on another occasion the wrong expiry date was manually entered into the LIMS for a unit of FFP. Other manual errors include the selection of the wrong twin on the LIMS.

There were 9 cases where the LIMS and patient administration system (PAS) systems had different patient demographics. On one occasion the patient had already pointed out the discrepancy in DOB but it had not been resolved and was described as an 'ongoing issue'.

Miscellaneous causes of discrepancy between LIMS and wristband n=6 (n=3 laboratory, n=3 clinical)

There were 6 cases where there was a discrepancy between the patient ID on LIMS and the patient's wristband. Two of these cases arose because the details on 'Choose and Book' were incorrect but had overwritten the LIMS and PAS systems with an incorrect DOB. One was due to the incorrect use of an 'alias' initially allocated to an unconscious patient that was used to crossmatch 5 days after admission when a hospital number had subsequently been assigned.

Learning point

- Wherever there is a manual step there has to be a careful checking process to be sure the correct data are entered onto the IT system. Checking is also important where historical records are available to detect any errors in data entry that might have occurred either manually of because of incorrect merging or uncontrolled overwriting of data

COMMENTARY

As discussed in previous years RBRP errors are preventable. Members of staff have a personal and professional responsibility to adhere to the correct patient identification procedures at: admission, sampling, on receipt of the sample and entering the patient ID details into the IT system and collection and administration processes.

The final patient identification check at the bedside prior to the administration is the last opportunity to detect any errors, however **every** person involved in the transfusion process is responsible for making sure their part of the process is undertaken accurately and that they follow the correct hospital procedures at all times.

Recommendations

There are no new recommendations for 2013

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.

13 Handling and Storage Errors (HSE)

Authors: Alexandra Gray and Hema Mistry

Definition:

All reported episodes in which a patient was transfused with a blood component or plasma product intended for the patient, but in which, during the transfusion process, the handling and storage may have rendered the component less safe for transfusion.

DATA SUMMARY
Total number of cases: n=193

Implicated components		Mortality/morbidity	
Red cells	168	Deaths definitely due to transfusion	0
Fresh frozen plasma (FFP)	9	Deaths probably/likely due to transfusion	0
Platelets	16	Deaths possibly due to transfusion	0
Cryoprecipitate	0	Major morbidity	0
Granulocytes	0	Potential for major morbidity (Anti-D or K only)	0
Anti-D Ig	0		
Multiple components	0		
Unknown	0		

Gender		Age		Emergency vs. routine and core hours vs. out of core hours		Where transfusion took place	
Male	81	≥18 years	175	Emergency	24	Emergency Department	12
Female	105	16 years to <18 years	1	Urgent	43	Theatre	10
Not known	7	1 year to <16 years	4	Routine	101	ITU/NNU/HDU/Recovery	21
		>28 days to <1 year	5	Not known	25	Wards	100
		Birth to ≤28 days	4			Delivery Ward	5
		Not known	4	In core hours	87	Postnatal	1
				Out of core hours	63	Medical Assessment Unit	13
				Not known/Not applicable	43	Community	6
						Outpatient/day unit	3
						Hospice	0
						Antenatal Clinic	0
						Other	13
						Unknown	9

(ITU=Intensive therapy unit; NNU=Neonatal unit; HDU=High dependency unit)

The categories remain the same as in previous years. There has been a decrease (38.9%) in the number of reports submitted under the HSE category in 2013 (193 reports) compared with 2012 (316 reports) across all categories apart from 'excessive time to transfuse', where there was a 33.9% increase in reports (62 in 2012 and 83 in 2013). Fourteen cases involved paediatric patients. More than half of the incidents, 101/193 (52.3%) occurred in a routine setting, 67/193 (34.7%) were urgent or emergencies and in 25/193 (13.0%) the urgency was unknown. There were no reported transfusion-related deaths or instances of major morbidity.

Technical transfusion errors n=20

There were 20 technical administration errors, a decrease of 35.5% from 31 reports in 2012. In 13/20 (65.0%) cases the incident resulted from the use of the wrong type of giving set. In 3 cases the patients were overtransfused due to errors when setting up the blood pump, including 2 paediatric patients. Three patients received red cells more rapidly than prescribed, 2 of these patients were aged 78 years. A neonate failed to receive an urgent transfusion of red cells due to a technical error related to a 3-way tap. The errors related to children are discussed in Chapter 25 Paediatric Cases.

Case 1: Undertransfusion due to error when setting up the infusion pump

A neonate requiring an urgent transfusion had red cells commenced at 14:45. At 15:40 it was noted that the 3-way tap on the blood transfusion line was open and the blood had gone back into the bag rather than into the baby.

Transfusion of expired blood components n=23

Fourteen errors originated in the clinical environment. All these 14 resulted from components being issued with a short expiry date and/or still being available for collection close to or after the expiry date; in 2 cases the person collecting the component ignored an electronic warning that the component had expired. The remaining 9/23 errors are detailed in the Annual SHOT Report 2013 Supplement for Chapter 9 located on the SHOT website, www.shotuk.org under SHOT Annual Reports and Summaries, Report, Summary and Supplement 2013. Further cases of component expiry are also discussed in Chapter 6 Medicines and Healthcare products Regulatory Agency (MHRA) Report on Blood Safety and Quality Regulation in 2013.

Excessive time to transfuse n=83

There has been an increase in the number of 'excessive time to transfuse' cases this year. Seventy-two cases (86.7%) took more than 6 hours (range 6–15 hours). In 10/83 cases (12.1%) the error resulted from a delay in commencing the transfusion; less than half of events (36/83 (43.4%)) took place during core hours (Table 13.1).

The recommended times for transfusing blood components are available in current guidelines [23].

Time period	In core hours/out of core hours	Number
08:00 to 20:00	Core hours	36
20:00 to 00:00	Out of core hours	23
00:00 to 08:00	Out of core hours	11
Unknown		13
Total		**83**

Table 13.1: Starting times for transfusions that took excessive time to run n=83

Cold chain errors n=67

Type of error	Number of cases 2012	Number of cases 2013
Equipment failure *(power failure/suspected refrigerator failure which failed to activate the alarm)*	101	11*
Alarm-related *(staff failed to carry out correct procedure following alarm being triggered on a refrigerator)*	18	3
Transport or delivery of components	12	7
Inappropriate storage of components (Tables 13.3 and 13.4)	65	46
Total	**196**	**67**

**Although there appears to be a dramatic decrease in the numbers compared with 2012 this is because one case reported in 2012 included*

Table 13.2: Cold chain errors n=67

multiple patients n=86

There were fewer cold chain errors reported to SHOT in 2013 compared to 2012. Errors involving inappropriate storage of components have reduced but still remain a large proportion of the overall number of cold chain errors, these are discussed below. In addition there have been 62 near miss incidents associated with HSE (Table 13.5), which are discussed at the end of this chapter.

Inappropriate storage of components n=46

Twenty two out of the 46 inappropriate storage errors occurred in a clinical setting and 24 in the laboratory, see Tables 13.3 and 13.4. Errors related to storage are one of the most frequently reported events to the MHRA; see Chapter 6 Medicines and Healthcare products Regulatory Agency (MHRA) Report on Blood Safety and Quality Regulation in 2013.

Table 13.3: Breakdown of laboratory causes of inappropriate storage of components n=24

Type of inappropriate laboratory storage error	Number of reports
Returned to stock when they should have been discarded	6
Stored inappropriately in laboratory area	2
Units transfused in which interval between sampling and transfusion had exceeded BCSH* guidelines – failure to clear the refrigerator	12
Where sample was invalid	4
Total	**24**

** BCSH = British Committee for Standards in Haematology*

Table 13.4: Breakdown of clinical causes of inappropriate storage of components n=22

Type of inappropriate clinical storage error	Number of reports
Returned to stock when they should have been discarded	6
Incomplete cold chain	6
Stored inappropriately in clinical area	10
Total	**22**

Over 50% of clinical storage errors (12/22) could have been prevented by improved communication between the clinical and laboratory staff. The BCSH Guidelines on the Administration of Blood Components [23] advise that the 'cold chain' must be maintained and the relevant storage and 'cold chain' documentation must be available. This allows staff to ensure that the controlled temperature storage of components is maintained at all times. Cold chain is not the same as 'traceability', where positive evidence of the transfusion of each component is fully documented in accordance with local policies and guidelines using electronic or manual systems.

All unused components should be returned as soon as possible and laboratories should be informed of the circumstances of their return. If components have been out of temperature controlled storage for over 30 minutes then they should not be put back into stock for re-issue. A robust procedure should be established for any returns and the cold chain should be maintained to prevent out of temperature controlled units being transfused to patients, see learning points.

There were 10 cases of blood components (7 red cells, 2 platelets, 1 FFP) being stored inappropriately in clinical areas. Clinical staff should be familiar with the BCSH guidelines on administration of blood components and familiar with their individual storage conditions. Blood must only be stored in designated temperature-controlled refrigerators, not in ward or domestic refrigerators. To avoid blood components being stored inappropriately in clinical areas, blood components should only be collected when the patient is ready for transfusion.

Near miss HSE cases n=62

Point in the process	Type of error made	Number of cases	Percentage of cases
Component selection	Expired unit	3	4.8%
Collection	Time-expired component available	31	50.0%
Administration	Incorrect transport/packing of units	4	30.7%
	Inappropriate storage in clinical area	11	
	>30 mins out of temperature in clinical area	2	
	Unit expired on ward	2	
Other	Outside time for sample suitability	5	14.5%
	Incorrect storage in the laboratory	2	
	Part used unit returned to refrigerator	1	
	Incorrect expiry date from Blood Service	1	
Total		**62**	**100%**

Table 13.5: Near misses that could have led to HSE n=62

It is a positive finding to see the number of near miss HSE cases that are being detected prior to the transfusion taking place. As mentioned in previous Annual SHOT Reports, every member of staff has a personal and professional responsibility to adhere to their local policies and guidelines when handling blood components. Continued vigilance can reduce wastage and clinical loss of blood components.

IT-related HSE cases n=9

There were 9 HSE cases that also had an IT element and these are described below. The numbers are included in tables above where appropriate, so these are not additional cases. There were 3 clinical errors, and 6 laboratory errors.

Warning flags in place but not heeded or warning flags not used n=7 (n=5 laboratory, n=2 clinical)

There were seven errors where IT systems tried to prevent the use of unsuitable components but the warning flag or alert was overridden.

There were four cases (two platelet and two red cell transfusions) where an electronic blood management system produced a flag to prevent collection of the component because it had expired. There were two further cases where the electronic blood management system highlighted that the components were out of temperature control. The components were collected and transfused, ignoring the warning.

A sample was not valid for compatibility testing because the patient had been recently transfused but the BMS did not know how to look back at previous transfusion history so concluded the computer alert was incorrect and ignored it, issuing blood on an invalid sample.

Incorrect use of the electronic blood management system n=1 (clinical)

Red cell units were not 'booked in' to the refrigerator so the system could not alert to prevent removal of the units of red cells that were beyond their expiry date.

Incorrect result entered manually n=1 (laboratory)

An error occurred when manually calculating the expiry date following irradiation of 12 units of red cells. Three of the time-expired units were transfused before the error was discovered and the remaining 9 units were not transfused. The report did not state whether all 3 units were transfused to the same patient.

COMMENTARY

As in previous years the clinical HSE cases involved staff from several different departments. In the majority of cases there were multiple opportunities to detect the errors but these were missed. It is the responsibility of the laboratory staff to ensure that blood components are only issued when there is a reasonable expectation that they will be transfused and are cleared from storage locations in a timely manner. It is the responsibility of the staff involved in the collection and distribution of blood components to check the expiry date before issuing or removing the component from the cold chain. It is the responsibility of the staff in the clinical area when taking receipt of the component and at the final identity check to ensure the component is within the expiry and prescription times before commencing the transfusion.

In addition whilst the collection of a component and the final bedside checks can assist in identifying errors associated with sample timing (and units past their de-reservation time), especially where warning labels have been attached to components stating not to transfuse after a certain time, the primary responsibility lies with the laboratory to clear the blood refrigerator thereby ensuring the removal of blood components that are past the de-reservation time, in excess of sample validity or time expired.

Learning points remain pertinent from 2011

- Red cell units CANNOT be returned to controlled temperature storage or reissued if they have been out of controlled temperature storage for more than 30 minutes. There should be a clearly designated area assigned in the blood refrigerator for units awaiting discard. If an information technology (IT) tracking system is being used it should be able to immediately alert the laboratory staff of the presence of any returned units that need withdrawal from stock
- Hospitals should have robust processes for stock control and component recall ensuring that components are not available for collection after their dereservation or expiry times or if recalled for safety reasons
- Blood components should only be collected when the patient is ready for transfusion [23]

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.

Adverse Events Related to Anti-D Immunoglobulin – Prescription, Administration and Sensitisation

14

Author: Tony Davies

Definition:

An adverse event relating to anti-D immunoglobulin (anti-D Ig) is defined as relating to the prescription, requesting, administration or omission of anti-D Ig which has the potential to cause harm to the mother or fetus immediately or in the future.

DATA SUMMARY
Total number of cases: n=354

Implicated components		Mortality/morbidity	
Red cells	0	Deaths definitely due to transfusion	0
Fresh frozen plasma (FFP)	0	Deaths probably/likely due to transfusion	0
Platelets	0	Deaths possibly due to transfusion	0
Cryoprecipitate	0	Major morbidity	1
Granulocytes	0	Potential for major morbidity (Anti-D or K only)	276
Anti-D Ig	354		
Multiple components	0		
Unknown	0		

Gender		Age		Emergency vs. routine and core hours vs. out of core hours		Where transfusion took place	
Male	0	≥18 years	345	Emergency	0	Emergency Department	0
Female	354	16 years to <18 years	7	Urgent	0	Theatre	1
Not known	0	1 year to <16 years	2	Routine	0	ITU/NNU/HDU/Recovery	0
		>28 days to <1 year	0	Not known	354	Wards	271
		Birth to ≤28 days	0			Delivery Ward	0
		Not known	0	In core hours	0	Postnatal	0
				Out of core hours	0	Medical Assessment Unit	0
				Not known/Not applicable	354	Community	82
						Outpatient/day unit	0
						Hospice	0
						Antenatal Clinic	0
						Other	0
						Unknown	0

(ITU=Intensive therapy unit; NNU=Neonatal unit; HDU=High dependency unit)

A total of 394 case reports involving anti-D immunoglobulin were submitted via the SHOT online reporting database in 2013. Of these 43 were withdrawn because they did not meet the criteria for anti-D reporting, 3 were moved to the new anti-D sensitisation group and 1, where anti-D sensitisation followed solid organ transplant, was moved to unclassifiable complications of transfusion (UCT). In addition, 3 cases were transferred in from the near miss category, and 4 cases from incorrect blood component transfused (IBCT).

The final analysis contains 354 case reports, each involving 1 individual. The reports are broken down into the reporting categories shown in Table 14.1.

Adverse events related to the prescription and administration of anti-D Ig are not required for the European Union (EU) and so are reportable as 'SHOT-only'. Clinical reactions to anti-D Ig are reportable to the Medicines and Healthcare products Regulatory Agency (MHRA) 'Yellow Card' system.

From January 2013 SHOT has been conducting a study to look at women who have produced immune anti-D that is detectable for the first time in the current pregnancy and an analysis of the data collected to the end of December 2013 is included as an appendix to this chapter.

Table 14.1: Reporting categories

Category of adverse event	Number of cases
Omission or late administration of anti-D Ig	277
Inappropriate administration of anti-D Ig	59
to an RhD positive woman	*23*
to a woman with immune anti-D	*21*
erroneously to a mother of an RhD negative infant	*11*
given to the wrong woman	*4*
Wrong dose of anti-D Ig given according to local policy	9
Handling and storage errors related to anti-D Ig	9
Total	**354**

Deaths n=0

There was no reported fetal mortality following the omission or delay in administration of anti-D Ig.

Major morbidity n=1

There was 1 case where a woman developed an immune anti-D following omission of prophylaxis during the current pregnancy.

Potential for major morbidity n=276

In a further 276 cases anti-D Ig was administered more than 72 hours following a potentially sensitising event, or omitted altogether, resulting in the potential for sensitisation of the woman to the RhD antigen. This satisfies the current SHOT definition of potential major morbidity. It is not known whether these events resulted in the production of immune anti-D.

Clinical versus laboratory errors

For the reporting year 2013, 354 events related to anti-D Ig administration are summarised in Table 14.2 below, with a breakdown of the proportion of clinical and laboratory errors that were primarily responsible.

Table 14.2: Staff groups primarily involved in anti-D Ig process failures

Type of event	Cases	Staff primarily involved		
		Nurse/ midwife	Laboratory	Doctor
Omission or late administration of anti-D Ig	**277**	245	20	12
Anti-D Ig given to RhD positive woman	**23**	15	4	4
Anti-D Ig given to woman with immune anti-D	**21**	5	15	1
Anti-D Ig given to mother of RhD negative infant	**11**	1	10	0
Anti-D Ig given to wrong woman	**4**	3	0	1
Wrong dose of anti-D Ig given	**9**	4	4	1
Anti-D Ig handling and storage errors	**9**	7	2	0
Totals	**354**	**280**	**55**	**19**

This year shows a change in the pattern of reports with an increase in clinical cases involving midwives, nurses and doctors accounting for 299/354 (84.5%) (up from 74.4% in 2012) and laboratory cases are reduced accounting for 55/354 (15.5%) (down from 25.6% in 2012) of the total reports related to prescription, requesting and administration of anti-D Ig.

Omission or late administration of anti-D Ig n=277

In 245/277 (88.5%) cases the primary error was made by a nurse or midwife, and in 12/277 (4.3%) cases by a doctor. Nineteen of 277 (6.8%) cases resulted from failures in the hospital laboratory and 1/277 (0.4%) cases from a Blood Service reference laboratory.

The location was in the community for 70 cases, and in a hospital setting for 207:

- 31 (11.2%) cases related to potentially sensitising events at <20 weeks of gestation
- 55 (19.8%) cases related to potentially sensitising events at >20 weeks of gestation
- 96 (34.7%) cases related to failures of routine antenatal Anti-D Ig prophylaxis (RAADP)
- 95 (34.3%) cases related to post-natal administration of anti-D Ig

There is a persistent theme of failure to collect anti-D Ig that has been issued by the laboratory, or where it has been collected it is not administered and is found days or weeks later in maternity refrigerators. All 12 cases involving medical staff were related to poor decision-making about the need for anti-D Ig which was clearly not in line with national guidance.

Case 1: Transcription errors when recording results

The laboratory telephoned results to the clinical area, advising that anti-D Ig was required for a woman who had delivered an RhD positive baby. The post-natal ward staff entered the maternal blood group into the results section for the baby, and the woman was discharged without receiving any anti-D Ig. On follow-up by the laboratory as to why the anti-D Ig had not been collected, the error was realised and it was eventually administered 5 days post delivery.

Case 2: System failure in the laboratory results in late administration of anti-D Ig

Mother and cord samples were sent in a timely manner post delivery. However, the laboratory was reportedly severely understaffed and also had no robust system in place to identify outstanding work, so the tests were not performed until the 72-hour window for administration had passed.

Case 3: System failure in testing and recording maternal blood group

Antenatal booking bloods were rejected by the laboratory because of a labelling error, but the woman was never recalled to have repeat samples taken. It was noted at delivery that she was RhD negative and had received no anti-D Ig prophylaxis during her pregnancy.

Case 4: Poor knowledge of prescribing doctor results in failure to administer anti-D Ig

A woman suffered a faint and fall with abdominal trauma at 34 weeks. She was reviewed by a speciality trainee in obstetrics who incorrectly informed her that as she had received RAADP at 28 weeks, no further anti-D Ig was required until after delivery.

Case 5: Misuse of Kleihauer test results in failure to administer anti-D Ig for a sensitising event

A woman presented with a vaginal bleed at 36/40 but was discharged without prophylactic anti-D Ig. Her midwife had recorded in the notes that as the woman had received RAADP at 28 weeks, and the Kleihauer test was 'negative', there was no need to administer further anti-D Ig.

Case 6: Changing a reference laboratory report results in missed administration of anti-D Ig

A Blood Service reference laboratory reported the presence of anti-C+D in a booking sample, so the woman was not offered anti-D Ig prophylaxis when she underwent an amniocentesis. The report was subsequently updated to say that the woman had anti-G rather than anti-C+D, so should have received anti-D Ig prophylaxis for the invasive procedure.

Learning point

- Where anti-C+D is suspected in an antenatal sample laboratories must perform differential adsorption studies to confirm antibody specificity before issuing a report

Case 7: Woman develops immune anti-D following omission of prophylaxis

A 27 year old woman fainted and fell down stairs at 26/40 gestation. She attended her general practitioner (GP) with abdominal pain, but was not given any anti-D Ig prophylaxis. When she attended antenatal clinic at 30 weeks for her RAADP, she was found by a Blood Service reference laboratory to have anti-D in her group and screen sample. She delivered 2 weeks later, but there are no details of post-natal tests on the baby.

Inappropriate administration of anti-D Ig n=59

This group is further subdivided into four categories.

Anti-D Ig given to RhD positive women n=23

Overall 15/23 (65.2%) errors were made by a nurse or midwife, 4/23 (17.4%) by a doctor, and 4/23 (17.4%) primary errors arose in the laboratory.

The majority, 16/23 (69.6%) cases originated in the hospital setting, with 7 in the community.

Case 8: GP administers anti-D Ig in error to an RhD positive woman

A pregnant woman attended her GP surgery for a routine visit. On the basis of an alleged family history of Rh immunisation, the GP went to another practice next door, requested a dose of anti-D Ig and proceeded to inject the woman without checking her blood grouping results. She was RhD positive.

Case 9: Anti-D Ig administered without checking records

Following an invasive procedure, the clinical fellow stated that he 'believed' the woman was RhD negative and administered anti-D Ig from stock held in the clinical area. The grouping records in her notes clearly showed her to be RhD positive.

Case 10: Merging of patient records leads to incorrect blood group being recorded

During registration, it was noted that there were two women with identical names on the hospital system, and a merge was authorised. The merge overwrote the blood group as RhD negative in the patient record, though they were in fact two different women and one was RhD positive. She received anti-D Ig for a sensitising event before the discrepancy in paper grouping records was noticed.

Anti-D Ig given to women with immune anti-D n=21

Most of these cases, 15/21 (71.4%), resulted from laboratory errors, and 6/21 (28.6%) resulted from a primary clinical error.

- 19/21 occurred in the hospital setting, and 2/21 in the community
- 15/21 cases resulted from failure to check laboratory records or to take note of grouping reports before requesting or issuing anti-D Ig
- 4/21 cases involved an assumption by the laboratory that positive antibody screens were due to residual prophylactic anti-D Ig, even though there was a computer record of one woman having multiple quantitations of immune anti-D

Case 11: Incorrect comment added to laboratory information management system (LIMS)

A woman known to have immune anti-D had a number of quantitations on record during her pregnancy. A biomedical scientist added a comment '? Prophylaxis' in response to a positive antibody screen, and erroneously issued anti-D Ig for a potentially sensitising event.

Case 12: Poor advice from haematologist

A consultant haematologist advised administering anti-D Ig to a woman confirmed to have immune anti-D, following an intrauterine death.

Case 13: Familiarity breeds complacency?

A 31 year old woman was known to have immune anti-D from previous pregnancies. The same midwife who had cared for her in these pregnancies incorrectly issued anti-D Ig from clinical stock in response to a sensitising event.

Anti-D Ig given erroneously to mothers of RhD negative infants n=11

- 10/11 of these errors originated in the laboratory, and 9/11 occurred in the hospital setting
- 3/11 cases involved misinterpretation of cord grouping results before telephoning the ward
- 3/11 involved the cord blood group being manually entered (incorrectly) onto the LIMS
- 2/11 involved issue of anti-D Ig without reference to LIMS results

Case 14: Clinical pressure to issue anti-D Ig

A woman had delivered an RhD negative baby, but persisted in asking the midwives where her anti-D injection was. They did not check results (which had been telephoned by the laboratory and recorded by the ward) but pressurised the duty biomedical scientist (BMS) on more than one occasion to issue anti-D Ig, which he eventually did without reference to the laboratory computer system.

Anti-D Ig given to the wrong woman n=4

These were exclusively clinical errors, involving failure by nurses, midwives or doctors to identify the correct woman, and all 4 cases occurred in the hospital setting.

Case 15: Misidentification in theatre

Anti-D Ig was prescribed for patient A undergoing an invasive procedure but was administered to patient B by a consultant anaesthetist who failed to identify the patient properly.

Case 16: Grouping reports filed in wrong notes

Anti-D Ig had been issued by the laboratory for patient A, but grouping reports from patient B had been filed in patient A's notes, and these reports were used to perform a bedside administration check for the wrong patient.

Wrong dose of anti-D Ig given n=9

All 9 errors occurred in hospital, 5/9 in the clinical area, and 4/9 in the laboratory.

Case 17: Overestimation of transplacental haemorrhage

A BMS interpreted a fetomaternal haemorrhage FMH (Kleihauer) test as showing a transplacental haemorrhage (TPH) of 15mL fetal cells, and the woman was administered 2000 international units (IU) anti-D Ig. On review by a senior BMS, the TPH was actually 0.3mL.

Case 18: Incorrect dose of anti-D Ig used for RAADP

A midwife issued 250IU anti-D Ig from stock held in the clinical area for a woman attending for RAADP at 28 weeks gestation, instead of the 1500IU indicated by hospital policy and national guidelines.

Case 19: Doctor administers inadequate dose of anti-D Ig

A woman presented with an antepartum haemorrhage (APH) at 39 weeks, and a specialty trainee in obstetrics administered 250IU anti-D Ig from stock held in the clinical area instead of the 500IU minimum indicated by guidelines.

Handling and storage errors related to anti-D Ig n=9

The majority, 7/9 (77.8%), of these errors occurred in the clinical area and 2/9 (22.2%) were laboratory errors. Eight errors occurred within a hospital, and 1 in the community.

- In 2/9 (22.2%) cases expired anti-D Ig was issued from stock held in the clinical area
- In 3/9 (33.3%) cases anti-D Ig was issued from clinical stock held in a ward refrigerator that had been out of temperature control for 10 days

Case 20: Expired anti-D Ig administered in the community setting

Anti-D Ig that had expired two months earlier was administered by community midwives from stock held at the GP clinic.

Near miss anti-D Ig cases n=35

The near miss cases related to administration of anti-D Ig prophylaxis have been sub-categorised showing the point in the process where the error was made.

Table 14.3: Near misses that could have led to errors related to anti-D Ig n=35

Point in the process	Type of error made	Number of cases	Percentage of cases
Request	Requested for RhD positive woman	7	28.5%
	Wrong volume requested	2	
	Not requested	1	
Sample receipt	Failure to notice request for RhD positive woman	3	8.50%
Testing	Misinterpretation	1	11.6%
	Incomplete testing prior to issue	1	
	Manual group error	1	
	Transcription	1	
Component selection	Wrong volume issued	8	37.1%
	Issued to mother of RhD negative baby	4	
	Issued to woman with immune anti-D	1	
Component labelling	Anti-D Ig mislabelled	4	11.4%
Collection	Collection for the wrong patient	1	2.9%
Total		**35**	**100%**

These near miss errors show similar mistakes to those incidents that progress to patient harm. Consideration should be given to the critical break points where errors occur in order to define whether improvements are possible.

IT-related anti-D Ig cases n=16

There were 16 anti-D Ig cases that also had an IT element and these are described below. The numbers are included in tables above where appropriate, so these are not additional cases. There was 1 clinical error, and 15 laboratory errors.

Error	Unnecessary anti-D Ig administered
Error when manually transcribing data	5
LIMS not updated with reference laboratory result	2
Failure to consult historical record	5
Failure to use flags, logic rules	4
Total	**16**

Table 14.5: IT errors relating to administration of anti-D Ig

This year there were 16 errors where IT systems failed to prevent anti-D Ig being given when it was not required. There were no IT-related errors that resulted in a failure to give anti-D Ig where it was required.

Where the results of RhD testing of the cord blood have to be entered manually onto the LIMS it is possible to transcribe the wrong result.

Where historical data are available, either from the current or previous pregnancies, they should be used in decision-making. Results from reference laboratories (immune anti-D quantification, anomalous D-typing results) should be available to the BMS issuing anti-D Ig. Errors have occurred where these records have not been consulted or when flags to highlight critical information have not been used to prevent issue of unnecessary anti-D Ig.

Computer systems can only be used to support laboratory and clinical procedures, they do not substitute for up to date and accurate knowledge of the importance of correct RhD grouping and the implications of immune anti-D for anti-D Ig prophylaxis. Although using the LIMS in a more robust way could have prevented some of the errors, many of these initial laboratory errors led to incorrect anti-D Ig administration because the clinical areas did not understand the principles of anti-D Ig prophylaxis.

Learning points

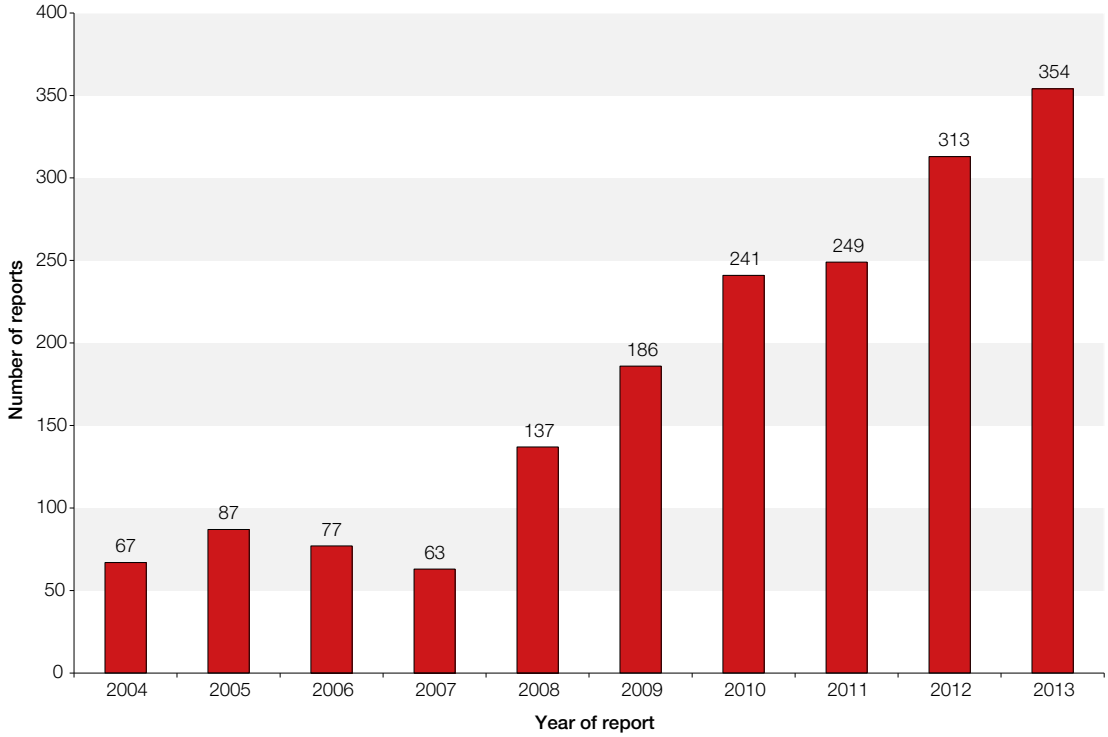
- Electronic transmission of cord RhD-typing results is preferable
- The LIMS should be configured where possible to prevent issue of anti-D Ig where immune anti-D has been documented
- There should be logic rules to prevent issue of anti-D Ig to RhD positive pregnant women and to RhD negative women where the cord blood shows the baby to be RhD negative

COMMENTARY

A total of 354 case reports were reviewed this year, of which 277 (78.2%) related to the omission or late administration of anti-D immunoglobulin. Most of these late or omission events 246/277 (88.8%) occurred after 20 weeks of gestation or at delivery, which are known to be the times of highest risk of sensitisation. This is a continuing worrying situation, putting a significant number of women at risk of potential sensitisation to the RhD antigen with potential mortality and morbidity in affected neonates.

