ANNUAL SHOT REPORT 2019

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MHRA

SHOT
Serious Hazards of Transfusion

Serious Hazards of Transfusion (SHOT)

Steering Group Chair	Professor Mark Bellamy
SHOT Medical Director	Dr Shruthi Narayan
Operations Manager	Ms Courtney Spinks
Haemovigilance Data Manager	Ms Debbi Poles
Patient Blood Management Practitioner	Mrs Jayne Addison
	Mrs Emma Milser
Clinical Incidents Specialist	Mr Simon Carter-Graham
Laboratory Incidents Specialist	Mrs Hema Mistry
	Mrs Victoria Tuckley
National Coordinator for Transfusion-Transmitted Infections (Public Health England)	Mr Joe Flannagan

Working Expert Group (WEG) & Writing Group, on behalf of the SHOT Steering Group

Chair: Dr Shruthi Narayan
Professor Mark Bellamy, Ms Courtney Spinks, Ms Debbi Poles, Mrs Hema Mistry, Mrs Victoria Tuckley, Mr Simon Carter-Graham, Mrs Jayne Addison, Mrs Emma Milser, Dr Peter Baker, Dr Andrew Bentley, Dr Janet Birchall, Dr Paula Bolton-Maggs, Mrs Heather Clarke, Dr Anicee Danaee, Dr Jennifer Davies, Mrs Pamela Diamond, Mr Joe Flannagan, Dr Sharran Grey, Dr Sarah Haynes, Dr Jane Keidan, Dr Anne Kelly, Dr Tom Latham, Dr Puneet Malhotra, Dr Alistair McGrann, Dr Helen New, Mrs Terrie Perry, Dr Jayne Peters, Dr Catherine Ralph, Dr Fiona Regan, Mr Chris Robbie, Dr Susan Robinson, Dr Megan Rowley, Ms Tracey Tomlinson, Dr Joseph Sharif, Mrs Diane Sydney, Dr Alison Watt

Steering Group (SG) during 2019

Chair: Professor Mark Bellamy

Dr Susan Robinson	British Society for Haematology Guidelines
Dr Shubha Allard	National Blood Transfusion Committee
Lynne Anderson	Scottish Clinical Transfusion Advisory Committee
Ms Jenny Berryman	Institute of Biomedical Science
Dr Paula Bolton-Maggs	Royal College of Pathologists (also member of WEG)
Dr Su Brailsford	Public Health England & Faculty of Public Health
Mr Graham Donald	Lay member
Dr Heidi Doughty	British Blood Transfusion Society
Dr Ruth Gottstein	Royal College of Paediatrics and Child Health
Dr Jeremy Groves	Intensive Care Society
Dr Sheila MacLennan	Joint Professional Advisory Committee
Dr Gail Miflin	UK Forum
Major Andy Miles	Defence Medical Services
Dr Kieran Morris	Northern Ireland Regional Transfusion Committee
Dr Ranga Mothukuri	Royal College of Emergency Medicine
Dr Charles Percy	British Society for Haematology
Felicity Plaat	Royal College of Obstetricians and Gynaecologists
Dr Krishna Ramachandran	Royal College of Anaesthetists
Dr James Reid	Royal College of Physicians
Mr Chris Robbie	Medicines and Healthcare Products Regulatory Agency
Mrs Rashmi Rook	UK Transfusion Laboratory Collaborative
Ms Rachel Scanlan	Royal College of Midwives
Mr Suman Shreshtha	Royal College of Nursing
Dr Andrew Thillainayagam	British Society of Gastroenterology and Royal College of Physicians
Mr John Thompson	Royal College of Surgeons
Ms Nina Vinall	Expertise in Patient Safety

Honorary Steering Group Members

Dr Hannah Cohen	Founder Member and former Steering Group Chair
Dr Dafydd Thomas	Former Steering Group Chair
Dr Lorna Williamson	Founder Member
Dr John Barbara	Founder Member
Prof John Lumley	Founder Member
Dr Brian McClelland	Founder Member
Dr Derek Norfolk	Founder Member
Dr Clare Taylor	Former SHOT Medical Director
Dr Sue Knowles	Former Interim Medical Director of SHOT
Dr Dorothy Stainsby	Former National Medical Coordinator of SHOT
Dr Elizabeth Love	Former National Medical Coordinator of SHOT

NB. All members of the WEG are members of the Steering Group in their own right.

Requests for further information should be addressed to:

Non-infectious hazards

SHOT Office
Manchester Blood Centre
Plymouth Grove
Manchester
M13 9LL

Tel +44 (0) 161 423 4208
Website www.shotuk.org
Twitter @shothv1

Enquiries shot@nhsbt.nhs.uk

Email m.c.bellamy@leeds.ac.uk
shruthi.narayan@nhsbt.nhs.uk
debbi.poles@nhsbt.nhs.uk
simon.carter-graham@nhsbt.nhs.uk
victoria.tuckley@nhsbt.nhs.uk

Infectious hazards

Joe Flannagan
Scientist (Epidemiology)
Public Health England Epidemiology Unit/NHSBT
61 Colindale Avenue
London NW9 5EQ

Tel +44 (0)20 8327 7602
Email joe.flannagan@phe.gov.uk

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Contents

Foreword

1

Author: Mark Bellamy

'May you live in interesting times' is often quoted as an ancient Chinese curse. In fact, the origins are probably British, and far later; there is no evidence for an ancient Chinese origin to this saying, nor, apparently, is there any equivalent expression in modern Chinese parlance. Nonetheless, the coronavirus era we have entered in the early part of 2020 is interesting, tragic and terrifying in equal measures. One of the upsides, however, of 'interesting times', is that they are indeed interesting, if not fascinating and full of challenge.

This year's Annual SHOT Report looks back at trends and data for the last calendar year, but also highlights several very important messages for us in the present extraordinary times. The data in the report come from across the United Kingdom (UK) and include material from all areas of healthcare where transfusion is practised. As in previous years, it is certain that under-reporting is significant. Reporting rates in some of the higher usage Trusts/Health Boards vary twentyfold. Given the cultural, resource and procedural similarities of these organisations, it is highly unlikely that the error and mishap rate varies by anything like this much, so reporting rates are likely to play a large part. One area where this is likely to have greatest impact is in the reporting of near misses, the most fertile learning area.

The leading causes of transfusion-related incidents are, again this year, 'human factors' related, with procedural failures and flawed decision-making contributing in large measure. While decision support tools and information technology have gained some traction, and continue to help us progress in these areas, their universal adoption remains some way off. Until these are more widespread, we continue to rely on education and peer pressure to encourage best practice.

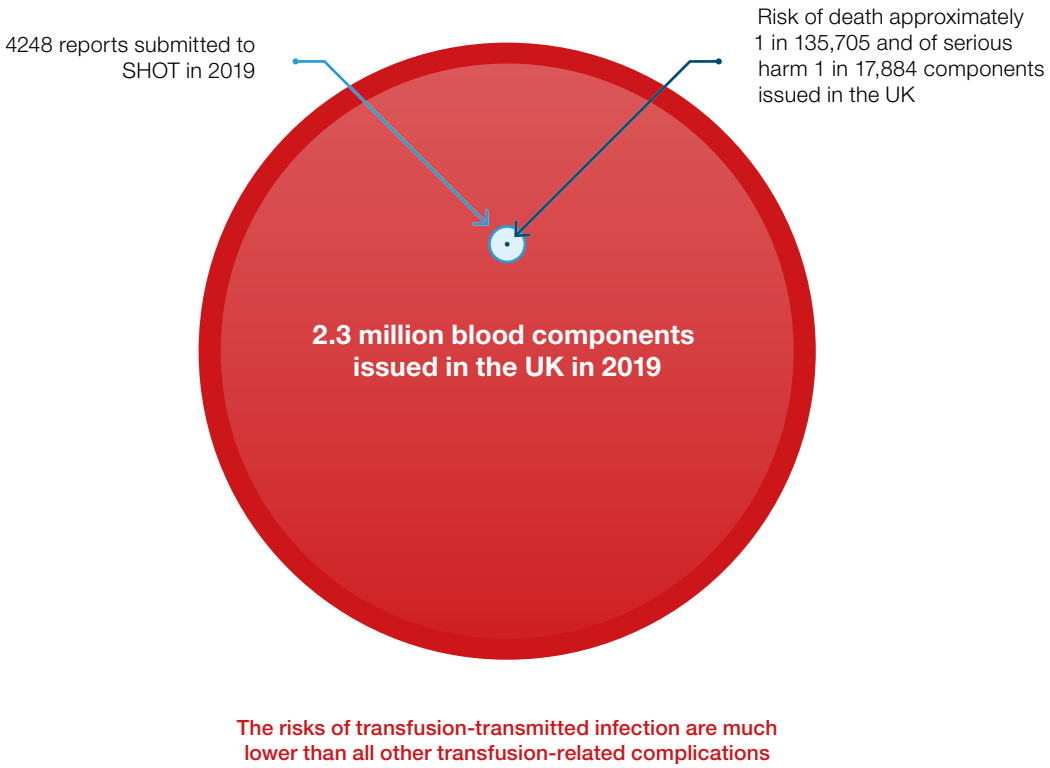
A 'human factors' approach is key to understanding why errors and accidents continue to occur, despite, in many cases, adequate training, knowledge, expertise and currency. Those areas of hospitals which are under greatest stress and pressure, for example, emergency departments, continue to report a year on year increase in errors. Despite this, transfusion remains very safe indeed,with the risk of serious harm being 1 in 17,884 and death 1 in 135,705 transfused components in the UK.

In the new era of the coronavirus pandemic there is economic and health-economic stress. Maintaining high rates of reporting, and a learning culture, is more important than ever. Actual harm remains rare; to learn effectively, and promote safety, we need to learn as much from the near misses as we do from the actual incidents. Learning from our mistakes is important; but so, too, is learning from what goes well. If we learn only from our mistakes, we assume that our underlying systems, procedures and culture are already robust, and the mistakes represent either glitches in the system, or deviations from it. But it is equally important for us to realise that this is seldom the case. Why do things go well? What is it about a system which prevents more frequent failures? Why are some systems better at this than others? For example, in a busy railway concourse, most people do not bump into one another. We take this for granted; and yet, it is quite extraordinary, something we should find surprising.

A 'Safety-II' approach should, and must, complement our traditional, error-focused 'Safety-I' culture. Safety-II must become embedded in our approach to improving and developing what we do. Why do things go well, how do systems and procedures adapt to promote and maintain safety, and what can we learn from that? The current extraordinary situation gives unprecedented opportunities to learn about resilience, to learn the lessons of what goes well, to understand how systems do not fail, and how this resilience can be generalised. We, at SHOT, are hugely thankful to all our reporters over the last year, for the quality and diligence of reporting. Although this may seem a subsidiary activity during the current

pandemic, it is not. The dark days of this pandemic, and its aftermath, offer us learning opportunities which are unique and unprecedented. It is crucial and more important than ever before to maintain and progress our reporting and learning culture.

Figure 1.1: Risk of harm or death from blood transfusion in the UK



Note: This is a representative image and not accurate to scale

Participation in United Kingdom (UK) Haemovigilance 2

Authors: Debbi Poles and Chris Robbie

Key SHOT messages

- Complete and accurate reporting is essential to ensure good quality haemovigilance
- Reporters are encouraged to report all relevant events to SHOT to help promote a shared learning culture so as to improve patient safety

Abbreviations used in this chapter

ANTID	Anti-D Ig administration errors
BSQR	Blood Safety and Quality Regulations
FFP	Fresh frozen plasma
Ig	Immunoglobulin
MB	Methylene-blue treated
MHRA	Medicines and Healthcare products Regulatory Agency
NHS	National Health Service
NM	Near miss
SABRE	Serious adverse blood reactions and events
SAE	Serious adverse events
SAR	Serious adverse reactions
SD	Solvent detergent-treated
UK	United Kingdom

Recommendation

- SHOT participation benchmarking data should be regularly reviewed to identify areas of potential under-reporting

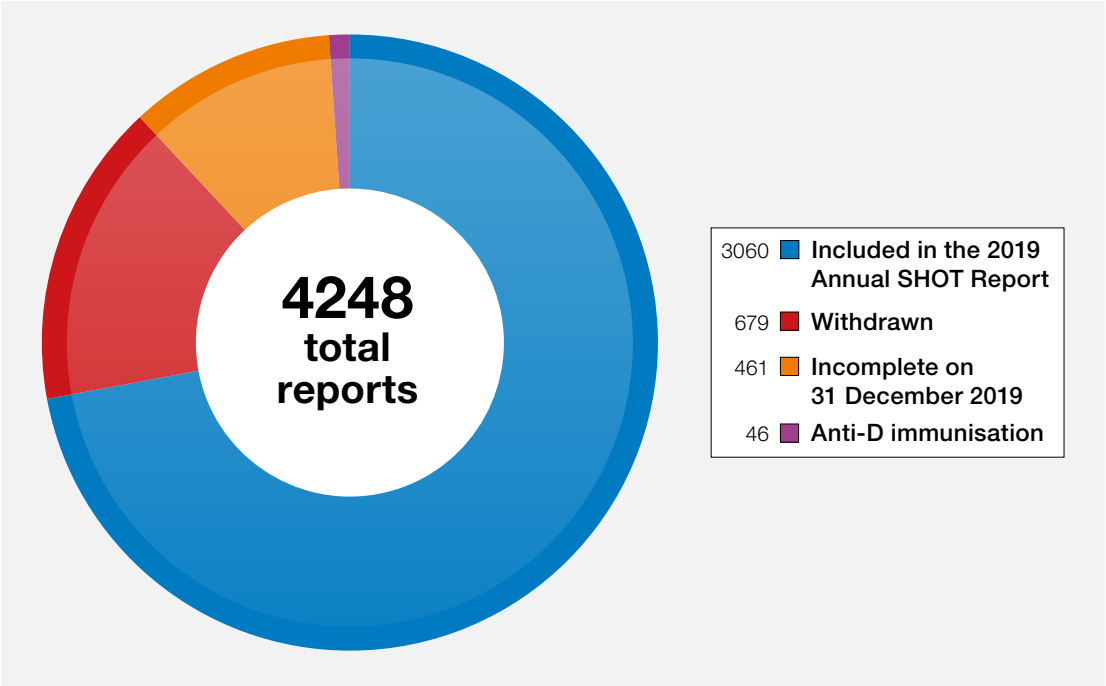
Action: Hospital transfusion committees

Introduction

Haemovigilance reporting in the UK continues to increase year on year. In the calendar year 2019, a total of 4248 reports were received by the SHOT on-line reporting system (Dendrite) via the Medicines and Healthcare products Regulatory Agency (MHRA) serious adverse blood reactions and events (SABRE) system. For full details of all MHRA data, see Chapter 26 of the 2019 Annual SHOT Report on the SHOT website (https://www.shotuk.org/shot-reports/).

Not all the reports submitted are SHOT-reportable or are included in the analysis for this SHOT Annual Report. Figure 2.1 details the fate of all submitted reports during 2019. Of the 679 withdrawn reports, 137 were submitted from the four Blood Services, and so are not reportable to SHOT (only to the MHRA). The remaining withdrawn cases are those that were either reported in error or were determined to be not SHOT-reportable. Some of these would still have been included by the MHRA as they would be reportable under the Blood Safety and Quality Regulations (BSQR). The 461 incomplete reports are those that are awaiting completion by the reporters. Reasons for non-completion could be that they are awaiting the outcome of investigations or were reported later in the year. Once complete, these reports will be reviewed for inclusion in the next Annual SHOT Report.

Figure 2.1: Status of reports submitted to SHOT in the calendar year 2019



Note: 2 reports are not included on this figure as they were reported to Public Health England (PHE) and discussed in the 2018 SHOT Annual Report, but not reported to SHOT until 2019

The outputs from a haemovigilance reporting system are dependent on the quality of the data submitted. It is imperative that the information provided is as complete and accurate as possible for the SHOT Working Expert Group to make a valid assessment. To help with this, feedback will be communicated to reporters where there has been a change to the reported category or imputability of an event or reaction.

While reporting levels are rising, the total number of blood components issued each year continues to decrease. This is reflected in Figure 2.2 by the increasing number of submitted reports per 10,000 components issued.