It should be noted that around 10% of the anti-D cases only came to light because of retrospective audit, whether locally or from participation in the National Comparative Audit of anti-D carried out in 2013. This underlines the fact that SHOT can only ever be a ‘snapshot’ of transfusion practice – many errors may simply remain unnoticed or are not reported.

Figure 14.1: Cumulative data for anti-D Ig-related events 2004-2013



While it is easy to pick out errors made by individuals it is clear that there are significant systems failures that contribute to these reports. Nevertheless, individual case studies provide perhaps our most effective method of education in SHOT.

Table 14.4: Examples of system failures

System failure	Examples in SHOT cases
Communication	• A worrying lack of communication between hospital midwifery teams and those in the community – failure of RAADP in the community was identified in 63 cases of delay or omission
Assumption/failing to take responsibility or ownership	• A lack of robust systems for identifying and flagging incomplete work in the laboratory • A lack of robust systems for identifying women eligible for RAADP • A lack of robust systems for handling women who transfer their care or who book late • Assumptions that someone else is sorting out a particular issue
Lack of knowledge/ training	• Failure of laboratory staff to consider the need for anti-D Ig when issuing RhD positive platelets for RhD negative females of childbearing potential (5 cases this year) • A lack of understanding of the principles behind anti-D Ig prophylaxis, compounded by availability of uncontrolled anti-D Ig stocks held by clinics • An increasing trend in poor advice being offered to women by medical staff, often at relatively senior level • Decision-making, issuing and administration of anti-D Ig without reference to blood grouping results, in both the laboratory and clinical area • The misinterpretation of FMH (Kleihauer) tests in hospital laboratories leading to errors in dosing with anti-D Ig • Failure of inventory management in both laboratory and clinical area, especially in the community setting
Pressures of work/ staffing issues	• Understaffing and availability of senior staff in both the laboratory and the clinical area leading to pressurised and poor decision-making
Poor practice/culture	• Manual transcription of blood grouping results onto notes, care plans and discharge sheets in the clinical area, an area of risk that is repeatedly highlighted by SHOT, but persists as poor practice • A culture of completing discharge paperwork when the interventions had not actually been performed • Devolving responsibility to the pregnant women to return at a later date for anti-D Ig administration, when they are obviously in a vulnerable and distressed state instead of managing it at the presentation visit, be that in the emergency department, day unit, or clinic • Use of the Kleihauer test to decide whether anti-D Ig should be given in the first place

The use of checklists to improve processes has been described in many different areas of practice, including surgery [37], and to this end SHOT has produced both a flowchart and checklist covering key points in the process that may be used as an aide memoire, poster or as an audit tool, and these may be found at http://www.shotuk.org/resources/current-resources/. These are also included as an appendix in the recently revised British Committee for Standards in Haematology (BCSH) Guidelines on the use of anti-D immunoglobulin in pregnancy [38]. They are of necessity generic and hospitals wishing to adapt the resources to better fit their own practice should apply to the SHOT Office where a bespoke pdf version can be produced including individual Trust/Health Board logo and version number.

Recommendations

- There must be robust systems in place to identify woman eligible for anti-D Ig prophylaxis and to communicate this information effectively to relevant care teams
- Anti-D Ig must be made readily available for administration to women when they present with potentially sensitising events, rather than putting the onus on them to return for the injection at a later date

Action: Hospital Transfusion Laboratories, Hospital Transfusion Committees, Trust/Health Board Chief Executive Officers (CEOs), Royal College of Obstetrics and Gynaecologists and Royal College of Midwives

Good practice points from previous years

- Current blood grouping and antibody screen results must be referred to when making decisions whether to issue or administer anti-D Ig
- FMH (Kleihauer) screening tests that suggest a TPH of >2mL, or that give equivocal results, should be referred for flow cytometry at the earliest opportunity
- If there is doubt about the RhD type, or whether detectable anti-D is immune or prophylactic, then anti-D Ig prophylaxis should be continued until the issue is resolved [38]
- Peak levels of prophylactic anti-D following administration of 1500IU anti-D Ig will very rarely exceed 0.2IU/mL if administered intramuscular (IM) or 0.4IU/mL if administered intravenously (IV)
- It is important that, regardless of any prior administration of anti-D Ig, any anti-D detected at 28 weeks is quantified and the results made available in the maternity notes [38]
- Anti-D Ig should be subject to the same standards of patient identification (ID) and traceability as blood components (Health Service Circular 'Better Blood Transfusion' 3) [39]
- There should be laboratory oversight of stock control if it is risk-assessed that a remote stock of anti-D Ig is required in a clinical location
- A larger dose of anti-D Ig should be given following delivery of a RhD positive child when cell salvage is used: The BCSH guideline recommends 1500iu as a standard dose [38]
- All healthcare professionals involved in the issue and administration of anti-D Ig must complete the anti-D modules in the Learn Blood Transfusion e-learning programme www.learnbloodtransfusion.org.uk
- Trusts/Health Boards must ensure that there is representation from midwives and obstetricians on hospital transfusion committees, with the aim of jointly drawing up straightforward local protocols for the request, issue and use of anti-D Ig based on well established national guidance
- Cases of late administration, omission, or inappropriate administration of anti-D Ig must be the subject of internal follow-up within Trusts/Health Boards via established governance mechanisms
- All organisations involved in the issue and administration of anti-D Ig must ensure that their systems are robust with respect to issue, receipt and recording, and should audit their systems with a view to increasing the safety and security of the process

- Anti-D Ig prophylaxis for sensitising events should be administered in addition to anti-D Ig given for routine antenatal anti-D prophylaxis (and vice versa)
- Anti-D Ig prophylaxis for sensitising events should be given regardless of the presence of detectable residual prophylactic anti-D or a 'negative' Kleihauer test

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.

Appendix: SHOT Anti-D Sensitisation Study

Author: Jane Keidan

Total cases analysed n=31

Introduction

From January 2013 SHOT has requested data on women who have produced immune anti-D that is found for the first time in the current pregnancy, whether detected at booking or later in the pregnancy.

Background

The introduction of anti-D Ig prophylaxis in pregnancy, initially for sensitising events in pregnancy and postpartum, and more recently as routine antenatal practice (RAADP) was predicted to reduce the incidence of anti-D sensitisation and haemolytic disease of the newborn secondary to anti-D. An update from the National Institute for Health and Care Excellence (NICE) in August 2008 [40] reviewed the available evidence and concluded that the practice should continue but that further research was required on optimal dosing. A more recent meta-analysis [41] of the available, relatively poor quality trial data reached the same conclusion. The efficacy of anti-D Ig requires not only that the intervention be effective, but that it is adminstered appropriately after potentially sensitising events and routinely in the antenatal and postpartum periods [42]. Since its start in 1996, SHOT has collected data about adverse events related to the prescription, requesting, adminstration or omission of anti-D Ig which have potential to cause harm to the mother or fetus immediately or in the future. From 2006 these data were actively sought but SHOT has been unable to undertake long term follow up of such cases nor identify the number of subsequently sensitised pregnancies.

Recent reports [43-45] have demonstrated a lack of detectable anti-D at delivery in women who have received RAADP and have raised concerns by commentators [46, 47] about the adequacy of current recommended practice in preventing sensitisation, particularly in overweight/obese women and in pregnancies that continue beyond 40 weeks. However, there is no systematic process for collecting data on anti-D sensitisation rates prospectively. A single centre retrospective study of 56 sensitised pregnant women [48] demonstrated that 48% of cases were due to potentially preventable causes, 'process failure', and would be SHOT-reportable. However, 20% of cases were not preventable, of which 16% occurred despite full RAADP and postpartum anti-D Ig administration.

One of the suppliers of anti-D Ig (CSL Behring) has recently amended their summary of product characteristics (SPC) following unpublished reports that the intramuscular administration of Rhophylac in patients with a body mass index (BMI) ≥30 is associated with a risk of lack of efficacy. For patients with a BMI ≥30 they now recommend intravenous administration. Such a recommendation has significant implications for maternity units and is being urgently discussed by the British Committee for Standards in Haematology Transfusion Task Force (personal communication). The end-point of effective RAADP is prevention of sensitisation and accurate data must be available to inform clinical practice. This new initiative by SHOT should address this lack of efficacy data for anti-D Ig prophylaxis.

Methods and results

For any women reported to SHOT as having immune anti-D detectable for the first time in the current pregnancy, there are supplementary questions about the pregnancy occurring immediately before the index pregnancy, recorded sensitising events, anti-D Ig prophylaxis, and outcome. It is hoped that the data will provide a better understanding of the causes of continuing anti-D sensitisations.

By the end of 2013 a total of 35 cases had been reported, although in 2 cases data were incomplete meaning there was insufficient information for analysis. Ten cases occurred in primagravidae and 23 in women with previous pregnancies, but 2 of these cases were excluded from analysis as immunisation had occurred prior to the index pregnancy, so 21 cases from multiparous women were analysed.

Primagravidae n=10

- In all cases anti-D was detected after 28 weeks gestation
- 4 women weighed <68kg at booking (assume normal BMI based on average female height in UK), 2 women weighed >68-80kg (overweight) and 2 women were >80kg (obese), there was no information in 2 reports
- All women received correctly administered RAADP as a single 1500IU dose of anti-D Ig at 28 weeks
- In 7 women there was no identifiable sensitising event during the pregnancy
- In 3 women (4 events) sensitising events occurred: 3 antepartum haemorrhages (APH) and 1 fall. In 3 instances the women received appropriate treatment including a Kleihauer test (where appropriate) and anti-D Ig within 24 hours
- Peak anti-D was <4iu/mL in 4 cases, >4iu/mL in 3 cases. No information was available in 3 cases
- No pregnancies required antepartum intervention
- All pregnancies resulted in live births, of which 6 had no complications, but 3 babies required phototherapy and 1 baby required exchange transfusion

Multiparous women n=21

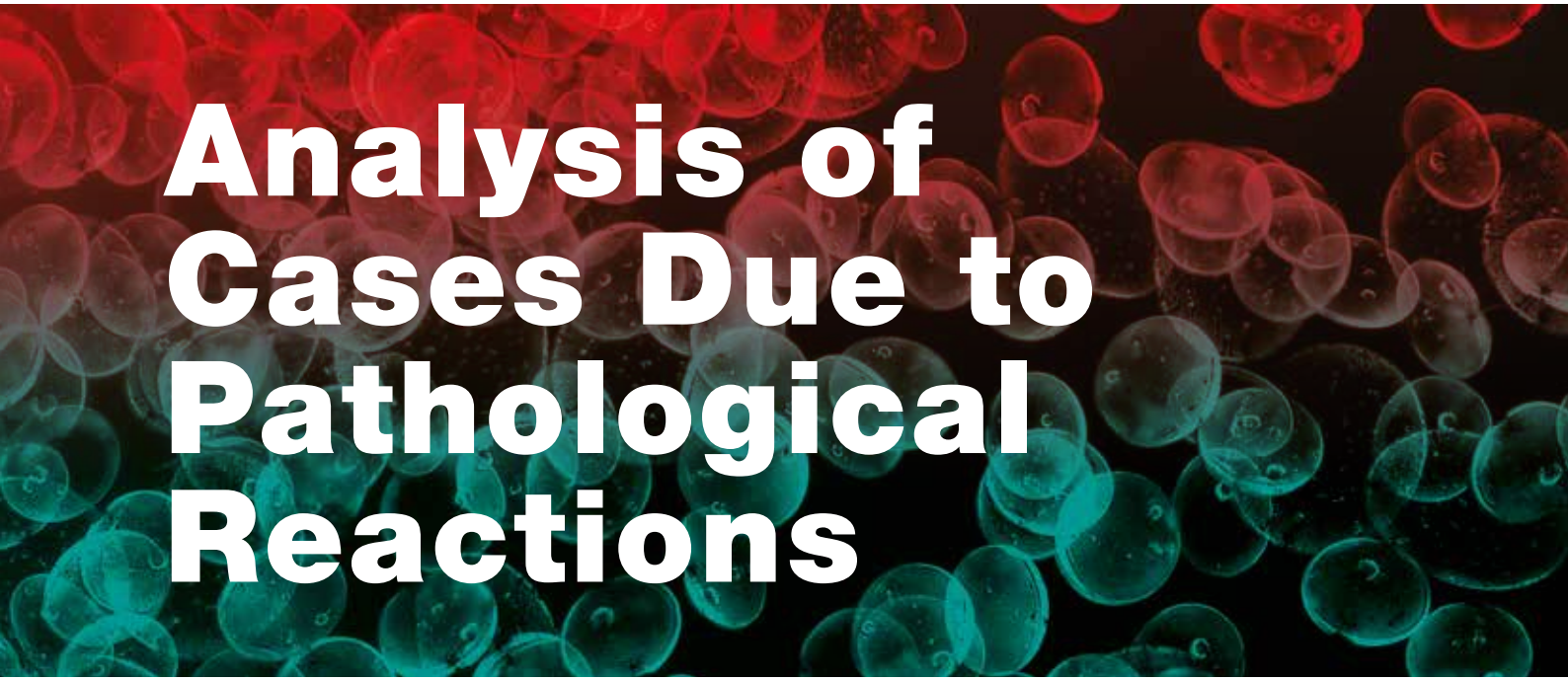
Note: 'previous pregnancy' refers to the pregnancy occurring immediately before the index pregnancy

- In 10 women anti-D was first detected at booking, in 8 women during the pregnancy and in 3 women at term
- The weight in previous pregnancy: <68kg at booking in 6 women, 68-80kg in 1 woman, >80kg in 3 women, no information in 11 women
- The weight in current pregnancy: <68kg at booking in 4 women, 68-80kg in 2 women, no women were >80kg, and there was no information in 15 reports
- RAADP in previous pregnancy: 11 women correctly received one dose (1500IU) regimen, 2 women correctly received two dose (500IU) regimen, 4 women did not receive RAADP and in 4 reports there was no information
- RAADP in current pregnancy: 9 women correctly received one dose (1500IU) regimen, 10 women did not receive RAADP as they were already immunised, in 2 cases there was no information
- Sensitising events in previous pregnancy: no identifiable event in 12 women, no information in 5 reports and identifiable events were noted in 4 women (3 APH, 1 fall) of which 3 were managed correctly with anti-D Ig
- Sensitising events in current pregnancy: no identifiable event in 11 women and 10 women were already sensitised
- Method of delivery in previous pregnancy: vaginal delivery in 5 women, elective caesarean section in 2 women, emergency caesarean section in 2 women and there was no information in 12 cases

- Gestation at delivery in previous pregnancy: no information yet as not requested on original data collection proforma (this has been added to the proforma for 2014 onwards)
- Postpartum prophylaxis in previous pregnancy: 14 women had Kleihauer test performed and received appropriate dose of anti-D Ig (2 women received a higher dose following positive Kleihauer test), 2 women did not receive postpartum anti-D Ig and in 5 reports this information was not available
- RhD type of baby: in previous pregnancy baby was RhD positive in 16/21 cases and information was not available in the other 5 cases
- Peak anti-D was <4iu/mL in 9 cases, >4iu/mL in 9 cases. No information was available in 3 cases
- Antepartum intervention was only required in one woman where ultrasound was performed to exclude fetal anaemia
- Pregnancy outcome information was available for 7 women - all were live births, 2 babies required phototherapy and 1 baby required exchange transfusion

COMMENTARY

These are very preliminary data so that it is not possible to draw any conclusions. However a larger more complete data set should provide much needed evidence about the reasons for continuing anti-D sensitisation. In the light of recent concerns regarding a ***potential*** trend for lack of efficacy (or reduced efficacy) in patients with a BMI ≥30 who are receiving Rhophylac via the intramuscular (IM) route of administration, we will now collect additional data about the previous pregnancy including weight and gestation at delivery and on the route of anti-D Ig administration. There are many gaps in the data, as it is likely that reporters are starting a file when anti-D is detected in the index pregnancy but do not complete the report once delivery has occurred. SHOT will be setting up a robust system to capture outcome data.



Analysis of Cases Due to Pathological Reactions

15 Acute Transfusion Reactions (Allergic, Hypotensive and Severe Febrile) (ATR)

Authors: Hazel Tinegate, Fiona Regan and Janet Birchall

Definition:

Acute transfusion reactions are defined in this report as those occurring at any time up to 24 hours following a transfusion of blood or components excluding cases of acute reactions due to incorrect component being transfused, haemolytic reactions, transfusion-related acute lung injury (TRALI), transfusion-associated circulatory overload (TACO), transfusion-associated dyspnoea (TAD) or those due to bacterial contamination of the component. However, the possibility that a reaction could belong to one of these serious categories must be kept in mind during recognition, initial assessment and treatment.

DATA SUMMARY
Total number of cases: n=320

Implicated components		Mortality/morbidity	
Red cells	182	Deaths definitely due to transfusion	0
Fresh frozen plasma (FFP)	31*	Deaths probably/likely due to transfusion	0
Platelets	96	Deaths possibly due to transfusion	0
Cryoprecipitate	0	Major morbidity	76
Granulocytes	0	Potential for major morbidity (Anti-D or K only)	0
Anti-D Ig	0		
Multiple components	11		
Unknown	0		

Gender		Age		Emergency vs. routine and core hours vs. out of core hours		Where transfusion took place	
Male	121	≥18 years	298	Emergency	34	Emergency Department	13
Female	192	16 years to <18 years	4	Urgent	49	Theatre	14
Not known	7	1 year to <16 years	15	Routine	213	ITU/NNU/HDU/Recovery	39
		>28 days to <1 year	2	Not known	24	Wards	174
		Birth to ≤28 days	1			Delivery Ward	17
		Not known	0	In core hours	168	Postnatal	0
				Out of core hours	70	Medical Assessment Unit	0
				Not known/Not applicable	82	Community	3
						Outpatient/day unit	57
						Hospice	0
						Antenatal Clinic	0
						Other	3
						Unknown	0

(ITU=Intensive therapy unit; NNU=Neonatal unit; HDU=High dependency unit)

**Including 2 reactions to methylene blue-treated FFP (MB-FFP) and 2 reactions to solvent-detergent treated FFP (SD-FFP)*

This analysis includes 320 cases including 4 transferred from haemolytic transfusion reactions (HTR) and 3 from unclassifiable complications of transfusion (UCT). A further 3 cases with predominantly respiratory features were transferred to TAD and 8 to TACO. Other cases were withdrawn as the reporters subsequently attributed the clinical features to other causes, and others were classified as mild and these have now not been included in the main analysis, according to recent SHOT guidance.

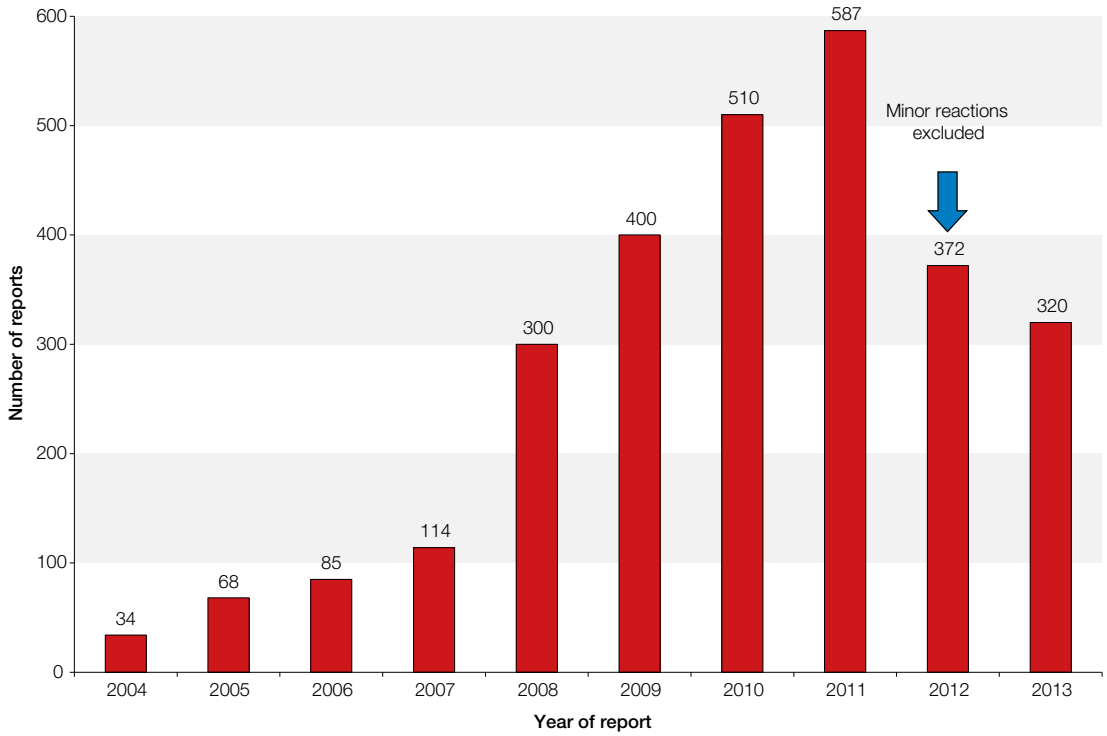


Figure 15.1: Numbers of cases of acute transfusion reactions 2004-2013

Introduction

The total number of ATR cases reported has fallen slightly since last year, from 372 to 320. Where possible, reactions have been classified according to the latest International Haemovigilance Network/ International Society for Blood Transfusion (IHN/ISBT) draft definitions which are available online [49]. These have been adopted by the British Committee for Standards in Haematology (BCSH) [50].

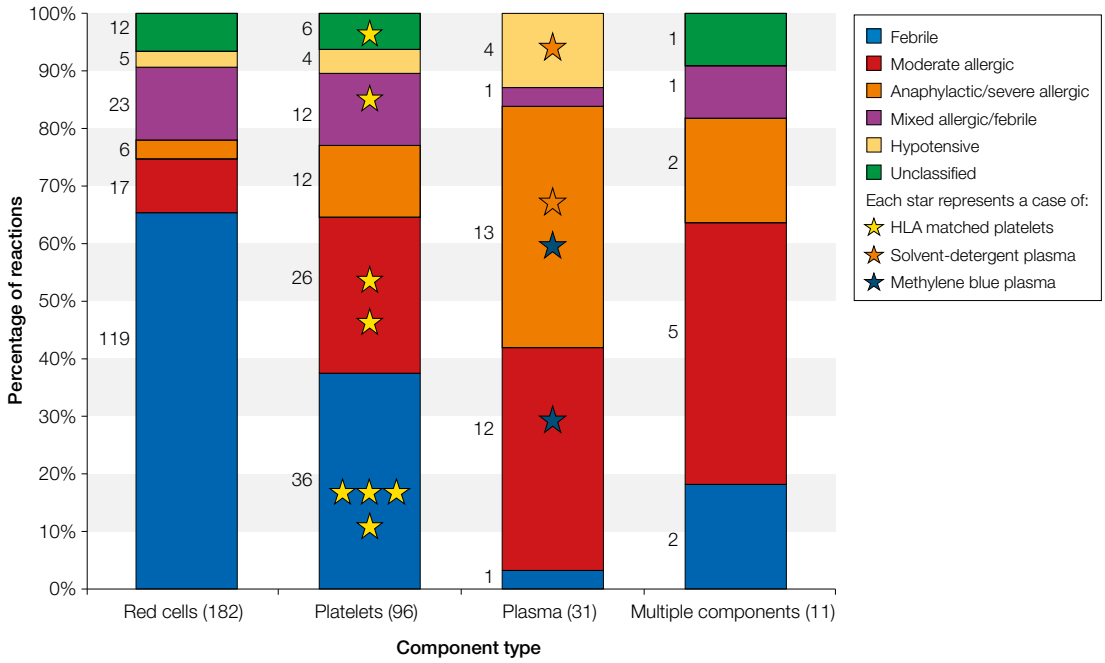
The pattern of reactions remains similar (see Figure 15.2, reaction by component type). The figures for anaphylaxis and severe reactions are similar. As in previous years, many reactions are difficult to classify. In some of these cases, symptoms and signs could be due to the patient's underlying condition rather than transfusion. This is more likely to be true for reactions where multiple components were given and where patients have complex clinical problems. This year, many reports lacked important details about blood pressure changes, which has led to 19 cases being unclassifiable.

Types of reactions

As far as possible, reactions have been classified and the following figures obtained:

- 158 febrile (136 moderate, 22 severe)
- 93 allergic (33 anaphylactic or severe allergic, 60 moderate)
- 37 mixed allergic/febrile (5 severe, 30 moderate and 2 whose severity could not be determined as insufficient information was provided)
- 13 hypotensive (6 severe, 6 moderate and 1 whose severity could not be determined as insufficient information was provided)
- 19 reactions were unclassifiable as the reaction was significant but not typical of an acute transfusion reaction. These included reactions where pain was a significant feature, or where the patient felt faint or lost consciousness. The imputability of many of these reactions is difficult to determine

Figure 15.2: Reaction by component type



The pattern is similar to previous years, in that febrile reactions are rarely seen with plasma and much reduced with platelets compared to red cells. There is a larger number of mixed allergic/febrile reactions: whether this is due to more detailed reporting is unclear.

Reactions in children

There were 22 reactions in children aged less than 18 years. These are further discussed in Chapter 25 Paediatric Cases.

Deaths n=0

Although there were 14 deaths reported in patients having ATRs, none was thought to be related to the transfusion.

Severe reactions n=76

The IHN describes reactions as life-threatening if major intervention such as use of vasopressors or admission to intensive care is required to prevent death, or severe if the reaction requires, or prolongs, hospitalisation [49].

There were 66 cases which the analysts classified as severe, consisting of 33 cases of anaphylaxis or severe allergic reaction, 22 severe febrile reactions, 5 severe hypotensive reactions and 6 severe mixed febrile and allergic reactions.

In addition to these 66 cases, a further 10 cases have been included as they were described by reporters as experiencing severe reactions although the reported symptoms and signs suggested moderate reactions. There were no patients reported to have long-term morbidity.

These cases indicate that transfusion reactions, although rarely associated with prolonged morbidity, may nevertheless have a significant impact on the patient and on hospital resources.

Specific types of reactions

Anaphylactic or severe allergic reactions n=33

Anaphylaxis is defined by the UK Resuscitation Council (UKRC) [51] and National Institute for Health & Care Excellence (NICE) [52] as: ‘ ...a severe, life-threatening, generalised or systemic hypersensitivity reaction... characterised by rapidly developing life-threatening airway and/or breathing and/or circulation problems usually associated with skin and mucosal changes’. Case 1 (below) provides a characteristic

example of an anaphylactic reaction in an obstetric setting.

Thirty three reactions were consistent with anaphylaxis or severe allergy, one in a 1 year old child who died. Death was stated to be unrelated to the reaction. Seven occurred on day units. Only one case cited the possibility of another agent potentially being the cause of the reaction (oral morphine).

Fifteen patients documented to have anaphylactic reactions were recorded as being given adrenaline which is stated to be the first line treatment by the UKRC. In 10 cases this was given with other medication, most commonly antihistamine and hydrocortisone. In two cases it was given as the sole medication. Noradrenaline was given in two cases.

The number of cases of anaphylaxis reported to SHOT in recent years has remained very stable, as can be seen in Figure 15.3.

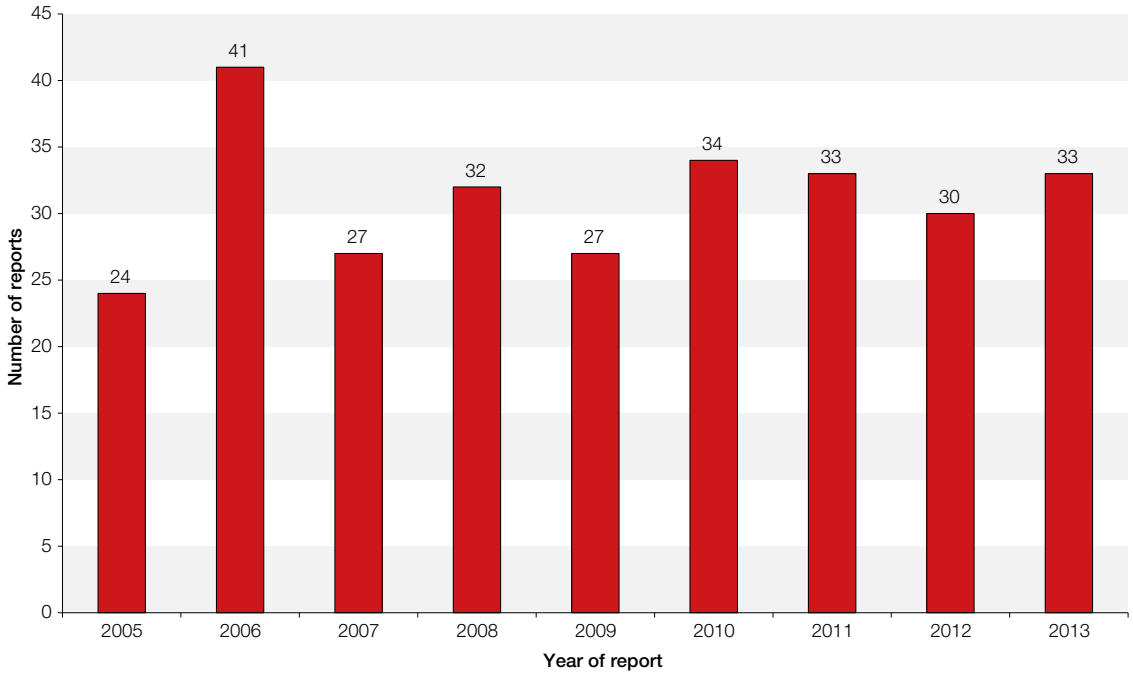


Figure 15.3: Cases of anaphylaxis 2005-2013

Case 1: Anaphylaxis triggered by FFP

A patient with a postpartum haemorrhage (PPH) received 2 units of red cells and 1 unit of fresh frozen plasma (FFP) with no ill effect. She had a further unit of red cells and a second unit of FFP. Eight minutes into this transfusion, the nurse noticed the patient was coughing, and had swollen eyes, lips and throat. There was evidence of bronchospasm and O2 saturations dropped. Blood pressure was unrecordable and the patient briefly lost consciousness. She was treated with adrenaline, intravenous (IV) hydrocortisone, chlorphenamine, salbutamol nebuliser and a multiple electrolyte replacement fluid, as well as syntocinon for management of the PPH.

Moderate allergic reactions n=60

These include reactions with respiratory components, not severe enough to be termed anaphylaxis. This includes 19 patients with angioedema.

Hypotensive reactions n=13

Six reactions were assessed as being severe. However, key data on blood pressure prior to, and during, the reaction were often not available.

Previous SHOT reports have suggested that hypotensive reactions tended to occur during or shortly after cardiac bypass procedures. However, there was only one severe hypotensive reaction reported in a cardiac surgery patient in 2013.

Severe febrile reactions n=22

Twenty-two febrile reactions were classified as severe. Five reports involved patients with underlying sepsis or line infection (two reports from the same patient).

The differential diagnosis of a severe febrile reaction includes bacterial transfusion-transmitted infection (TTI), an acute haemolytic transfusion reaction, and underlying inflammation or infection. If bacterial TTI is considered a possibility, the Blood Service should be contacted regarding recall of associated components from the donation, and the unit should be cultured by a department that has the capability of sampling the unit by aseptic technique as well as culture.

Case 2: A severe febrile reaction

One hour and 20 minutes into a transfusion of red blood cells the patient developed 2.2°C rise in temperature, severe rigors, tachycardia, vomiting, chest pain and a decrease in oxygen saturation. Rigors prevented measurement of the blood pressure. The urine was positive for haemoglobin, but the patient was known to have haematuria. Cold antibodies were detected which were felt not to have been responsible for the reaction. The implicated unit was negative on culture.

Mixed febrile/allergic reactions n=37

Reactions were classified as mixed as there was a combination of febrile features and a rash. Five cases were severe.

How transfusion reactions present

Whilst 114 reactions were first noticed by patients and a further seven by relatives, 148 reactions were first detected by routine observations. Although 117 of these were moderate reactions, 24 were severe/life-threatening (7 could not be classified). Out of the 24, 11 were severe allergic/anaphylactic reactions, and 1 was a severe hypotensive reaction. The median time of onset (where data were provided) was 30 minutes. This highlights the value of routine observations in the early detection of significant adverse events.

Speed of onset

The time of onset of symptoms from the start of transfusion of the implicated component was recorded in 128 cases. The median time to onset was 30 minutes (range 1 minute to 7.5 hours).

Management of the transfusion

Stopping the transfusion

In the case of a suspected transfusion reaction it is important to stop the transfusion at least temporarily, confirm the identity of the patient and that documented on the component, and check for obvious contamination. In severe reactions, the component should be taken down and retained for further investigation as necessary and venous access maintained by physiological saline. (Clinical judgement is required in the case of hypotension in a bleeding patient, where continuation of the transfusion may be life-saving). There is no published evidence to guide clinicians as to whether continuation of transfusion in moderate or mild reactions would be of harm.

Reports on the fate of transfusion were received as follows:

- 224 reports stated the transfusion was discontinued
- 2 transfusions were continued then stopped as symptoms recurred or worsened
- 2 cases continued at the same rate
- 5 cases continued at a slower rate
- 12 were stopped temporarily for observation: it was not clear what the subsequent management was
- 64 reports stated that the transfusion had already been completed
- 11 provided no details of further management

Transfusion reactions occurring at home

There were 57 reactions in day case patients, including 15 cases with features of severe reactions. Three patients experienced reactions when they had returned home.

Outpatient departments and day case units should ensure patients have information about what to do if they undergo a transfusion reaction.

Investigations

The purpose of investigation is to contribute to continued patient management, for example, by excluding other causes for the patient's symptoms/signs, and to guide management of further transfusion. Data for 2013 were encouraging as, in many cases, investigation was directed towards the patient's presenting symptoms and signs. However, there is still evidence that inappropriate testing for human leucocyte antigen (HLA), human platelet antigen (HPA) and granulocyte antibodies is being performed.

Respiratory investigations

A chest X-ray was reported to have been performed in 30 cases, and oxygen saturation in 70 cases.

Investigations for Immunoglobulin A (IgA) deficiency

IgA levels were measured in 53 patients: 14 with features of anaphylaxis, 16 other allergic reactions, 12 febrile reactions, 6 mixed allergic/febrile reactions, 3 hypotensive reactions and 2 unclassifiable reactions. There were two reports of very low levels, both in patients who had experienced anaphylaxis. Immunologists define IgA deficiency as an IgA level <0.07g/L, in the presence of normal levels of other immunoglobulins, in patients aged 4 years or more. It may form part of the spectrum of common variable immunodeficiency. However, the Blood Service experience is that the few patients who have been shown to be IgA deficient with severe allergic transfusion reactions have had very low IgA levels, <0.0016g/L, often in the presence of anti-IgA antibodies. In practice, about one in 500 of the UK population have a level as low as this, and 25% of people with very low IgA levels also have anti-IgA antibodies. IgA levels are now frequently measured as part of the investigation of coeliac disease and other auto-immune diseases. Given the rarity of severe reactions and comparative frequency of IgA deficiency, in the absence of a history of transfusion reaction, these patients should receive standard blood components [53].

Mast cell tryptase

There were only two reports showing a slight sequential 'rise and fall' in mast cell tryptase (MCT). One was a report of a patient with anaphylaxis and one related to a patient with a moderate allergic reaction. Several reports contained only one MCT result which was elevated, which on its own is of little diagnostic value. In one case three serial results were all moderately high. This is not typical of anaphylaxis. MCT testing is not routinely required, but if needed because the clinical diagnosis of anaphylaxis is in doubt, then serial MCT levels should be performed. Few cases seem to have had serial MCTs performed and it appears this test is rarely used in UK transfusion practice. Although MCT testing is often quoted as being important in the investigation of anaphylactic reactions to transfused blood and components, there are very few published studies of its role in transfusion reactions. In practice, adequately-timed samples are rarely obtained. The diagnosis of anaphylaxis should therefore primarily be made on clinical grounds.

HLA/HPA/granulocyte antibodies

HLA testing of the patient was performed in 16 cases, and HPA testing in two cases. Only one of the patients was reported to be refractory to platelets. For the 13 cases where diagnosis was known, 8 were haematology patients. Positive results were found in 10 cases, and in 5 instances the clinical team decided to use HLA-matched platelets in the future. These instances included one severe and two moderate febrile reactions, a moderate allergic, and a moderate mixed allergic/febrile reaction.

Comment

Patients who experience transfusion reactions should not be HLA- or HPA-antibody tested unless they experience repeated severe reactions that are not reduced by using washed red cells or platelets in suspension medium or there is evidence of platelet refractoriness [54]. This year, SHOT received 8 reports of moderate/severe reactions to HLA-matched platelets with a similar incidence per 100,000 units issued to that seen with standard platelets.

Investigations to exclude bacterial contamination

Patient blood cultures were performed in 149 cases, the majority having febrile reactions (n=99). Cultures were positive in 17 cases, but none of these were associated with severe febrile reactions, and were very unlikely to have been caused by bacterial contamination during transfusion.

In 115 reports the unit was cultured. Implicated components were: red cells, 71 instances, platelets, 38, plasma, 5, platelets and plasma in one. Cases included 12 severe febrile reactions where the investigation was highly appropriate, 12 cases of anaphylaxis and one severe hypotensive reaction (in these cases it may have been appropriate if the cause of collapse was not clear). In 62 moderate febrile reactions, 10 mixed allergic/febrile reactions, 2 moderate hypotensive reactions and 11 cases of moderate allergic reactions, cultures were performed and were likely to have been inappropriate. In five additional cases the reaction could not be easily classified. In 66 cases the culture was performed by the hospital laboratory and in 44 cases by the Blood Service, both laboratories in three cases and not stated in two cases. There were three reports of positive growth from hospital cultures which were later found to be negative by Blood Service laboratories. None of the units investigated by Blood Service laboratories had positive cultures. The initial positive growth was usually of mixed organisms and likely to be due to contamination at the point of sampling.

Very few of the 66 reports involving culture of the unit by hospital laboratories mention contacting the appropriate Blood Service to discuss recalling other components from the implicated donation (although undoubtedly this will have been done in many of the cases). This is an essential and potentially life-saving action when bacterial contamination of blood components is suspected.

Comment

Despite the fact that there have been no cases of bacterial transfusion-transmitted infection of blood components reported by the UK Blood Services in the last four years (including 2013), bacterial contamination should remain part of the differential diagnosis when a patient presents with a marked rise in temperature or rigors, especially when there is evidence of hypoxia, hypotension or shock.

Seven of the 40 cases of bacterial TTI reported to SHOT since 1996 (last cases in 2009) were associated with red cells. Febrile reactions are most common with red cells, and in 2013, 119 of the 182 reports implicating red cells were of febrile reactions, 13 of which were severe. In fact the unit was cultured in only 5 of these instances.

Bacterial infection has not been described with plasma transfusion, and reactions to plasma do not require unit cultures to be carried out.

When bacterial contamination is suspected, the clinical team should contact a Blood Service consultant to discuss the need for a recall of associated components from the donation.

Reactions to methylene blue-treated plasma components (MB-FFP or cryoprecipitate) or solvent-detergent treated plasma (SD-FFP) n=4 patients in total

Methylene blue-treated components

There were two reactions: a teenage boy who was being treated for haemorrhage developed what appeared to be a severe allergic (but not anaphylactic) reaction and a 7 year old with angioedema, a moderate allergic reaction.

Solvent-detergent treated plasma

There were two reactions, both in adult patients undergoing plasma exchange. One patient who experienced severe hypotension was later exchanged using standard plasma with no problems. Imputability was stated to be certain. A second patient experienced anaphylaxis.

Transfusion reactions are considered to be less frequent, and usually less severe, with solvent-detergent treated plasma (SD-FFP) than with standard plasma, possibly due to dilution of donor allergens in a large pool, or denaturation of allergens via the solvent detergent process. Analysis of allergic reactions to plasma reported to SHOT 2010-2012 showed the incidence was 2 per 100,000 with SD-FFP compared to 11.5/100,000 with standard plasma ($p<0.001$). Although 'standard' SD-FFP is still available, all new stock ordered by hospitals will have been treated to eliminate prions.

Recommendations

New recommendations

- Reporters should report cases fully, including clinical data such as temperature and blood pressure prior to, and during, a reaction, especially if fever or hypotension is reported

Action: Hospital Transfusion Teams (HTT)

- Patients who have experienced transfusion reactions should only be tested for platelet or granulocyte antibodies within guidelines such as those set out in England by the National Health Service Blood and Transplant (NHSBT) in their Histocompatibility and Immunogenetics user guide [54]. The main indication here would be persistence of severe reactions despite the use of platelets where the plasma has been removed and replaced by suspension medium

Action: HTTs, Histocompatibility and Immunogenetics laboratories

- Outpatient departments and day case units should ensure patients have information about what to do if they experience a transfusion reaction after leaving the unit

Action: HTTs, Day case wards

Recommendations from previous years: still active

- If a transfusion reaction is considered sufficiently severe that bacterial contamination is considered as a possible diagnosis, clinicians must contact the Blood Service to discuss whether a recall of associated components from the donation is necessary. This also applies when the hospital performs its own bacterial testing of the component

Action: Hospital Transfusion Committees (HTC)

- Patients who have experienced an anaphylactic transfusion reaction should be discussed with an immunologist regarding further investigation and management

Action: Haematologists

- Transfusions should only be performed where there are facilities to recognise and treat anaphylaxis, according to UK Resuscitation Council (UKRC) guidelines. This recommendation is also relevant for other transfusion-related emergencies such as respiratory distress caused by transfusion-associated circulatory overload (TACO) or transfusion-related acute lung injury (TRALI). In supplying to community hospitals or for home transfusions, providers must ensure that staff caring for patients have the competency and facilities to deal with this reaction. This is particularly relevant in the light of proposed increase in treatment of patients outside the secondary care setting

Action: HTTs, Royal College of General Practitioners

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.

Haemolytic Transfusion Reactions (HTR) 16

Author: Clare Milkins

Definition:

Acute haemolytic transfusion reactions (AHTRs) are defined as fever and other symptoms/signs of haemolysis within 24 hours of transfusion; confirmed by one or more of the following: a fall of Hb, rise in lactate dehydrogenase (LDH), positive direct antiglobulin test (DAT), positive crossmatch.

Delayed haemolytic transfusion reactions (DHTRs) are defined as fever and other symptoms/signs of haemolysis more than 24 hours after transfusion; confirmed by one or more of the following: a fall in Hb or failure of increment, rise in bilirubin, incompatible crossmatch not detectable pre transfusion.

NB - Simple serological reactions (development of antibody with or without a positive DAT but without clinical or laboratory evidence of haemolysis) may be reported in the Alloimmunisation category.

This chapter does not include haemolytic reactions resulting from inadvertent ABO-incompatible red cell transfusions, which are described in Chapter 8, Incorrect Blood Components Transfused (IBCT).

DATA SUMMARY
Total number of cases: n=49

Implicated components		Mortality/morbidity	
Red cells	48	Deaths definitely due to transfusion	0
Fresh frozen plasma (FFP)	0	Deaths probably/likely due to transfusion	1
Platelets	1	Deaths possibly due to transfusion	0
Cryoprecipitate	0	Major morbidity	8
Granulocytes	0	Potential for major morbidity (Anti-D or K only)	0
Anti-D Ig	0		
Multiple components	0		
Unknown	0		

Gender		Age		Emergency vs. routine and core hours vs. out of core hours		Where transfusion took place	
Male	17	≥18 years	46	Emergency	8	Emergency Department	4
Female	32	16 years to <18 years	0	Urgent	6	Theatre	3
Not known	0	1 year to <16 years	3	Routine	32	ITU/NNU/HDU/Recovery	7
		>28 days to <1 year	0	Not known	3	Wards	17
		Birth to ≤28 days	0			Delivery Ward	0
		Not known	0	In core hours	0	Postnatal	1
				Out of core hours	0	Medical Assessment Unit	3
				Not known/Not applicable	49	Community	0
						Outpatient/day unit	14
						Hospice	0
						Antenatal Clinic	0
						Other	0
						Unknown	0

(ITU=Intensive therapy unit; NNU=Neonatal unit; HDU=High dependency unit)

Number of cases

A total of 49 cases have been included, 17 acute and 32 delayed reactions.

Age range and median

There were 3 paediatric cases this year (ages 5, 8 and 13 years). The overall age range was 5 to 94 years, with a median age of 59 years.

Deaths n=1

There were 6 deaths in total. In 5 cases the patient died from their underlying disease, but in one case the haemolytic transfusion reaction contributed to the patient's death by triggering a severe sickle cell crisis:

Case 1: Severe sickle cell crisis triggered by DHTR

A patient was treated with a 10 unit exchange transfusion for a sickle chest crisis. He was readmitted 11 days later, unwell and with generalised sickle pain, and reported passing dark urine. The DAT was positive and anti-Jk^{b} and –S were identified in the post-transfusion plasma and eluate. The Hb fell from 98g/L on re-admission to 61g/L by the following day, the bilirubin rose to 674micromol/L and the creatinine rose to 140micromol/L, requiring ITU admission. He later died as a result of liver failure due to an ongoing sickle cell crisis, probably triggered by the delayed transfusion reaction.

Major morbidity n=8

There were 8 cases of major morbidity, 2/8 relating to acute and 6/8 to delayed reactions. Six involved patients with sickle cell disease, with 3/6 due to hyperhaemolysis. Five of 8 patients required ITU admission and 2/8 suffered a life-threatening drop in Hb (one with autoimmune haemolytic anaemia (AIHA) and another with sickle cell disease). The final patient suffered renal failure, requiring renal dialysis, but is since making a gradual recovery.

Clinical and laboratory signs and symptoms

Acute haemolytic transfusion reactions n=17

The most common clinical symptom was fever, reported in 12/17 (70.6%) cases, usually accompanied by rigors. Dyspnoea (6 cases), back or chest pain, and dark urine were the next most commonly reported symptoms (5 cases each). Less common were chills (4 cases), jaundice (3 cases), hypotension, tachycardia, and nausea and vomiting (2 cases each). There were single reports of hypertension, sweating, diarrhoea and myalgia.

An increase in bilirubin and/or a fall in Hb (or no Hb increment) were the usual laboratory signs of haemolysis, in 14 and 13 cases, respectively. The DAT was positive in 9/17 (52.9%) cases and there were 5 reports of a high LDH.

Delayed haemolytic transfusion reactions n=32

In 10/32 (31.3%) reports there were no obvious clinical symptoms associated with the DHTR, which was diagnosed by laboratory signs of haemolysis. Of the remaining 22/32 patients, the most common clinical feature reported was dark urine or jaundice, in 10/22 cases each (45.5%). The next most common presenting feature was fever (9 cases), followed by chest or back pain (8 cases). Other symptoms included dyspnoea, chills and hypotension.

Haemolysis was confirmed in all cases by a fall in Hb or lack of expected Hb increment. A rising bilirubin was reported in 24/32 cases (75.0%). Six patients were reported to have haemoglobinuria, and 15 had a raised LDH. A DAT was undertaken as part of the DHTR investigation in 30/32 cases (93.8%). It was negative in 9 cases, and positive in the remaining 21, with 10 demonstrating IgG coating only, 2 C3d coating only and 9 both.

Serological findings

Acute

There were 3/17 cases again this year where an antibody to a low frequency antigen was likely to have caused the reaction: two anti-Wr^a and one unspecified. One followed transfusion with red cells matched by electronic issue and another by immediate spin. In both cases the DAT was negative but the implicated donation was retrospectively found to be incompatible and there were clear signs of haemolysis, including a fall in Hb and a rise in bilirubin. The third case occurred in a patient with panagglutinins and a positive DAT, where the indirect antiglobulin test (IAT) crossmatch was incompatible, but the presence of alloantibodies had been excluded by the Blood Service reference laboratory. An eluate from the post-transfusion sample showed panagglutinins, but the implicated unit was found to be incompatible using adsorbed plasma. This patient also showed clear signs of haemolysis including jaundice, accompanied by a sharp rise in bilirubin.

Learning point

- Clinical staff need to be vigilant for acute haemolytic reactions and laboratory staff need to be aware of antibody-mediated transfusion reactions caused by antibodies to low frequency antigens, which may not have been detected in electronic or abbreviated crossmatching. This is a known, but accepted small risk of electronic issue and laboratory investigations of suspected haemolytic transfusion reactions should include a retrospective crossmatch

There was one case, where haemolysis may have been caused by an enzyme-only anti-E, but the patient had received fludarabine, which had previously caused a haemolytic episode in the same patient (Case 3).

There was one case of possible anti-Jk^a, although this was unconfirmed when tested by the Blood Service reference laboratory. Another patient developed weak anti-Jk^a+E 24 hours after one transfusion, identified when a further sample was taken following a febrile reaction during a transfusion the next day (Case 4). Anti-Fy3+Kp^a caused a severe acute reaction, requiring ITU admission in a sickle cell patient who already had red cell antibodies, and was probably in combination with a delayed reaction to a transfusion given 7 days previously. There was also one case due to anti-f.

For the first time in 5 years, there was one report of group O platelets causing a mild acute haemolytic episode in a group AB child. The platelets were found retrospectively to have a high-titre of IgG anti-A.

In the remaining 8/17 cases, no red cell alloantibodies were detected, although the patients appeared to have laboratory signs of haemolysis and varying clinical symptoms for which the transfusion was stopped.

Case 2: Major morbidity with no clear cause

A middle aged woman was admitted with a chest infection, for which she was already on antibiotics, and chronic anaemia (Hb 51g/L), a weakly positive DAT (C3 coating only) and panagglutinins by BioRad technique. Whilst being investigated by the Blood Service reference laboratory, she was given a considerable volume of fluid causing her Hb to fall to 40g/L. No antibodies were detected by LISS tube technique and red cells were issued as suitable for transfusion. The patient suffered a severe reaction half way through the second unit, with hypertension, vomiting, dyspnoea, cyanosis and abdominal pain. The post-transfusion plasma appeared haemolysed and she also had haemoglobinuria, with a rising bilirubin and creatinine, although the latter was already raised. She was transferred to the renal unit and required dialysis. Despite extensive investigation, no cause has been established for her anaemia and no red cell antibodies have been detected to explain the haemolytic episode.

Case 3: Acute haemolytic reaction in patient with enzyme-only anti-E and a history of haemolysis with fludarabine

An elderly patient with Waldenstrom's macroglobulinemia on fludarabine became cyanosed and dyspnoeic, and his oxygen saturation fell at the end of a 2 unit red cell transfusion. The bilirubin rose from 14 to 91micromol/L, the Hb fell quickly back to the pre-transfusion level and the patient had haemoglobinuria. The DAT was negative and the only red cell antibody to be detected was an enzyme-only anti-E. The reporters have also considered that this could be a case of fludarabine-related haemolytic anaemia, as this is a recognised phenomenon and the patient's Hb had been noted to drop following a previous dose of fludarabine.

Learning point

- Fludarabine has been associated with episodes of autoimmune haemolytic anaemia and could contribute to a confusing picture when the patient has also been transfused [55]

Case 4: Anti-Jk^a not immediately identified

A young male patient on extracorporeal membrane oxygenation therapy (ECMO), was given one unit of red cells without any problem. However, 180mL into a second unit of red cells the following day, the patient had a rise in temperature and the transfusion was stopped. The antibody screen was negative pre transfusion but weakly positive on the post-transfusion sample. The DAT had become weakly positive, with C3 coating only, and the bilirubin rose from 17 to 32micromol/L. No antibody was identified but 2 units of E-K- units were issued. Three days later, anti-E+Jk^a were clearly identified and the DAT was more strongly positive (again C3 coating only). Another 5 days later, spherocytes were noticed on the blood film, the bilirubin was rising again and the DAT was now mixed field positive with both C3 and IgG coating, but the eluate was negative. The patient may have been suffering from a mild delayed HTR in addition to the acute HTR.

It is possible that the anti-Jk^a (and maybe the anti-E) could have been identified when the antibody screen was weakly positive, by using more sensitive techniques such as an antiglobulin test using enzyme treated cells or by testing serum rather than plasma.

Learning point

- Kidd antibodies are often weak, complement-binding and difficult to identify. More sensitive techniques, such as an enzyme antiglobulin test, and/or a serum sample may be required for conclusive identification

Case 5: Acute reaction in a sickle cell patient with a history of hyperhaemolysis

A patient with sickle cell disease, and a history of hyperhaemolysis at another hospital, had fever, rigors, chest pain and dyspnoea during the second unit of a transfusion. The Hb rose from 38g/L to 48gL post transfusion, but began to fall again next day. The bilirubin increased from 95 to 143micromol/L and there was a slight rise in the absolute reticulocyte count. The pre and post DAT were positive but the antibody screen was negative on both samples. The reporter queried whether this was an episode of hyperhaemolysis.

This is not typical of hyperhaemolysis as the reaction occurred during the transfusion and there was no evidence that the Hb dropped to below pre-transfusion levels. However, the patient had a clear haemolytic episode with no evidence of alloantibodies. This patient is usually given IVIg cover when transfused at his local hospital but IVIg was not given on this occasion.

Case 6: Mild haemolysis following transfusion of group O platelets to a group AB child

A young child, group AB, received group O, cytomegalovirus (CMV) negative, irradiated, high-titre (HT) negative platelets, post chemotherapy. Two hours later the patient developed fever, chills and rigors during a group A red cell transfusion. The post-transfusion DAT was positive and anti-A was

eluted from the red cells. There were no other red cell antibodies detected. The platelets were retrospectively confirmed as having an IgM titre of 128 but an IgG titre of 2048. In future, this hospital plans to give group A platelets to non group O paediatric patients.

Learning point

- Group O platelets can cause haemolysis in non group O recipients, even when labelled as 'High-titre negative'. Paediatric patients are especially vulnerable, and where possible, (non group O recipients) should be given group specific or group A platelets in preference to group O

Delayed haemolytic transfusion reactions

No antibodies were detected in 8 patients with sickle cell disease (further details are shown in Table 16.2). The antibodies from the remaining cases are summarised in Table 16.1. Further details can be found in a Table on the website in the Annual SHOT Report 2013 Supplement, www.shotuk.org under SHOT Annual Report and Summaries, Report, Summary and Supplement 2013.

Table 16.1 Delayed – specificity of antibody

Antibody specificity by blood group system and antigen	Number of cases	Number of cases where this was the sole new antibody
Kidd		
Jk^a	9	7
Jk^b	5	2
Rh		
E	1	1
c (±E)	4	3
C	1	1
e	1	1
Fy		
Fy^a	2	2
Kell		
K	1	0
MNS		
M	1	1
S	2	1
s	1	0

Case 7: Unrecognised DHTR at home

An elderly woman with myelodysplastic syndrome received 2 units of red cells on the haematology day unit with no ill effect. Eight days later she experienced loin pain and passed black urine, which continued for 5 days. The primary care team prescribed antibiotics, but did not take a urine sample or report this to the haematologist. It was not until 3 weeks later, when the patient returned to the day unit for an appointment that a DHTR (due to anti-c) was diagnosed.

Learning point

- Primary care teams should be aware of the symptoms of a delayed haemolytic transfusion reaction (DHTR), and instigate appropriate investigations

Case 8: Anti-Jk^b could have been identified in the pre-transfusion eluate

A young patient with sickle cell disease was admitted with a painful crisis; the patient grouped as a D variant, with anti-C+D in the plasma. The Hb was 57g/L and 2 units of red cells were transfused. Six days later the Hb had fallen to 60g/L and a further 2 units of red cells were transfused. The patient was readmitted 13 days later with a Hb of 57g/L, the antibody screen was positive, anti-C+D was again identified and 2 units of CDE, K negative red cells were issued as crossmatch compatible. The following day, an antibody panel was performed on a new sample and anti-Jk^b was also identified. The DAT was positive pre and post transfusion and anti-Jk^b was eluted from both the pre- and post-transfusion samples. All 6 units were confirmed as Jk(b+).

Learning point

- The possibility of a delayed haemolytic transfusion reaction (DHTR) should always be considered when the patient's Hb drops within 2 weeks of a transfusion – in this case a direct antiglobulin test (DAT) should be undertaken, followed by an eluate if the DAT is positive

Haemolytic reactions in patients with sickle cell disease

HTRs were reported in 16 patients with sickle cell disease. There were no red cell antibodies detected in 9 of these; hyperhaemolysis was indicated in at least six cases. Table 16.2 shows more details of these cases.

Table 16.2: HTRs in patients with sickle cell disease

Reaction type	Cause	Clinical signs	Morbidity	Additional comments
Acute	Unknown	Fever, rigors, chest pain, dyspnoea	Minor	History of HHTR*
Acute & delayed	Anti-Fy3+Kp^a	Chest pain, dyspnoea	Major: ITU admission	May have required ITU admission due to sickle cell crisis
Delayed 10 days	Anti-Jk^b	None noted in report	Minor	
Delayed 9 days	Anti-Jk^b	Fever and generally unwell	Minor	
Delayed 8 days	HHTR	None noted in report	Minor	
Delayed 7 days	HHTR	Back pain, fever & chills	Major: Hb fell to 34g/L	Previous episodes of HHTR and methyl prednisolone cover given
Delayed 6 days	?HHTR	Jaundice	Minor	Complicated by sickle cell crisis
Delayed 17 days	HHTR	Fever	Major: ITU admission	
Delayed 10 days	HHTR	Fever & chills	Major: ITU admission	
Delayed 8 days	HHTR	Fever, rigors & back pain	Minor	
Delayed 8 days	Anti-S	Back pain	Minor	
Delayed 8 days	Anti-Jk^b+Le^a	Dark urine	Minor	Patient under shared care between 4 hospitals and transfusion history not always available
Delayed 11 days	Anti-Jk^b+S	Fever, chills, back & chest pain, jaundice, restlessness, dyspnoea & dark urine	Major: ITU admission and death	Sickle cell crisis ongoing in the liver
Delayed 23 days	Unknown	Fever, chest pain, dyspnoea & red urine	Minor	
Delayed 16 days	Anti-Jk^b+s	None noted in report	Major: ITU admission	
Delayed 5 days	Unknown	Fever, back pain, chest pain/ discomfort, dyspnoea/difficulty breathing, dark urine & jaundice	Major: ITU readmission	

** HHTR = Hyperhaemolyic transfusion reaction*

Eluates

Eluates were prepared and tested in the majority of cases: 22/32 (68.8%) DHTRs and 8/9 (88.9%) AHTRs (in the 9/17 cases where the DAT was positive). The eluate was helpful in 14/22 (63.6%) DHTR investigations by revealing specific antibody. In one case (Case 8), anti-Jk^{b} was only detectable in the eluate. The eluate only revealed a specific antibody in 2 of the AHTR cases (anti-A and anti-Kp^{a}).

There were 4 cases where the DAT was positive, but no eluate was tested, even though at least one of the investigations was undertaken by a Blood Service reference laboratory.

Timing of reaction

Acute

Twelve of the acute reactions occurred during the transfusion, 3 within 2 hours and 2 within 7 hours of transfusion.

Delayed

The delayed reactions were detected between 2 and 23 days post transfusion with a median of 8.5 days as shown in Figure 16.1.