Figure 2.2: Number of reports submitted to SHOT, and per 10,000 components issued 2010-2019

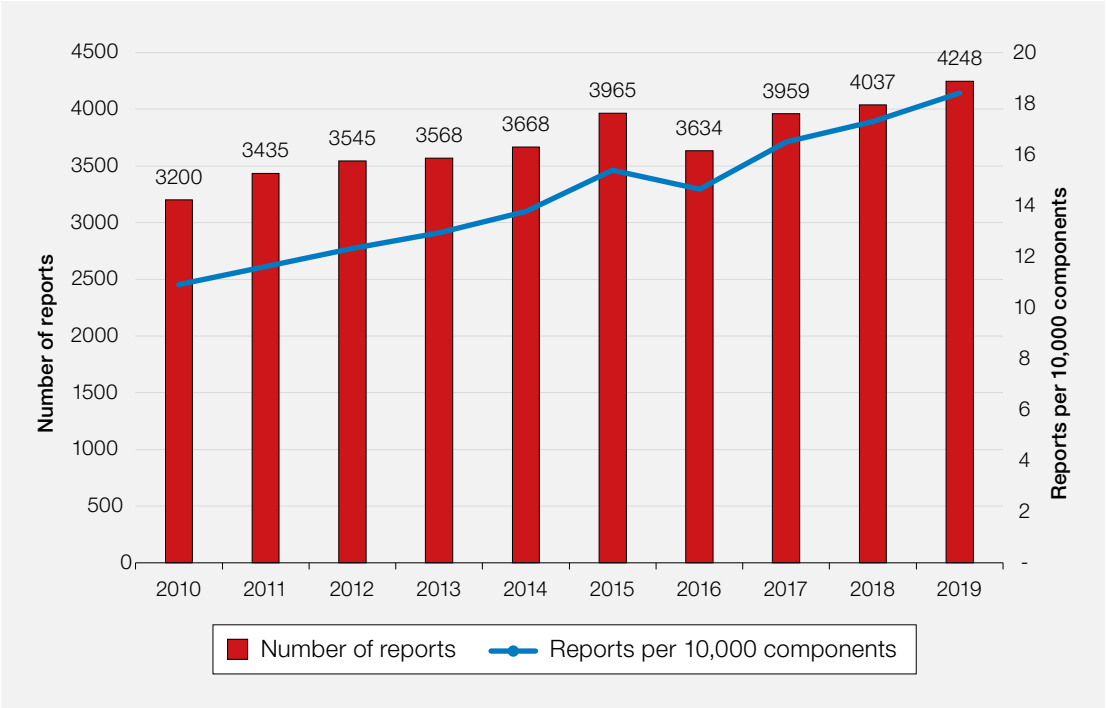


Figure 2.3 shows the flow of information from the submission of a report to the publication of the Annual SHOT Report.

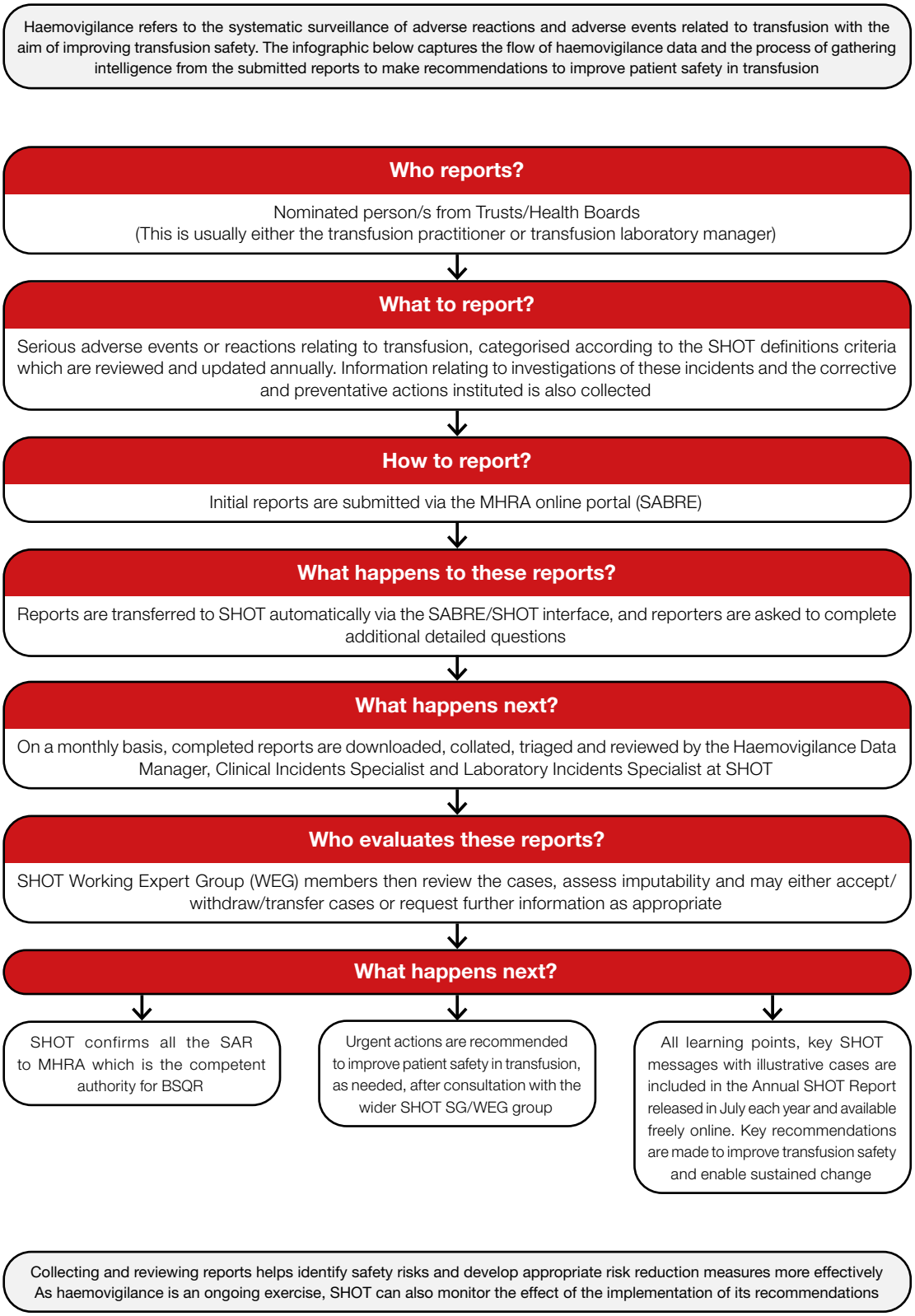


Figure 2.3: Flow of SHOT haemovigilance data

MHRA=Medicines and Healthcare products Regulatory Agency; SABRE=serious adverse blood reactions and events; SAR=serious adverse reactions; BSQR=Blood Standards and Quality Regulations; SG=steering group

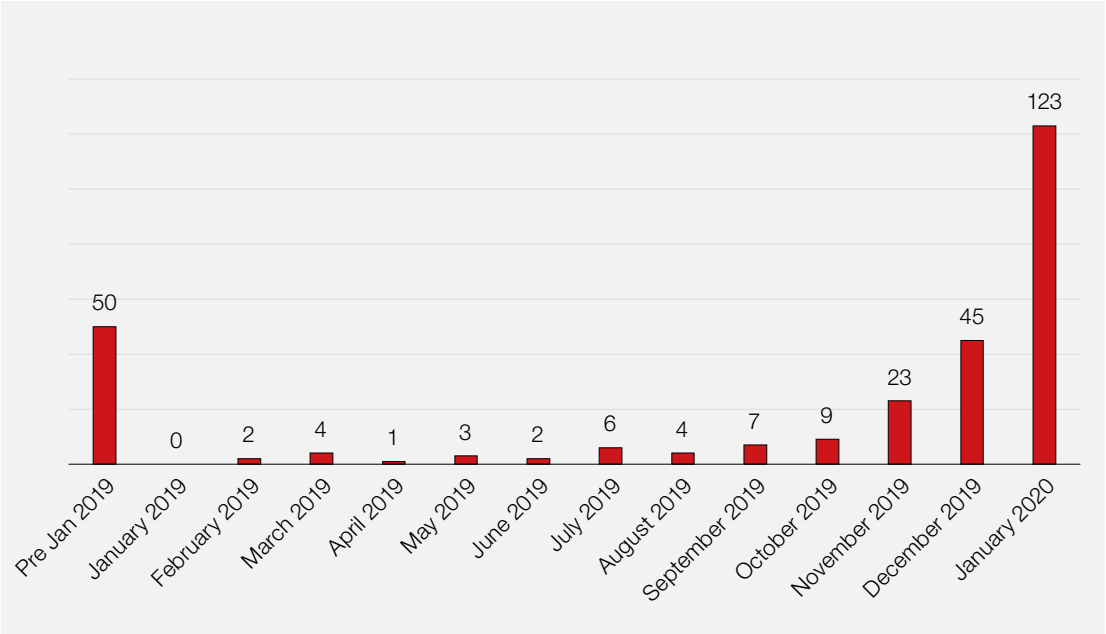
Reporting organisations in 2019

All but three UK National Health Service (NHS) Trusts/Health Boards submitted reports during 2019. Of the three non-reporting organisations, two were indirect users and the third was a low user of blood components.

There were 26 non-NHS organisations that submitted reports in 2019.

MHRA data demonstrates that most SABRE reporters are actively engaged in the UK haemovigilance reporting process with most active reporters reporting in the previous month. The few that have never reported or haven't reported in the last year are either facilities, care homes, private hospitals and very small NHS organisations with fewer than 200 units issued per year. The figure also includes those reporters who have an account for SHOT-only reporting purposes.

Figure 2.4: The last time a report was received on SABRE from an active SABRE account



Participation levels 2019

Analysis of the reporting levels by organisation and usage level has been carried out again for 2019 data. Although participation is generally high, and the number of reports submitted is increasing each year, there are very variable levels of reporting by organisations of similar size based on blood component usage.

Figure 2.5 emphasises these large differences, and at one end of the scale, a very high usage organisation submitted 5 or fewer reports, while at the other end, another high user submitted in excess of 100 reports.

Table 2.1: SHOT participation benchmarking usage levels 2018

Usage level	Total components per annum
Very low	<1,000
Low	1,001–6,000
Medium	6,001–10,000
High	10,001–19,000
Very high	>19,001

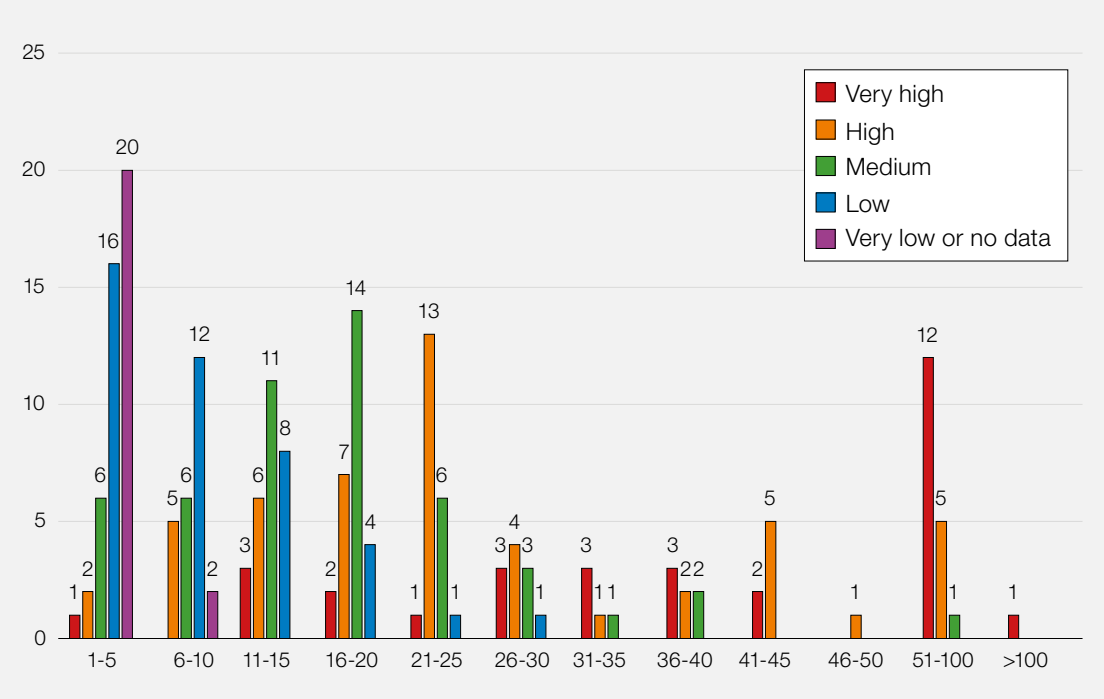


Figure 2.5: Number of 2019 reports by reporting organisation and component usage level

Additional analysis has been undertaken to review the variety of report types submitted by each NHS Trust/Health Board.

Serious adverse events (SAE), serious adverse reactions (SAR), near miss (NM) and anti-D immunoglobulin (Ig) administration errors (ANTID) reports have been included in the analysis to determine how many of these four main reporting categories were reported by each NHS organisation.

Encouragingly there were 85/171 (49.7%) of NHS organisations that submitted reports across all four reporting categories and indicates a broad reporting culture in these organisations. However, there were 38 organisations that only submitted reports in one or two different categories. Whilst low use organisations may not submit many reports if they do not perform many transfusions, it is worrying that 10/38 (26.3%) of these were 'high' or 'very high' blood component users. This could either indicate sub-optimal reporting arrangements in those organisations or conversely some hospitals may have robust safety measures in certain areas that considerably reduce risk of error.

There were also 12 'high' or 'very high' usage organisations that submitted no SAR reports in 2019.

Since 2012, SHOT has produced participation benchmarking data at NHS Trust/Health Board level, and for any independent, non-NHS reporting organisations that have reported during the preceding two years. These data are available on the SHOT website (https://www.shotuk.org/reporting/shot-participation-benchmarking/), and reporters are encouraged to review these data when they are published in the autumn each year.

Table 2.2: Category of reports submitted by NHS Trusts/Health Boards

Number of reporting categories	Number of NHS organisations by usage size					
	Very high	High	Medium	Low	Very low	Total
1	1	2	2	8	2	**15**
2	3	4	11	4	1	**23**
3	7	15	11	15	-	**48**
4	20	30	25	10	-	**85**
Total	**31**	**51**	**49**	**37**	**3**	**171**

3 NHS organisations did not submit any reports

Blood component issue data 2019

Table 2.3: Total issues of blood components from the Blood Services of the UK in the calendar year 2019

	Red cells	Platelets	FFP	SD-FFP	MB-FFP	Cryo	Totals
NHS Blood and Transplant	1,400,536	254,735	164,505	88,720	7,288	42,073	**1,957,857**
Northern Ireland Blood Transfusion Service	41,160	8,493	3,819	2,460	264	991	**57,187**
Scottish National Blood Transfusion Service	137,393	22,749	15,406	7,260	503	3,240	**186,551**
Welsh Blood Service	82,506	11,111	7,457	3,820	-	494	**105,388**
Totals	**1,661,595**	**297,088**	**191,187**	**102,260**	**8,055**	**46,798**	**2,306,983**

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

SD-FFP data supplied by Octapharma

Paediatric/neonatal MB-FFP are expressed as single units; Cryoprecipitate numbers are expressed as pools and single donations as issued; all other components are adult equivalent doses

SHOT reporting by UK country

Figure 2.6 shows the numbers of submitted reports and issued blood components across all four UK countries. The number of reports submitted for Northern Ireland in 2018 was artificially inflated as a result of 1 refrigerator failure case that resulted in 106 patients being administered anti-D Ig that was out of controlled temperature (Narayan et al. 2019). For 2019, the numbers for Northern Ireland have reverted to levels more consistent with previous years, which still show the highest level of reporting per 10,000 component of the four countries.

Wales has submitted its lowest number of reports and reports per 10,000 components for a number of years with 165 reports, and 15.7 reports per 10,000 components in 2019 (223, 20.7 in 2016; 189, 16.7 in 2017 and 196, 18.0 in 2018).

Reporting levels for England and Scotland per 10,000 components have continued to increase each year, the largest increases being in Scotland.

It is important that a 'low' reporting rate from an organisation should not be interpreted as a 'safe' organisation, as this may represent under-reporting which could be due to multiple factors including staffing issues, infrastructure and reporting culture. Similarly, a 'high' reporting rate should not be interpreted as an 'unsafe' organisation, as this may actually represent a culture of greater openness. It is well known that as the reporting culture in an organisation matures, staff are more likely to report incidents. Therefore, an increase in incident reporting should not be taken as an indication of worsening patient safety, but rather reflective of an increased awareness of safety issues amongst healthcare professionals and a more open and transparent culture across the organisation. It is also important to note that NHS Trusts/Health Boards are changing constantly with closures, mergers, and restructuring of services with very different risk profiles and these will have to be borne in mind when reviewing haemovigilance data. Regular review of these data by hospital transfusion teams, and shared learning from peers is strongly recommended to help system-wide meaningful changes in transfusion practices to improve patient safety.