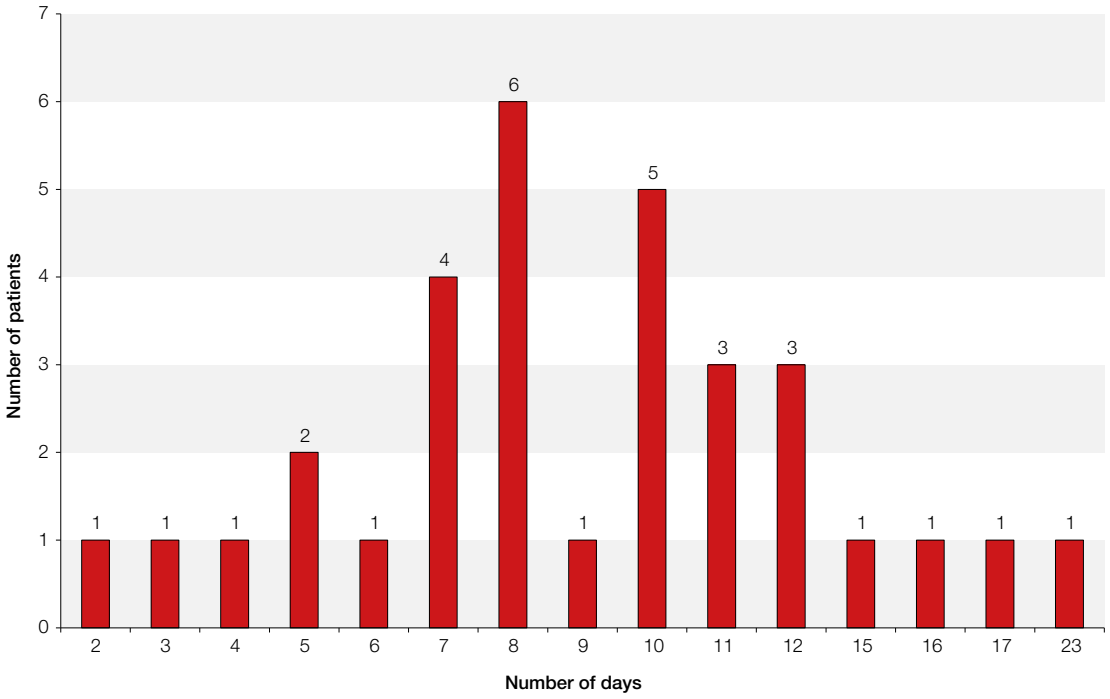


Figure 16.1: Number of days between transfusion and detection of DHTR

Technology and retrospective testing

Retrospective retesting of the pre-transfusion sample was undertaken in 6/32 (18.8%) cases of DHTR. The same result was obtained in all 6 cases; however, retesting was undertaken using the same techniques in 4 cases and by the same individual in one case; in only 2 cases was the testing confirmed by a reference laboratory. The majority of the time the sample had been discarded by the time the reaction was recognised.

In the vast majority of cases, 41/45 (91.1%), pre-transfusion antibody screening was undertaken using full automation (4 gave no answer), with a range of IAT technology, reflecting what would be expected based on standard practice data collected through United Kingdom National External Quality Assessment Service (UK NEQAS) questionnaires.

Learning point

- BCSH guidelines for pre-transfusion compatibility testing [19] advise that a pre-transfusion sample should be retained for at least 3 days post transfusion and that it is useful to keep plasma available for 7–14 days post transfusion for investigation of delayed transfusion reactions

COMMENTARY

- Kidd antibodies were once again implicated in the majority of the DHTRs where there was an antibody present 14/24 (58.3%). These antibodies can be weak and difficult to detect or identify, but often become clear when an enzyme antiglobulin test is used. If the hospital transfusion laboratory does not have a validated enzyme-IAT technique, samples may require referral to a Blood Service reference laboratory. Kidd antibodies usually bind complement and may also be easier to identify in a serum rather than a plasma sample. British Committee for Standards in Haematology (BCSH) guidelines recommend that a clotted sample is requested in addition to an EDTA sample for investigation of suspected HTRs [19]
- For the second year running, 3 AHTRs were due to antibodies to low frequency antigens, not present on screening cells. This is a small, but acceptable risk of electronic issue
- There were 8 cases reported as AHTRs where no alloantibodies were detected, and a further 2 where the presence of an alloantibody was dubious. All these patients had clinical reactions during or shortly after the transfusion, with clear laboratory signs of haemolysis. The cause of these reactions is not clear, and in at least 2 cases the only laboratory indication of haemolysis was a rise in bilirubin, which does not necessarily indicate immune haemolysis. Transfusion of red cells at the end of their shelf life has been shown to be associated with a rise in bilirubin levels (with no significant change in Hb, haptoglobin or LDH), peaking at 4 hours post transfusion and returning to normal after 24 hours [56]. Mechanical haemolysis may also occur following rapid resuscitation techniques using red cells under pressure through narrow access, both venous and intraosseous [57]. A similar picture has previously been seen in haemodialysis due to kinking of dialysis lines [58]. Clinical teams should report any suspected episodes of haemolysis associated with rapid resuscitation, in both the hospital and pre-hospital space, providing details of the equipment and techniques used
- HTRs were reported in 16 patients with sickle cell disease, representing nearly a third of all cases. Five of these were associated with major morbidity, and in one case contributed to the patient's death. These patients are known to have a higher incidence of alloimmunisation than the patient population as a whole, often develop multiple antibodies, and frequently have shared care. In one case this year, the patient was attending 4 different hospitals, making it more difficult to track the transfusion and antibody history (see also Chapter 26, Summary of Transfusion Complications in Patients with Haemoglobin Disorders)
- Hyperhaemolyic transfusion reactions (HHTR) were implicated in at least 6 patients with sickle cell disease. These are not always easy to distinguish from classic DHTRs, as alloantibodies may also be present, although this year, only one had detectable alloantibodies. In HHTRs the post-transfusion Hb is lower than the pre-transfusion Hb, indicating haemolysis of both patient and donor red cells. Serial Hb and HbS levels are helpful in confirming the diagnosis of HHTR. For further discussion, see Chapter 26 Summary of Transfusion Complications in Patients with Haemoglobin Disorders

Recommendations

- A clotted sample should be requested for investigation of suspected haemolytic transfusion reaction (HTR) to allow identification of weak complement binding antibodies, particularly anti-Jk^{a} and anti-Jk^{b}

Action: Transfusion Laboratory Managers

- Hospital transfusion laboratories should actively seek an antibody history when a sickle cell patient requires transfusion, using the NHS Blood & Transplant (NHSBT) Sp-ICE system where available (Specialist Services Electronic Reporting using Sunquest ICE)

Action: Transfusion Laboratory Managers

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.

17 Alloimmunisation

Author: Clare Milkins

Definition:

Alloimmunisation is defined as demonstration of clinically significant red cell antibodies after transfusion, which were previously absent (as far as is known), when there are no clinical or laboratory signs of haemolysis.

This is an optional reporting category; however we are actively seeking reports of alloimmunisation to anti-D, whether or not the patient has deliberately or inadvertently received RhD positive red cell components, or where the cause is unclear.

DATA SUMMARY
Total number of cases: n=114

Implicated components		Mortality/morbidity	
Red cells	114	Deaths due to transfusion	0
Fresh frozen plasma (FFP)	0	Deaths probably/likely due to transfusion	0
Platelets	0	Deaths possibly due to transfusion	0
Cryoprecipitate	0	Major morbidity	0
Granulocytes	0	Potential for major morbidity (Anti-D or K only)	0
Anti-D Ig	0		
Multiple components	0		
Unknown	0		

Gender		Age		Emergency vs. routine and core hours vs. out of core hours		Where transfusion took place	
Male	53	≥18 years	112	Emergency	0	Emergency Department	0
Female	61	16 years to <18 years	0	Urgent	0	Theatre	0
Not known		1 year to <16 years	2	Routine	0	ITU/NNU/HDU/Recovery	0
		>28 days to <1 year	0	Not known	114	Wards	0
		Birth to ≤28 days	0			Delivery Ward	0
		Not known	0	In core hours	0	Postnatal	0
				Out of core hours	0	Medical Assessment Unit	0
				Not known/Not applicable	114	Community	0
						Outpatient/day unit	0
						Hospice	0
						Antenatal Clinic	0
						Not applicable	114

(ITU=Intensive therapy unit; NNU=Neonatal unit; HDU=High dependency unit)

Number of cases

There are 114 cases, including 6 transferred from haemolytic transfusion reactions (HTR), and 5 from right blood right patient (RBRP). This represents an increase of 65.2% from 69 cases last year, which was the first year of reporting alloimmunisation in a separate chapter from HTR.

Age of patients

Patient ages ranged from 3 to 97 years, median 71 years.

Specificity of new antibodies identified post transfusion

Table 17.1 shows these in order of how commonly they were identified, rather than by blood group system, and the top four are the same as last year. The definition states that antibodies should be of clinical significance, and some of those reported have been classed as 'unlikely to be of clinical significance' [19], e.g. anti-Le^a and anti-Lu^a. However, as there is no absolute definition of clinical significance they have all been included.

Table 17.1: Specificity of new antibodies

Specificity	Number of cases
E	21
K	17
Mixture including Rh (4 Rh only, one including anti-D)	17
Jk^a	16
Fy^a	8
c (±E)	6
D	3
Fy^b	3
Lu^a	3
Kp^a	3
Jk^b	2
Cw	2
C, Le^a, S, unspecified	1 of each
Other mixture	9

Development of anti-D

Two patients, one 29 year old male patient with chronic anaemia, and one 56 year old female patient being transfused post chemotherapy, developed auto anti-D post transfusion.

In one interesting case, an elderly RhD negative (rr) patient, who had had 5 previous pregnancies (no details available), apparently made anti-C+D following transfusion with 2 units of RhD negative red cells. One of the donations was r'r (Ccddee) which would explain the presence of anti-C. The post-transfusion serology showed a strong reaction by indirect antiglobulin test (IAT) and enzyme against R_1R_1 (CCDee) and R_2R_2 (ccDEE) cells and a weak reaction (enzyme-only) against r'r cells, suggesting strong anti-D and weak anti-C. However, adsorption of the plasma by r'r cells left 1+ reactivity against R_2R_2 cells only, whilst adsorption with Ro (ccDee) cells, left no reactivity, suggesting anti-D+G. The donations were confirmed as RhD negative by molecular testing, so it is unclear how the patient made anti-D. One possibility is that the r'r donation stimulated a secondary immune response to the RhD antigen, through cross-reactivity with the C (and G) antigen. Another possibility is that the patient actually has anti-C+G, but the anti-G has not been completely adsorbed, making it appear to be anti-D.

In the 4th case, an elderly female haematology patient made anti-D following transfusion with RhD positive, human leucocyte antigen (HLA)-matched platelets.

Learning point

- HLA matching may take precedence over RhD matching in patients where there is no response to non-matched platelets. In these circumstances, patients only require anti-D Ig prophylaxis if they are of childbearing potential

Interval between the transfusion and detection of new antibodies

The time intervals reported ranged from 2 days to weeks, months or even years.

COMMENTARY

Once again, this year, it is notable that the profile of the antibodies identified differs from those reported in the delayed haemolytic transfusion reaction (DHTR) category and is similar to last year. The majority of antibodies causing DHTRs were anti-Jk^{a}, whereas the vast majority in this chapter are anti-E and anti-K, reflecting the higher clinical significance of Kidd antibodies.

Wherever possible, RhD negative patients who require chronic transfusion support should receive RhD negative red cell components [19]. However, this may not always be possible where HLA matching is also required. Females of childbearing potential should receive prophylactic anti-D in these circumstances [38].

The development of apparent anti-D following transfusion of RhD negative components should be investigated by molecular techniques to confirm that the donors are RhD negative rather than RhD variant. In the case reported this year, the donations were confirmed as RhD negative, and it is of interest to understand whether the patient has developed anti-D+C or anti-G+C, although it has no bearing on her clinical management. However, apparent anti-D+C in pregnancy should be investigated using adsorption techniques to distinguish between anti-D (+anti-C and/or -G) and anti-G (± anti-C), as routine anti-D prophylaxis would be indicated in the latter [59].

From January 2014 we asked for all reports of RhD-sensitisation. The risk of alloimmunisation in RhD negative patients given RhD-variant and DEL blood that types as RhD negative remains uncertain [2]. To date no case of anti-D immunisation after transfusion of apparently RhD negative red cells has been documented by SHOT although there have been a small number of cases reported in other countries.

In order to investigate this further we propose to collect data regarding cases of alloimmunisation in **RhD negative recipients** who have received **RhD negative red cell transfusions**.

Hospital transfusion laboratories are ideally placed to help in this project as alloimmunisation is now reportable to SHOT. Cases of **apparently unexplained RhD alloimmunisation** will be referred to the red cell immunohaematology reference laboratory so that the implicated RhD negative donors can be identified and samples may be investigated by additional serological methods and molecular typing.

In parallel with this work, SHOT is asking that **all cases of RhD immunisation in both women and men** are notified so that a detailed analysis of the causes of continuing immunisation (including transfusion of apparently RhD negative components) can be performed, alongside the ongoing assessment of the effectiveness (or not) of the antenatal and postnatal anti-D prophylaxis programmes. We hope you will be able to collaborate in this work. Cases not linked to pregnancy should be reported using the alloimmunisation questionnaire on the SHOT online database (Dendrite).

Post-Transfusion Purpura (PTP) 18

Author: Catherine Chapman

Definition:

Post-transfusion purpura is defined as thrombocytopenia arising 5-12 days following transfusion of cellular blood components (red cells or platelets) associated with the presence in the patient of antibodies directed against the HPA (human platelet antigen) systems.

DATA SUMMARY
Total number of cases: n=3

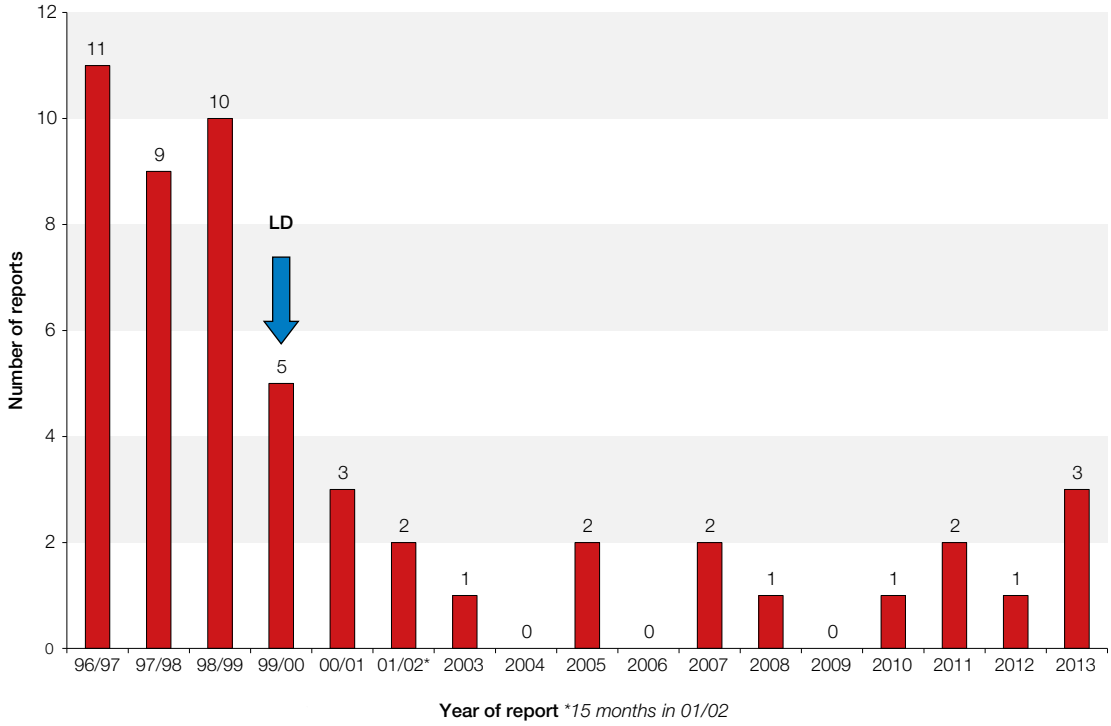
Implicated components		Mortality/morbidity	
Red cells	1	Deaths definitely due to transfusion	0
Fresh frozen plasma (FFP)	0	Deaths probably/likely due to transfusion	1
Platelets	0	Deaths possibly due to transfusion	0
Cryoprecipitate	0	Major morbidity	0
Granulocytes	0	Potential for major morbidity (Anti-D or K only)	0
Anti-D Ig	0		
Red cells and platelets	2		
Unknown	0		

Gender		Age		Emergency vs. routine and core hours vs. out of core hours		Where transfusion took place	
Male	0	≥18 years	3	Emergency	0	Emergency Department	0
Female	3	16 years to <18 years	0	Urgent	1	Theatre	0
Not known	0	1 year to <16 years	0	Routine	2	ITU/NNU/HDU/Recovery	1
		>28 days to <1 year	0	Not known	0	Wards	2
		Birth to ≤28 days	0			Delivery Ward	0
		Not known	0	In core hours	0	Postnatal	0
				Out of core hours	0	Medical Assessment Unit	0
				Not known/Not applicable	3	Community	0
						Outpatient/day unit	0
						Hospice	0
						Antenatal Clinic	0
						Other	0
						Unknown	0

(ITU=Intensive therapy unit; NNU=Neonatal unit; HDU=High dependency unit)

Three cases of PTP were analysed this year. Four suspected cases were initially reported but one of these was withdrawn because patient HPA alloantibodies had been excluded. This compares with 1 probable case last year.

Figure 18.1: The number of cases of PTP with confirmed HPA alloantibodies reported annually to SHOT since 1996, a total of 53 reports.



LD indicates the introduction of leucodepletion in 1999

One patient (Case 1) died this year following PTP; the reporters assessed that transfusion had contributed to her death (imputability 2). The other two patients recovered fully.

All three cases this year were women in their fifties. None was known to have had an acute transfusion reaction during the transfusions which preceded the development of thrombocytopenia. All had had pregnancies more than 20 years previously but there was no known history of neonatal alloimmune thrombocytopenia. All had alloantibodies with specificity for HPA-1a alone.

Analysis of cumulative data since 1996 has shown that there have been 53 cases of serologically confirmed PTP, and 52/53 were female. The single male had a history of prior transfusion. Alloantibodies with specificity for HPA-1a remain the commonest cause of PTP found either alone or in combination with other antibodies in 75.5% of cases. The annual number of reported cases has decreased since the introduction of universal leucodepletion of cellular components during 1999. Whole blood leucodepletion filters have been shown to reduce contaminating platelets by 100-fold.

Table 18.1: Cumulative causative antibody specificity 1996-2013

Causative antibody specificity	Number of cases
HPA-1a alone	35
HPA-1a with other HPA antibodies	5
Other HPA antibodies (HPA-1b,-2b, -3a, -3b, -5a, -5b and-15a)	13
Total	**53**

Case 1: Death associated with PTP

A 54 year old woman underwent aortic root surgery. She had had previous aortic valve surgery including aortic valve replacement with a metal valve and was on long term warfarin. Her preoperative platelet count was 213x10^9/L. Her anticoagulant management was 'in line with standard practice'. She received massive transfusion perioperatively: 8 units of red blood cells (RBC), 8 FFP, 3 pools platelets (plt), and I unit cryoprecipitate. Immediately after surgery her platelet count was 34x10^9/L. Her count recovered to 134x10^9/L by the 6th postoperative day. Unexpectedly, her platelet count then dropped to 3x10^9/L on the 8th postoperative day. She had 'blood blisters in her mouth' but was otherwise well with no other signs of bleeding. Warfarin was withheld at this point. A diagnosis of PTP due to HPA-1a antibody was made on the following day and treatment with intravenous

immunoglobulin (IVIg) and vitamin K was planned. She was transferred to ITU and whilst gaining intravenous (IV) access for treatment she complained of headache and then deteriorated rapidly with a catastrophic intracerebral bleed. She was treated with random donor platelets (and a prothrombin complex concentrate) but with no increase in platelet count. She died on the following day.

She had a history of previous transfusion and one pregnancy with no history of neonatal alloimmune thrombocytopenia but no known history of acute transfusion reaction (ATR) with transfused components.

Investigation summary: patient anti-HPA-1a detected, patient HPA type: HPA-1b1b.

The reporters assessed that her death was due to haemorrhage in which the transfusion had contributed. Imputability: 2.

Case 2: PTP with full recovery

A 52 year old woman had a very long history of iron deficiency and a recent diagnosis of gastric ulceration. She had a three week history of increasing symptoms of anaemia and her General Practioner (GP) found her to have Hb 69g/L. She was admitted to hospital and was transfused with 2 units of red cells with no ATR. Her post-transfusion Hb was 96g/L and plt 414x10^9/L.

Twelve days later she attended her GP with petechiae and haemoptysis and her platelet count had dropped to 3x10^9/L. She was admitted to hospital and treated with IVIg (140g over 2 days). Her platelet count recovered to >50x10^9/L in 1 day and >100x10^9/L in 3 days. She was discharged 4 days after admission with platelet count of 273x10^9/L. She had had two pregnancies >20 years before but no history of neonatal alloimmune thrombocytopenia.

Investigation summary: patient anti-HPA-1a detected, patient HPA type: HPA-1b1b

COMMENTARY

Case 1 demonstrates sadly that PTP can result rapidly in a catastrophic outcome.

The SHOT PTP definition was updated this reporting year to include transfusion of 'cellular blood components (red cells or platelets)' instead of red cells only. All cases this year had received red cells; two had also received platelets.

All three cases this year were due to HPA-1a alloantibodies.

Recommendations

New recommendation:

- Individuals who have been identified as having confirmed human platelet antigen (HPA)-specific alloantibodies should be informed about the potential risk of post-transfusion purpura (PTP) following transfusion and, in the case of females of childbearing potential, the possibility of neonatal alloimmune thrombocytopenia. The hospital clinician should take responsibility for informing such patients and providing an antibody card provided by the laboratory as recommended in the Guidelines for the Blood Transfusion Services [60]
- Clinicians need to maintain awareness of this rare complication to facilitate prompt recognition and treatment of PTP. Treatment with high dose intravenous immunoglobulin (IVIg) should be commenced early when PTP is suspected. Serological confirmation is not required before treatment is started. Further information about PTP and advice on management is available in Practical Transfusion Medicine [61]

Action: Royal College of Obstetricians to educate maternity departments about this complication; Blood Services will provide antibody cards for patients with clinically relevant platelet (HPA) and/or neutrophil (HNA) antibodies and these are supplied to the consultant haematologists whose responsibility it is then to inform and educate the patient

Recommendations still active from previous years:

Clinicians are encouraged to contact Blood Services if they suspect PTP (for advice and to arrange for patient investigation at platelet reference laboratory as required)

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.

Transfusion-Transmitted Infection (TTI) 19

Authors: Claire Reynolds and Su Brailsford

Summary

This year, there is no data summary table in this chapter, because cases will now be identified by the year of transfusion, rather than the year in which the report was made to SHOT or in which the investigation was completed. Table 19.1 includes the number of confirmed TTI incidents, by year of transfusion with total infected recipients and outcomes (death, major morbidity, minor morbidity) in the UK between October 1996 and December 2013 (Scotland included from October 1998).

The risks of a component potentially infectious for HBV, HCV or HIV being released for use in the UK are very low, however haemovigilance is maintained and investigations performed if a recipient is suspected to have been infected via transfusion.

Bacterial contamination of a component remains possible despite screening of platelets and the Blood Service should be informed immediately of all adverse reactions and events including those suspected of being the result of bacterial contamination of a component.

This chapter describes the possible transfusion-transmitted infection incidents investigated by the United Kingdom (UK) Blood Services and reported to the National Health Service Blood and Transplant (NHSBT)/Public Health England (PHE) Epidemiology Unit in 2013.

UK Blood Service investigations in 2013 have confirmed:

- One probable transfusion-transmitted hepatitis B virus (HBV) incident investigated in 2013 following a transfusion in 2012
- One hepatitis E virus (HEV) transfusion-transmitted incident pending from a 2012 investigation
- No proven bacterial transfusion-transmissions were reported in 2013
- One near miss bacterial incident (this was not reported to SHOT as a near miss incident, so is not included in the overall near miss figures in Chapter 7 Near Miss Reporting (NM))

  A retrospective study has detected HEV ribonucleic acid (RNA) in 0.03% of 225,000 donors in England at the time of donation.

Definition of a TTI:

A report was classified as a transfusion-transmitted infection if, following investigation:

- The recipient had evidence of infection following transfusion with blood components and there was no evidence of infection prior to transfusion and no evidence of an alternative source of infection

and, either:

- At least one component received by the infected recipient was donated by a donor who had evidence of the same transmissible infection

or:

- At least one component received by the infected recipient was shown to contain the agent of infection

Requesting and reporting a suspected TTI investigation

The data in the TTI chapter are mostly based on UK Blood Service investigations into suspected transfusion-transmitted infections (TTI) which are reported to the NHSBT/PHE Epidemiology Unit. The investigation reports are reconciled with reports by hospitals to the SHOT online reporting system which, in most cases, will also have been reported to the Medicines and Healthcare products Regulatory Agency (MHRA).

Guidance on reporting an incident, and the required supporting information, for suspected transfusion-transmitted infections (TTIs) for hospitals served by NHSBT can be found on the Requests for Investigation of Adverse Events & Reactions page at http://hospital.blood.co.uk/library/request_forms/aer/.

For other UK Blood Services please contact the local Blood Centre.

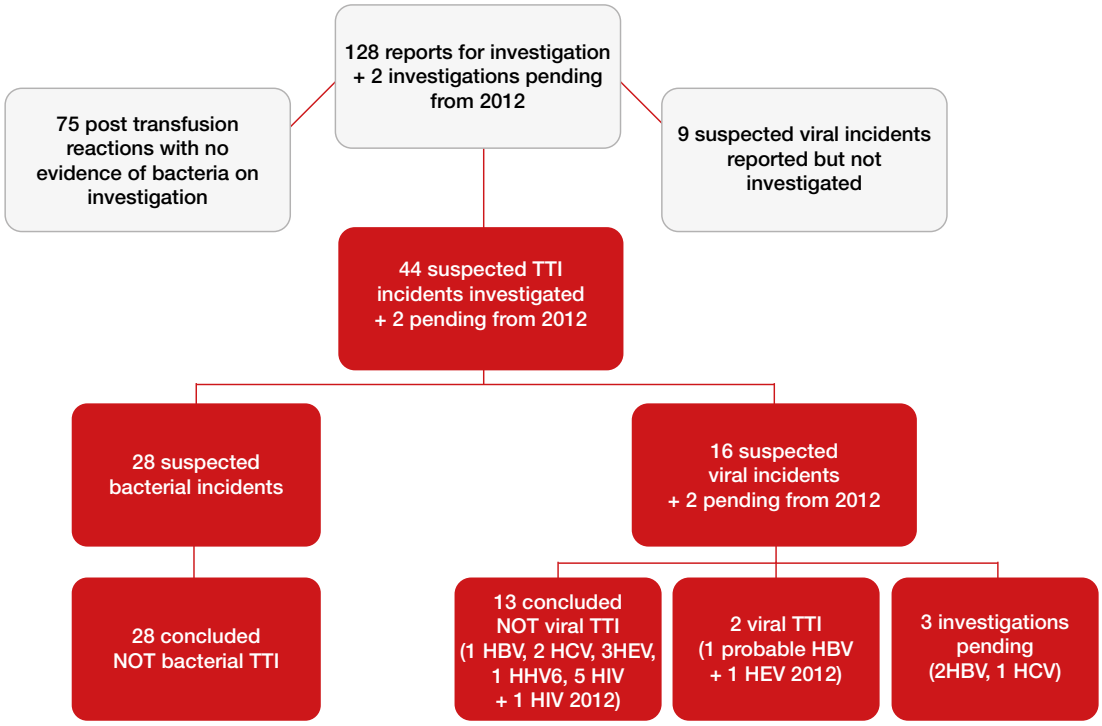
Learning point

- Cases should be reported to both SABRE and SHOT as soon as practical once the TTI investigation is requested, and reports should be updated once the outcome of the Blood Service investigation is received. This advice applies to all cases, whether or not infections are currently screened for by the UK Blood Services. Where reports are made initially by sources outside the transfusion team, a report to SHOT/SABRE will need to be completed as soon as the transfusion team become aware of the case

Summary of reports made to the NHSBT/PHE Epidemiology Unit in 2013

During 2013, the UK Blood Services were asked to investigate 128 suspected TTI incidents (see Figure 19.1), a similar number to recent years, consisting of 103 possible bacterial cases and 25 suspected viral incidents. A further 2 pending investigations from 2012 were finalised in 2013.

Figure 19.1: Outcome of reports of suspected TTIs made to the NHSBT/PHE Epidemiology Unit in 2013



HBV = hepatitis B virus; HCV = hepatitis C virus ; HEV = hepatitis E virus; HIV = human immunodeficiency virus; HHV6 = Human herpes virus 6

Bacterial reports 2013

Similar to previous years, 75/103 packs returned to the Blood Service with a request for bacterial culture following a patient reaction had no bacteria detected in the pack, and no positive patient blood culture reported by the hospital. These were reclassified as possible transfusion reactions. Sixteen of these were known to have been reported to SHOT as acute transfusion reactions (ATR). Others may have been deemed too mild to report, reported to other categories or not reported.

In the remaining 28 possible bacterial cases, the recipient's transfusion reaction was probably not caused by bacteria from a transfusion of a blood component from the UK Blood Services. Reconciliation with the MHRA showed that these cases included two of the three cases reported to SABRE in 2013 as a possible bacterial TTI (see Chapter 6 Medicines and Healthcare products Regulatory Agency (MHRA) Report on Blood Safety and Quality Regulation in 2013). The third possible case reported to SABRE was not reported to the Blood Service for bacterial investigation and is included in Chapter 15 Acute Transfusion Reactions (ATR). Seven of the 28 cases were known to have been reported to SHOT as ATR.

Learning points

- If a transfusion reaction is suspected to have been caused by bacterial contamination of the pack the Blood Service should be informed immediately so that any associated packs can be recalled
- Reports of UK Blood Services investigations into possible transfusion-transmitted infections (TTI) may not align with the Serious Adverse Blood Reactions and Events (SABRE) reporting year or category

Bacterial TTIs 2013

There were no proven bacterial incidents in 2013 but one near miss described below.

Bacterial contamination noticed before transfusion 2013

In September 2013 hospital staff noted clumping in an apheresis platelet pack 'A' and contacted the Blood Service prompting a recall of an associated pack 'B' which had been issued to another hospital. Both packs were returned to the Blood Service for testing. Clumps were no longer visible in pack 'A' but were beginning to form in pack 'B' on return. Figure 19.2 shows an example of clumping in a contaminated pack. Gram-positive cocci were observed from samples taken from both platelet packs and on culture identified as *Staphylococcus aureus*. The isolates from the two packs were indistinguishable on molecular typing. Growth had not been detected in the original BacT Alert screening by day 7, however, the bottles were not available for further testing. There was no evidence of any failure in the screening process - all protocols were followed and it could be shown that both platelet packs were sampled. The donor was shown to be a carrier of *Staphylococcus aureus* and permanently suspended from the donor pool. The most likely reason for the failure of detection was due to a lack of organisms being present in the original samples either due to 1) low bacterial numbers in the packs at the time of sampling or 2) the microorganisms growing in clumps or as a biofilm and not spread evenly through the packs at the time of sampling.

Note: the white clumping seen in the top left hand corner is similar to that seen in the incident described above, illustrating that vigilance is still required despite screening

Figure 19.2: Example of a platelet pack contaminated with *Staphylococcus aureus*

Bacterial TTIs 1996-2013

The last documented confirmed bacterial TTI was in 2009, but this predated universal bacterial screening of platelets throughout the UK Blood Services and the lack of cases may not, therefore, be totally explained by the introduction of screening. Conversely screening of platelet components cannot guarantee freedom from bacterial contamination. Packs are released for issue as 'negative-to-date' which may be before bacteria have multiplied sufficiently to trigger an initial screening reaction. On the other hand, an initial screen reactive result may be a false positive result, or related to bacteria which are of low pathogenicity and unlikely to cause any noticeable reaction in the recipient. A total of 36/43 bacterial transfusion-transmissions to individual recipients (33 incidents) have been caused by the transfusion of platelets (Table 19.1) since reporting began.

Learning points

- Screening will not prevent all contaminated units entering the supply
- Visual inspection of packs before use can alert staff to signs of bacterial growth
- Swift reporting of a suspected contaminated pack allows recall to occur before any associated packs are used
- Bacterial contamination is a factor to be considered if a transfusion reaction occurs
- Be aware that bacterial transmissions also have the potential to occur via red cells

Advice on clinical management and investigation of serious adverse reactions can be obtained from the hospital consultant responsible for blood transfusion and the British Committee for Standards in Haematology (BCSH) guideline on investigation and management of acute transfusion reactions [50]. See Chapter 15 Acute Transfusion Reactions (ATR), for comment on bacterial investigations following an acute transfusion reaction.

Viral TTI reports 2013

In 2013 nine suspected viral incidents reported to the Blood Service were not investigated for the following reasons: positive antibody results were due to passive transfer during intravenous immunoglobulin therapy (1 HBV); infection was not confirmed (2 HCV); infection was not proven to be absent prior to transfusion (2 cytomegalovirus (CMV)); infection was more likely to have been acquired by another route e.g. recipient born in and/or transfused or operated on in an endemic country (3 HBV, 1 HCV).

Learning points

- A post-transfusion investigation will not commence until the infection status of the recipient has been clarified:

– Requests for investigation of possible hepatitis C (HCV) transmission in individuals who are HCV polymerase chain reaction (PCR) negative, HCV antibody reactive, will not be investigated unless HCV antibody reactivity has been confirmed using two different assays, because of the possibility of non-specific antibody reactivity. If not locally available, the Blood Service can perform the required testing

– Cytomegalovirus (CMV) seroconversion should be demonstrated by testing pre- and post-transfusion samples in parallel by the same laboratory

– Immunoglobulin therapy can lead to passive transfer of antibodies which may be confused with infection. Careful review of the markers and timing can rule out infection before a report is made to the UK Blood Services

Viral investigations 2013

Sixteen reports of suspected viral TTIs made in 2013 were investigated. One suspected HBV incident was confirmed as a probable TTI according to the above definition, Case 1 below.

Viral investigations pending in 2012

Two investigation outcomes were pending at the end of 2012 and finalised in 2013. One suspected HEV TTI incident has been confirmed as proven, Case 2 below. One HIV TTI investigation was concluded as not TTI.

Case 1: Report of probable HBV transmission investigated in 2013

An elderly female on immunosuppressive therapy received 7 units of red cells in summer 2012 during surgery for a bowel problem. The recipient was first tested in April 2013 because of mildly abnormal liver function tests (LFT) and found to be hepatitis B surface antigen (HBsAg) positive, low level IgM antibodies to hepatitis B core (anti-HBc IgM) , hepatitis B e antigen (HBeAg) positive, avidity results inconclusive. The virus was identified as belonging to genotype A. Another sample taken from the patient in June 2013 suggested that this was a HBeAg-positive chronic hepatitis B infection. There was no obvious source of this hepatitis B infection and due to the possibility of recent acquisition the case was reported for investigation. Of the seven donors investigated, six were negative for evidence of hepatitis B infection but one was found to be HBV deoxyribonucleic acid (DNA) reactive on the index archive sample, tested retrospectively by individual sample testing having tested negative by routine pooled triplex nucleic acid test (NAT) screening at the time of donation. The donor was found to be anti-HBc positive on a subsequent sample. An archive sample from 2011 was also antibody to hepatitis B core (anti-HBc) positive, but HBV DNA negative. A follow-up sample from the donor has been found to be antibody to hepatitis B surface antigen (anti-HBs) positive and HBV DNA positive. These test results could reflect a resolving HBV infection or reactivation of an occult chronic HBV infection. Both donor and recipient are of non-UK, European heritage. Tattooing was reported by the donor but not in the timeframe that would be thought to correspond to active infection at the time of the index donation or that would require deferral (within 4 months of donation) or additional testing for anti-HBc (between 4 to 12 months prior to donation). This is a case of probable HBV transmission. Genotyping of the donor virus could not be undertaken due to insufficient HBV DNA in the donor's samples.

Case 2: Report of HEV transmission investigated 2012/13

A male recipient with multiple medical problems on immunosuppressive therapy received 129 donor exposures during a period of intensive plasma exchange and blood transfusion in May 2012. He became HEV RNA positive in July 2012 and seroconverted in August 2012. The vast majority of donors were cleared on the basis of subsequent negative serology and all tested index samples were RNA negative except for one. This donor was HEV RNA positive, anti-HEV negative at the time of the index donation and had cleared the HEV virus and seroconverted at the time of the next donation 5 months later. Sequencing confirmed this donation to be the source of infection in the recipient. The donor was a male repeat donor over 60 years old who reported no pre- or post-donation illness.

Viral TTIs 1996-2013

The year of transfusion may be many years prior to the year in which the case is investigated and reported to SHOT because of the chronic nature, and therefore late recognition, of some viral infections. Since 1996, 25 confirmed incidents of transfusion-transmitted viral infections have been reported, involving a total of 30 recipients. HBV is the most commonly reported proven viral TTI in the UK. This is partly because the 'window period' where an infectious donation from a recently infected donor is not able to be detected by the screening tests is longer than for HCV or HIV, despite NAT testing.

Risks of HBV, HCV or HIV being transmitted by transfusion

The risks of a component potentially infectious for HBV, HCV or HIV being released for use in the UK are very low. It is currently estimated that, of 2.4 million donations made in the UK each year, testing will NOT identify approximately two potentially infectious HBV window period donations every year, one potentially

infectious HCV window period donation every 12 years and one potentially infectious HIV window period donation every three years [62]. Far fewer TTIs are observed in practice, partly because the estimates have wide uncertainty and the model is based on the risk in all packs released. The model does not incorporate pack non-use, recipient susceptibility to infection, or underascertainment/underreporting, for example due to recipients dying from an underlying medical condition before a chronic asymptomatic viral condition is identified, or, in the case of HBV, an asymptomatic acute infection.

HEV commentary

The UK Blood Services' Standing Advisory Committee on Transfusion Transmitted Infection (SACTTI) is alerted to any new infectious threats to the UK blood supply through a wide range of reporting mechanisms, and will commission risk assessments where necessary to inform decisions on whether action should be taken to protect the safety of the blood supply [63]. There has been a recent increase in the number of cases of HEV reported to the UK Blood Services for investigation as suspected TTI incidents, probably due to increased awareness [64]. In 2012 and 2013 seven cases were reported for investigation with two proven to be HEV TTI. An HEV study has been conducted jointly by NHSBT and PHE to address the growing concern about HEV and blood safety.

The study aimed to define:

- The incidence of HEV in donors
- The extent of HEV transmission from virus-containing components
- The outcome of acquiring HEV from transfused components

The following study results are extra to cases reported to SHOT. Retrospective HEV RNA testing on a total of 225,000 donations given in 2013 indicated that 0.03% of tested donations were viraemic. A total of 62 HEV-containing components were transfused into 60 recipients, of whom 42 were available for follow-up; testing for HEV markers indicated infection in 19, giving a 43% overall transmission rate. Red cells were less likely to be linked to transmission than platelets or FFP. Antibody titres were more likely to be lower, and HEV RNA viral loads to be higher, in donations that resulted in transmission. Infected immunocompetent recipients cleared the virus very quickly, usually in the absence of any signs or symptoms of hepatitis. Immunosuppressed recipients exhibited a more prolonged viraemia, as reported elsewhere [65], but eventual clearance has been confirmed in those cases where prolonged follow-up was possible. This study indicates a high HEV incidence in donors, with an associated high transmission rate to recipients. Understanding the outcome of receiving HEV-containing components was an essential and complex part of this study, with the underlying medical condition and its management in the recipient playing a significant role [66].

Learning points

- The risk of transfusion-transmitted hepatitis B virus (HBV), hepatitis C virus (HCV) or human immunodeficiency virus (HIV) is very low in the UK and this is one reason the UK Blood Services will require evidence of confirmed infection and/or seroconversion prior to commencing an investigation
- The large number of donors to investigate in some cases, and the retrospective nature of some investigations, emphasises the importance of UK Blood Services maintaining an easily accessible system for archive samples

Parasitic TTIs

There were no reported parasitic infections for investigation in 2013. There have been two proven malaria TTIs reported to SHOT, the last in 2003 (Table 19.1). Malaria antibody testing was not applicable at the time according to information supplied at donation, and the donor selection guidelines were updated after these incidents to minimise the risk of further malaria TTIs [67]. The current selection guidelines on deferral and additional testing for malaria can be accessed at the UK transfusion guidelines web pages at http://www.transfusionguidelines.org.uk.

Variant Creutzfeld-Jakob Disease (vCJD) 2013

There were no vCJD investigations in 2013.

vCJD 1996-2013

The three vCJD incidents (Table 19.1) took place prior to the introduction of leucodepletion and other measures taken by the UK Blood Services to reduce the risk of vCJD transmission by blood, plasma and tissue products [68].

vCJD control measures

Despite international research efforts there is currently no suitable blood test available for screening blood donations for vCJD. The Advisory Committee on the Safety of Blood, Tissues and Organs (SaBTO) has been reviewing the measures in place to prevent transmission through blood transfusion [69]. This included considering the potential uses of donations from people in the UK at lower risk of vCJD i.e. those born since January 1996 and not thought to be exposed via the food chain. These young adults became old enough to donate in the UK from January 2013. New data published in 2013 suggests 1 in 2000 people in the UK may be carriers of vCJD [70] and a House of Commons Select Committee inquiry is currently underway to determine if the control measures in place are sufficient to minimise transfusion-transmitted infection in light of the potential for large numbers of carriers.

Cumulative data

Table 19.1: Number of confirmed TTI incidents*, by year of transfusion** with total infected recipients and outcomes (death, major morbidity, minor morbidity) in the UK between October 1996 and December 2013 (Scotland included from October 1998)

Year of transfusion*	Number of incidents (recipients) by infection											Implicated component			
	Bacteria	HAV	HBV	HCV	HEV	HIV	HTLV I	Parvovirus (B19)	Malaria	vCJD/ prion	Total	RBC	Pooled platelet	Apheresis platelet	FFP
Pre 1996	0	0	1 (1)	0	0	0	2 (2)	0	0	0	**3 (3)**	3	0	0	0
1996	0	1(1)	1 (1)	1 (1)	0	1 (3)	0	0	0	1 (1)	**5 (7)**	5	1	0	1
1997	3 (3)	0	1 (1)	1 (1)	0	0	0	0	1 (1)	2 (2)	**8 (8)**	6	1	1	0
1998	4 (4)	0	1 (1)	0	0	0	0	0	0	0	**5 (5)**	2	1	2	0
1999	4 (4)	0	2 (3)	0	0	0	0	0	0	‡ (1)	**6 (8)**	5	3	0	0
2000	7 (7)	1 (1)	1 (1)	0	0	0	0	0	0	0	**9 (9)**	1	5	3	0
2001	5 (5)	0	0	0	0	0	0	0	0	0	**5 (5)**	0	4	1	0
2002	1 (1)	0	1 (1)	0	0	1 (1)†	0	0	0	0	**3 (3)**	2	1	0	0
2003	3 (3)	0	1 (1)	0	0	0	0	0	1 (1)	0	**5 (5)**	1	1	3	0
2004	††	0	0	0	1 (1)	0	0	0	0	0	**1 (1)**	1	0	0	0
2005	2 (2)	1 (1)	1 (1)	0	0	0	0	0	0	0	**4 (4)**	1	3	0	0
2006	2 (2)	0	0	0	0	0	0	0	0	0	**2 (2)**	0	1	1	0
2007	3 (3)	0	0	0	0	0	0	0	0	0	**3 (3)**	2	1	0	0
2008	4 (6)	0	0	0	0	0	0	0	0	0	**4 (6)**	0	2	4	0
2009	2 (3)	0	0	0	0	0	0	0	0	0	**2 (3)**	1	0	2	0
2010	0	0	0	0	0	0	0	0	0	0	**0**	0	0	0	0
2011	0	0	1 (2)	0	1 (2)	0	0	0	0	0	**2 (4)**	2	0	0	2
2012	0	0	1 (1)	0	1 (1)	0	0	1(1)	0	0	**3 (3)**	2	0	0	1
2013	0	0	0	0	0	0	0	0	0	0	**0**	0	0	0	0
Number of incidents	**40**	**3**	**12**	**2**	**3**	**2**	**2**	**1**	**2**	**3**	**70**				
Number of infected recipients	43	3	14	2	4	4	2	1	2	4	**79**	**34**	**24**	**17**	**4**
Death due to, or contributed to, by TTI	11	0	0	0	0	0	0	0	1	3	**15**				
Major morbidity	28	2	14	2	2	4	2	1	1	1§	**57**				
Minor morbidity	4	1	0	0	2	0	0	0	0	0	**7**				
Implicated component															
RBC	7	1	11	2	2	2	2	1	2	4	**34**				
Pooled platelet	20	2	1	0	0	1	0	0	0	0	**24**				
Apheresis platelet	16	0	1	0	0	0	0	0	0	0	**17**				
FFP	0	0	1	0	2	1	0	0	0	0	**4**				

**No screening was in place for vCJD, human T cell lymphotropic virus (HTLV), HAV, HEV or parvovirus B19 at the time of the documented transmissions. In both malaria transmissions, malaria antibody testing was not applicable at the time according to information supplied at donation*

*** Year of transfusion may be prior to year of report to SHOT due to delay in recognition of chronic infection*

† The two HIV incidents were associated with window period donations (anti-HIV negative/HIV RNA positive) before HIV NAT screening was in place. A third window period donation in 2002 was transfused to an elderly patient, who died soon after surgery. The recipient's HIV status was therefore not determined and not included

†† In 2004 there was an incident involving contamination of a pooled platelet pack with Staphyloccoccus epidermidis, which did not meet the TTI definition because transmission to the recipient was not confirmed, but it would seem likely. This case was classified as 'not transfusion-transmitted'

‡ Same blood donor as one of the 1997 transmissions so counted as the same incident; note: counted as two separate incidents in previous reports

§ A further prion case died but transfusion was not implicated as the cause of death. The outcome was assigned to major morbidity instead because although there was post-mortem evidence of abnormal prion proteins in the spleen the patient had died of a condition unrelated to vCJD and had shown no symptoms of vCJD prior to death

Please contact the National Coordinator for Transfusion Transmitted Infections (see page 2, inside front cover) for further information or alternative breakdown of data.

Recommendations

- Clinical staff requesting investigation of a possible transfusion-transmitted infection (TTI) by the UK Blood Services are reminded to report as soon as practical to Serious Adverse Blood Reactions and Events (SABRE) and SHOT. The reporter should remember to tick the SHOT box to prompt SHOT reporting. Reporters should update their report once the outcome of the UK Blood Services investigation is known. These should be reported even if not currently screened for by the Blood Service

Action: Hospital Transfusion Teams (HTT), Trust/Health Board Chief Executive Officers and Medical Directors responsible for all clinical staff

2012 Recommendations still active

- Retain suspected bacterially contaminated packs, even if near empty, for return to the Blood Service as the residue can be washed out and cultured. Report a suspected bacterial transfusion-transmitted infection (TTI) promptly to the Blood Service to allow recall of any associated packs for testing. If sampling packs locally for bacterial testing, use ports rather than breaching the pack to minimise environmental contamination of the pack

Action: Trust/Health Board Chief Executive Officers and Medical Directors responsible for all clinical staff, Transfusion and Microbiology Laboratory Managers (see Chapter 15, previous recommendation on recall)

- Hospitals and Blood Centres investigating a possible viral TTI are reminded of the importance of locating any archived recipient samples (transfusion-related or not) for testing. It is important that laboratories facilitate access to those samples (with due consent of appropriate parties including the patient)

Action: Trust/Health Board Chief Executive Officers and Medical Directors responsible for all clinical staff, Transfusion Laboratory Managers, HTTs

2010 Recommendations still active

- Even if TTI is excluded in a case of ATR, the case should still be reported to SHOT as an ATR If necessary

Action: HTTs, Trust/Health Board Chief Executive Officers and Medical Directors responsible for all clinical staff

- Clinicians investigating suspected viral TTIs should explore all possible risk exposures in parallel with the Blood Service investigations, in order to determine the patient's most likely source of infection. This includes checking records and testing samples taken prior to the implicated transfusion(s) to check that the recipient was not infected prior to transfusion

Action: Trust/Health Board Chief Executive Officers and Medical Directors responsible for all clinical staff, UK Blood Services

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.

20 Cell Salvage and Autologous Transfusion (CS)

Authors: Joan Jones and Dafydd Thomas

Definition:

Any adverse event or reaction associated with autologous transfusion including intraoperative and postoperative cell salvage (washed or unwashed), acute normovolaemic haemodilution or preoperative autologous donation.

In addition specific definitions for cell salvage events are as follows:

- **Adverse events due to operator error, machine failure and availability of trained staff where the event impacts on the care of the patient**
- **Adverse clinical events during the cell salvage process**
- **Pathological reactions to *reinfused* blood**

DATA SUMMARY
Total number of cases: n=12

Implicated components		Mortality/morbidity	
Red cells	12	Deaths definitely due to transfusion	0
Fresh frozen plasma (FFP)	0	Deaths probably/likely due to transfusion	0
Platelets	0	Deaths possibly due to transfusion	0
Cryoprecipitate	0	Major morbidity	0
Granulocytes	0	Potential for major morbidity (Anti-D or K only)	0
Anti-D Ig	0		
Multiple components	0		
Unknown	0		

Gender		Age		Emergency vs. routine and core hours vs. out of core hours		Where transfusion took place	
Male	7	≥18 years	9	Emergency	5	Emergency Department	0
Female	4	16 years to <18 years	0	Urgent	0	Theatre	0
Not known	1	1 year to <16 years	1	Routine	7	ITU/NNU/HDU/Recovery	0
		>28 days to <1 year	0	Not known	0	Wards	0
		Birth to ≤28 days	0			Delivery Ward	0
		Not known	2	In core hours	6	Postnatal	0
				Out of core hours	3	Medical Assessment Unit	0
				Not known/Not applicable	3	Community	0
						Outpatient/day unit	0
						Hospice	0
						Antenatal Clinic	0
						Other	0
						Unknown	12

(ITU=Intensive therapy unit; NNU=Neonatal unit; HDU=High dependency unit)

Twelve cases were reviewed and none were withdrawn. No cases were transferred to another chapter. There were no reports of adverse events related to acute normovolaemic haemodilution or preoperative autologous donation (the use of these autologous transfusion methods is almost non-existent within current UK practice since the European Blood Directive).

Specialty involved in the event

The following specialties were involved in the 12 cases reviewed:

- 5 were orthopaedic
- 5 were obstetric
- 1 was neurosurgery
- 1 was vascular

Type of cell salvage

- In 8 cases intraoperative cell salvage was involved
- In 3 cases postoperative cell salvage was involved
- In 1 case a combined system was used

Adverse reactions n=8

There were 8 adverse reactions reported this year. Two reactions occurred in postoperative systems and one in a combined system (postoperative phase) where the reporters classed the reactions as minor morbidity. In these three cases the patients displayed rigors and hypotension. Five reactions occurred where intraoperative cell salvage was being undertaken and in none of these cases did the reporters class the reaction as major morbidity although all cases showed signs of severe hypotension. In the five cases of hypotension reported, four occurred during reinfusion of cell saved blood through leucodepletion filters (LDF) and in all cases the anticoagulant used was acid citrate dextrose (ACD). Three of these cases are described in the vignettes below. The fifth case was an orthopaedic procedure where the patient was undergoing a revision hip replacement. The hypotension was associated with the reinfusion of the intraoperatively collected blood following washing and filtration. In this instance no LDF was used and the anticoagulant used was heparin.

Case 1: Hypovolaemia related to leucodepletion filter use in obstetrics (1)

A young woman was taken to theatre for resuscitation, laparotomy and hysterectomy. The haemorrhage was surgically under control and the patient haemodynamically stable. Cell salvage was used and while reinfusing autologous blood, the patient became profoundly hypotensive (systolic pressure 60mmHg) which was corrected with vasopressors, fluids, and the patient's observations normalised. The autologous blood reinfusion was recommenced and again immediate hypotension occurred. It was therefore assumed to be related to the LDF. The filter was removed and autologous blood reinfused without problem. The patient remained intubated and ventilated postoperatively in ITU.

Case 2: Hypovolaemia related to leucodepletion filter use in obstetrics (2)

The patient's blood was collected using cell salvage during an emergency caesarean section. After the procedure the patient was haemodynamically stable but had lost a reasonable amount of blood which was processed and 800mL given back to the patient again through an LDF. After about 15 minutes of commencing the cell salvage reinfusion (estimated 100mL) the patient became hypotensive and with a systolic blood pressure of <90mmHg, the patient felt dizzy and nearly fainted. The transfusion was stopped and the blood pressure returned to a normal value and the dizziness settled. The patient also stated that she felt her vision was blurry and she developed a mild facial rash, all of which resolved after stopping the transfusion.

Case 3: Hypovolaemia related to leucodepletion filter use in tumour removal

A patient was undergoing removal of a giant nerve sheath tumour from the lumbar spine region and the intraoperatively collected blood was filtered through an LDF because of the malignant nature of the tumour. Hypotension occurred on reinfusion.

Description of these cases has been included to make clinicians aware and vigilant of similar adverse reactions when using leucocyte depleting filters (LDF) combined with cell salvage and to encourage reporting to SHOT if they occur.

Adverse events n=4

There were four reports in this category. Two were related to machine failures and therefore no blood could be processed or reinfused. In another case black particulate material was noted in the processed blood. In the fourth case the infusion of postoperative autologous blood continued well outside the specified time.

COMMENTARY

Again this year we have reports of significant hypotension which is managed by stopping the reinfusion of cell salvaged red cells. In one of the cases the link with LDFs became more obvious when the reinfusion of salvaged blood was continued without the LDF and no hypotension occurred. This is a recognised complication which may be related to elevated levels of interleukin 6 [71], and is reviewed by Sreelakshmi [72].

Learning points

- The use of leucodepletion filters (LDF) with cell salvaged blood can, rarely, cause significant hypotension
- Stopping the infusion and resuscitation with fluids and vasopressors may be necessary although all reports describe only transient hypotension
- In cases where there is brisk haemorrhage and the blood is needed, try infusing without the LDF

Recommendations

- Ensure that all cell salvage users in your institution are made aware of this complication and the simple measures that need to be taken should it occur

Action: Hospital Transfusion Committees (HTC), Hospital Transfusion Teams (HTT)

- Ensure all cases of serious reactions are reported to SHOT via the hospital transfusion team

Action: HTTs, Operating Department Practitioners, Cell Salvage Operators

- Consider where a machine failure occurs, which is not due to operator error, these are reported to the Medicines and Healthcare products Regulatory Agency (MHRA) under the Medical Devices reporting scheme

Action: Cell Salvage Operators, HTTs

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.

Unclassifiable Complications of Transfusion (UCT) 21

Author: Paula Bolton-Maggs

Definition:

Occurrence of an adverse effect or reaction temporally related to transfusion, which cannot be classified according to an already defined transfusion event and with no risk factor other than the transfusion, and no other explanation.

DATA SUMMARY
Total number of cases: n=6

Implicated components		Mortality/morbidity	
Red cells	3	Deaths definitely due to transfusion	0
Fresh frozen plasma (FFP)	0	Deaths probably/likely due to transfusion	0
Platelets	0	Deaths possibly due to transfusion	1
Cryoprecipitate	0	Major morbidity	1
Granulocytes	0	Potential for major morbidity (Anti-D or K only)	0
Anti-D Ig	1		
Multiple components	2		
Unknown	0		

Gender		Age		Emergency vs. routine and core hours vs. out of core hours		Where transfusion took place	
Male	2	≥18 years	2	Emergency	0	Emergency Department	0
Female	4	16 years to <18 years	0	Urgent	2	Theatre	2
Not known	0	1 year to <16 years	1	Routine	3	ITU/NNU/HDU/Recovery	2
		>28 days to <1 year	1	Not known	1	Wards	1
		Birth to ≤28 days	2			Delivery Ward	0
		Not known	0	In core hours	2	Postnatal	0
				Out of core hours	2	Medical Assessment Unit	0
				Not known/Not applicable	2	Community	0
						Outpatient/day unit	0
						Hospice	0
						Antenatal Clinic	0
						Other	0
						Unknown	1

(ITU=Intensive therapy unit; NNU=Neonatal unit; HDU=High dependency unit)

Six cases are included in this summary. Four reports relate to children.

Necrotising enterocolitis (NEC)

Two neonates (10 and 25 days of age) developed necrotising enterocolitis shortly after receiving red cell transfusions, both died, but only one of these was possibly related to the transfusion, and these are discussed further in Chapter 25 Paediatric Cases (Case 3).

Hyperkalaemia in bypass fluid

A 4-month old infant was being prepared for open heart surgery. A neonatal large volume unit of red cells was used to prime the bypass circuit. However, the potassium level was found to be very high at 13.76mmol/L. The potassium level in the bag itself was 41.4mmol/L (expected range 10.6-15.0mmol/L). The red cell unit had been properly managed and the incident has been fully investigated. This is further discussed in Chapter 25 Paediatric Cases.

Alloimmunisation after RhD mismatched transplant

A 13 year old girl, group B RhD negative, developed anti-D following liver transplant from a live donor whose group was O RhD positive. Anti-D immunoglobulin was not given to cover this. Anti-D antibodies were detected 11 weeks later. The transplant unit did not have a protocol for this situation. It was not thought to be a problem with cadaveric livers which are washed out prior to transplant. A national survey of liver units is planned to discover if any units have a protocol. Similar issues apply to RhD mismatched renal transplants, and although some units have policies for anti-D immunoglobulin, there are no national guidelines.

Unexplained thrombocytopenia

Two adults were reported with unexplained thrombocytopenia after transfusion. The aetiology of the thrombocytopenia was unclear but probably multifactorial (sepsis, poor bone marrow function) and in both cases the tests for post-transfusion purpura and/or heparin-induced thrombocytopenia were negative. Thrombocytopenia in elderly patients who are unwell is not uncommon, but treatable causes should be excluded by appropriate tests.

Pain during or after transfusion

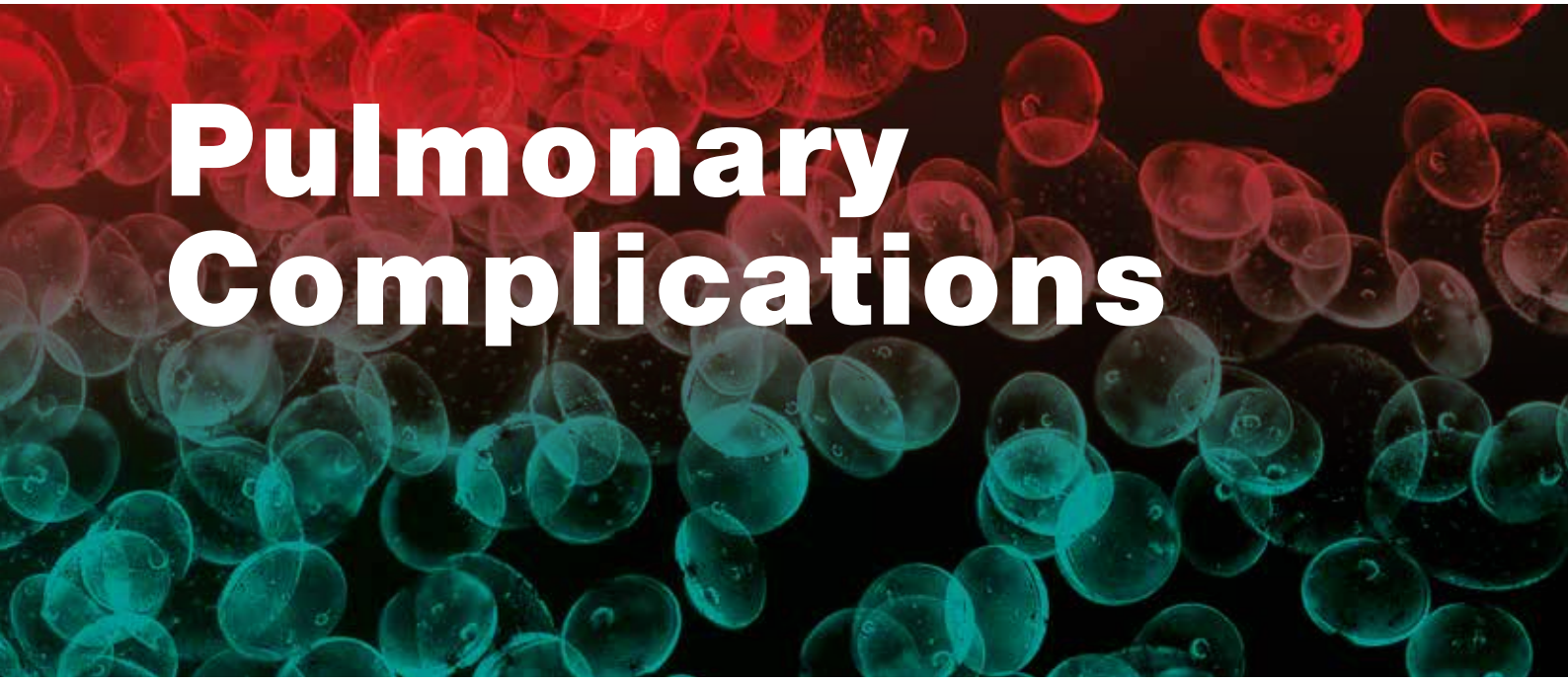
Last year we reported a patient with beta thalassaemia who was very difficult to manage due to unexplained severe disabling pain in relation to transfusion which continues to interfere with her normal life and work. One year on the problems continue despite the use of different plastic bags, washing techniques and other measures.