Full tables containing the breakdown of data from 2019 and previous years can be found in the supplementary information on the SHOT website (https://www.shotuk.org/shot-reports/report-summary-and-supplement-2019/).

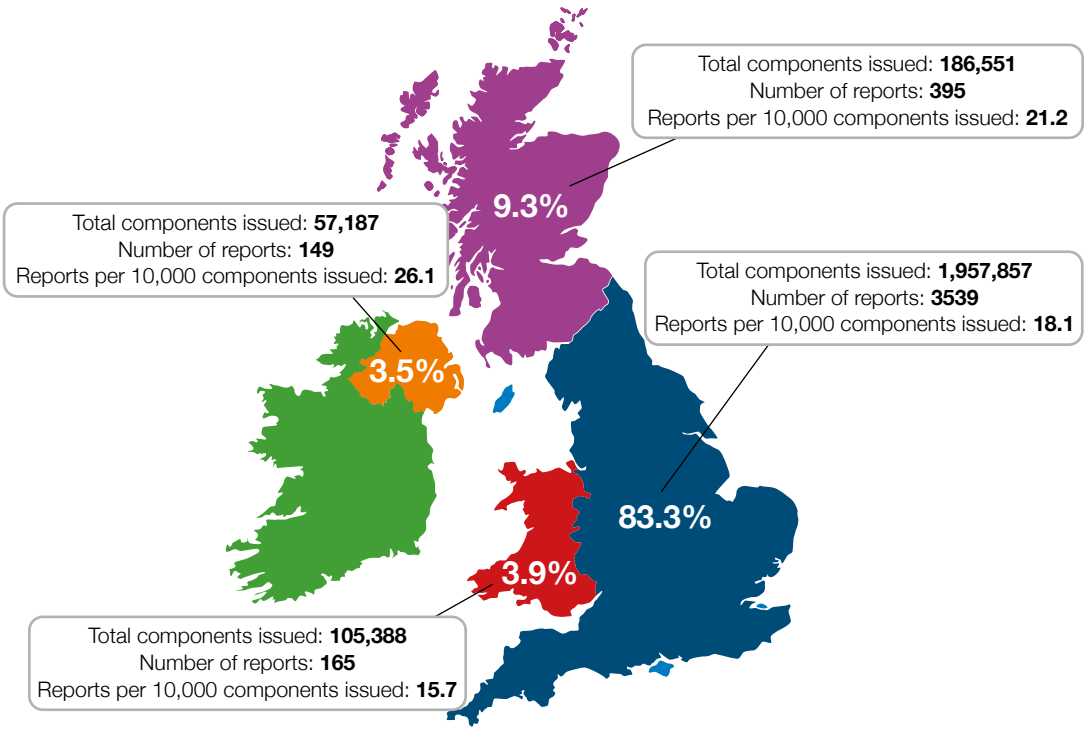


Figure 2.6: Percentage of SHOT reports submitted by UK country

Cases included in the 2019 Annual SHOT Report n=3397

The total number of reports analysed and included in the 2019 Annual SHOT Report is 3397. This is an increase of 71 from the 3326 reports analysed in the 2018 Annual SHOT Report (published 2019).

This number does not include 54 reports of immunisation against the D-antigen as these are part of a separate study.

The total number of 3397 is made up of the 3060 completed reports submitted in 2019 (Figure 2.1) plus 337 reports that were submitted in 2017 and 2018, but not finalised until 2019.

The number of reports with potential for patient harm (excluding 'near miss' and 'right blood right patient') is 1867, a 12.5% increase from 1659 in 2018.

Analysis of errors by location

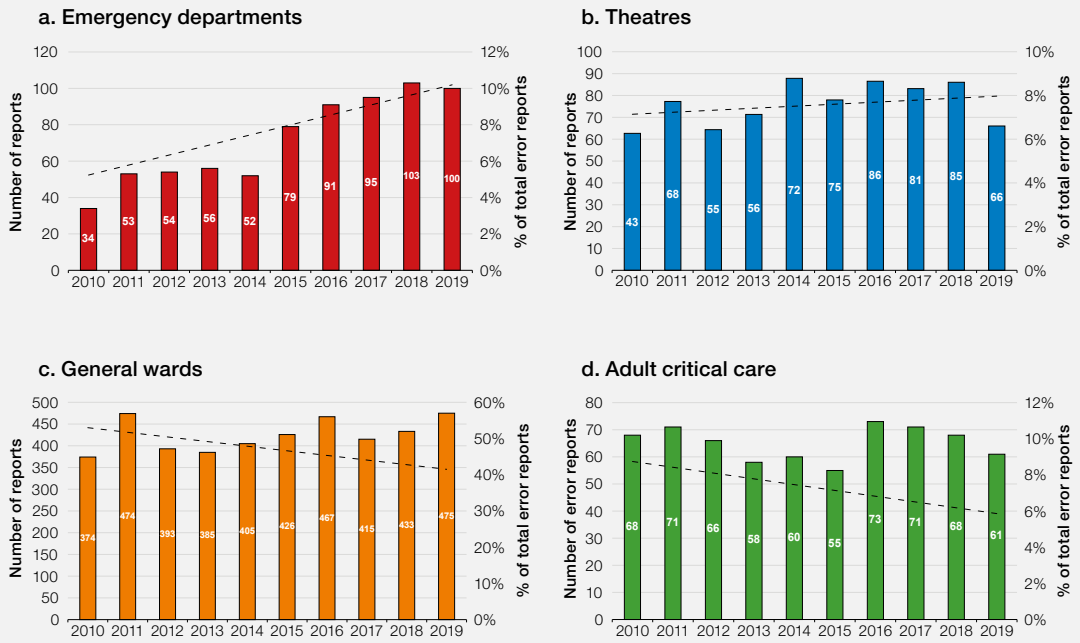
Following a steady increase in reports from emergency departments in the last few years, 2019 sees a slight drop in numbers for the first time, and although the trendline is still on an upwards trajectory, the actual percentage of total error reports in 2019 has dropped from 10.4% in 2018 to 8.9% in 2019.

The number of reports submitted from theatres is the lowest since 2013.

The downward trends in percentage of error reports continue in general wards and adult critical care, despite an increase in the absolute number of reports from wards in 2019.

Unfortunately, there are no denominator data available with regard to the number of transfusions undertaken in each of these areas.

Figure 2.7: Trend of error reports from different departments



Conclusion

Engagement with haemovigilance reporting in the UK is generally very high, however there are wide variations between reporting organisations, and there is likely to be under-reporting in some areas.

SHOT publishes annual participation benchmarking data to assist organisations in understanding their own level of reporting, and how it compares to organisations with a similar level of blood component usage.

Reporters are encouraged to report fully across all types of incident report, SAE, SAR, NM and ANTID, to ensure a full and accurate picture of UK haemovigilance.

References

Narayan S (Ed), Poles D, et al. (2019) on behalf of the Serious Hazards of Transfusion (SHOT) Steering Group. The 2018 Annual SHOT Report. https://www.shotuk.org/shot-reports/ [accessed 08 June 2020].

Headline Data: Deaths, Major Morbidity and ABO-Incompatible Transfusions

3

Authors: Shruthi Narayan and Debbi Poles

Key SHOT messages

- Transfusion in the United Kingdom (UK) is generally safe and SHOT data for the last five years show the risk of death from transfusion as 0.87 per 100,000 components issued
- Non-infectious complications, especially operational procedural errors and those related to transfusion decisions continue to be the most common causes of transfusion-related deaths in the UK. Delays in transfusion and pulmonary complications (mainly transfusion-associated circulatory overload (TACO)) were the main causes of reported transfusion-related deaths in 2019
- Errors continue to account for majority of the reports. In 2019, 84.1% (2857/3397) of all reports (including near miss (NM) and right blood right patient (RBRP)), and 74.7% of incidents excluding NM and RBRP were due to errors
- Near miss events continue to account for a large proportion (1314/3397, 38.7%) of the incidents reported to SHOT
- Inadequate staffing, lack of adequate training, poor supervision and poor safety culture have been identified as contributory to numerous incidents reported to SHOT. These need to be addressed urgently to reduce the risk to patient safety
- Trends in pathological transfusion reactions, like the febrile, allergic, hypotensive, and haemolytic reactions are similar to previous years. All staff involved in transfusions must be competent and confident in recognising and appropriately managing transfusion reactions in recipients

Abbreviations used in this chapter

ABOi	ABO-incompatible	**TAD**	Transfusion-associated dyspnoea
HTR	Haemolytic transfusion reaction	**TACO**	Transfusion-associated circulatory overload
MHRA	Medicines and Healthcare products Regulatory Agency	**TRALI**	Transfusion-related acute lung injury
NHS	National Health Service	**TTI**	Transfusion-transmitted infections
NM	Near miss	**UCT**	Uncommon complications of transfusion
RBRP	Right blood right patient	**UK**	United Kingdom

Recommendation

- NHS Trusts/Health Boards must use intelligence from all patient safety data including national haemovigilance data to inform changes in healthcare systems, policies and practices to embed the lessons learnt and truly improve patient safety

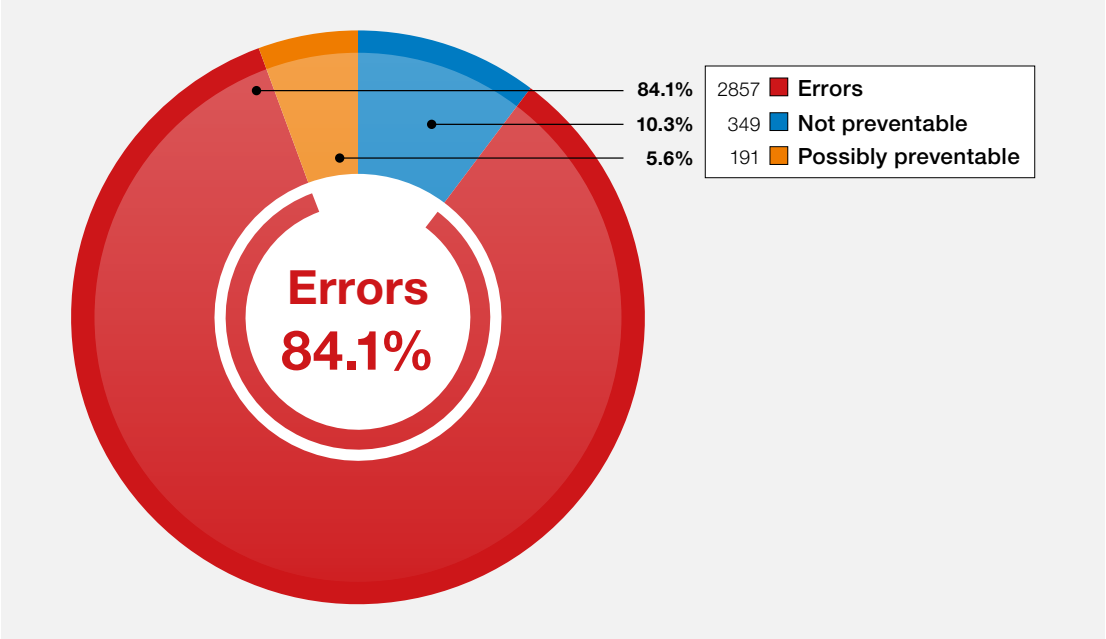
Action: Hospital chief executives and medical directors, National Blood Transfusion Committee (or the equivalent for the devolved countries), hospital transfusion teams

Introduction

Reporting transfusion adverse events and reactions to SHOT and the Medicines and Healthcare products Regulatory Agency (MHRA) supports the National Health Service (NHS) to learn from mistakes and to take action to improve transfusion safety. A reporting culture is a key aspect of patient safety and this is reflected in the continuing high number of reports received by SHOT, and a good level of participation and engagement with the haemovigilance scheme (see Chapter 2, Participation in United Kingdom (UK) Haemovigilance). Evaluation of submitted reports continues to provide assurance that transfusions in the UK are generally safe with around 18 reports submitted to SHOT per 10,000 components.

Errors continue to account for most reports and may reflect that systemic factors are not properly identified or rectified, leading to short term results rather than sustained improvement.

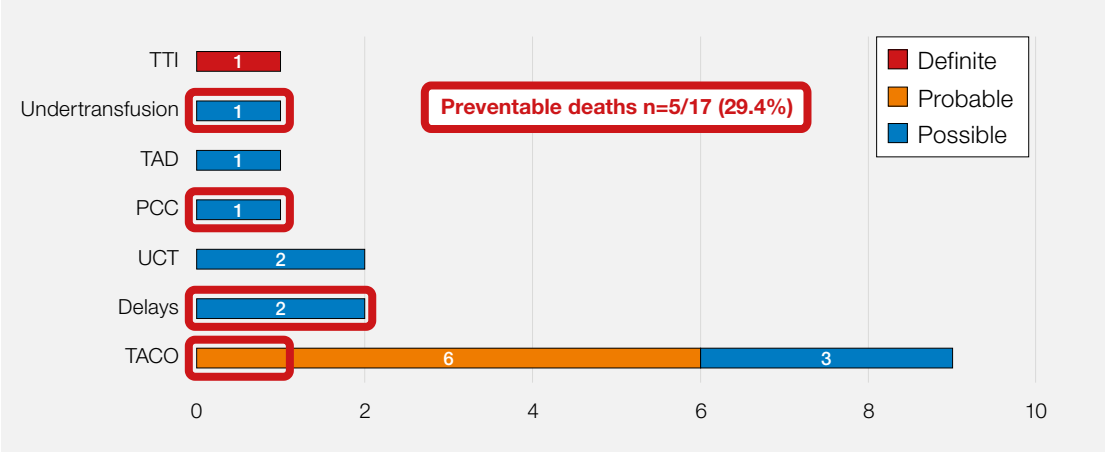
Figure 3.1: Errors account for most reports: 2857/3397



Deaths n=17

There were 17 deaths in total and this number includes deaths definitely, probably and possibly (imputability 3, 2, and 1 respectively) related to the transfusion. Delays in transfusion and pulmonary complications (mainly TACO) were the main causes of reported transfusion-related deaths in 2019. Transfusions with pulmonary complications contributed most to both deaths and major morbidity.

Figure 3.2: Deaths related to transfusion (with imputability) reported in 2019 n=17



TTI=transfusion-transmitted infections; TAD=transfusion-associated dyspnoea; PCC=prothrombin complex concentrate; UCT=uncommon complications of transfusion; TACO=transfusion-associated circulatory overload

Non-infectious complications, especially TACO and delays in transfusion, continue to be the most common causes of transfusion-related deaths in the UK. Figure 3.3 shows the distribution of causes of transfusion-related deaths reported from 2010-2019.

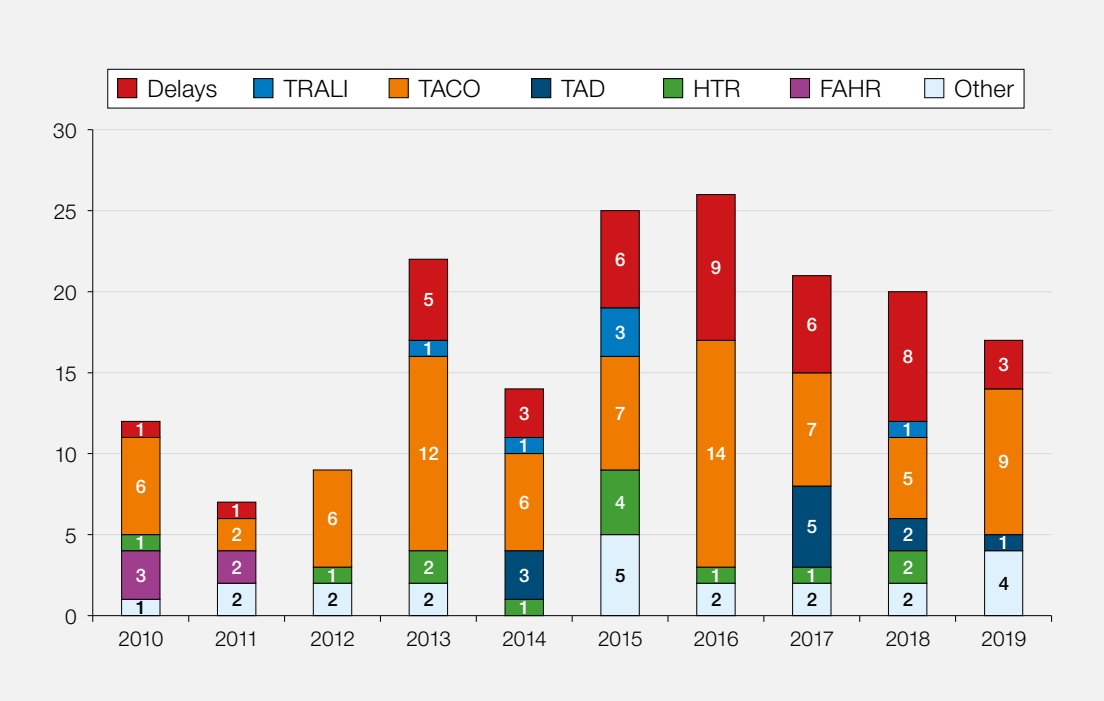


Figure 3.3: Transfusion-related deaths 2010 to 2019 n=173

TRALI=transfusion-related acute lung injury; TACO=transfusion-associated circulatory overload; TAD=transfusion-associated dyspnoea; HTR=haemolytic transfusion reaction; FAHR=febrile, allergic and hypotensive reaction

Delays include 1 delay due to PCC in 2019; HTR includes 2 deaths due to ABO-incompatibility; 'Other' includes 1 each for post-transfusion purpura, transfusion-associated graft-versus-host disease (2012) and anti-D related; there were 7 in the avoidable, over or undertransfusion category, 3 transfusion-transmitted infections, and 9 deaths related to other unclassified reactions

Improved decision making, patient monitoring and education, addressing factors contributing to errors, building safer systems and continued vigilance are vital in improving transfusion safety.

Major morbidity n=129

Most cases of major morbidity were caused by febrile, allergic or hypotensive transfusion reactions and pulmonary complications. These are further detailed in the respective subject chapters in this report.

Major morbidity is defined as:

- Intensive care or high dependency admission and/or ventilation, renal dialysis and/or renal impairment
- Major haemorrhage from transfusion-induced coagulopathy
- Evidence of acute intravascular haemolysis e.g. haemoglobinaemia or severe haemoglobinuria
- Life-threatening acute reaction requiring immediate medical intervention
- Persistent viral infection
- Acute symptomatic confirmed infection
- Sensitisation to D or K in a woman of childbearing potential
- Reaction resulting in a low or high haemoglobin (Hb) level of a degree sufficient to cause risk to life unless there is immediate medical intervention

Potential for major morbidity is defined as:

- Potential risk of D or K sensitisation in a woman of childbearing potential

Summary data and risks associated with transfusion

Data collected in 2019 are shown in Figure 3.4. Near miss reporting continues to provide valuable learning opportunities and contributed to 1314 (38.7%) of the total 3397 reports. Cumulative data for 23 years are shown in Figure 3.5.

Figure 3.4: Summary data for 2019, all categories (includes RBRP and NM) n=3397

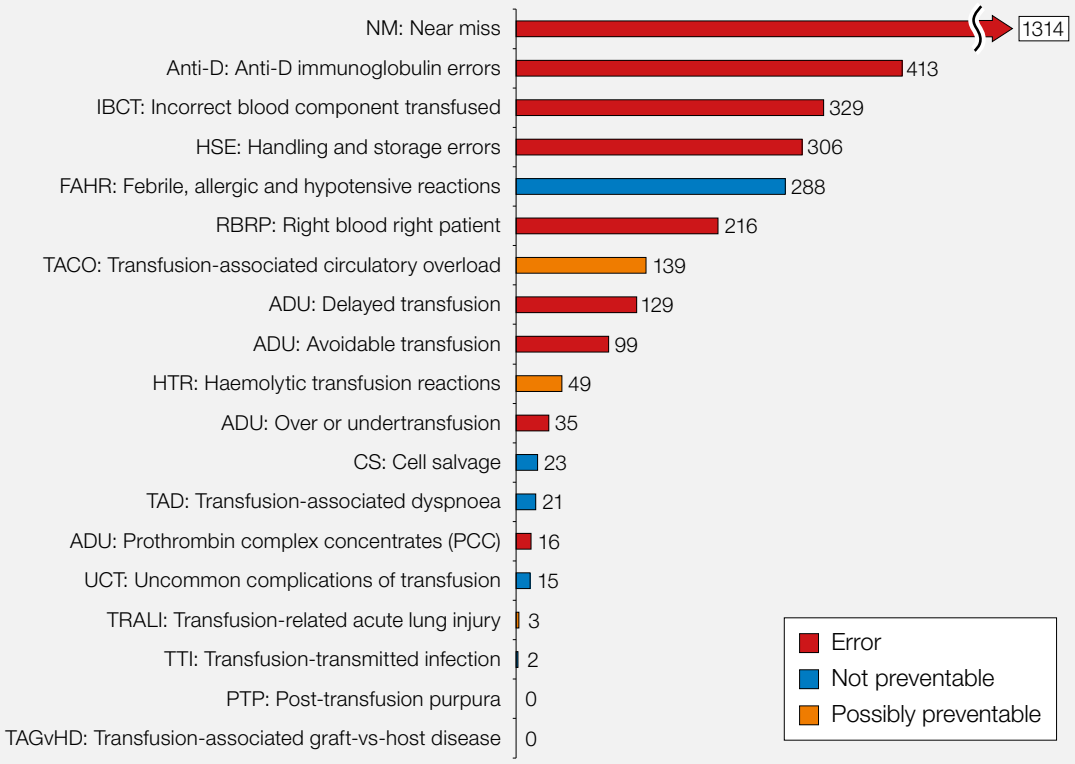
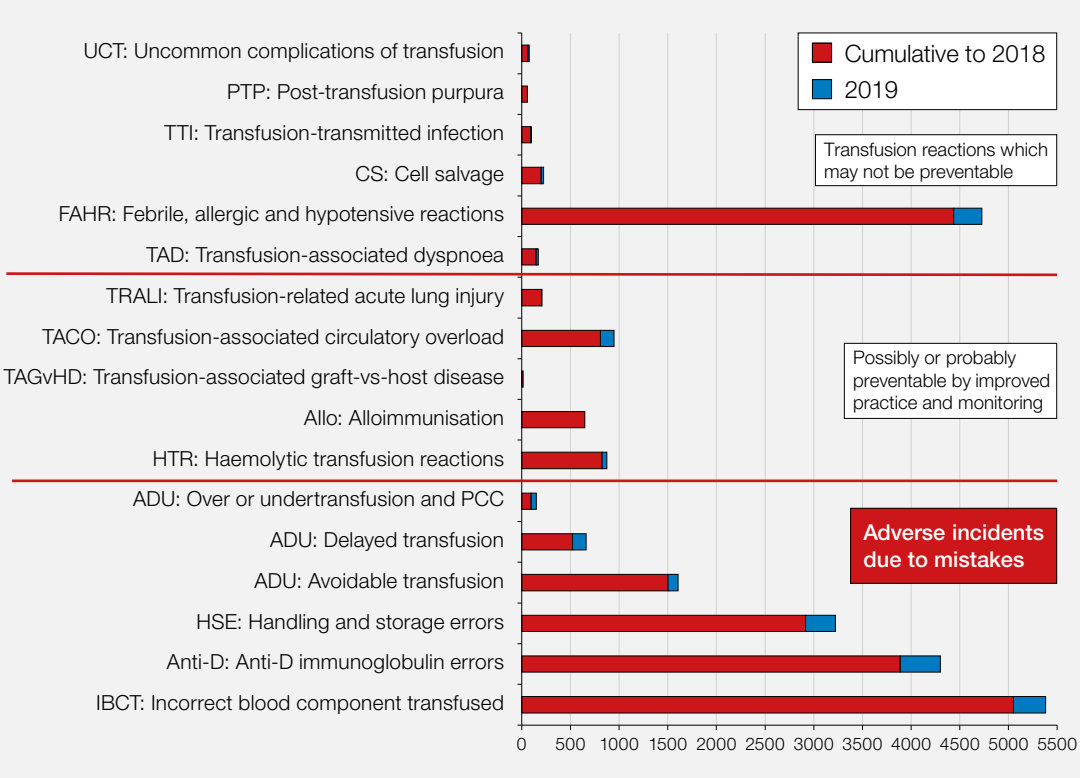


Figure 3.5: Cumulative data for SHOT categories 1996-2019 n=23341



**Data on alloimmunisation has not been collected since 2015*

Transfusion risks are calculated per 10,000 components issued. This translates into a risk of death close to 1 in 135,705 components and of serious harm close to 1 in 17,884 components issued in the UK. The risks of transfusion-transmitted infection are much lower than all other transfusion-related complications (see Chapter 20, Transfusion-Transmitted Infections (TTI)).

The following Figure 3.6 provides a useful reminder of why it is important to report and investigate near misses. Though recording and investigating incidents presents a more detailed picture, this is still a lagging indicator - measuring 'after' the event. Recording and investigating near misses, on the other hand, not only helps us to assess the strength of safety management systems but also provides an opportunity to fix problems before the occurrence of any adverse impact on patients, donors or staff i.e. a 'proactive approach' to safety. Building a strong safety culture is seeing risk where none was seen before, and actively mitigating risks before they become fatal.

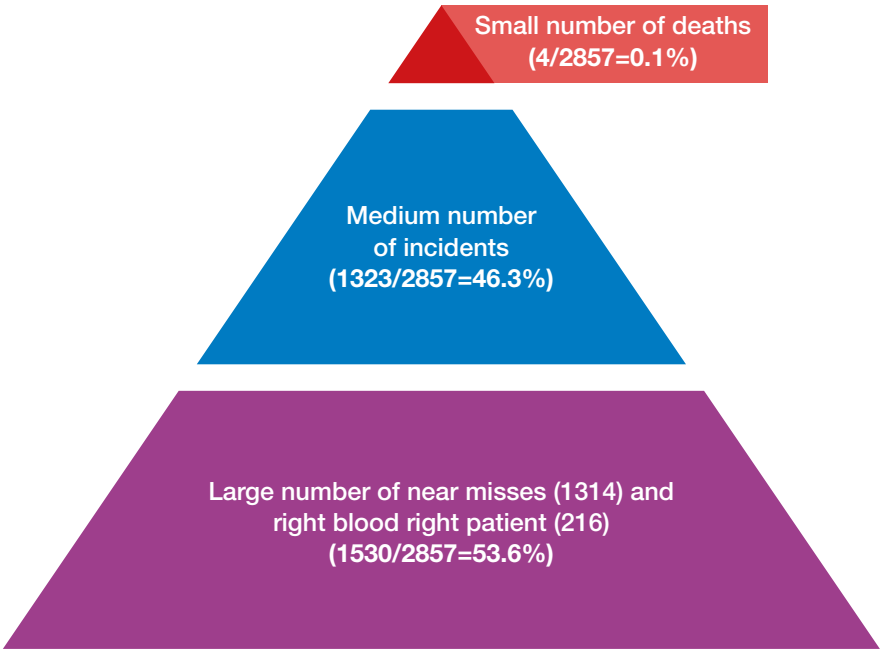
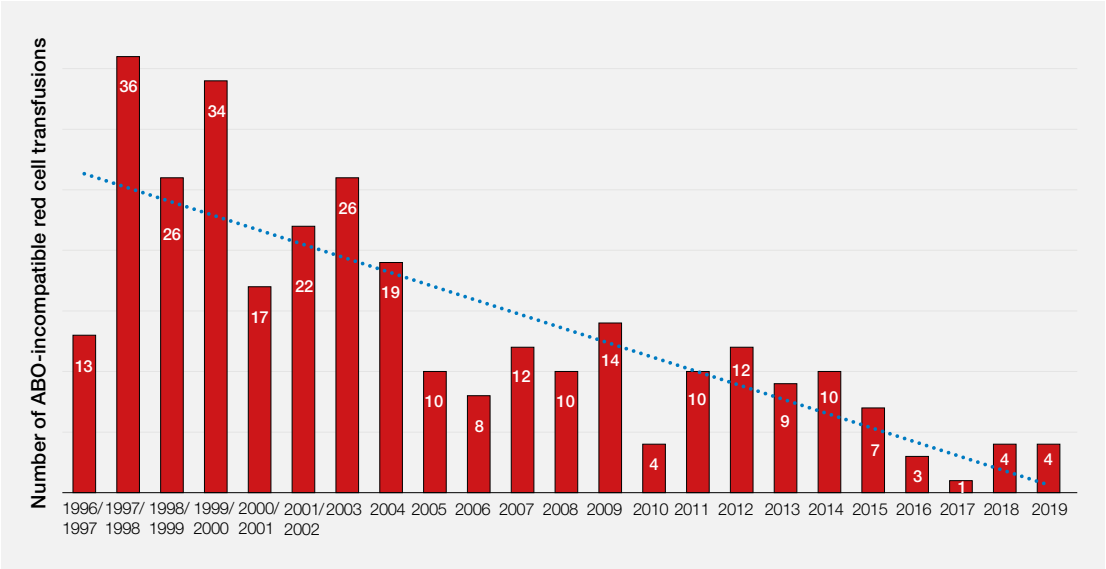


Figure 3.6: Reported errors triangle

ABO-incompatible (ABOi) transfusions n=6

In total, there were 4 ABO-incompatible red cell transfusions and 2 ABOi FFP transfusions reported in 2019. Of these, 3 were related to errors at component selection, 2 were primarily collection errors and 1 was related to an error at administration of the blood component. No patient deaths or major morbidity were reported in any of these cases. One of these was a paediatric case while the other 5 were in adult patients. These are further described in Chapter 9, Incorrect Blood Component Transfused (IBCT). Of note, in 4/6 (66.7%) cases, transfusions occurred between 20:00-08:00, reflecting the need to avoid unnecessary elective transfusions out-of-hours when staffing levels are low but also the importance of due diligence and vigilant monitoring of patients having transfusions at any time. It is also disturbing to note that despite previous SHOT recommendations and a recommendation from the Chief Medical Officer (Department of Health 2017), a bedside checklist is not universally applied, and this safety check could potentially have picked up these ABOi transfusions. Mistakes have also occurred as staff have not been adequately trained or their competencies assessed. Sources of cognitive bias and inattention blindness have been identified as contributory factors such as unfamiliarity with process, interruptions, assumptions, fatigue, etc.

Figure 3.7: Number of ABO-incompatible red cell transfusions 1996-2019



The trend over time towards reduced numbers of potentially fatal ABO-incompatible red cell transfusions is encouraging (Figure 3.7). However, review of near miss data shows that these are the tip of a much larger iceberg. Data from 2016-2019 show that although there were 12 ABO-incompatible red cell transfusions there were 1236 near misses where an ABOi transfusion would have resulted. Most of these in 2019, 308/329, resulted from wrong blood in tube (WBIT) errors. These will not be detected unless there is a historical record in the transfusion laboratory and demonstrate the importance of the group-check policy (BSH Milkins et al. 2013). In reports of WBIT samples, most reports (625/728, 85.9%) had this policy in place and 308/625 (49.3%) instances of WBIT were detected as a result of this. These errors, which could have lethal outcomes, demonstrate the importance of correct patient identification at the time of sampling, and the correct accurate completion of the final bedside check (BSH Robinson et al. 2018).

Figure 3.8: ABO-incompatible transfusions 2016-2019: few events (n=12) but many near misses (n=1236)

Healthcare organisations should consider strategies to increase the awareness of cognitive biases and promote work conditions that can detect, protect against, and recover from cognitive biases and associated risks. Cognitive biases, also known as 'heuristics', are cognitive short cuts used to aid our decision-making (O'Sullivan 2018). Errors persist although they should be reduced by good clinical and laboratory practices, automation, warning flags, education, and competency-assessment. Cognitive bias and inattention blindness are known to contribute to errors in healthcare, with lapses increasing during excessive workload and distraction (e.g. answering telephone queries and multitasking). These factors are often identified during incident investigation but are not always given weight when formulating a root cause, therefore are not addressed in corrective action (Grissinger 2012). Laboratory errors may be reduced if procedures and quality management systems are examined, then redesigned to complement the environment. For example; allocating a further member of staff to deal with queries will reduce distractions, variation in simple tasks will reduce 'autopilot', and removing ineffective computer flags will draw attention to the key safety checks. For additional discussion of cognitive bias, please see Chapter 7, Human Factors.