COMMENTARY

NEC continues to be intermittently reported and the relationship with transfusion remains unclear. Hyperkalaemia in some units of red cells is under investigation since it has been recognised that some cases are caused by an unrecognised congenital red cell membrane defect in the donors who remain asymptomatic [73].

Thrombocytopenia is a common complication in sick adults and may have many contributory factors as shown in these cases. It is however, important to attempt a diagnosis since there are some serious conditions which require particular treatment (thrombotic thrombocytopenic purpura and heparin-induced thrombocytopenia).

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.



Pulmonary Complications

22 Transfusion-Related Acute Lung Injury (TRALI)

Author: Catherine Chapman

Definition:

Transfusion-related acute lung injury (TRALI) is defined as acute dyspnoea with hypoxia and bilateral pulmonary infiltrates during or within 6 hours of transfusion, not due to circulatory overload or other likely causes.

DATA SUMMARY Total number of cases: n=10							
Implicated components (with concordant antibodies)		**Mortality/morbidity**					
Red cells	4	Deaths definitely due to transfusion	0				
Fresh frozen plasma (FFP)	0	Deaths probably/likely due to transfusion	0				
Platelets	0	Deaths possibly due to transfusion	1				
Cryoprecipitate	0	Major morbidity	9				
Granulocytes	0	Potential for major morbidity (Anti-D or K only)	N/A				
Anti-D Ig	0						
Multiple components	0						
No concordant antibodies identified	6						
Gender		**Age**		**Emergency vs. routine and core hours vs. out of core hours**		**Where transfusion took place**	
Male	4	≥18 years	10	Emergency	2	Emergency Department	0
Female	6	16 years to <18 years	0	Urgent	3	Theatre	2
Not known	0	1 year to <16 years	0	Routine	5	ITU/NNU/HDU/Recovery	3
		>28 days to <1 year	0	Not known	0	Wards	3
		Birth to ≤28 days	0			Delivery Ward	1
		Not known	0	In core hours	0	Postnatal	0
				Out of core hours	0	Medical Assessment Unit	0
				Not known/Not applicable	10	Community	0
						Outpatient/day unit	1
						Hospice	0
						Antenatal Clinic	0
						Other	0
						Unknown	0

(ITU=Intensive therapy unit; NNU=Neonatal unit; HDU=High dependency unit)

Ten cases of suspected TRALI have been included this year. Four other reports were transferred to another SHOT category following review. The number of case reports this year is similar to 2012 when 11 cases were reported.

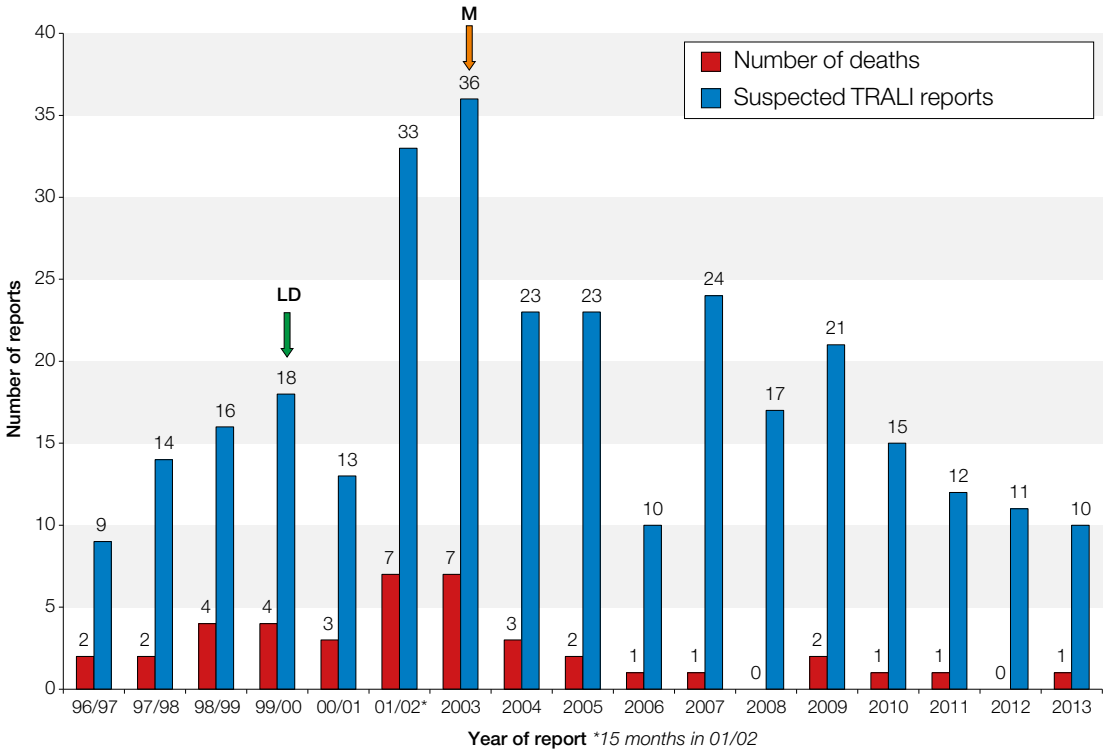


Figure 22.1: Number of suspected TRALI cases and deaths at least possibly related to TRALI by year of report

LD marks the date when universal leucodepletion was introduced (during 1999). M marks the date (from September 2003) when National Health Service Blood and Transplant (NHSBT) introduced use of male donor plasma only for FFP and preferential use of male plasma for suspending pooled platelets. Hospital stocks of female FFP were not recalled.

Patient outcomes

Deaths n=1

One patient (Case 1) died following transfusion of red blood cells in optimal additive solution (RBCOA) but had additional contributory factors associated with his further respiratory deterioration. The initial event was classified as probable TRALI as he had received RBCOA with concordant human leucocyte antigen (HLA) antibodies. It was assessed that TRALI had possibly contributed to his subsequent death (imputability 1).

Major morbidity n=9

All patients who suffered major morbidity subsequently made full recoveries from their respiratory events except for one patient (Case 3). She had metastatic cancer and respiratory infection and died in a hospice 3 weeks after her transfusion. Her death was assessed as unlikely to have been related to TRALI (imputability 0). Cases classified as major morbidity included 2 patients already on ITU who deteriorated, 4 admitted to ITU or HDU and 3 others who required immediate medical intervention with oxygen (including Case 3).

Recovery n=8

All 8 surviving patients recovered fully from their respiratory events.

Assessment of TRALI

There is no diagnostic test for TRALI and it is difficult to distinguish from other causes of acute lung injury, circulatory overload or infection. Most reported cases are complex with several possible contributory factors. The probability of TRALI has been assessed in each case using the criteria in Table 22.1. Clinical factors which influence this assessment include: timing; radiological features; possibility of infection; other risk factors for acute lung injury or acute respiratory distress syndrome; evidence of circulatory overload and/or impairment of cardiac function; pre-existing cardiac, pulmonary, renal, hepatic or other disease and response to diuretics. Serological results are also considered.

Two intensive care specialists and a transfusion medicine expert (TRALI expert panel) assessed clinical details of all NHSBT cases (8 of 10 cases) before laboratory investigation was initiated. Cases are subsequently categorised to take account of the laboratory results (Table 22.2):

Table 22.1: SHOT criteria for assessment of TRALI cases

Probability	SHOT criteria
Highly likely	where there was a convincing clinical picture and positive serology
Probable	where there was either a less convincing history and positive serology or a good history and less convincing or absent serology
Possible	where either the clinical picture or serology was compatible with TRALI, but other causes could not be excluded
Unlikely	where the picture and serology were not supportive of the diagnosis

Table 22.2: TRALI case probability (SHOT criteria)

Probability	Number of cases
Highly likely	1
Probable	4
Possible	0
Unlikely	5
Total	**10**

Additional information is found in the 2013 Annual SHOT Report Supplement located on the SHOT website www.shot-uk.org under SHOT Annual Reports and Summaries, Report, Summary and Supplement 2013.

This includes data extracted from individual TRALI questionnaires and the associated laboratory results.

TRALI Table 1 Patient characteristics and component details

TRALI Table 2 Clinical characteristics and radiological features of cases reported as TRALI

TRALI Table 3 Treatment, outcomes, investigation results and likelihood of case being TRALI

Patient characteristics

Age

Ages ranged from 20 to 72, median 57.5 years.

Clinical specialty

The case specialty was haematology in 4 cases, surgery in 4, obstetrics in 1 and oncology in 1.

Clinical presentation

All patients were hypoxic and had bilateral changes on chest X-ray. Eight patients were treated in ITU of whom two were already in ITU before the event. Four of these required full mechanical ventilation for 2, 5, 8 and 23 days respectively. One patient was transferred to HDU and 1 patient was treated on the ward. Fever was present in 3, absent in 5 and unreported in 2. Hypotension was present in 1, absent in 7 and was unreported in 2.

Laboratory investigations

Results were available for 8 patients and 2 cases had not been investigated. The expert panel had advised against investigating one case because they considered TRALI improbable based on the clinical history. The other was a very recent report.

Concordant donor HLA or granulocyte-specific antibodies were found in 4 cases, the antibody specificities are tabulated below in Table 22.3. In 1 further case, a red blood cell (RBC) donor had been identified with human neutrophil antigen (HNA)-2 specific antibodies. The recipient had not been typed for HNA-2 but this is a high frequency antigen and it is most likely that the HNA-2 antibody was concordant. Concordant donor antibodies were excluded in 3 cases.

Donor antibody	Concordant specificity	Component	Other risk factors	Outcome
HLA class I	A24 and B51	RBCOA	Sepsis, pulmonary haemorrhage	Died imputability 1 (Case 1)
HLA class I	B57	RBCOA	Respiratory infection and some response to diuretic after event	Died imputability 0 (Case 3)
HLA class II	DR15	RBCOA	Cardiac surgery, signs of heart failure	Full recovery
HLA class II	DR17	RBCOA	*E Coli* septicaemia	Full recovery

Table 22.3: Concordant donor antibodies - specificities and implicated components

Patients who have suspected TRALI no longer need to be tested for leucocyte antibodies unless granulocytes have been transfused. This is because all other UK blood components are leucodepleted.

Cumulative serological data

Since 1996 there have been 188 cases which have had full laboratory investigation for TRALI. Concordant antibodies were identified in 110 (58.5%). Of these, the most frequently identified antibody specificities (either alone or in combination with other concordant antibodies) have been HLA-DR4 (19 cases, 17.3%), HLA-DR52 (16, 14.5%) and HLA-A2 (17, 15.5%). All other HLA antibody specificities have been identified in less than 10% of cases. Concordant HNA specific antibodies, alone or in combination, have been found as follows: HNA-1a (9 cases, 8.2%); HNA-2 (1, 0.9%); HNA-3a (2, 1.8%). There have been 12 cases of non-specific positive results in granulocyte crossmatch investigations.

Classification of cases according to Canadian consensus criteria

All reports have also been classified using the Canadian consensus criteria [74, 75] to allow international comparison.

All 10 cases were categorised as possible TRALI according to these criteria. Two were reported to have had evidence of new or worsening heart failure, 4 had severe sepsis, 3 had haemorrhagic shock and 1 had pre-existing respiratory compromise.

Case 1: Death following probable TRALI

A male patient in his fifties was admitted with sepsis and hypoxia. He was receiving chemotherapy for lymphoma and had associated idiopathic thrombocytopenic purpura (ITP). His condition improved during treatment with intravenous antibiotics. Two days later he developed severe haemoptysis and worsening hypoxia following 2 units of platelets and 1 RBCOA. His chest X-ray showed bilateral consolidation. He was admitted to ITU and was reported as responding well to mechanical ventilation and antibiotics. Ten days later, whilst still requiring mechanical ventilation, he deteriorated again quite quickly with worsening of arterial blood gases. He continued on antibiotics for his infection and treatment for atrial fibrillation but his respiratory function failed to improve. He developed multi-organ failure and died after 23 days on a ventilator.

Laboratory investigation identified that the female donor of the RBCOA unit had multiple HLA class I and II antibodies which included concordant HLA class I antibodies specific for HLA-A24 and HLA-B51.

The initial respiratory deterioration after transfusion was categorised by SHOT as probably due to TRALI. It was not categorised as highly likely because he already had respiratory impairment and sepsis before transfusion which were likely to have been contributory. Frank pulmonary haemorrhage is not a recognised symptom of TRALI.

His subsequent death was categorised by SHOT as possibly related to TRALI. He deteriorated rapidly 10 days after transfusion. It is extremely atypical for patients with TRALI to recover partially and then relapse and it was considered that other factors such as sepsis and his treatment for atrial fibrillation were likely to have contributed to his subsequent deterioration and multi-organ failure. A *post mortem* examination was not performed.

Case 2: Probable TRALI related to anti-HNA-2 antibodies

A 45 year old woman with breast cancer developed a large haematoma following mastectomy and breast reconstruction and required transfusion (4 RBC). She returned to theatre for surgical evacuation and received further 2 units of RBC and 4 units of FFP.

One hour after completion of transfusion she became dyspnoeic with an increased respiratory rate and her oxygen saturation dropped from 99% to <90% on air. Her blood pressure (BP) decreased from 120/60 to 80/40 and her heart rate increased from 95 to 105/minute. The chest X-ray showed evidence of rapid development of widespread air space shadowing bilaterally and a small pleural effusion. She required mechanical ventilation for 2 days. She had no previous cardiac, respiratory or renal impairment. She made a complete recovery from this event.

Laboratory investigation of females who had donated components which had been transfused within 6 hours of this event identified one female red cell donor who had antibodies specific for HNA-2. This is a high frequency antigen. A patient blood sample was not obtained so concordance could not be confirmed but it is most likely that the patient was positive for this antigen. It was concluded that this was probable TRALI.

Case 3: Patient with co-morbidities also shows evidence of probable TRALI

A 70 year old woman with metastatic pancreatic cancer received an outpatient transfusion of 2 units RBCOA. She had anaemia secondary to chemotherapy and had a chronic cough with mild breathlessness before transfusion. Upon completion of the second unit of red cells she felt dizzy and breathless with cough. Her BP increased from 131/69 to 181/101, respiratory rate increased from 20 to 24 breaths per minute and oxygen saturation dropped to 65% in air. The computerised tomography (CT) scan was reported as showing progression of ground glass shadowing and respiratory culture showed a scant growth of candida albicans and detection of pneumocystis deoxyribonucleic acid (DNA) (borderline level which could not exclude pneumocystis pneumonia (PCP) infection). She was treated with oxygen and furosemide with some improvement following the diuretic. The chest X-ray eight days later showed progression of patchy shadowing throughout both lung fields.

Laboratory investigation identified that one female donor had multispecific HLA class I antibodies including concordant anti-HLA-B57.

The timing, in relation to her blood transfusion, is consistent with transfusion-related lung injury as is the presence of concordant anti-HLA-B57 but there were also clear additional reasons for respiratory deterioration. The subsequent radiological progression was more consistent with infection. Her initial deterioration was assessed as probable TRALI. She died 3 weeks later in a hospice and it is unlikely that her death was related to TRALI.

COMMENTARY

One death occurred which was possibly related to TRALI.

Concordant donor antibody with HLA specificity was found in four cases this year. The implicated component was RBCOA in each. All four patients had additional risk factors for respiratory deterioration.

During the last three consecutive years no case has been reported where TRALI was linked with transfusion of female plasma rich components (FFP, apheresis platelets or plasma contribution to platelet pool) containing concordant HLA or granulocyte-specific antibody.

Reported rates of TRALI remain consistently lower than when TRALI risk reduction measures were first initiated in late 2003.

All UK Blood Services now use male donors to provide 100% FFP and plasma for platelet pooling. It is not yet feasible for all UK Blood Services to prepare pooled granulocytes exclusively from male donors.

Recommendations

No new recommendations

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.

23 Transfusion-Associated Circulatory Overload (TACO)

Author: Hannah Cohen

Definition:

The International Society of Blood Transfusion (ISBT) definition states that TACO includes any 4 of the following that occur within 6 hours of transfusion [76]

- **Acute respiratory distress**
- **Tachycardia**
- **Increased blood pressure**
- **Acute or worsening pulmonary oedema**
- **Evidence of positive fluid balance**

DATA SUMMARY
Total number of cases: n=96

Implicated components		Mortality/morbidity	
Red cells	78	Deaths definitely due to transfusion	0
Fresh frozen plasma (FFP)	2	Deaths probably/likely due to transfusion	5
Platelets	1	Deaths possibly due to transfusion	7
Cryoprecipitate	0	Major morbidity	34
Granulocytes	0	Potential for major morbidity (Anti-D or K only)	0
Anti-D Ig	0		
Multiple components	15		
Unknown	0		

Gender		Age		Emergency vs. routine and core hours vs. out of core hours		Where transfusion took place	
Male	36	≥18 years	96	Emergency	18	Emergency Department	3
Female	59	16 years to <18 years	0	Urgent	28	Theatre	9
Not known	1	1 year to <16 years	0	Routine	50	ITU/NNU/HDU/Recovery	10
		>28 days to <1 year	0	Not known	0	Wards	46
		Birth to ≤28 days	0			Delivery Ward	2
		Not known	0	In core hours	38	Postnatal	1
				Out of core hours	29	Medical Assessment Unit	14
				Not known/Not applicable	29	Community	1
						Outpatient/day unit	6
						Hospice	0
						Antenatal Clinic	0
						Other	4
						Unknown	0

(ITU=Intensive therapy unit; NNU=Neonatal unit; HDU=High dependency unit)

A total of 96 cases of TACO are analysed, compared with 82 in 2012, which represents a 17.1% increase. Eighty-eight pulmonary questionnaires were received (2 initially reported as acute transfusion reaction (ATR), 3 as transfusion-associated dyspnoea (TAD) and 3 as transfusion-related acute lung injury (TRALI)), 6 additional cases were transferred from ATR and 2 from avoidable, delayed or undertransfusion (ADU).

The SHOT pulmonary questionnaire, to which reporters are directed if the predominant feature is respiratory distress, was completed in 2 of the 8 ATR cases subsequently categorized as TACO.

Patients

There were 36 males and 59 females (with gender not stated in 1 case). The median age was 77.5 (range 22-96) years. Sixty-one patients (63.5%) were 70 years or more and 18 (18.8%) 50 years or less. There were no patients under 18 years of age.

Diagnosis of TACO

Cases were assessed for probability of a diagnosis of TACO based on the ISBT definition, available on the SHOT website (www.shotuk.org) [76].

Cases were also assessed for probability of TACO using a definition based on the key features of this condition which comprise:

Any of the following, which occur within six hours of transfusion:

- Acute respiratory distress (in the absence of other specific cause)
- Acute or worsening pulmonary oedema
- Evidence of positive fluid balance
- Evidence of volume intolerance*

*volume intolerance – anybody, however young and fit can be volume-loaded into pulmonary oedema. Large volume or rapid infusion or both can produce TACO in normal subjects. Lower and slower volumes may provoke TACO in individuals with poor volume tolerance, which may result from renal, hepatic or more typically cardiac disease including any arrhythmia.

Cases should, as far as possible, include information about the confirmatory features for TACO (see SHOT definition above).

The following cases should also be reported:

- Cases where TACO is suspected even if the available information suggests that not all defining criteria for TACO are met
- Cases which occurred between 6 and 24 hours were included in the latter definition if key features detailed above were also present

TACO case probability	(ISBT criteria) Number of cases	Definition based on key features Number of cases
Highly likely	21	44
Probable	33	29
Possible	38	22
Excluded/unlikely	4	1
Total	**96**	**96**

Table 23.1: TACO case probability

Table 23.1 demonstrates that the definition of TACO impacts on the case probability of TACO and thus its identification. The cases below highlight the differences between ISBT and definition of TACO based on the key features of this condition detailed above: the potential implications for optimal recognition of TACO are discussed in the commentary below.

Case 1: Possible versus highly likely case of TACO

A 60 year old female returned to theatre due to haemorrhage following laparoscopic cholecystectomy. Whilst under anaesthetic and ventilated, she was transfused 4 units of red cells and 2 units of FFP. She was also given 2000mL crystalloid and 500mL colloid. Her fluid input in the 24 hrs prior to the

procedure was 3500mL, with her output not reported. During the procedure, her oxygen saturation ranged between 93% to 98% and her pulmonary artery wedge pressure was raised. At the end of the procedure, red froth was noted in the endotracheal tube. Her oxygen saturation was 94%. A chest X-ray was consistent with pulmonary oedema. Her pulse and blood pressure (BP) at baseline and at the time of the reaction were 87 and 90 beats per minute (bpm) and 132/81 and 100/50 respectively. She was admitted to the ITU for mechanical ventilation and remained there for 5 days.

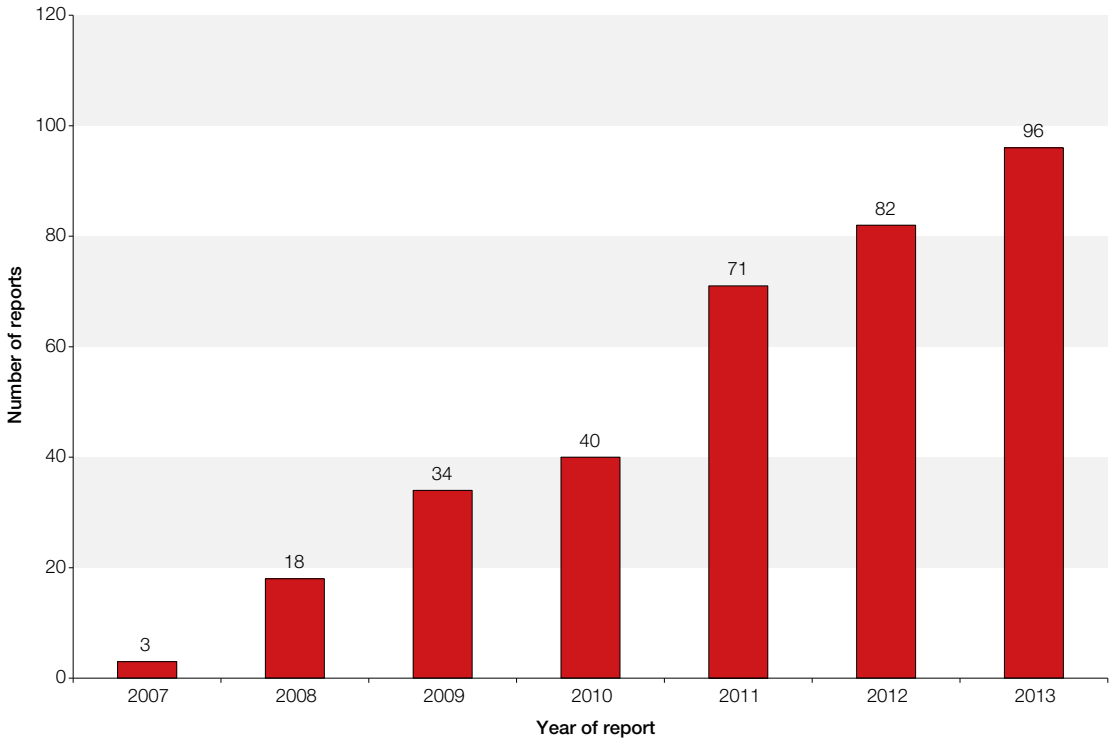
The absence of tachycardia, hypertension and fluid balance details make this a case of possible TACO according to ISBT criteria, whereas using a definition based on the presence of key features of TACO detailed above, this case would be categorized as highly likely to be TACO.

Case 2: TACO occurring more than 6 hours after transfusion of platelets

A 61 year old male patient with major haemorrhage - haematemesis and melaena due to a gastro-oesophageal tumour, on a background of alcoholic liver disease - developed respiratory compromise at 08:00 after a platelet transfusion completed at 01:00. The platelet transfusion was preceded by several other blood components: 16 units of red cells, 8 units of FFP and platelets (2 apheresis packs and 2 pools) over the preceding 36 hours. He also received colloid and crystalloid, with the total fluid volume input 13,050mL and output 2065mL (positive fluid balance of 10,985mL). The pO2 was 9.31 and 9.42 at baseline and at the time of the reaction respectively, with corresponding values for the pulse and BP 140 and 180bpm and 105/70 mmHg and 180/20 respectively. A chest X-ray showed pulmonary infiltrates. Treatment included an intravenous infusion (IVI) of furosemide. Copious amounts of fresh blood were found during oesophago-gastro-duodenoscopy (OGD). A large haematoma was found during laparotomy at the tumour site. A partial gastrectomy was carried out. He recovered with full resolution of his symptoms.

This case would be a highly likely case of TACO as although it occurred more than 6 hours after the platelet transfusion, the patient displayed key features of TACO detailed above. However, the occurrence of the reaction more than 6 hours after completion of the platelet transfusion would exclude a diagnosis of TACO by ISBT criteria.

Figure 23.1: Number of cases of TACO reported to SHOT each year



Learning point

- These two cases emphasise the importance of recognition of transfusion-associated circulatory overload (TACO) even in the absence of full International Society of Blood Transfusion (ISBT) criteria. Improved recognition of TACO enables early institution of treatment which in turn may reduce the associated morbidity and mortality

Deaths n=12

TACO was possibly (n=7) or probably/likely (n=5) contributory to death in 12 patients. There were a further 10 deaths where the transfusion was excluded/unlikely (n=7) to be contributory to death or not assessable (n=3).

Case 3: Fatal TACO following red cell transfusion for probable chronic iron deficiency anaemia

A 78 year old female, weight 63.3kg, was brought to the attention of a Trust transfusion practitioner with a possible allergic transfusion reaction. On assessment, there was no evidence of an allergic reaction and a diagnosis of TACO was made. The patient had been admitted to the emergency department (ED) unwell and feeling faint. All vital signs were within normal limits, and her Hb was 59g/L with a microcytic blood picture, with the likely cause chronic iron deficiency. Two units of red cells were ordered by the ED doctor. The first unit was commenced at 14:12 and she was transferred to the acute medical unit (AMU). During a consultant led ward round on AMU, 2 more red cell units were prescribed. She received 3 red cell units and approximately 290mL of the fourth unit when she developed massive pulmonary oedema and left ventricular failure. Her pulse and blood pressure at baseline and at the time of the reaction were 98 and 82bpm and 120/75mmHg and 152/111 respectively. An electrocardiograph showed atrial fibrillation and T wave changes. She was admitted to ITU where she received continuous positive airway pressure (CPAP) and a furosemide infusion, however she subsequently died.

Learning points

- As stated in previous Annual SHOT Reports, red cell transfusion is not an appropriate treatment for chronic iron deficiency anaemia. It puts individuals, particularly the elderly, at risk of transfusion-associated circulatory overload (TACO), with even fatal consequences as in this case
- Iron deficiency should be treated with iron and the underlying cause established and treated
- 'Don't give two without review*' - When transfusing adult patients at increased risk of TACO, clinical review should be undertaken after each red cell unit to check that the patient has not developed any evidence of TACO, and single units considered where appropriate, irrespective of whether the individual has a low body weight. Risk factors for TACO include cardiac failure, renal impairment, hypoalbuminaemia or fluid overload, age more than 70 years and low body weight
- The 2012 British Committee for Standards in Haematology (BCSH) addendum to the guidelines on blood administration states that for patients identified at increased risk of TACO, a written request should be made that during the administration of blood components, specific attention should be given to monitoring the patient for signs of circulatory overload, including fluid balance [23, 25]. This information should be included in clinical handover templates

**This advice is inspired by a campaign devised by NHSBT's Patient Blood Management (PBM) team with resources on the Hospitals and Science Website http://hospital.blood.co.uk*

Major morbidity n=34

34 patients developed major morbidity, all of whom required ITU/HDU admission +/-ventilation.

Case 4: ITU admission for TACO following red cell transfusion for chronic anaemia

An 80 year old male with renal impairment, chronic anaemia, Hb 91g/L, and a history of angina and previous myocardial infarction, became acutely breathless part way through the second unit of a two unit red cell transfusion. He had not been given diuretic cover. The first red cell unit had been commenced at 06:20 and transfused over 3 hours. The second unit of red cells was commenced at 10:30 and stopped at 11:30 because he had become acutely breathless. His respiratory rate rose from 20 to 26 per minute, his oxygen saturation fell from 98% to 79%, with his pulse 114 and 120 and his BP 67/57 and 108/50 at baseline and at the time of the reaction respectively. He was in positive fluid balance (3800mL), with fluid input 4150mL and output 350mL. A chest X-ray showed pulmonary oedema. He was admitted to ITU where he received continuous CPAP and made a full recovery.

Learning points

- Patients at increased risk of transfusion-associated circulatory overload (TACO) should be carefully assessed for the risks versus benefits of transfusion
- This case highlights that all clinical staff involved in blood transfusion should be aware of and receive education and training on measures to avoid TACO. If red cell transfusion is undertaken, the 2012 British Committee for Standards in Haematology (BCSH) addendum to the guidelines on blood administration [25] should be followed. These state that in patients at increased risk of TACO, such as with renal impairment as in this case, risk factors should be documented, and considered when prescribing the volume and rate of transfusion, and in deciding whether diuretics should be prescribed

The following 2 cases of TACO, both associated with major morbidity, occurred after transfusion as a day case.

Case 5: Respiratory arrest after patient sent home following outpatient red cell transfusion

A 67 year old female was transfused 3 units of red cells for chronic anaemia related to myelodysplastic syndrome (MDS), between 10:00 and 17:00, in the haematology day unit. She was sent home after the transfusion, but felt ill on the way home and returned immediately to the ED, where she suffered a respiratory arrest and was admitted to ITU. The chest X-ray appearances were reported to be in keeping with LVF. She made a full recovery.

Case 6: TACO necessitating HDU admission in patient at increased risk of TACO after transfusion as a day case

A 78 year old female with myeloma, weight 56kg, was transfused 3 units of red cells as a day case despite being at increased risk of developing TACO (renal impairment, hypoalbuminaemia, age ≥70 years, low bodyweight). She developed fluid overload and pulmonary oedema with hypertension and hypoxia before the end of the third unit of red cells. She initially responded to diuretic administration and was sent home by a junior doctor, but was unable to lie flat all night because of shortness of breath. She was readmitted to the HDU within 24 hours with pulmonary oedema and an ST segment elevation myocardial infarction (STEMI).

Learning point

- Patients who receive red cell transfusion in the day case setting should be assessed post transfusion with specific attention to symptoms and signs of transfusion-associated circulatory overload (TACO) prior to being discharged. Consideration should be given to elective inpatient admission for transfusion if the patient is at increased risk of TACO

Clinical details and transfused fluids in TACO cases

One or more concomitant medical conditions that increase the risk of TACO (cardiac failure, renal impairment, hypoalbuminaemia or fluid overload) were reported in 56/96 (58.3%) of cases (not reported

in 16 cases). Since 2012 we have requested body weights, as low body weight is also a risk factor for TACO. These were provided by the reporter in 25/96 cases (26.0%; 20.7% in 2012); 5 of these 25 patients had a body weight of 50kg or less.

Complete details on fluid balance were supplied by the reporter in 27/96 (28.1%) of cases (24.4% last year). The time interval between the transfusion and the onset of symptoms (information was available in 93/96 cases), was 0-2 hours in 51.6% (48/93), 2-6 hours in 33.3% (31/93) and between 6-24 hours in 15.1% (14/93) patients.

As in previous years, several patients with (in one case probable) chronic iron deficiency (5 this year) developed TACO following red cell transfusion.

Learning points

- Risk factors for transfusion-associated circulatory overload (TACO) should be identified in all patients prior to transfusion of a blood component, so that measures can be taken to reduce the risk of TACO. This includes the concomitant medical conditions detailed above, fluid overload and low body weight individuals
- Fluid balance should be prescribed and monitored carefully during transfusion to minimize the risk of development of TACO

Acute haemorrhage cases in which more than one component was transfused n=14

There were 14 cases of acute haemorrhage where more than 1 blood component was transfused. Red cells and FFP were transfused in 7 cases: 3 surgical bleeds, 2 obstetric, 1 gastrointestinal and 1 not specified; and together with platelets in 3 cases: 2 gastrointestinal (GI) bleeds (one related to alcoholic liver disease and to aspirin ingestion) and 1 to bleeding from a puncture site following femoral access for an atrial fibrillation ablation. Red cells, FFP, platelets and cryoprecipitate were transfused in 3 cases, 1 patient had a major bleed related to alcoholic cirrhosis, 1 had an obstetric haemorrhage and in 1 the indication was not specified. Red cells, FFP and cryoprecipitate were transfused in 1 case of obstetric haemorrhage.

Cases in which red cells were transfused n=92 (some had multiple components)

Red cells were transfused in a total of 92 cases, in the absence of suspected acute haemorrhage in 54 cases. In these 54 cases, where details were given, the median duration of transfusion/red cell unit was 2.5 (range 1.5-5) hours. TACO was observed after transfusion of 2 red cell units or less in 28 cases, in 13 of these after transfusion of 1 unit or less. Three cases of obstetric haemorrhage (one related to an ectopic pregnancy) received red cell transfusion alone.

Learning point

- As in previous Annual SHOT Reports, it is emphasised that transfusion-associated circulatory overload (TACO) can occur after relatively small volumes of red cells, even 1 unit or less, particularly in patients at increased risk of developing TACO in whom the rate of transfusion should be carefully assessed and the use of diuretics considered

Cases in which FFP was transfused n=16 (some had multiple components)

There were 16 cases where FFP was transfused, in 14 within the context of acute haemorrhage. One patient who experienced a postpartum haemorrhage with subsequent disseminated intravascular coagulation (DIC) and who was not actively bleeding, received FFP and platelets to prevent bleeding during dialysis catheter removal.

Cases in which platelets were transfused n=9 (some had multiple components)

There were 9 cases where platelets were transfused, 6 for acute haemorrhage.

COMMENTARY

TACO remains a leading cause of transfusion-related morbidity and mortality. This year TACO was contributory to death in 12 patients (possibly (n=7) or probably/likely (n=5)) and to major morbidity in 34, with these serious outcomes together comprising 47.9% (46/96) of TACO cases analysed. There has been a further increase of 17.1% (from 82 cases in 2012 to 96 in 2013) in the number of TACO cases reported, however TACO probably remains under-reported as it is likely that many cases are unrecognized and therefore unreported. Improved recognition of TACO is of key importance as it enables early institution of treatment, which in turn may reduce the associated morbidity and mortality.

TACO was observed (as previously noted) after transfusion of 2 red cell units or less, in 28 cases, in 13 of these after transfusion of 1 unit or less. When transfusing adult patients at increased risk of TACO, clinical review should be undertaken after each red cell unit, and single units considered where appropriate, irrespective of whether the individual has a low body weight. Risk factors for TACO include cardiac failure, renal impairment, hypoalbuminaemia or fluid overload, age more than 70 years and low body weight. In last year's report, being transferred (between wards or hospitals) during a transfusion episode was also identified as a risk factor for TACO [3].

Cases this year also highlight that all clinical staff involved in blood transfusion should be aware of TACO and be educated and trained in measures to reduce this potentially avoidable complication. The 2012 BCSH addendum to the guidelines on blood administration, based on SHOT observations and recommendations, highlights the importance of clinical assessment prior to a blood transfusion to identify patients at increased risk of TACO, so that measures can be taken to reduce the risk of TACO. The dose of red cells and rate of transfusion are critical in avoidance of TACO. A dose of 4 mL/kg raises the haemoglobin concentration by approximately 10g/L. The concept that one unit of red cells gives a Hb increment of 10g/L only applies to patients with a weight around 70kg [25]. The risk of TACO is reduced by careful pre-transfusion clinical assessment and use of single-unit transfusions, or prescription in millilitres, for elderly or small, frail adults where appropriate [24, 25]. The median duration of transfusion/red cell unit where red cells were transfused in the absence of suspected haemorrhage was 2.5 (range 1.5-5) hours. It is emphasised that, particularly in patients at increased risk of developing TACO, risk factors should be documented, and considered when prescribing the volume and rate of transfusion, and in deciding whether diuretics should be prescribed [25]. Infusion devices should be monitored regularly during transfusion to ensure the correct volume is being delivered at the correct rate [3]; this also applies to rapid infusion devices.

In patients identified to be at risk of TACO, clinical handover templates should include information on measures to avoid TACO, such as furosemide and a slower rate of transfusion, as well as appropriate monitoring for symptoms and signs of TACO. A pre-transfusion checklist to reduce the risk of TACO has been suggested [77]. Specific attention should be given to monitoring the patient for signs of circulatory overload, including fluid balance [23, 25]. Complete details on fluid balance were supplied by the reporter in 28.1% of cases (24.4% in 2012 and 14.1% in 2011). This sustained increase is encouraging. Close attention to fluid balance and its documentation is essential in all patients receiving transfusion of blood components.

There were several cases of TACO in the outpatient/day case setting, in some with identifiable risk factors for TACO. Patients who receive red cell transfusion in the day case setting should be assessed post transfusion with specific attention to symptoms and signs of TACO prior to being discharged. Consideration should be given to elective inpatient admission for transfusion if the patient is at increased risk of TACO.

Eight obstetric patients were reported to develop TACO in the context of transfusion after major haemorrhage, bringing these to a total of 23 cases reported since 2008, and highlighting that this complication does occur in these young individuals who are often regarded to be 'immune' to TACO. Contributory factors are difficulties in estimating actual blood loss, particularly because of the changing blood volume and circulatory capacity. In addition, pre-eclampsia remains an important cause of hypertensive acute pulmonary oedema in pregnancy [78] and affected women are therefore potentially also at risk of TACO.

A number of cases are observed where the case probability of TACO was designated to be possibly lower than it was. Examples are pulmonary oedema occurring post transfusion where the pulse and BP have not been provided by the reporter, or patients where a clinical picture suggestive of TACO is associated with hypotension rather than hypertension, particularly but not exclusively in cases associated with acute haemorrhage, and cases occurring more than 6 hours after transfusion (15.1% of cases this year). This year, cases were assessed for probability of a diagnosis of TACO based on the ISBT definition [76], available on the SHOT website (www.shotuk.org), and also assessed using a definition of TACO based on the presence of key features of this condition detailed above in this chapter. There was a two-fold increase in the number of cases of highly likely TACO cases using the latter versus the ISBT definition (44 versus 21). These findings should be taken into consideration in the current review of the ISBT criteria for TACO. Improved recognition of TACO enables early institution of treatment which in turn may reduce the associated morbidity and mortality.

Recommendations

New recommendations from this report

- All clinical staff should be receive education and training on measures to avoid transfusion-associated circulatory overload (TACO) and the recognition of TACO, which should be included in the curricula of trainee doctors, nurses and midwives

Action: The Royal Colleges (of Physicians, Surgeons, Anaesthetists, Obstetricians and Gynaecologists, and Pathologists) in association with the General Medical Council and the Nursing and Midwifery Council

- 'Don't give two without review': When transfusing adult patients at increased risk of TACO, clinical review should be undertaken after each red cell unit, and single units considered where appropriate, irrespective of whether the individual has a low body weight

Action: Hospital Transfusion Committees, Hospital Transfusion Teams

- Patients with chronic iron deficiency anaemia, particularly those who are elderly, should receive iron replacement therapy, with the underlying cause of iron deficiency identified and treated

Action: Royal College of Physicians, Royal College of General Practitioners

Recommendations still active from previous years

The recommendations in the 2012 report, detailed below, remain pertinent.

- The 2012 British Committee for Standards in Haematology (BCSH) addendum to the blood administration guidelines on measures to reduce the risk of transfusion-associated circulatory overload (TACO) [23, 25] should be followed
- Transfer of patients during a transfusion episode is potentially hazardous and should be avoided wherever possible. If unavoidable, clinical handover templates should include information on measures to reduce the risk of TACO and appropriate monitoring in patients identified to be at risk by clinical assessment pre transfusion
- Post-transfusion clinical assessment should be also be undertaken and patients monitored for evidence of TACO during the first 24 hours after transfusion so that appropriate and timely management can be instituted
- Transfusions should only take place where there are facilities and trained staff to monitor and manage adverse incidents

Action: Trust/Health Board Chief Executive Officers and Medical Directors responsible for all clinical staff

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.

24 Transfusion-Associated Dyspnoea (TAD)

Author: Hannah Cohen

Definition:

Cases were assessed by the reviewer for probability of a diagnosis of TAD based on the International Society of Blood Transfusion (ISBT) definition [49]. A standardised definition, which is under review, will help haemovigilance organisations generate data that will be comparable at an international level.

The cases included in this chapter are heterogeneous, with the unifying salient feature respiratory distress, the essential diagnostic feature of TAD.

DATA SUMMARY
Total number of cases: n=6

Implicated components		Mortality/morbidity	
Red cells	5	Deaths definitely due to transfusion	0
Fresh frozen plasma (FFP)	0	Deaths probably/likely due to transfusion	0
Platelets	0	Deaths possibly due to transfusion	0
Cryoprecipitate	0	Major morbidity	1
Granulocytes	0	Potential for major morbidity (Anti-D or K only)	0
Anti-D Ig	0		
Multiple components	1		
Unknown	0		

Gender		Age		Emergency vs. routine and core hours vs. out of core hours		Where transfusion took place	
Male	2	≥18 years	6	Emergency	0	Emergency Department	1
Female	3	16 years to <18 years	0	Urgent	1	Theatre	0
Not known	1	1 year to <16 years	0	Routine	5	ITU/NNU/HDU/Recovery	1
		>28 days to <1 year	0	Not known	0	Wards	3
		Birth to ≤28 days	0			Delivery Ward	0
		Not known	0	In core hours	2	Postnatal	0
				Out of core hours	2	Medical Assessment Unit	1
				Not known/Not applicable	2	Community	0
						Outpatient/day unit	0
						Hospice	0
						Antenatal Clinic	0
						Other	0
						Unknown	0

(ITU=Intensive therapy unit; NNU=Neonatal unit; HDU=High dependency unit)

TAD is a diagnosis of exclusion. The importance of TAD as a diagnostic category is not clear. Several cases included as TAD could equally have been considered as moderate or severe allergic transfusion reactions. When a patient presents with dyspnoea associated with transfusion, it is of key importance to investigate and treat the symptoms appropriately.

Cases considered to be TAD may contain elements of transfusion-associated circulatory overload (TACO), transfusion-related acute lung injury (TRALI) or allergic reactions, but they do not meet the

criteria for any of these. Cases designated as TAD should also not be explained by the patient's underlying condition or any other known cause, although these can be difficult to exclude definitively. The SHOT pulmonary questionnaire, to which reporters are directed when the predominant feature is respiratory distress, provides a common dataset, which enables accurate categorization of pulmonary complications of transfusion. It should be used for all patients who develop respiratory distress in association with a blood transfusion.

A total of 6 cases of TAD are analysed, approximately one-third (6/19; 31.6%) of the 19 cases analysed last year (Figure 24.1). Seven questionnaires on TAD were received (compared with 14 last year); 4 of these were transferred to the TACO category, 3 cases were transferred in from acute transfusion reactions (ATR) (10 the previous year), with the SHOT pulmonary questionnaire completed in none of these 3 cases.

Patients

There were 2 males and 3 females (with gender unstated in one patient). The median age was 72.5 (range 50-90) years.

TAD case probability	Number of cases
Highly likely	0
Probable	1
Possible	5
Excluded/unlikely	0
Total	**6**

Table 24.1: TAD case probability based on ISBT criteria

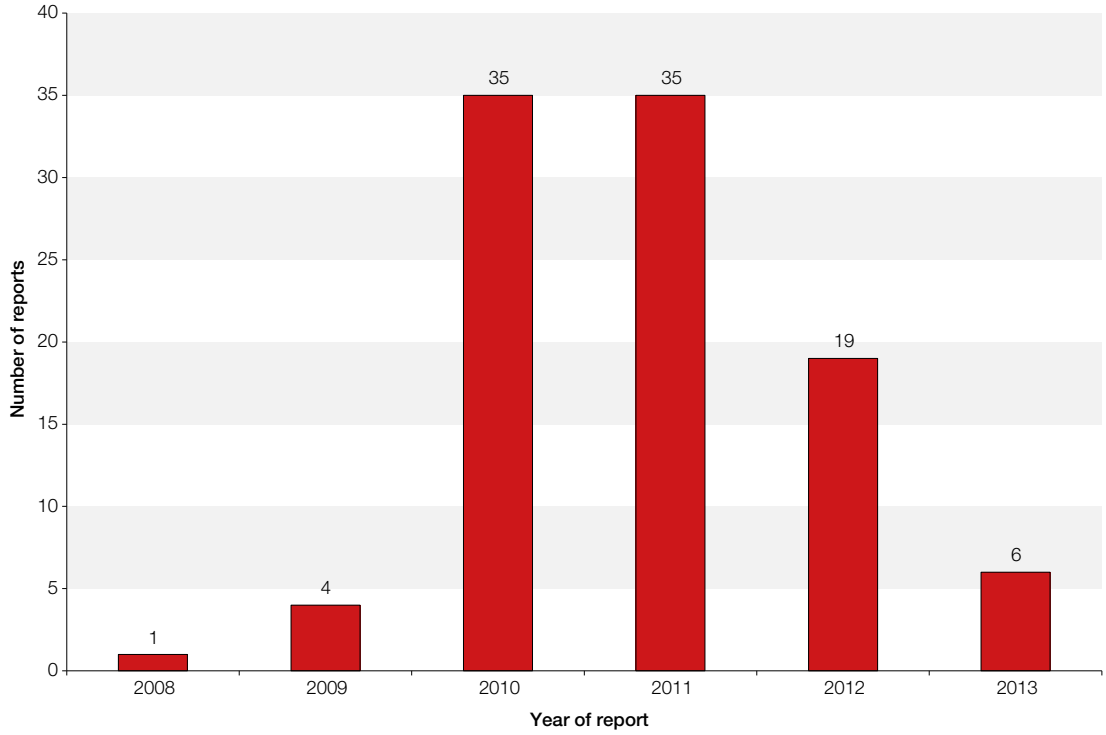


Figure 24.1: Number of cases of TAD reported each year*

**TAD was introduced as a SHOT reporting category in 2009*

Deaths n=0

There were no reported deaths.

Major morbidity n=1

Case 1: Possible TAD in patient with neutropenic sepsis and pulmonary oedema

A 50 year old male with haematological malignancy was admitted to the intensive care unit (ICU) for aggressive fluid management as he was hypotensive secondary to neutropenic sepsis post chemotherapy. A mobile chest X-ray pre transfusion was reported to show bilateral perihilar shadowing consistent with acute pulmonary oedema. Twenty minutes after the start of the transfusion when 20mL red cells had been transfused, he complained of feeling hot, flushed and sweaty, and was also wheezy. His blood pressure (BP) was 73/38mmHg pre transfusion, with a drop in the systolic BP to 60 following commencement of the transfusion. He had been desaturating pre transfusion, with his O2 saturation satisfactory at 96% on 28% oxygen in association with the reaction. His symptoms were relieved following discontinuation of the transfusion and an increase in noradrenaline. He was also given a salbutamol nebuliser and hydrocortisone. Blood cultures taken 9 hours pre transfusion grew Escherichia coli.

This case illustrates the difficulty in diagnosing TAD - the reaction demonstrates features of an ATR, and occurred in the context of pre-existing pulmonary oedema and neutropenic sepsis, both of which could have been contributory to the patient's symptoms.

Clinical features

Symptoms and signs

Three cases occurred between 5 and 20 minutes after the start of transfusion, 2 occurred at 0-2 hours and 1 at 2-6 hours.

Tachycardia was noted in 3 of 4 patients where reported. Two patients were hypotensive and 1 hypertensive.

Blood samples were taken for microbiological culture in 3 of 6 patients with a positive culture for *Escherichia coli* in 1 case (Case 1).

Investigations

O2 saturation/arterial gases were reported to have been measured in all 6 patients (100% compared with 57.9% (11/19) cases last year). The O2 saturations were reported to be low at 78% and 81% in 2 patients respectively, and 96% on 28% O2 in a third. A chest X-ray was reported to have been performed in 3 of 6 cases (50.0% compared with 36.8% (7/19) last year).

Case 2: Probable TAD following FFP administration for warfarin reversal

A 65 year old male with a metallic aortic valve replacement developed rash, shortness of breath (SOB), wheeze, increased respiratory rate and a drop in O2 saturation after transfusion of 300mL of FFP and halfway through a subsequent red cell unit. The indication for transfusion was acute blood loss, stated to be life-threatening. The transfusion was stopped and he recovered following administration of salbutamol, atrovent and chlorphenamine.

Learning point

- Prothrombin complex concentrate (PCC) and not fresh frozen plasma (FFP) should be used for warfarin reversal in accordance with British Committee for Standards in Haematology (BCSH) guidelines [79]

Implicated components

All 6 cases were related to red cell transfusion (100.0% compared with 78.9% (15/19) last year). In one case of probable TAD, the patient received 1 unit of FFP prior to the red cell transfusion.

COMMENTARY

The number of TAD cases reported this year has decreased by 68.4% to 6 from 19 last year. The total number of cases initially reported as TAD also dropped by 50.0% from 14 last year to 7. The observed decrease is due to both fewer cases reported and a further reduction in cases transferred from the ATR category.

There was 1 case of major morbidity in a possible case of TAD and no mortality associated with TAD. This makes the total number of TAD cases associated with major morbidity since SHOT began receiving reports of TAD in 2008, 11 of a total of 100 (11.0%).

Several cases included as TAD could equally have been considered as moderate or severe allergic transfusion reactions. When a patient presents with dyspnoea associated with transfusion, it is of key importance to investigate and treat the symptoms appropriately. It is encouraging that O2 saturation/arterial gases were measured in all 6 patients reported.

The dwindling number of TAD cases raises the issue of how best to represent these cases within the SHOT Annual Report. TAD may be clinically significant even if the episode is not severe as this could 'tip the balance' and critically compromise an extremely ill patient.

Appropriate investigation of patients with respiratory distress, which should include assessment of oxygen saturation/arterial blood gases and a chest X-ray, is required for appropriate patient care. Although the number of TAD cases this year is small, it is encouraging that O2 saturation/arterial gases were reported to have been measured in all 6 patients (100% compared with 57.9% cases last year), and a chest X-ray was reported to have been performed in 3 of 6 cases (50.0% compared with 36.8% last year).

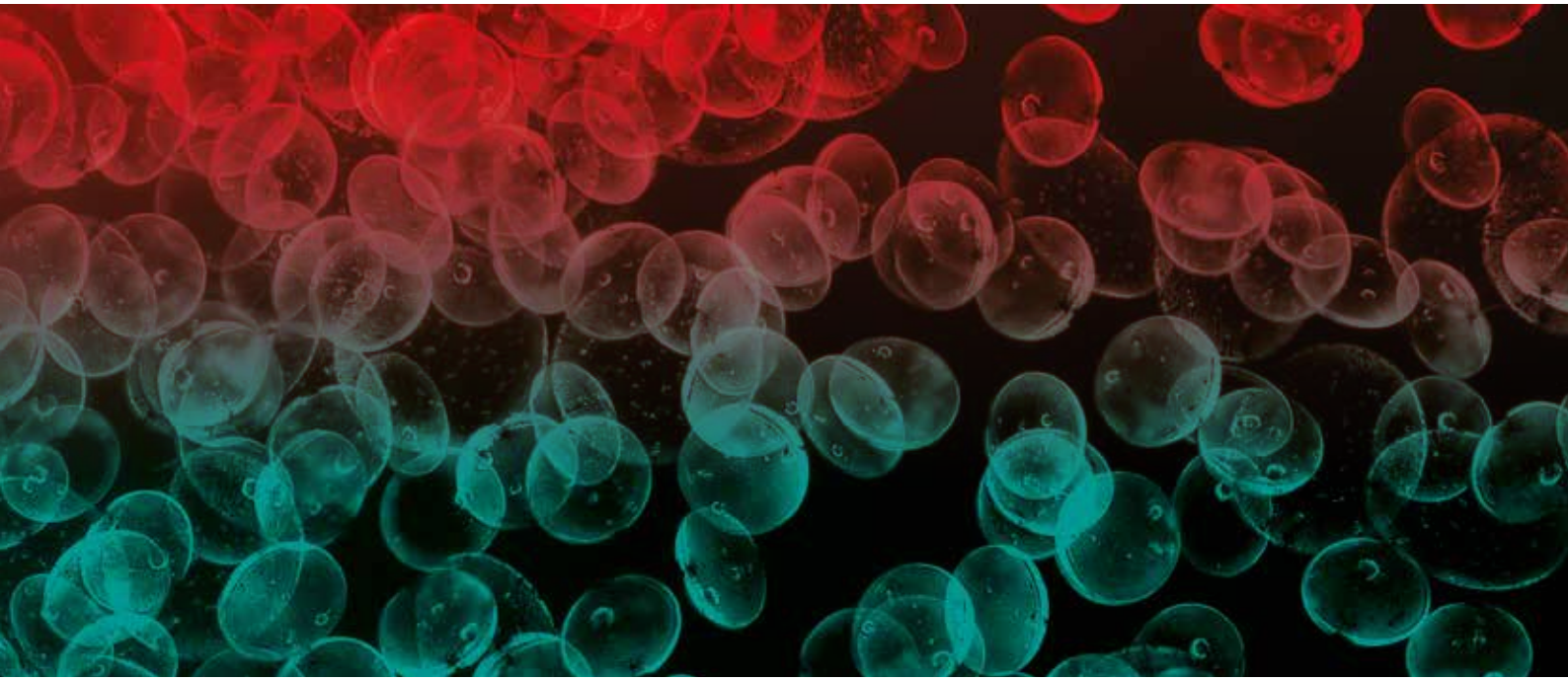
Case 2 illustrates that FFP is still being used for warfarin reversal rather than PCC. The BCSH guidelines, which recommend PCC rather than FFP for warfarin reversal [79] should be followed.

Particularly as TAD is a diagnosis of exclusion, adequate information is of key importance in its identification. The SHOT pulmonary questionnaire, to which reporters are directed when the predominant feature is respiratory distress, provides a common dataset, which enables accurate categorisation of pulmonary complications of transfusion. It should be used for all patients who develop respiratory distress in association with a blood transfusion. This questionnaire will provide relevant information, which will enable a more systematic delineation of the clinical and diagnostic characteristics of TAD, as well as other transfusion-related pulmonary complications. This in turn will provide a basis for a systematic approach toward the recognition, investigation and management of TAD.

Recommendations

There are no new recommendations this year

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.



Special Clinical Groups

25 Paediatric Cases

Author: Helen New

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.

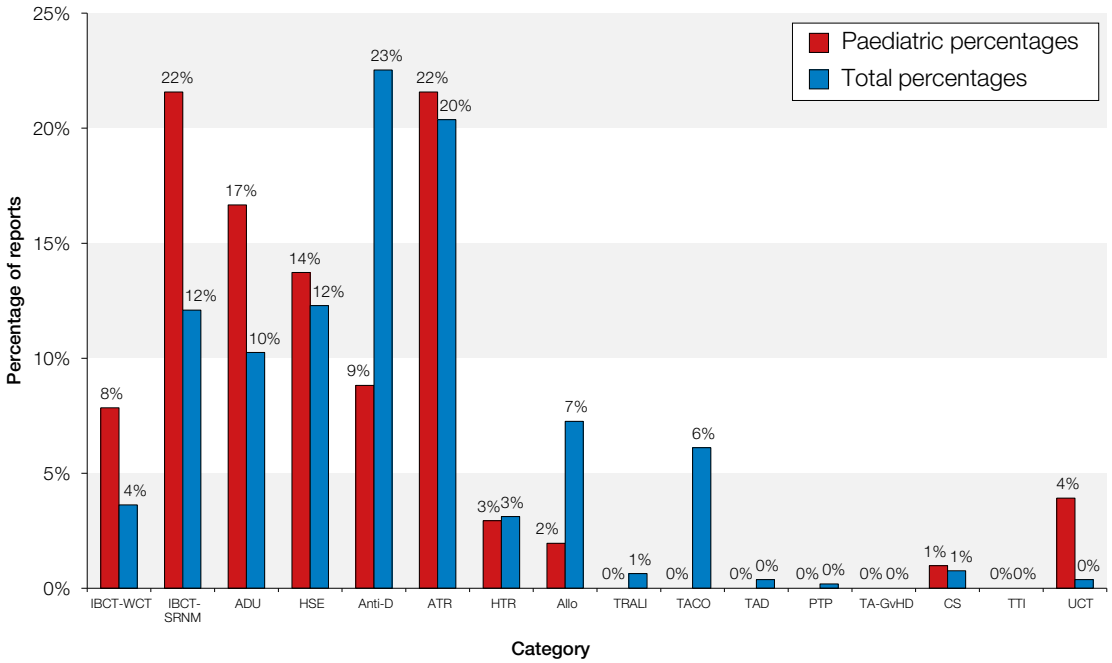


Figure 25.1: Percentages of paediatric and total reports in each category

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

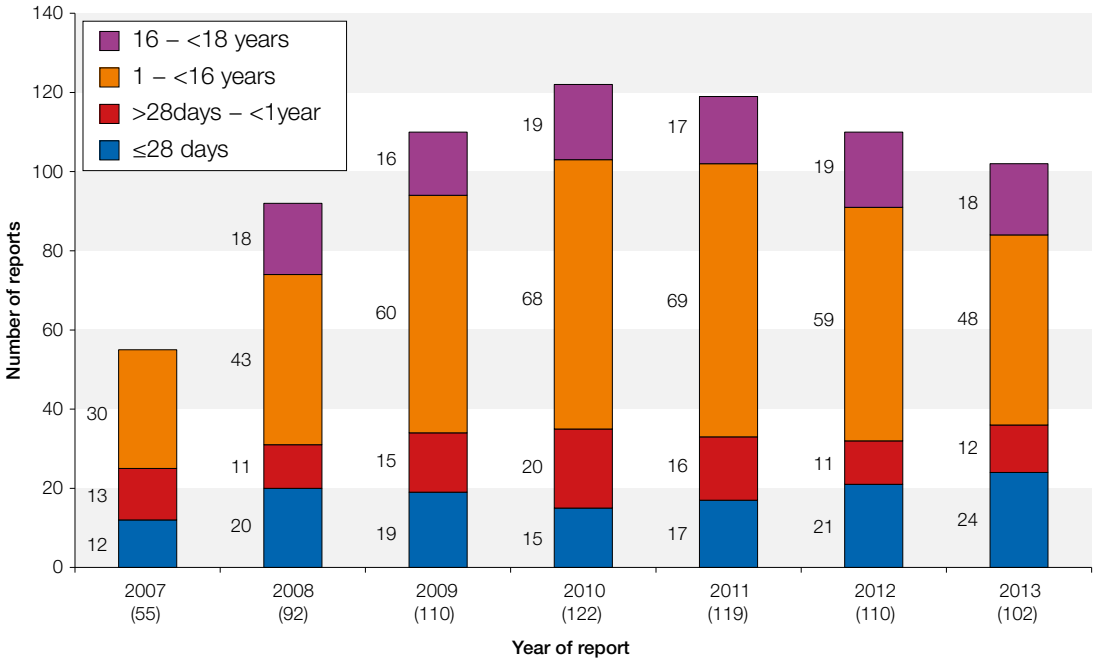
There were 13 reports where the transfused child died, but in only 2 cases was the death possibly (1) or definitely (1 delayed) related to the transfusion. A child with sickle cell disease died with severe anaemia during a delayed transfusion (see Chapter 11 Avoidable, Delayed or Undertransfusion (ADU)). 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

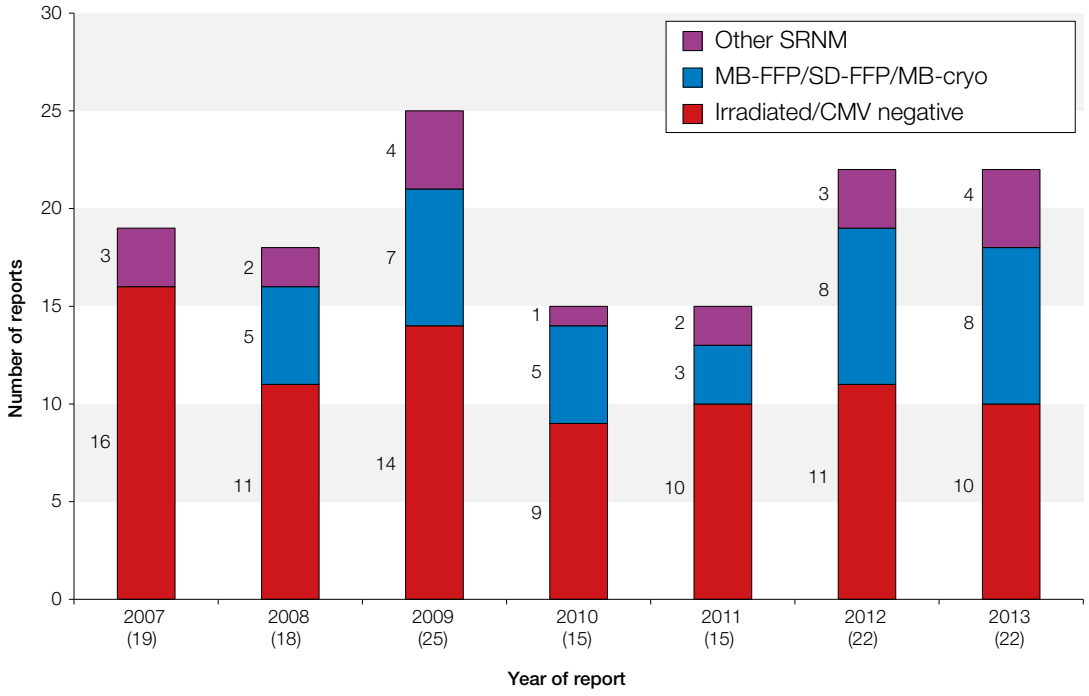
There were two severe acute transfusion reactions to platelets and one to methylene blue-treated fresh frozen plasma (MB-FFP).