Conclusion

It is imperative that lessons learnt from incidents reported to SHOT are used to improve and adapt healthcare systems, transfusion policies and practices including training/education and investigation of incidents. These measures will help improve transfusion safety and can be evidenced by a reducing trend of such reports to SHOT in the future. Near misses also present valuable learning opportunities and should be investigated thoroughly. System level changes are needed to ensure that healthcare is a robust, safe and effective learning system with feedback loops.

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4 Key Messages and Recommendations

Authors: Shruthi Narayan and Mark Bellamy

Abbreviations used in this chapter

EPI	Electronic patient identification	**PID**	Patient identification
HFE	Human factors and ergonomics	**RBRP**	Right blood right patient
HSIB	Healthcare Safety Investigation Branch	**SOP**	Standard operating procedures
IBCT	Incorrect blood component transfused	**WBIT**	Wrong blood in tube
NHS	National Health Service	**WCT**	Wrong component transfused
NTS	Non-technical skills	**WHO**	World Health Organization

Key SHOT messages

- **Patient safety culture:** Fostering a strong and effective safety culture that is 'just and learning' is vital to ensure a reduction in transfusion incidents and errors, and to improve patient safety
- **Shared care:** Clear, timely and comprehensive communication between all teams and hospitals involved in patient-care is vital in ensuring patient safety. Robust and transparent processes must be in place for safe and effective transfer of information at all points in the patient care pathway
- **Investigating incidents:** Investigations must be systematic and thorough, proportionate to the risk and impact, identifying systems-based corrective and preventative actions. Systemic and organisational problems should be fully investigated, as staff-related amendments are less likely to resolve underlying systemic issues
- **Staffing challenges:** Staffing levels must be appropriate in all areas involved in transfusion. Staff should not be permitted (let alone instructed) to undertake tasks for which they have not been competency-assessed
- **Standard operating procedures (SOP):** SOP need to be simple, clear, easy to follow and explain the rationale for each step. This will then ensure staff are engaged and more likely to be compliant and follow the SOP
- **Learning from near misses:** Reporting and investigating near misses helps identify and control risks before actual harm results, providing valuable opportunities to improve transfusion safety

Blood components continue to be very safe. Morbidity and mortality associated with transfusions are often due to suboptimal practices and ill-judged transfusion decisions that need to be improved.

Transfusion is a complex multistep process involving members of several different professional groups i.e. nurses, doctors, laboratory scientists as well as the donors and recipients. The key messages and recommendations from the previous Annual SHOT Reports remain relevant and all healthcare organisations involved in transfusion are encouraged to continue implementing these and ensuring measures have been effective.

The principles of safe prescribing and safe administration of medications (Royal Pharmaceutical Society 2016) led to the development of the 10 'Rs' framework and acknowledges that the responsibility for

managing the environment in which drug administration takes place, and reducing the possibility of drug errors, is a multi-disciplinary concern (Edwards 2015).

Similarly, to reduce transfusion errors and ensure safer transfusion practices it is imperative to employ a broader, holistic understanding of the transfusion process end to end. Transfusion errors have been seen along all steps of the transfusion process and the 10 'Rights' includes considerations to follow before, during and after transfusions by both clinical and laboratory transfusion staff. These considerations are flexible and encompass the need to include critical thinking when making transfusion decisions which can be complex. Assessing risks and making such decisions requires complex thought processes to ensure safe practices. All staff involved in blood transfusions need to have essential knowledge of the blood components, indications for use, alternate options available, risks and benefits and possible reactions and their management.

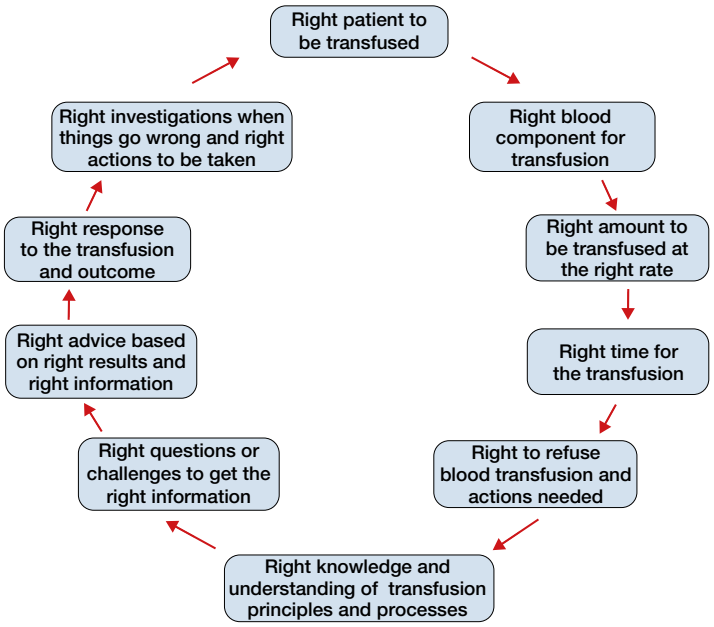

Figure 4.1: Ten 'Rights' for safe transfusions

The Safe Transfusion Checklist helps cover most aspects of the transfusion process at the bedside. The updated ABCDE approach to transfusions helps in the decision-making process and is shown below:

A

Assess patient
Any avoidable blood loss
(frequent, unnecessary tests/interventions)

B

Blood results (all) reviewed including trends – valid and reliable?
Best treatment option—is transfusion the best treatment option? If yes, what components needed, how many, what order and any specific requirements needed?

C

Consent/communication (adequate patient information—both verbal and written) to patients and where appropriate to families and carers
Correctable factors to be addressed like bleeding, haematinic deficiency

D

Do not forget other measures (vitamin K, tranexamic acid, cell salvage, etc)
Do not hesitate to question colleagues regarding decisions made and ask for rationale
Do not forget to document in patient's notes and in discharge summaries

E

Ensure timely communications to laboratory- need to be clear, concise and accurate
Ensure all relevant transfusion checklists including TACO risk assessment and actions arising thereafter have been completed
Evidence based decisions made weighing risks, benefits and options available
Ensure patient receives adequate post-transfusion information if transfusion given as a day case

Figure 4.2: The A-E decision tree to facilitate decision making in transfusion

Key SHOT recommendations for 2019

Patient identification (PID) errors

Despite the priority placed on addressing PID in previous Annual SHOT Reports, significant problems persist in both the clinical and laboratory areas. Patient misidentification has been recognised in several incidents reported to SHOT in various categories like incorrect blood component transfused (IBCT), right blood right patient (RBRP) and anti-D immunoglobulin errors.

A fundamental criterion for PID is an accurate identifier. Problems identified included inadequate aspects of identifier design, including illegibility (small font, or handwritten bands), ink that degraded with exposure to water, bands too narrow to accommodate the printed PID sticker. In July 2007 the National Patient Safety Agency (NPSA) issued Safer Practice Notice 24 – Standardising wristbands improves patient safety (NPSA 2007). This outlined the actions for NHS organisations to ensure standardised minimum criteria were used for patient wristbands and contained important information to guide local PID policy writing. Identification bands may be inaccessible or removed, posing risks for vulnerable patients who are unable to communicate or are confused. Similarly, specimen labels were often unclear due to small font size along with inadequate demarcation between labels printed for different patients.

If PID protocols are not being followed, organisations should consider seeking feedback from staff, and minor alterations in design may prove helpful. Simple low-technology measures (larger wristband size, using different ink) that reflect smart, thoughtful design using human factors principles will provide solutions. The use of electronic patient identification (EPI) systems has been shown to result in a lower incidence of wrong component transfused (WCT) and near misses such as wrong blood in tube (WBIT) compared to manual processes (Murphy et al. 2019). The Healthcare Safety Investigation Branch (HSIB) recommend (Recommendation 2019/46 (HSIB 2019)) that hospitals should take steps to ensure '*the adoption and ongoing use of electronic systems for identification, blood sample collection and labelling'.* It is important to note that PID errors have been reported even with EPI, often due to a system being used incorrectly, poorly located or staff inappropriately trained.

Registration and merging of patient records should be standardised with a policy in each healthcare setting to reduce the risks associated with incorrectly merging records. If electronic systems for patient identification are available, they should be utilised correctly by appropriately trained staff.

Studies have shown that involving the patient in their own care can lead to improvement in professional practice. Sustained long-term improvements will likely require a combination of good design, smart technology, and ongoing staff involvement.

Accurate patient identification is fundamental to patient safety and must underpin patient care at every stage, to ensure a safety-focused culture.

Main recommendation 1

- Accurate patient identification is fundamental to patient safety. Organisations must review all patient identification errors and establish the causes of patient misidentification. Recognising gaps in existing processes, use of electronic systems, empowerment of patients and staff will reduce these errors

Action: Hospital chief executives and medical directors, National Blood Transfusion Committee (or the equivalent for the devolved countries), hospital transfusion teams

Rethinking education and training of transfusion staff

While knowledge gaps and sub-optimal training of clinical and laboratory transfusion staff have been identified to contribute to several instances of poor transfusion decision-making, errors have been seen with trained and competent staff as well (Mistry et al. 2019). It is imperative and timely to review the content, delivery and assessment of transfusion education to all healthcare professionals.

Transfusion is an aspect of patient care which can occur within any discipline in the hospital. Hospital transfusion teams should escalate the findings from Annual SHOT Reports to medical directors and corporate governance teams to ensure transfusion safety is improved throughout the patient journey and that learning opportunities from serious adverse events and serious adverse reactions are not missed. It is crucial that all staff involved in transfusion are trained in relevant transfusion policies and procedures, but this alone does not suffice. As this training may no longer be classed as 'mandatory' by many Trusts and Health Boards, difficulties may occur in capturing all required staff groups. It is recommended that transfusion training and competency-assessment is included as a core component of hospital induction.

All staff in the NHS must be familiar with human factors and ergonomics (HFE) concepts. This was a key SHOT recommendation in last year's Annual SHOT Report. However, in order to truly improve transfusion and overall patient safety, HFE principles need to be integrated into all healthcare systems. Non-technical skills (NTS) such as interpersonal skills which include communication, leadership, teamwork, decision-making and situation-awareness skills need to also be embedded within staff. While technical skills help staff to get the job done e.g. the technical skill or know-how to operate a machine or conduct a certain operation, NTS enumerated above complement these technical skills and, when applied well, are invaluable in maintaining system safety and ensuring efficient and effective operations (Flin et al. 2008 and Gordon et al. 2012).

Clinical and laboratory transfusion staff must be given training in patient safety principles and quality improvement approaches including how to investigate incidents. Those investigating high level incidents occurring in complex systems need to be aware of and apply systems thinking principles. This will enable them to identify all contributing factors and map them from a systems perspective to bring about a system-wide change. Systems thinking provides a holistic investigative approach which considers a broad range of factors which lead to safety incidents (Canham et al. 2018).

Cognitive biases are short cuts used to aid our decision-making and are increasingly recognised to contribute significantly to errors in healthcare. The causes of bias are varied, and include learned or innate biases, social and cultural biases, a lack of appreciation for statistics and mathematical rationality, and even simply environmental stimuli competing for one's attention. Several types of bias have been identified which may exist in different healthcare scenarios. Staff need to be aware of the potential for such bias, and be trained to recognise, and if possible, prevent through simple interventions such as formally 'slowing down', checklists and 'metacognition' (considering alternatives). Such strategies may help mitigate the effect of cognitive bias in healthcare and help make systems safer (O'Sullivan 2018).

Technology-enhanced learning aligned to adult learning principles will help better staff engagement and retention of key messages. Multidisciplinary learning with interprofessional education leads to better collaborative working, better teamwork between health professionals, improves patient/donor outcomes and helps overcome any perceived barriers that can hinder communication (McPherson 2001).

Main recommendation 2

- Clinical and laboratory staff should be trained in fundamentals of transfusion, human factors, cognitive biases, investigating incidents and patient safety principles. Such a holistic approach will ensure safe, high-quality, patient-centred care and help embed an organisation-wide culture of learning from patient safety incidents

Action: National Blood Transfusion Committee (or the equivalent for the devolved countries), hospital transfusion teams and all teams involved in educating staff

Holistic approach to improving patient safety

The approach to patient safety has been conceptualised as two models: Safety-I and Safety-II. Safety-I refers to traditional or current approaches to safety management. It includes practices such as incident reporting, investigations, root cause analysis, guidelines and targets and is predicated on a 'find and fix' model. Most Safety-I practices are reactive – they are designed to retrospectively identify what went wrong after harm has occurred and are limited by ability to recall, inadequate reporting and hindsight bias affecting how the event is judged. Solutions often involve individual or team training or warnings and sanctions against individuals. Compliance with targets and procedures is also a feature of a Safety-I approach.

Safety-II seeks to understand the ability of staff in healthcare to adapt to problems and pressures. It is based on the view that healthcare is a complex adaptive system that is constantly changing in unexpected and unpredictable ways. The linear approach of Safety-I, which involves tracing causes of events and mapping out steps in procedures, does not consider the dynamic and flexible nature of healthcare practices. In a complex adaptive system, it is the humans who make things work by problem solving and adapting to the pressures in their environment. This is termed resilience as it refers to the capacity to bounce back from problems and pressures safely. Safety-II is a proactive approach that seeks to strengthen ability of staff to prevent problems before they occur and ensure high quality care even when there are pressures and competing demands.

Both Safety-I and Safety-II approaches are needed to build safer systems (Hollnagel 2015 and Braithwaite 2018). Safety-II does not replace Safety-I, instead both approaches complement each other. Resilience of any organisation is thought to involve four capacities: the ability to respond safely to problems as they occur, the ability to learn from experience and share that experience, the ability to monitor how things are going so that the need to respond can be identified as soon as possible, and the ability to anticipate future needs. The first step in trying to improve safety is to understand how well one's organisation or team is doing on these four capabilities and how they could be strengthened. Proactively and simultaneously seeking signals for improvement from unsafe, suboptimal and excellent care helps understand and build safer systems.

Main recommendation 3

- All healthcare organisations should incorporate the principles of both Safety-I and Safety-II approaches to improve patient care and safety. Healthcare leaders should proactively seek signals for improvement from unsafe, suboptimal as well as excellent care

Action: Hospital chief executives and medical directors, National Blood Transfusion Committee (or the equivalent for the devolved countries), hospital transfusion teams

Bringing everything together: making system wide changes

Transfusion error reports received are seldom due to recklessness on the part of healthcare professionals or due to lack of trying hard enough. More commonly, errors are caused by faulty systems, processes, and conditions that lead people to make mistakes. The key to eradicating transfusion errors and advancing patient safety is to create systems for reliable healthcare delivery.

Systems-based strategies with a collaborative effort by everyone from board to ward in healthcare are needed urgently to reduce, if not eliminate, medical errors and bring about sustainable and tangible improvements in patient safety.

The World Health Organization's (WHO) 'Building Blocks' framework (WHO 2007) highlighted that a health system, like any other system, is a set of inter-connected parts that have to function together to be effective and in order to improve services, all inter-linked aspects of this system will need to be strengthened. According to this framework (see Figure 4.3), six building blocks constitute a health system. These are the six essential functions of the health system. Each building block needs to be strong to achieve the overall goals. Intermediate goals are access, coverage, quality and safety.

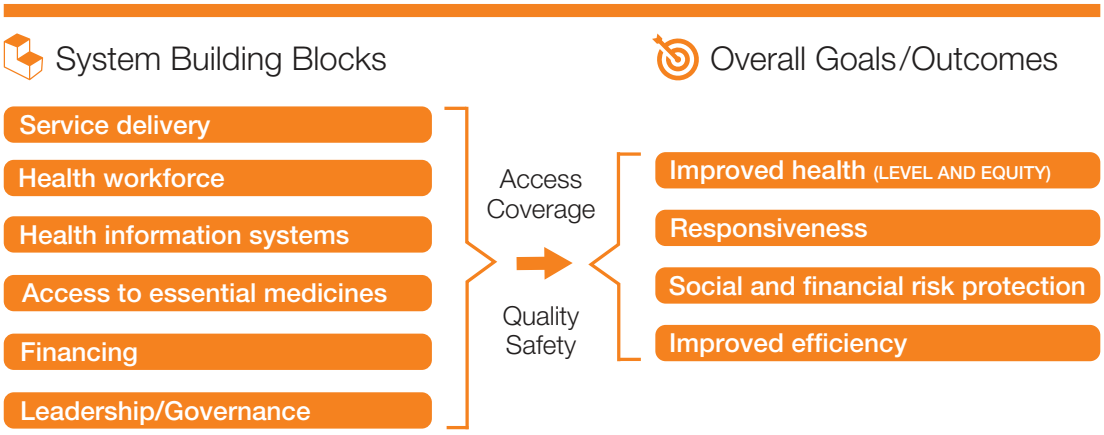

Figure 4.3: The WHO health system framework

Main recommendation 4

- Healthcare management must recognise that safety and outcomes are multifaceted, a linear view of safety does not fully acknowledge the interdependencies of resources including their leadership, adequate staffing and knowledge. Healthcare leaders should ensure these are all in place to improve patient safety

Action: Hospital chief executives

In order to acknowledge how the building blocks were interconnected and interacted with each other, and to emphasise the fact that patients (consumers) and communities are at the centre of the health system, in 2009, WHO published an adapted version of the building blocks framework in a seminal publication on systems thinking (De Savigny 2009). This placed 'people' at the centre and showed the interconnectedness of the different blocks.

There are several frameworks highlighting the interdependency to bring about sustained improvements in patient safety. WHO's six building blocks illustrate clearly that improvements must be multifaceted. Focussing on healthcare professionals, without an awareness of what influences peoples' behaviours, is unlikely to produce sustained, tangible improvements (WHO 2010).

It is time to have a holistic approach towards achieving safer transfusions. Let's rethink strategy, consider the people involved, address their behaviours, attitudes, relationships and culture; ensure resources are in place, including adequate financial support with a well-trained, well-informed, resilient and competent workforce. Using technology to automate processes and reduce human intervention is vital. Clinical

and laboratory practices need to be evidence-based with robust governance processes and a safety culture that promotes learning from experience including instances of unsafe, suboptimal and excellent care. The long term aims of an incident reporting system, such as SHOT, are to help reduce incidents that result in harm while moving towards increased reporting of near miss events for future learning. Facilitating system-wide changes is a step in the right direction.

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Acknowledging Continuing Excellence (ACE) in Transfusion

5

Authors: Shruthi Narayan, Courtney Spinks, Debbi Poles, Emma Milser, Simon Carter-Graham, Victoria Tuckley and Fahim Ahmed

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Abbreviations used in this chapter

ACE	Acknowledging continuing excellence	**NHS**	National Health Service
IV	Intravenous	**TAGvHD**	Transfusion-associated graft-versus-host disease
IVIg	IV immunoglobulin	**UK**	United Kingdom
MH	Massive haemorrhage		

Introduction

Starting this year, the ACE SHOT chapter will be included in the Annual SHOT Report to acknowledge excellent practices in transfusion. Identifying examples of excellence in the Annual SHOT Report will provide new opportunities for learning, improving resilience and staff morale, contributing to a holistic approach to patient safety.

Recommendation

- All National Health Service (NHS) organisations should embrace a Safety-II approach as a complement to Safety-I. It is necessary to analyse where and when things go wrong, whilst proactively seeking to promote good practice by celebrating when things go right and developing ways to support, augment and encourage this

Action: All NHS Trusts/Health Boards

Safety culture

Fostering a strong and effective safety culture is vital to reducing transfusion incidents and errors, thereby directly improving patient safety. The safety culture of an organisation is a combination of individual and group values, attitudes, perceptions, competencies and patterns of behaviours that determine the commitment to, and the style and proficiency of, an organisation's health and safety management. Strong, collective, empathetic and authentic leadership is critical in safety culture. Organisations with a positive safety culture are characterised by communications founded on mutual trust, shared perceptions of importance of safety and by confidence of the efficacy of preventive measures (Stavrianopoulos 2012).

Five critical elements have been identified for an engaged organisation with a good safety culture (Haddon-Cave 2009):

- **Reporting culture:** an organisational climate where people readily report problems, errors and near misses
- **Just culture:** an atmosphere of trust where people are encouraged and even rewarded for providing safety-related information; and it is clear to everyone what is acceptable and unacceptable behaviour
- **Flexible culture:** a culture that can adapt to changing circumstances and demands while maintaining its focus on safety
- **Learning culture:** the willingness and competence to draw the right conclusions from its safety information and the will to implement major safety reforms
- **Questioning culture:** It is vital to ask, 'What if?' and 'Why?' questions. Questions are the antidote to assumptions, which so often incubate mistakes

Annual SHOT Reports have continually shown a good, strong reporting culture in the United Kingdom (UK). The participation data is heartening and an increasing number of reports and near misses have been submitted to SHOT year on year. However, as noted in Chapter 2, Participation in United Kingdom (UK) Haemovigilance, areas of under-reporting have been recognised and are possibly due to staff shortage and inadequate resources which needs to be addressed and investigated further.

A just culture ensures balanced accountability for both individuals and the organisation responsible for designing and improving systems in the workplace. NHS Improvement's 'A just culture guide' provides a powerful tool to help promote cultural change in organisations or teams where a blame culture is still prevalent (NHSI 2018). Such a culture helps empower employees to proactively monitor practices in the workplace and ensure safety. Risk reduction will be achieved by focusing on human behaviours and redesigning systems. One of the 2018 key SHOT recommendations was that all NHS organisations must move away from a blame culture and towards a just and learning culture. While there are still instances of punitive blame culture, there is increasing awareness and adoption of just culture in healthcare organisations in the UK.

Some reported cases are withdrawn each year, as upon expert review, it was agreed that in all such situations the clinical/laboratory teams have consciously made transfusion decisions taking into account the overall clinical picture of the patient and assessing risks and benefits (as per the 2018 key SHOT recommendation). In such cases, there may have been an increased risk or anticipated side effect of the transfusion but the intended benefit from transfusion is deemed to justify the risk of harm and its possible severity. A couple of examples are recounted here:

Example 1: A patient was admitted with acute upper gastrointestinal bleed to the emergency department. The major haemorrhage protocol was appropriately activated, and the patient received two units of non-irradiated components. Medical staff were aware that the patient had specific requirements but could not wait for the irradiated components to come from the Blood Service. The patient was potentially at risk of transfusion-associated graft-versus-host disease (TAGvHD) due to previous fludarabine exposure. Risk of death from massive haemorrhage is often greater than the risk of TAGvHD. Clinicians also need to be aware that irradiated red cells have higher potassium levels, and a shorter shelf life. Transfusing all irradiated units in massive haemorrhage (MH) has been reported to be associated with risk of hyperkalaemia and death in some susceptible patients, including infants.

Example 2: A patient with obstetric bleeding and anti-Fy^{a} antibodies was given emergency O D-negative red cells. It is important to remember that in cases of massive haemorrhage, every minute counts and emergency transfusion saves lives. In a genuine emergency, if further delays risk patient harm, group O D-negative blood (consider O D-positive in males and females >50 years) should be given until alternative blood can be given safely. In MH, where the antibody screen is positive or the patient has known antibodies for which compatible blood is not readily available, ABO and RhD compatible, serologically least incompatible blood should be transfused with extra caution with intravenous (IV) methylprednisolone 1g +/or IV immunoglobulin (IVIg) cover if required. This decision should be made

on the balance of risk of severe haemorrhage (anaemia, urgent requirement), versus a haemolytic transfusion reaction with potential complications including renal failure. If time/stocks allow, choose ABO compatible, full Rh and K compatible blood. In 80% of patients, antibodies are within the Rh & K systems. Discuss the need for methylprednisolone +/or IVIg with a clinical haematologist. Monitor patients (including urine output) for delayed haemolytic transfusion reactions, in light of alloantibodies and any incompatible blood transfused. For further information see SHOT Bite No 8. Massive Haemorrhage - Delays (available on the SHOT website https://www.shotuk.org/resources/current-resources/shot-bites/) and NHSBT guidelines for the management of urgent red cell transfusion and situations when serological compatibility cannot be assured (NHSBT 2019).

Incident investigations continue to be an area of concern and can often lack scope, depth and detail. Actions generally identified continue to target individuals and are therefore less impactful. Opportunities to address systemic/organisational factors are regularly missed with suboptimal attempts to identify trends and corrective and preventative actions. Investigations must be systematic, comprehensive, and efficient with appropriate allocation of resources. It is equally important to share lessons learnt with other healthcare professionals. Ensuring that the right questions are asked, making each experience count and making the messages/lessons stick will help address the implementation gap and truly improve patient safety in transfusion.

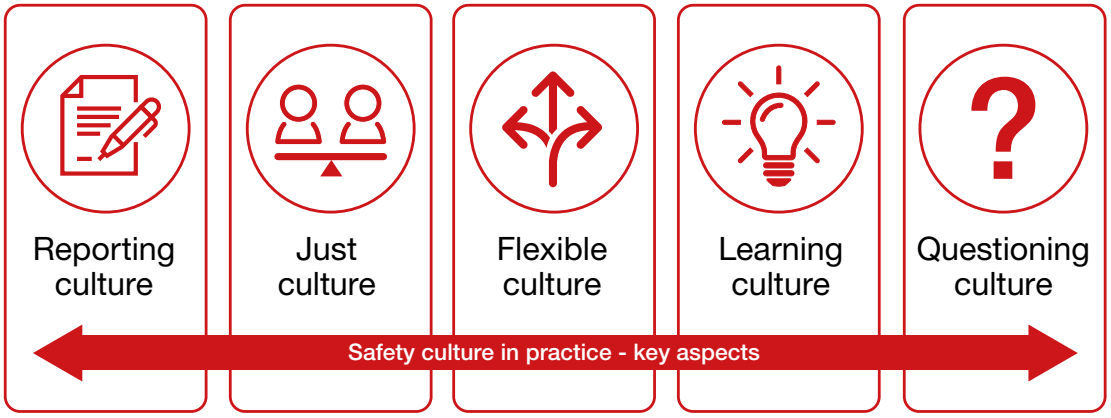


Figure 5.1: Critical elements of a safety culture

Safety-I and Safety-II approaches

Patient safety incident reporting and learning systems, the traditional Safety-I approach, where systemic improvements are instituted by primarily focussing on when things go wrong, play a crucial role in making healthcare safer. Healthcare leaders, and their organisations, must be responsible for developing robust mechanisms to ensure patient safety incident reporting systems capture essential information that can inform improvement efforts, be systematically interrogated and used to redesign care processes.

Safety-II is a proactive approach looking at safe episodes of care to inform improvement in healthcare systems (Hollnagel 2015). While understanding errors is critical, it is also important to understand and appreciate how frontline staff handle dynamic situations throughout the day, constantly adapting, and getting so much right so that we can begin to identify the factors and conditions that underpin the success. This helps to optimise organisational learning and significantly improve patient safety further and has formed the basis for Safety-II thinking. In Safety-II, organisational learning in healthcare is based on a deeper understanding of the adaptations healthcare workers make in their everyday clinical work, and that learning and improvement should be more democratic by promoting participation and ownership among a broader range of stakeholders as well as patients.

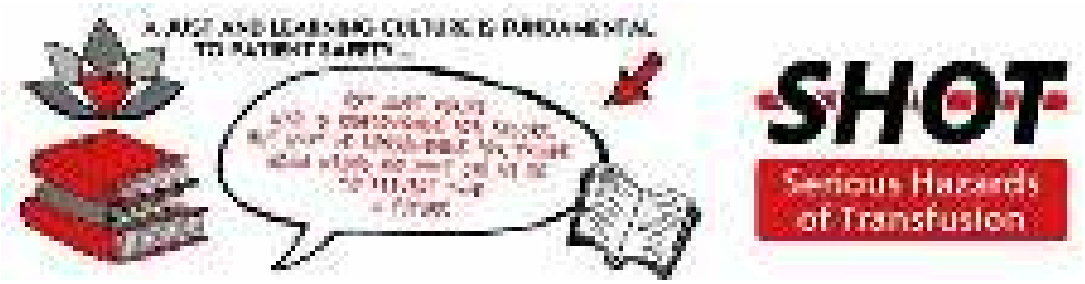
It is important, to recognise that Safety-II isn't about looking only at success or the positive. Safety-II is about all possible outcomes: involving normal, everyday, routine performance; exceptionally good performance, near-misses, accidents and disasters. Our traditional approach, Safety-I, has largely limited itself to the latter – the accidents (actual or potential). Safety-II is about the whole distribution, and its profile. We normally ignore 'normal performance'. To improve system performance, we need to focus more on normal performance and frequent events, which are easier to change and manage.

Table 5.1: Overview of Safety-I and Safety-II (Hollnagel 2015)

	Safety-I	Safety-II
Definition of safety	That as few things as possible go wrong	That as many things as possible go right
Safety management principle	Reactive, respond when something happens or is categorised as an unacceptable risk	Proactive, continuously trying to anticipate developments and events
View of the human factor in safety management	Humans are predominantly seen as a liability or hazard. They are a problem to be fixed	Humans are seen as a resource necessary for system flexibility and resilience. They provide flexible solutions to many potential problems
Accident investigation	Accidents are caused by failures and malfunctions. The purpose of an investigation is to identify the causes	Things basically happen in the same way, regardless of the outcome. The purpose of an investigation is to understand how things usually go right as a basis for explaining how things occasionally go wrong
Risk assessment	Accidents are caused by failures and malfunctions. The purpose of an investigation is to identify causes and contributory factors	To understand the conditions where performance variability can become difficult or impossible to monitor and control

Please see Figure 7.4 in Chapter 7, Human Factors in SHOT Error Incidents

Combining Safety-I and Safety-II approaches will help provide a more holistic understanding of the underlying reasons for errors and procedural violations and will help identify aspects of practice that could benefit from targeted interventions to help support staff in providing safe patient care (Braithwaite et al. 2015). Leaders should proactively and simultaneously seek signals for improvement from unsafe, suboptimal and excellent care (Learning from Excellence n.d.). It is important to turn healthcare into a constantly learning system, with everyone involved attuned to systems features and with strong feedback mechanisms to try to build momentum for change (Braithwaite 2018). Such an approach will help build resilience in the system.



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Donor Haemovigilance

6

Authors: Dr Stuart Blackmore, Consultant Donor Medicine, Welsh Blood Service (WBS) and Sue Mackinnon, Lead Quality and Governance Nurse, WBS

With contributions from:

Dr Shruthi Narayan, SHOT Medical Director and Consultant in Donor Medicine, National Health Service Blood and Transplant (NHSBT)

Philip Carter-Graham, Senior Nurse Practitioner, Clinical Support Team, NHSBT

Dr Jayne Hughes, Specialty Doctor, Scottish National Blood Transfusion Service (SNBTS)

Dr Angus Wells, Clinical Director Donors and Manufacturing, SNBTS (till end December 2019)

Dr Kathryn Maguire, Consultant in Transfusion Medicine, Northern Ireland Blood Transfusion Service (NIBTS)

Definitions:

Donor haemovigilance is the systematic monitoring of adverse reactions and incidents in the whole chain of blood donor care, with a view to improving quality and safety for blood donors.

Serious adverse reaction:

An unintended response in donor or in patient associated with the collection or transfusion of blood or blood components that is fatal, life threatening, disabling, incapacitating, or which results in, or prolongs, hospitalisation or morbidity (according to Article 3 (h) of Directive 2002/98/EC).

Key messages

- The overall incidence of serious adverse event of donation (SAED) remains low. The rate of SAED for 2019 was 0.23 per 10,000 donations
- Vasovagal events resulting in donor hospitalisation or injury along with arm problems in blood donors persisting for more than 12 months post venepuncture continue to be the most frequently reported SAED
- Improving donor experience with measures to reduce risk of complications related to blood donation along with prompt recognition and management of complications is vital

Abbreviations used in this chapter

BSQR	Blood Safety and Quality Regulations
DAE	Donor adverse events
DIL	Donor Information Leaflet
EU	European Union
ISBT	International Society of Blood Transfusion
NHSBT	National Health Service Blood and Transplant
NIBTS	Northern Ireland Blood Transfusion Service
SAED	Serious adverse event of donation
SNBTS	Scottish National Blood Transfusion Service
VVR	Vasovagal reaction
WBS	Welsh Blood Service

Recommendation

- Blood Services must take reasonable care to ensure that the blood donors are aware of any 'material risks' involved in donating blood

Action: All staff involved in care and management of blood donors

Introduction

The four UK Blood Services rely on blood donations given by voluntary blood donors gifting their time and donations altruistically. This ensures a sustainable blood supply for patients. Blood donation is usually an uneventful experience for most donors, but as with any clinical intervention, there are risks associated with blood donation. These are usually minor adverse events but, on occasion, may potentially have lifelong consequences for the donor. The overall incidence of the SAED for the UK Blood Services for January to December 2019 was 0.23 per 10,000 donations. This is low and has remained relatively static for 4 years.