Figure 25.2: Trends in paediatric reports 2007-2013

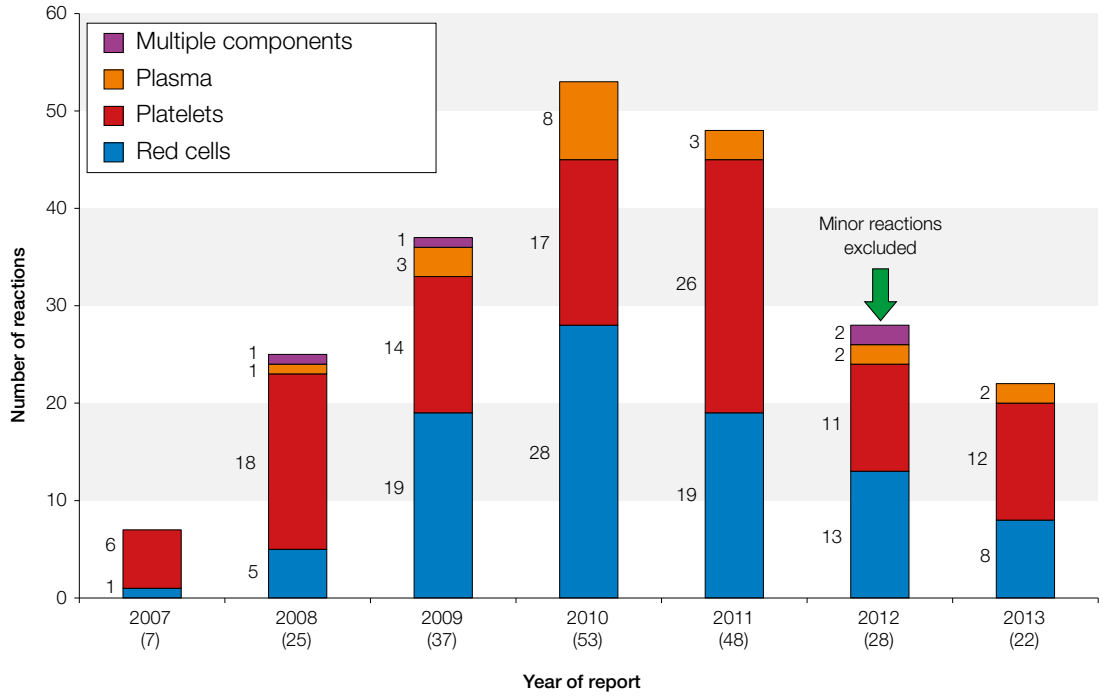
a. Total numbers of paediatric reports



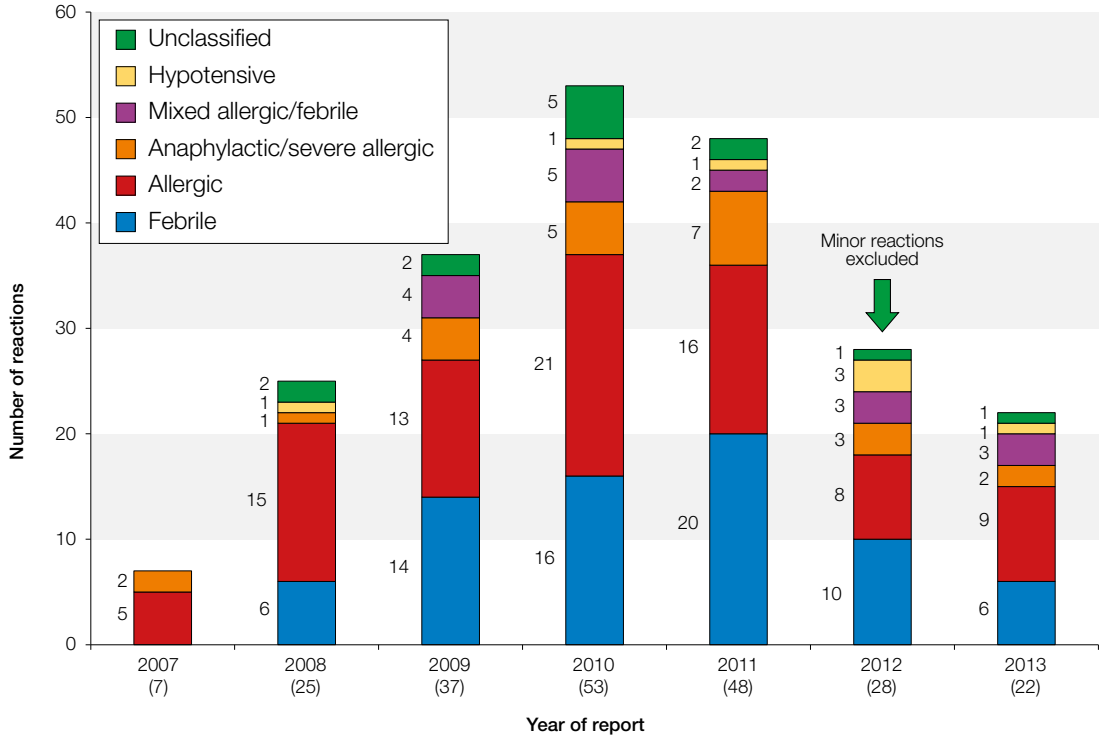
b. Paediatric SRNM reports



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).

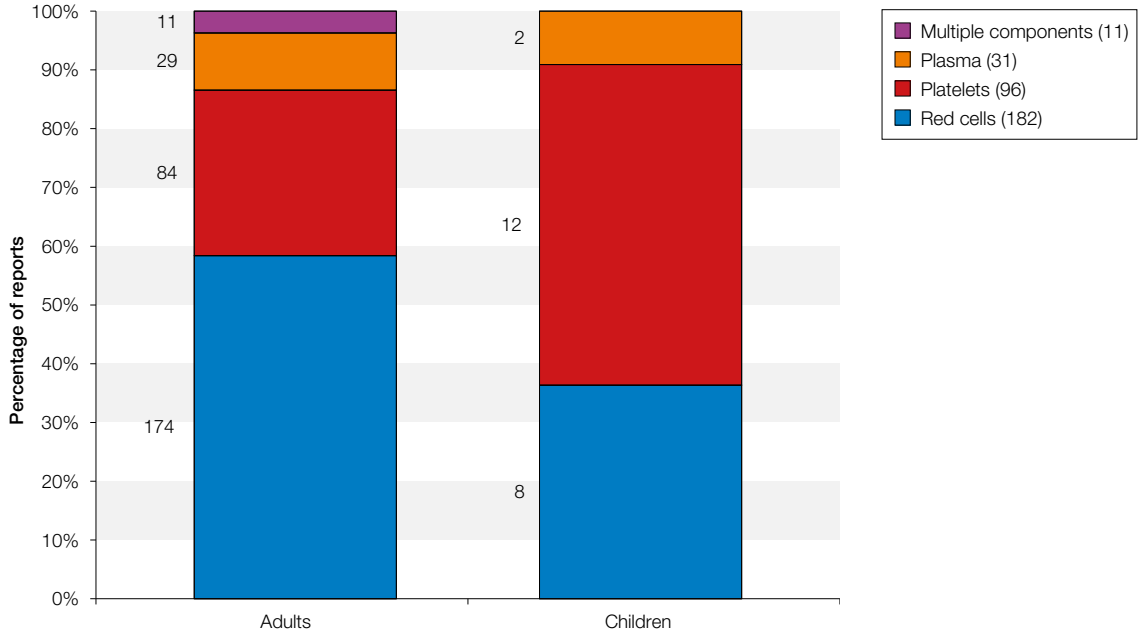
Case 1: Overtransfusion of a child with sickle cell disease

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.

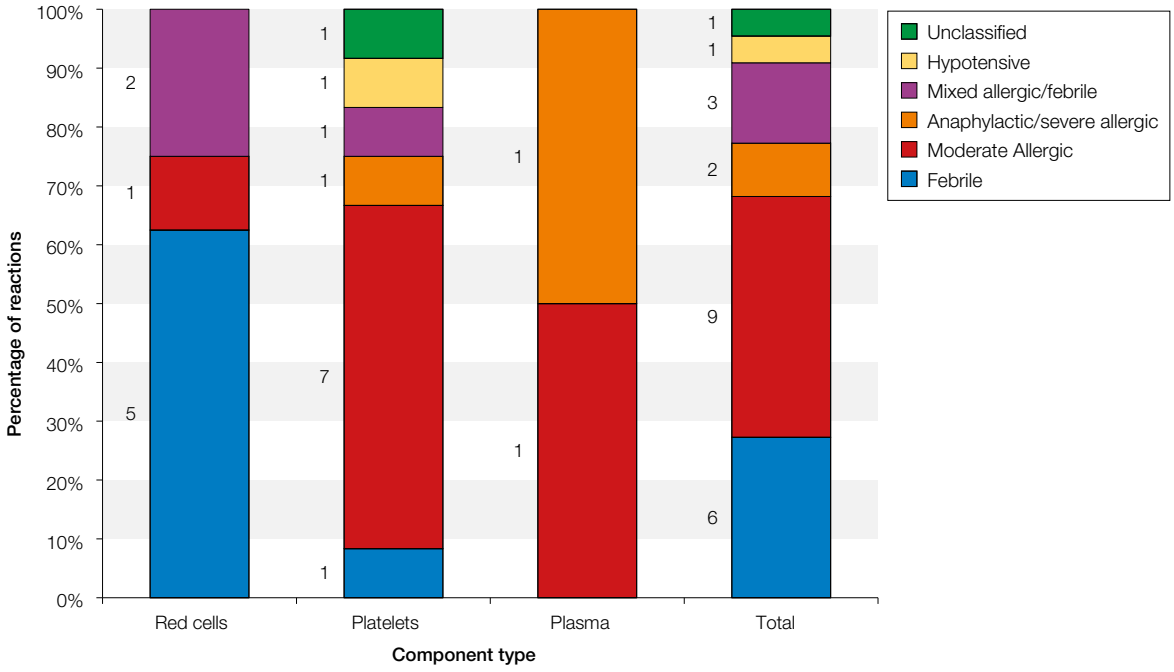
Although there were no serious adverse outcomes, a high Hb can risk neurological complications for patients with sickle cell disease and this case illustrates the need for meticulous calculation and prescription of transfusion volumes for children.

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.

26 Summary of Transfusion Complications in Patients with Haemoglobin Disorders

Author: Paula Bolton-Maggs

A total of 36 cases were reported in patients with haemoglobin disorders in 2013. The median age of this group of patients is 29.5 years, range 3 to 83 years. The tables show the reporting categories for patients with sickle cell disease and beta thalassaemia major (excluding 3 cases of handling and storage errors, 1 right blood right patient, and 1 near miss incident in 2013). Haemolytic transfusion reactions (16 reported in 2013) remain a major feature in patients with sickle cell disease.

Table 26.1: Adverse incidents in haemoglobinopathy patients - cumulative data for 4 years (2010-2013)

Category	Sickle cell disease (SCD)				Total 4 yrs	Outcome
	2010	2011	2012	2013		
HTR	4	5	7	16	**32**	2 deaths, 17 MM
SRNM	3	6	7	7	**23***	1 alloimmunisation
ATR	4	3	2	2	**11**	Minor morbidity
NM	2	2	0	1	**5**	
ADU	0	1	1	2	**4**	2 deaths
TACO	0	1	0	0	**1**	1 MM
TAD	0	1	0	0	**1**	
TTI	0	0	1	0	**1**	Parvovirus

Category	Beta thalassaemia major				Total 4 yrs	Outcome
	2010	2011	2012	2013		
ATR	6	3	3	2	**14**	Minor morbidity
SRNM*	0	2	2	1	**5**	
IBCT	0	0	2	0	**2**	One ABO incompatible transfusion
NM	0	0	1	0	**1**	

(MM=major morbidity; ATR=acute transfusion reactions; HTR=haemolytic transfusion reactions; TACO=transfusion-related circulatory overload; TAD=transfusion-associated dyspnoea; ADU=avoidable, delayed or under transfusion; SRNM=specific requirements not met; NM=near miss events; IBCT=incorrect blood component transfused; TTI=transfusion-transmitted infection

**This total includes an additional woman in 2012 with HbH disease who did not receive CMV-screened blood because the clinicians did not inform the laboratory that she was pregnant*

COMMENTARY

There has been a marked increase in reports of delayed haemolytic transfusion reactions in patients with sickle cell disease in 2013. Six of these were associated with major morbidity and in one case the reaction contributed to death. In 9 cases no alloantibodies were identified despite definite evidence of haemolysis. These are discussed in Chapter 16 Haemolytic Transfusion Reactions (HTR). The mechanisms for sensitisation and possible solutions are discussed in a recent review; the evolution of molecular typing to improve red cell matching may lead to a reduction in sensitisation [86]. Hyperhaemolysis occurred in at least 6 cases (Table 16.2). The outcome has been to recommend avoiding transfusion in future in 4 of them, including a woman with a stroke. The investigation in one case established that the patient was attending 4 different hospitals and the investigators recommend a national review of arrangements for shared care. This issue has been identified in successive Annual SHOT Reports particularly for these patients where their specific requirements are not met in the absence of good information about the diagnosis and/or presence of previously identified antibodies.

A 7-year old child in sickle crisis died as a result of inadequately treated severe anaemia with delay and this is discussed in Chapter 11 Avoidable, Delayed or Undertransfusion (ADU).

Hyperhaemolytic transfusion reactions (HHTR) have been described in adults and children with sickle cell disease and less commonly in patients with other haematological disorders [87, 88] but the incidence of this complication is not known [89, 90]. The mechanism is not understood, but macrophage activation is thought to play a role [87].

It is important to distinguish between HHTR and classical delayed haemolytic transfusion reaction (DHTR) with the latter generally occurring between 2 to 10 days post transfusion with a positive direct antiglobulin test (DAT) associated with identification of new red cell alloantibodies not detected pre transfusion. In classical DHTR, only transfused cells are destroyed and further transfusion with antigen-negative units is likely to correct the anaemia.

In contrast, HHTR appears to be more complex as both the transfused and autologous red cells are destroyed with post-transfusion Hb levels falling disproportionately and to lower than pre-transfusion levels. Additional transfusion, even with antigen-negative, crossmatch-compatible units may further exacerbate haemolysis with a potentially fatal outcome.

HHTR was reported to SHOT as a complication resulting in the death of a 10 year old child in 2010 with 3 further cases of major morbidity included in the SHOT report for 2011. Further cases were reported in 2012. Accordingly SHOT is now asking hospitals to report cases of suspected HHTR via the following mechanism so that that we can characterize these cases in a systematic way with feedback of any lessons learnt to hospitals. For hospitals served by National Health Service Blood and Transplant (NHSBT), the hospital clinician will contact their red cell immunohaematology (RCI) consultant in normal working hours or the Blood Service consultant on call as soon as possible once hyperhaemolysis is suspected or recognised. Details will be collected on a proforma and when completed (including treatment and outcome), the anonymised data reported to SHOT. Reported cases will be discussed by an expert panel (similar to the current decisions on transfusion-related acute lung injury). The expert panel includes Nay Win, Shubha Allard, Clare Milkins and Paul Telfer. The devolved countries are invited to participate in this study.

Recommendations

- Any case of suspected hyperhaemolysis should be reported (for hospitals served by NHSBT) to the National Health Service Blood and Transplant (NHSBT) red cell immunohaematology (RCI) consultant or consultant on call at the local Blood Centre as soon as possible to enable real-time data collection and diagnosis

Action: Hospital haematologists and transfusion teams

- A national review of shared care arrangements could be performed as part of the forthcoming haemoglobinopathy audit

Action: Haemoglobinopathy audit group

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.

27 Summary of Incidents Related to Transplant Cases

Authors: Alison Watt and Paula Bolton-Maggs

The key message from the incidents reported in 2013 is that anti-D immunoglobulin prophylaxis should be given to RhD negative females of childbearing potential who receive RhD positive solid organ transplants, especially when organs are transplanted from living donors. This follows a case of a female of childbearing potential who developed anti-D after a liver transplant with a lobe from a live donor (reported in Chapter 21 Unclassifiable Complications of Transfusion (UCT)). The transfusion laboratory was not informed about the RhD mismatch, so the patient did not receive any prophylactic anti-D immunoglobulin. There appear to be no national guidelines recommending action in the event of RhD positive organs being transplanted to RhD negative females of childbearing potential.

Organs from cadaveric donors are flushed through before transplant meaning there are few donor red cells left in the organ. The risk of red cell antibody sensitisation may be higher in live transplants, because the organs may not be flushed through before transplanting. It is likely that the number of transplants from live donors will continue to increase, so it is particularly important for recipients who are females of childbearing potential that RhD status is considered.

Table 27.1: Summary of errors made in transplant cases n=52

Type of transplant	ABO/RhD errors	SRNM*	Other UCT**	Total
Haemopoietic stem cell transplant (HSCT)	8	10	0	18
Solid organ	1	31	1	33
HSCT + Solid organ (lung)	0	1	0	1
Total	**9**	**42**	**1**	**52**

**SRNM = specific requirements not met*

***This case is the female of childbearing potential who produced anti-D (Chapter 21 UCT)*

Table 27.2: ABO/RhD errors n=9

SHOT category	ABO error	RhD error	Total
Incorrect blood component transfused (IBCT)	3	3	6
Near miss	1	2	3
Total	**4**	**5**	**9**

Transplants using ABO and/or RhD non-identical haemopoietic stem cells may create complex requirements for transfusion. All cases reported this year, detailed in Table 27.3, were laboratory based errors, which may suggest some lack of understanding. Laboratory information management systems (LIMS) can be used to control these complex situations, but only if used effectively. In 3/9 cases the LIMS had not been updated with the patient's ABO or RhD requirements and in 5/9 incidents the flags on the LIMS system were ignored or overridden. In 1/9 cases the patient's original group was amended on the LIMS.

The liver transplant case listed in Table 27.3 highlights another area of confusion. The 2012 British Committee for Standards in Haematology (BCSH) guidelines for pre-transfusion compatibility procedures in hospital transfusion laboratories [19] recommend that recipients of minor ABO incompatible transplants should be crossmatched for the first 3 months post transplant, by an indirect antiglobulin technique and blood should not be selected by an electronic issue system. This is because of the risk that passenger lymphocytes in the transplanted organ may produce donor specific IgG ABO antibodies, which are incompatible with the patient's own red cells.

Passenger lymphocyte syndrome (PLS) is a self-limiting condition, so alternatively, donor type or group O red cells may be given for the first three months post transplantation. A literature review of PLS following renal transplantation [91] concluded that donor B-lymphocytes require stimulation after transfer (through infection) or relative recipient T-lymphocyte inhibition (increased specific immunosuppression such as depleting antibodies, anti-thymocyte globulin (ATG)) to allow donor T cell activation and so maximise antibody production. Donor antibodies are often not detected in recipient sera immediately post transplantation. PLS is heterogeneous, and the triggers for antibody production and haemolysis are still incompletely understood. Some transplant centres opt for a policy of transfusing donor group red cells for 3 months, rather than crossmatching recipient group cells.

Recent publications from the British Transplant Society (BTS) do not include any recommendations for selection of red cells, but in the liver transplant case reported here, the patient's own group (B) was transfused following electronic issue, hence it was neither crossmatched, nor a group compatible with the donor, i.e. group O.

ABO/RhD non-identical	Component	Gender	Transplant type	Patient group	Donor group	Group transfused	Outcome
Incorrect blood component transfused (IBCT) as a result of laboratory error							
ABO	Red cells	Male	Liver	B	O	B	No adverse reaction
ABO	Red cells	Female	HSCT	A	O	A	No adverse reaction
ABO	Red cells	Male	HSCT	A	O	A	No adverse reaction
RhD	Platelets	Female	HSCT	RhD+	RhD-	RhD+	No adverse reaction
RhD	Platelets	Male	HSCT	RhD+	RhD-	RhD+	No adverse reaction
RhD	Red cells	Female	HSCT	RhD+	RhD-	RhD+	No adverse reaction
Near misses – no components transfused. Intended components and groups listed							
ABO	Red cells	Female	HSCT	A	O	A	Near miss
RhD	Platelets	Female	HSCT	RhD+	RhD-	RhD+	Near miss
RhD*	Red cells	Female	HSCT	RhD+	RhD-	RhD-	Near miss

Table 27.3: Summary of transplant-related ABO/ RhD non-identical transfusions or near misses n=9

**Patient originally transfused correctly, but post transfusion the patient's original group was erroneously changed to RhD negative on the LIMS. This mistake was discovered before the next transfusion and although it would not have led to an incorrect transfusion for this patient, it could have been a dangerous error for another combination of recipient and donor groups*

SHOT category	Irradiated	CMV neg	Irradiated & CMV neg	Other	Total
Errors related to solid organ transplants					
SRNM clinical error	28	0	1	0	**29**
SRNM laboratory error	0	0	0	1	**1**
Near miss clinical error	1	0	0	0	**1**
Near miss laboratory error	0	0	0	0	**0**
Subtotal errors solid organ	**29**	**0**	**1**	**1**	**31**
Errors related to HSCT - includes one patient who had HSCT and solid organ (lung) transplant					
SRNM clinical error	6	0	0	1	**7**
SRNM laboratory error	0	0	0	0	**0**
Near miss clinical error	2	0	0	0	**2**
Near miss laboratory error	1	1	0	0	**2**
Subtotal errors HSCT	**9**	**1**	**0**	**1**	**11**
Total	**38**	**1**	**1**	**2**	**42**

Table 27.4: Failure to provide components with specific requirements n=42

The solid organ cases in Table 27.4 include 27 of 28 SRNM clinical errors where non-irradiated components were used for patients treated with alemtuzumab. This includes a multiple report of 16 cases from one reporting organisation. The patients had been treated at a regional centre, which did not require the use of irradiated components for solid organ recipients treated with alemtuzumab. Therefore, the renal team did not communicate the treatment to the local hospital transfusion laboratory, where the policy was to follow current BCSH guidelines on the usage of irradiated blood components [28].

Usage of irradiated components following treatment with alemtuzumab for non-haematological indications, such as solid organ transplants, remains controversial. The BCSH guidelines are about to be rewritten and the transplant clinicians can then be directed by this guidance. An addendum to the BCSH irradiated guidelines was published in 2012 to clarify the situation in the interim [92].

Table 27.5: Causes of errors, including near miss errors

Error made	ABO/RhD error	SRNM	Other	Total
Errors related to solid organ transplants				
Clinical error - protocol or communication	0	30	1	**31**
Laboratory error - LIMS flags not heeded or updated	1	1	0	**2**
Subtotal errors solid organ	**1**	**31**	**1**	**33**
Errors related to HSCT - includes one patient who had HSCT and solid organ (lung) transplant				
Clinical error - protocol or communication	0	9	0	**9**
Laboratory error - LIMS flags not heeded or updated	8	2	0	**10**
Subtotal errors HSCT	**8**	**11**	**0**	**19**
Total	**9**	**42**	**1**	**52**

Conclusion

In the 2012 Annual SHOT Report (published 2013) [3], it was noted that there was a surprising gap in the transplant guidelines, because no guidance required the transfusion laboratory to be informed when a transplant may affect the patient's blood group or transfusion requirements. It appears that there is a similar gap in the guidelines when there might be a need for anti-D immunoglobulin prophylaxis to be given to females of childbearing potential. There seems to be no published guidance on the prevention of sensitisation in RhD negative women of childbearing potential when receiving solid organs from an RhD positive donor [93].

Recommendation

- Guidelines should be developed that cover the procedures, particularly communication protocols, necessary for managing female transplant patients who are of childbearing potential, where RhD positive transplants have been given to RhD negative recipients. This should be a standard for all transplant centres

Action: British Committee for Standards in Haematology Transfusion Task Force in association with the British Transplant Society

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.

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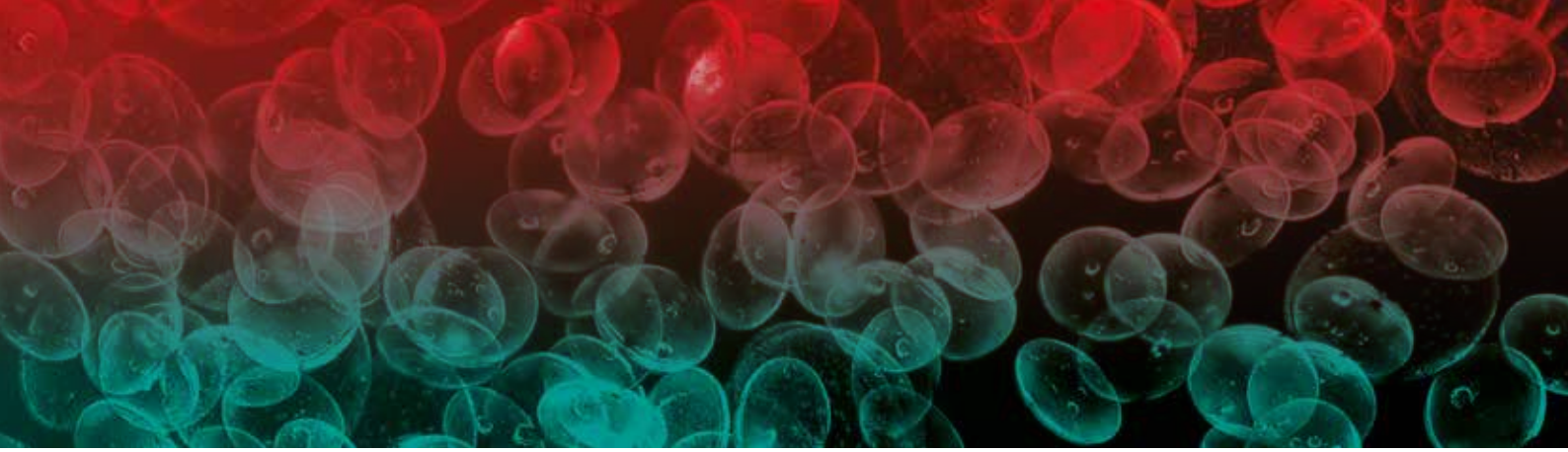
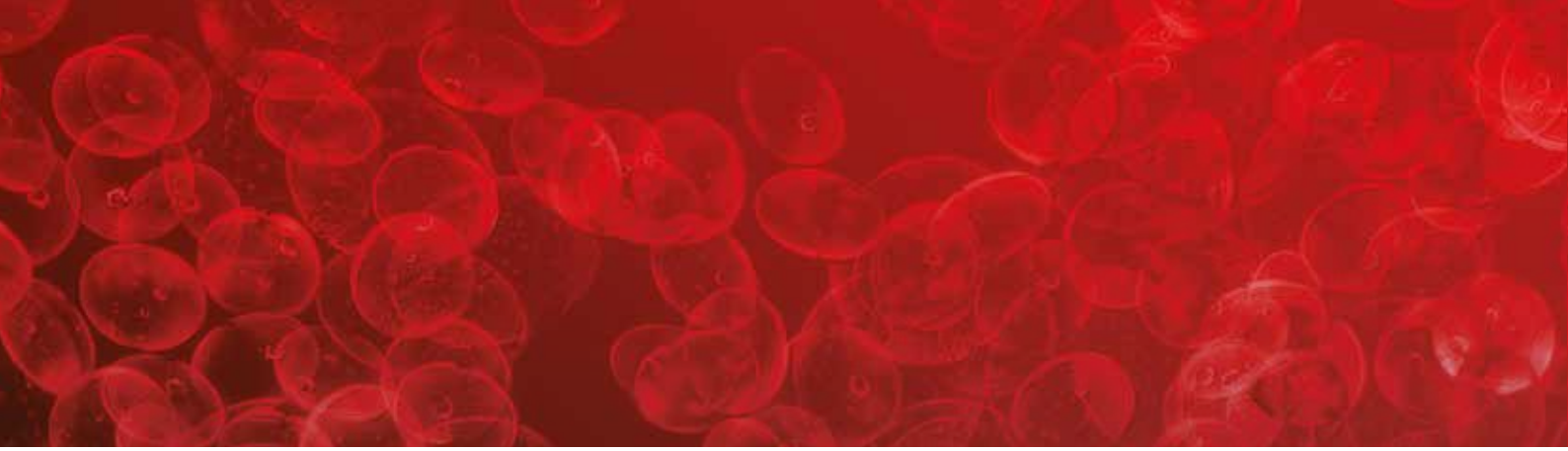
Acknowledgements

The steering group take this opportunity to thank the following individuals and organisations for their contributions without which the publication of this 17th Annual SHOT Report would not have been possible:

- The Blood Services of the United Kingdom for funding and support
- The Royal College of Pathologists to which SHOT is affiliated
- The Blood Services of the United Kingdom for the provision of data relating to the issue of blood components:
  - Mrs Sue Holdsworth, National Stock Planning Manager, NHSBT
  - Ms Amanda Stewart, Principle Transfusion Data Analysis Manager, SNBTS
  - Mr Edward Stack, Management Information Analyst, SNBTS
  - Mrs Samantha Rainbird, Head of Processing, Verification and Issue, WBS
  - Mrs Barbara Mullin, Hospital Services Deputy Manager, NIBTS
  - Mr. Andy Rowley, Business Manager, Critical Care, UK and Republic of Ireland, Octapharma Ltd for data relating to SD-FFP (Octaplas®)
- The expert group who reviewed TRALI cases:
  - Dr Neil Soni, Chelsea and Westminster Hospital
  - Dr Cliff Morgan, Royal Brompton Hospital
  - Dr Tom Latham, NHSBT Bristol
  - Dr Nay Win, NHSBT Tooting
  - Dr Peter Davis, Bristol University Hospitals NHS Foundation Trust
- Clinical and scientific staff, in hospitals and reference laboratories, who have contributed to the clinical and laboratory investigation of cases
- Toast Design Consultancy Ltd for maintenance of the SHOT website
- Dendrite Clinical Systems for the update of the online reporting system
- Sarah Doyle SHOT Information Officer
- Suzie Baillie SHOT Information Officer
- Lisa Parker SHOT Information Officer
- Hazel Macauley, Personal Assistant to Paula Bolton-Maggs
- ARC-UK Technologies for design and production of the report
- Hospital Transfusion Teams for submitting case reports to the scheme





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