Donor consent process in the UK Blood Services

The UK Blood Services have a duty of care to ensure all donors' donation journeys are as inconvenience free as possible. An essential part is ensuring donors are fully informed about the donation process, donation testing, donation use and the potential side effects of donation. Montgomery vs Lanarkshire 2015 (Chan et al. 2017) was a landmark legal case that changed the patient consent process fundamentally and specifically focussed on individualising the informed consent process. Donors are managed as a population and donor risk assessments are usually made using data generated from populations rather than individuals. It is therefore easy to apply similar criteria when consenting blood donors. It is imperative that the Blood Services consent donors in a way that aims to comply with Montgomery's principles as far as possible. Blood donors complete a health and lifestyle questionnaire prior to donating and this aims to screen out any donors with medical conditions that could be affected adversely by donating. Similarly, potential donors with medical conditions that would adversely affect any recipient of their blood component are screened out. This goes some way to individualising the consent process, but it is imperative that donors deemed medically fit to donate are informed of the possible adverse consequences of donation and consented in a way that complies as closely as possible with Montgomery's principles.

The WBS aims to achieve this by:

- Ensuring the 'Before You Donate' booklet is up to date. This document details the donation process, the tests performed on donations, how donations are used and the possible adverse consequences of donating blood or platelets (including incidences of donation related adverse events)
- Giving donors the opportunity to read all the information contained in the 'Before You Donate' booklet prior to attending a donation clinic. Donors at WBS are sent a link to the Blood Service website that details this information with the text or e-mail they are sent reminding them of their donation appointment. Donors will thus be familiar with the document content when arriving on donation clinic and not only read this information just prior to donating
- Having nominated 'Consent Champions' on every WBS donation clinic who deal with any consent queries and target first time donors to ensure they understand all the donation processes and possible consequences, thus individualising the consent process further
- Donors sign a consent form at the donation clinic confirming they have read and understood all the contents of the 'Before You Donate' booklet and had any queries answered

NIBTS has a specific leaflet entitled 'Risks of Blood Donation' which is provided to each donor when they present for donation. Donors are given time to read this (which contains up to date figures of the rate of adverse events in the UK), and they sign the consent section of the health check questionnaire indicating that they understand the nature of the donation process and the possible risks involved as set out in the leaflet. Documentation posted out to donors in advance of donation contains a link to the

NIBTS website which sets out the donation process (in writing and by short video) and again states the risks involved.

At NHSBT, donors are provided with the 'Welcome booklet' prior to their blood donation. This printed booklet is provided to each donor when they present for donation, either whole blood or component donation by apheresis and provides an overview about the donation process, tests performed on donations, information regarding risks and potential complications and how the donation and donor information is used. Donors are given time to read this (which contains up to date figures of the rate of adverse events at NHSBT) and get a chance to discuss with staff if they have any concerns or additional queries. They sign the consent section of the health check questionnaire indicating that they have understood the information provided and have had the chance to discuss this. This information is available and easily accessible online from the website https://www.blood.co.uk/the-donation-process/what-happens-on-the-day/ which donors access as well.

In SNBTS, all donors are asked to read the Donor Information Leaflet (DIL) before they give blood. The DIL includes information on the blood donation process, blood safety, microbiological testing, use of blood, and the nature and rate of donor adverse events (DAE). Figures included in the DIL are based on recent DAE rates recorded by SNBTS. During health screening, staff check that the donor has had an opportunity to read the DIL and discuss any questions or concerns the donor raises. Finally, before donation, the donor is asked to sign the 'Donor Declaration' on the session record. This includes a statement that they have read and understood the DIL. The DIL and further information about blood donation is also available on the Scotblood website.

All blood donors must be made aware of any 'material risks' involved in donating blood. A 'material risk' is one in which 'a reasonable person in the donor's position would be likely to attach significance to the risk, or the healthcare professional is or should reasonably be aware that the particular donor would be likely to attach significance to it' (BMA 2019 and Agnew 2015).

Serious adverse events of donation

The UK Blood Services have implemented the 'Standard for Surveillance of Complications Related to Blood Donation' issued by the International Society of Blood Transfusion (ISBT) (Goldman et al. 2016). The adverse events of donation can be divided into those that are **generalised** and affect the donor's body and those that are **localised** affecting the donor's arm. Presyncopal vasovagal reactions and bruises/haematomas are the most frequently observed adverse events in each category (Gavillet et al. 2013).

The current European Blood Directives, issued and enforced between 2003 and 2005 (2002/98/EC and 2005/61/EC), provide the regulatory bases of haemovigilance requirements for traceability and notification of serious adverse reactions and events (European Union (EU) Directives). The EU Directives were transposed into UK law through the Blood Safety and Quality Regulations (BSQR) 2005. These regulations ensure that all transfusion services have a system for receiving and registering reports of serious adverse reactions and serious adverse events related to quality and/or safety of blood or components for transfusion. SAED have been included in the donor haemovigliance chapter as part of the Annual Report from the SHOT UK haemovigilance scheme and are categorised in Table 6.2. This year category 5 (Problems relating to needle insertion persisting for more than one year) has been divided into two subcategories based on the main cause identified for the donor's arm problems.

Assigning severity and imputability (the strength of relation between donation and complication) can be difficult, especially when information is incomplete, and some terms, such as long-term pain and/or disability, are subjective. There are currently no uniformly agreed objective criteria to separate levels of severity or imputability and there is considerable variation in how this is recorded (Land et al. 2018).

Recording imputability for donor events in the UK, whilst not a mandatory requirement under BSQR, is assessed and recorded for every SAED as follows:

3. Definite or certain link to donation

2. Probable or likely link to donation

1. Possible link to donation

0a. Link to donation unlikely

0b. Link to donation excluded

It is clear, on occasion that the reported post-donation complication is unrelated or very unlikely to be related to the donation event itself. For example, a donor developing a complication relating to diverticulitis requiring admission within 24 hours of giving a donation. Hence the risk of SAED in the UK has been calculated using all reported cases in the first instance and in addition, risk after excluding those that are clearly not related to donation, see Table 6.3.

Data

A total of 1,841,660 whole blood and component donations were collected by the 4 UK Blood Services in 2019. This is summarised in the Table 6.1 below:

Table 6.1: Cumulative donation data from the 4 UK Blood Services for the period January to December 2019

Donations from 2019		NHSBT	SNBTS	NIBTS	WBS
Whole blood	Donations from male donors	708,740	66,196	22,516	44,781
	Donations from female donors	767,660	79,506	20,851	48,038
	Donations from new donors	138,134	12,512	5,168	9,137
	Donations from repeat donors	1,338,266	133,190	38,199	83,682
Apheresis	Donations from male donors	62,593	6,413	4,444	2,312
	Donations from female donors	6,315	407	523	365
	Donations from new donors	9,139	0	40	81
	Donations from repeat donors	59,769	6,820	4,927	2,596
Total number of donations in 2019		**1,545,308**	**152,522**	**48,334**	**95,496**

Table 6.2 summarises the number of SAED by category for all 4 UK Blood Services combined for the period January to December 2019. There was 1 death reported of a whole blood donor in his 50s who died unexpectedly 2 days post donation. The cause of death was reported as bilateral pulmonary embolism which was unrelated to blood donation. The donor had been well and reported no ongoing issues at time of his donation.

Table 6.2: SAED by category in 2019

SAED category	Total Number
01. Death within 7 days of donation	1
02. Hospital admission within 24 hours of donation	11
03. Injury resulting in a fracture within 24 hours of donation (including fractured teeth)	9
04. Road traffic collision (RTC) within 24 hours of donation	0
05a. Problems relating to needle insertion persisting for more than one year (this mainly includes suspected or confirmed nerve and tendon injuries)	18
05b. Problems relating to needle insertion requiring hospitalisation/intervention (this mainly includes vascular complications)	3
06. Acute coronary syndrome (ACS) diagnosed within 24 hours of donation	0
07. Anaphylaxis	0
08. Haemolysis	0
09. Air embolism	0
10. Other event	0
Total reported SAED in 2019	**42**

Table 6.3 details the total number of whole blood and component donations and the total number of SAED reported for each of the 4 UK Blood Services for 2019. This equates to 0.23 SAED per 10,000 donations or 1 SAED per 43,849 donations, similar to the previous 4 years. Table 6.3 also gives a summary of total number of SAED excluding imputability scores of 0a, 0b for 2019. This equates to 0.19 per 10,000 donations or 1 SAED per 52,619 donations.

	NHSBT	SNBTS	NIBTS	WBS
Whole blood donations	1,476,400	145,702	43,367	92,819
Apheresis/component donations	68,908	6,820	4,967	2,677
Total donations	**1,545,308**	**152,522**	**48,334**	**95,496**
Total number of SAED in the calendar year 2019	35	5	0	2
Rate of total SAED per 10,000 donations in UK for 2019 (all submitted reports irrespective of imputability)			0.23	
Total number of SAED excluding those cases unlikely or not related to blood donation	28	5	0	2
Rate of SAED per 10,000 donations in UK for 2019 excluding those cases unlikely or not related to donation			0.19	

Table 6.3: Summary of total donations for the 4 UK Blood Services and total numbers of SAED for 2019

Comparison with previous years

The four UK Blood Services have produced an annual summary report to SHOT of SAED recorded since 2015. The 2019 figures are similar to the previous 4 years.

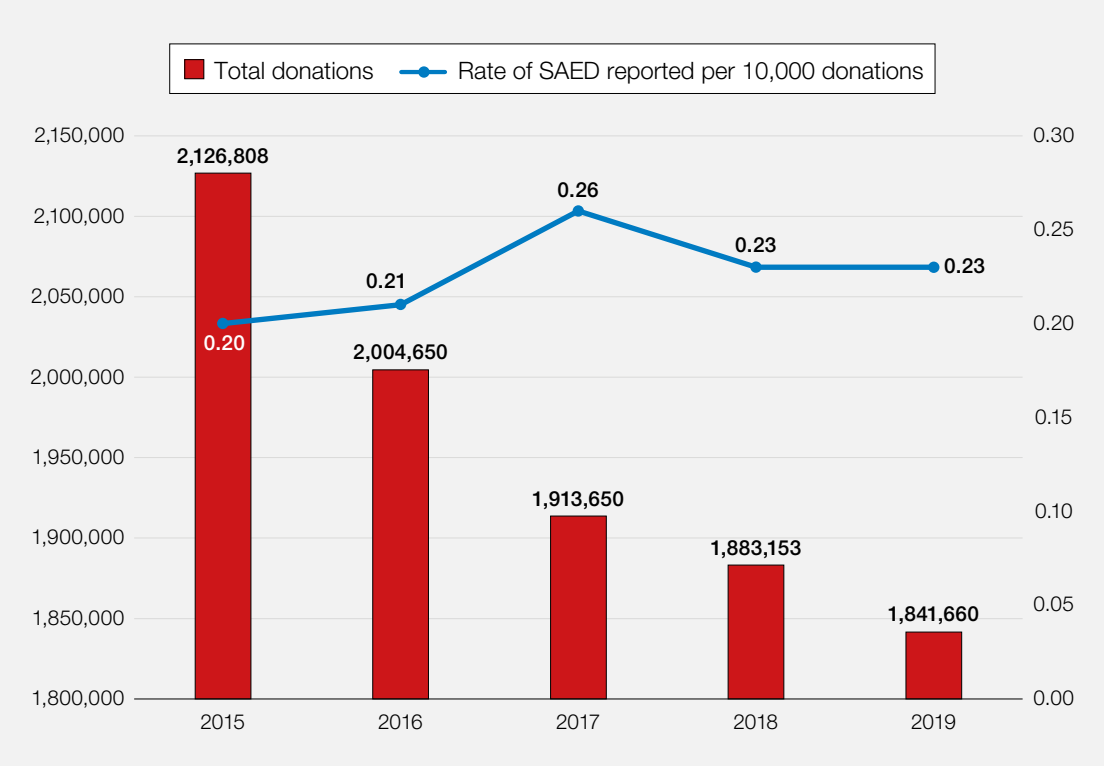
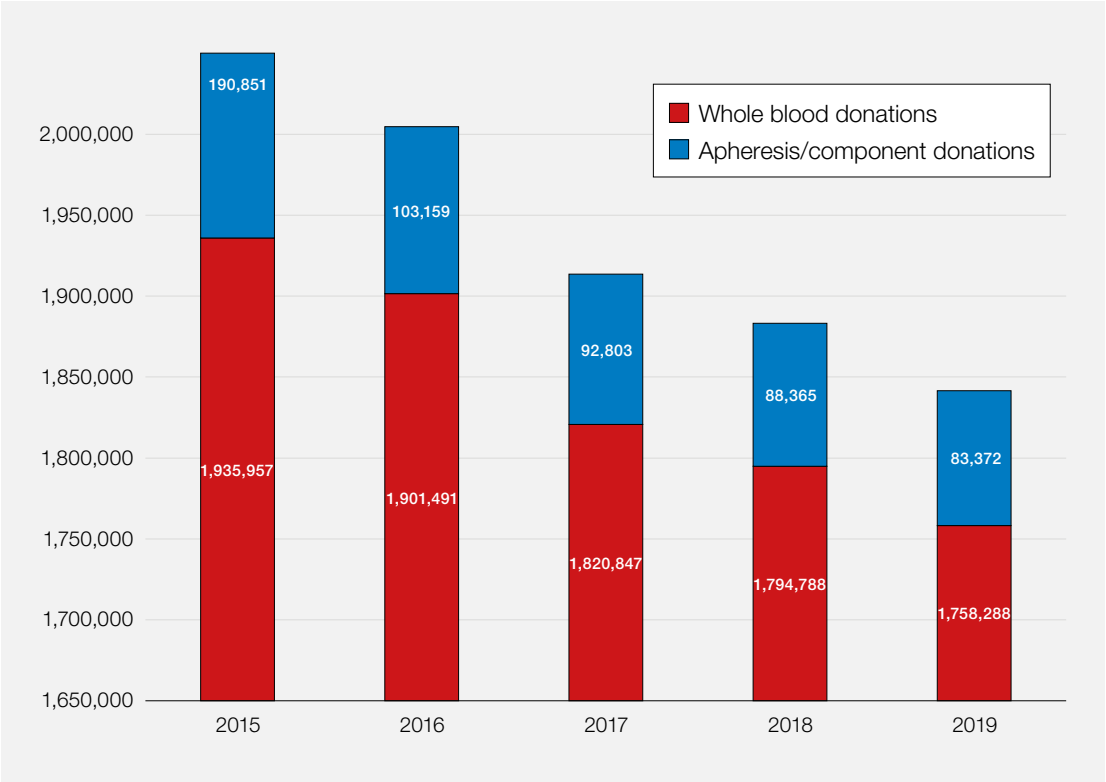


Figure 6.1: Rate of SAED reported per 10,000 donations in the UK from 2015-2019

Figure 6.2: Trend in number of donations collected in UK Blood Services 2015-2019



Illustrative case examples of SAED

Case 6.1: Development of a venous aneurysm/varix in the right cubital fossa - the site of repeated venepuncture for blood donation

A regular female donor in her 50s, contacted the WBS as she had developed an unexpected complication in her right arm. Her treating surgeon thought it was donation related. She last donated in January 2014, which she described as an uneventful donation. She however developed a lump at the venepuncture site several weeks post donation that slowly enlarged and pulsated on occasion. She saw her general practitioner, who initially prescribed symptomatic treatment but was referred to a vascular surgeon in January 2019 as the swelling was slowly enlarging. Of note is that this donor had no relevant past medical history, notably no history of a collagen vascular disorder.

Ultrasound showed that the swelling communicated with adjacent veins. She had the swelling surgically excised. At surgery it arose from the median cubital vein and contained thrombus. It was dissected clear of surrounding tissues, the feeding median cubital vein was ligated and divided proximally and distally and the swelling was removed. The surgeon's diagnosis was that of a venous aneurysm/varix at the site of repeated venepuncture for blood donation. At surgery, there was no association with the artery and thus the surgeon did not feel that she had developed an arteriovenous fistula at the time of venepuncture for blood donation.

This complication of blood donation is very rare. It is the first time that it has been described for SHOT. It is not mentioned in the standard definitions of donor adverse events developed by the ISBT Haemovigilance Working Party (Goldman et al. 2016), nor has it been found in a literature search.

How did this complication develop after an uneventful donation? A potential explanation is that at the time of venepuncture the needle damaged a venous valve, rendering it incompetent. This would allow the back flow of blood and the gradual enlargement of the segment of affected vein. The swelling may have become inflamed at times (i.e. developed a phlebitis) giving the donor the sensation of the swelling 'pulsating'. The swelling left untreated, would lead to the development of a varix or venous aneurysm as described by the donor's surgeon.

Case 6.2: Delayed faint in a regular whole blood donor resulting in ankle fracture

A regular female whole blood donor in her 60s who had donated over 25 times gave blood uneventfully. The donor's record had an instruction to give her extra rest after donation, following a delayed faint in 2017, so the donor remained at the donation session for 30 minutes. The donor felt light-headed whilst she was in a shop, so she left and went to a café for something to eat and drink. Whilst the donor was queueing to be served approximately 2 hours after her donation, she lost consciousness and fell to the floor. When the donor recovered, she attended a local ambulatory care centre where she was found to have a fracture to her left ankle. The donor has been withdrawn from blood donation.

A vasovagal reaction (VVR) is a general feeling of discomfort and weakness with anxiety, dizziness and nausea, which may progress to loss of consciousness. Syncope, or transient loss of consciousness, is the major cause of immediate morbidity of medical significance during blood donation and is the most severe of a spectrum of VVR, which range from mild pre-syncopal symptoms to severe reactions involving syncope. The overall prevalence of VVR in whole blood donors is estimated to be between 1.4 and 7% (moderate reactions) and between 0.1 and 0.5% (severe reactions) (Amrein et al. 2012). VVR have significant implications not only for the welfare of donors but also staff time and training, the management of donor sessions and perhaps more crucially on the retention of donors and security of the blood supply (France et al. 2004).

Both physiological and psychological factors may be important in VVR. The reaction is generated by the autonomic nervous system and further stimulated by psychological factors and the volume of blood removed, relative to the donor's total blood volume. VVR that occur after the donor has left the donation session are of concern, due to the potential for the donor to come to harm (Kamel et al. 2010). These are called delayed reactions and are a poorly understood complication of blood donation. They are thought to occur because of failure of the donor's normal compensatory reflexes to respond to the volume loss associated with donation. Occasional deaths have occurred because of accidents following delayed VVR. Inadequate fluid intake post donation, prolonged standing and high environmental temperature are recognised factors increasing the risk of a delayed VVR. Delayed reactions occur more frequently in female donors than male donors. Unlike immediate VVR, the risk of a delayed reaction is not significantly higher in first time and inexperienced donors compared to experienced and older donors. It is possible that experienced donors become less attentive about following advice to increase their fluid intake following donation, thereby increasing their risk of a delayed reaction.

Post-donation information must be provided to all donors. This should include the risk of delayed reactions and advice on prevention, in particular, on maintaining post-donation fluid intake, and avoidance of known precipitating factors such as overheating and prolonged standing. The mechanism for delayed VVR remains poorly understood. Understanding the physiological basis of such reactions may lead to the development of appropriate interventions to reduce their likelihood.

Case 6.3: Arterial puncture resulting in severe arm bruising in a regular whole blood donor

A regular female whole blood donor in her 40s who had donated several times previously, experienced pain on needle insertion. The donor did not inform staff of the discomfort that she experienced. The donation took around 4 minutes and no pain was experienced by the donor during the donation. The donor experienced pain on needle removal and was seen by a nurse who suspected an arterial puncture and was given care and advice. Later that day the donor's arm became painful and swollen, an ambulance was called, and she was taken to an emergency department. The donor was admitted overnight for observation due to severe bruising as a result of an arterial puncture. The donor was discharged the following morning. The donor has decided not to donate again.

Arterial puncture is a serious complication of donating blood with potentially long term, debilitating effects on the donor and necessitates timely recognition and appropriate management. The diagnosis of an arterial puncture is clinical and is based on a short collection time (≤3 minutes) or a combination of short collection time and bright red blood. Alternatively, the diagnosis could be based solely on a pulsating needle or pulsating tubing because the pulsation indicates that the needle is in the artery. A pulsating needle occurs in only about one-third of arterial puncture cases (Newman 2001).

Associated complications of arterial punctures include large bruises/haematomas and in severe cases compartment syndrome, arteriovenous fistula and brachial artery pseudoaneurysm with potentially long-term debilitating effects including permanent limb injury (Newman 2013). Because of the rapid blood flow, the risk of a large haematoma is increased and thereby risks of more serious pain and pressure syndromes listed above. Arterial punctures may also present as a needle falling out of the donor's arm. In the event of a needle falling out of an arm unless there is an obvious reason e.g. related to a needle manipulation it MUST be managed as an arterial puncture. As a precautionary measure to avoid vascular complications future donations will be taken from the other arm.

Conclusion

While blood donation is generally very safe, donor complications sometimes occur either during or after blood donation. Most of these are non-severe and resolve promptly but are still unpleasant for the donor. SAED occur infrequently and may result in long-term or permanent disability or injury to the donor. Preventing these adverse events must be a priority and when donor complications do occur, they should be managed promptly and appropriately. Continuing donor haemovigilance and embedding lessons learnt from surveillance helps improve quality and safety for all blood donors.

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Directive 2002/98/EC of the European Parliament and of the Council of 27 January 2003 setting standards of quality and safety for the collection, testing, processing, storage and distribution of human blood and blood components and amending Directive 2001/83/EC *OJ L 33, 8.2.2003*. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32002L0098 [accessed 08 June 2020].

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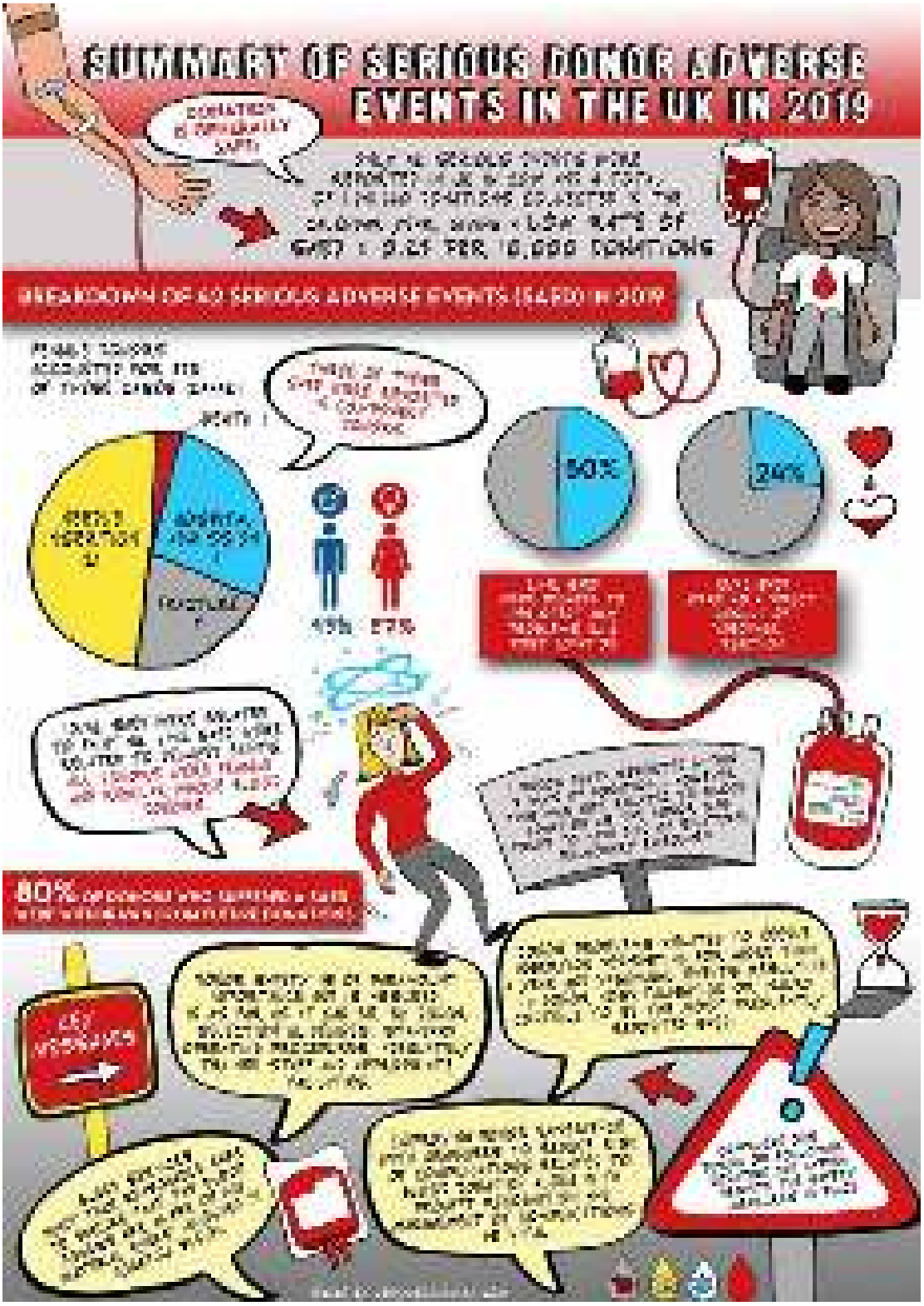


Figure 6.3: Summary of serious donor adverse events in the UK in 2019


SAFETY
LEARNING
LEARNING

ERROR REPORTS

7 Human Factors in SHOT Error Incidents n=2857

Author: Alison Watt

Key SHOT message

- To reduce the risk of attribution bias, incident investigators should analyse all evidence as impartially as possible. It may be advantageous for investigators to imagine themselves in the position of any key person being considered culpable for the adverse event and then consider what system and organisational factors could apply to the case
- The human factors questions from the SHOT database could be added to local incident documentation to encourage investigators to consider system and organisational factors when gathering data

Abbreviations used in this chapter

HF	Human factors	**IT**	Information technology
HFE	Human factors and ergonomics	**NCABT**	National Comparative Audit of Blood Transfusion
HFIT	Human factors investigation tool	**RCA**	Root cause analysis

Introduction

Human factors methodology has not always been applied rigorously to errors in healthcare, and there are concerns that some healthcare settings have a culture of blame and cover up rather than learning from errors. As part of a PhD research project (Watt 2020), SHOT has developed a human factors investigation tool (HFIT) for transfusion safety incidents, as detailed in the last three Annual SHOT Reports (Bolton-Maggs et al. 2017; 2018 and Narayan et al. 2019). HFIT results, including the 2019 analysis given below, indicate that safety investigators predominantly ascribe the root cause of an incident to errors by individuals, yet when respondents were asked what could be changed to avoid future errors 65.3% of responses proposed changes to organisational and systemic factors (Figure 7.1). This suggests that root cause analyses (RCA) still disproportionately blame individual members of staff for what are systems failures. SHOT has developed training resources to improve the value of RCA investigations and suggests that the HFIT questions could be added to local incident investigation documents, so human factors are considered while gathering information.

In the 2018 Annual SHOT Report (Narayan et al. 2019), one of the main recommendations was that all clinical and laboratory staff should be encouraged to become familiar with human factors and ergonomics (HFE) concepts and all healthcare organisations should consider employing a qualified HFE professional. An online survey was sent to all reporters to understand progress on implementing the 2018 key SHOT recommendations 6 months following their publication, which included questions relating to key recommendation 1 – moving away from a blame culture and towards a just and learning culture. It was encouraging that the majority of respondents perceived their organisation as never having had a blame culture and that the recommendations have influenced a positive change. The full results of the survey can be found on the SHOT website (https://www.shotuk.org/resources/shot-surveys/).

Attribution bias

Investigating incidents using a human factors approach is vital to understand what truly caused the incident, hence helping identify the appropriate corrective and preventative actions. It is also important to consider the human factors of incident investigations and how they can influence the quality and accuracy of investigations, and the ability for organisations to identify valid causal factors and remedial actions. To do this we will look at fundamental attribution error (Ross 1977).

Attribution bias is a type of cognitive bias and errors in cognition contribute to significant number of errors in healthcare. Essentially, cognitive biases are cognitive short cuts used to aid our decision-making. In social psychology, fundamental attribution error is a well-known bias that explains the way in which people tend to evaluate other people's behaviour. Fundamental attribution error suggests that people are likely to assume that the behaviour of another person is due to some internal trait of that person, for instance their personality, attitude or level of intelligence. This internal focus leads to a failure to recognise or underestimate external factors that have influenced behaviour. Interestingly, when a person is asked to reflect on their own behaviours, they often identify external factors that justify and explain their course of action. Fundamental attribution error is extremely relevant to incident investigations as it may negatively impact on an organisation's ability to learn; lead to flawed investigation conclusions; result in an incorrect use of 'just culture'; produce remedial actions that do not address underlying external causes; and waste valuable resources through poor allocation, for example investing time, money and resources into behavioural based safety programmes in a hope that this will result in 'good behaviour' while not adequately addressing the external driving factors that produce an undesired behavioural outcome.

From a cultural perspective fundamental attribution error may also have a negative impact on safety culture. If the workforce sees the organisation unfairly punishing individuals rather than dealing with broader external factors this could lead to a reduction in workforce engagement in safety programmes and so on.

Fundamental attribution error can be avoided by seeking to understand the behaviour in the context it occurs, staff training and increasing awareness of this error and other performance shaping factors. Performance shaping factors is a human factors term used to describe factors that increase the likelihood of human failure due to their influence on a person's behaviour. Raising the awareness of these factors with staff who conduct investigations and those responsible for agreeing remedial actions can ensure these factors are afforded the appropriate level of attention (O'Sullivan and Schofield 2018).

Analysis of the SHOT human factors investigation tool (HFIT)

Are HFIT scores disproportionately assigned to individual staff members?

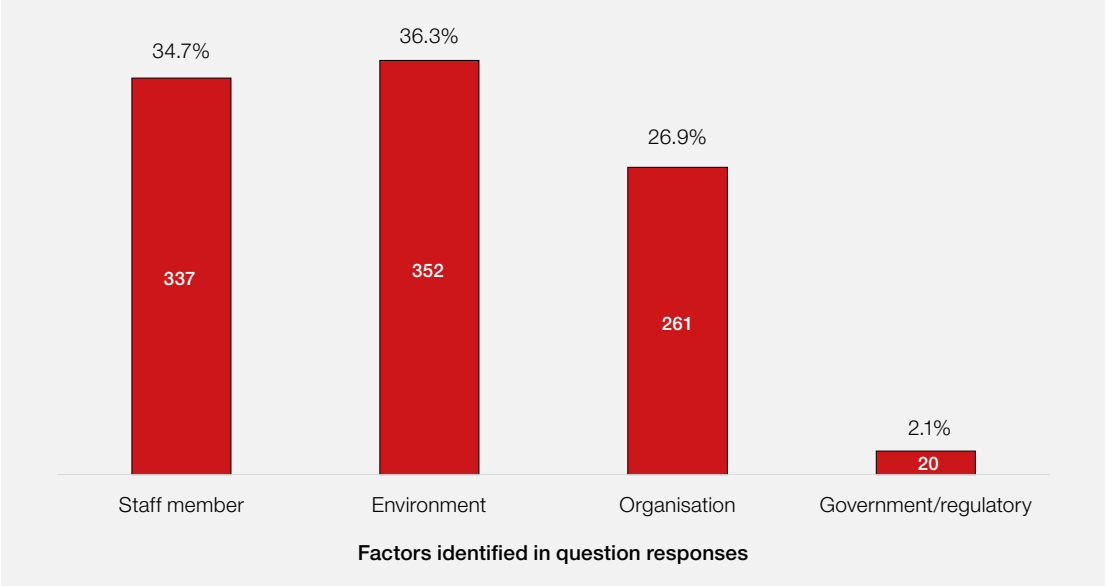
In 2019 689/2857 (24.1%) reports had a score of 10/10 for the contribution of the individual staff member(s). This is a questionably high percentage of maximum scores given to staff (Karl and Karl 2012), which means opportunities to consider system and organisational factors could be missed. In 201/689 (29.2%) cases where a maximum 10 score was assigned to the individual staff member(s) an answer was also given to a question about changing one thing to make this incident less likely to recur and 115/201 (57.2%) responses indicated a change could be made to organisational and system factors, i.e. less than half, (86/201, 42.8%) identified a staff-related item as the primary change required, despite scoring maximum for staff culpability (Case 7.1). Figure 7.1 shows an analysis of all the cases that had answers to the question 'If you could change one thing to make this incident less likely to happen again, what would it be?', 970/2857 (34.0%).

Case 7.1: Overemphasis on staff culpability when there were obvious system failures

Four separate samples were collected from one patient, by four different staff members and all were labelled with an incorrect hospital number rather than the patient's actual number from their wristband. This was classified as poor practice and the incident was given a score of 10/10 for unsafe practice by individual staff member(s) with no scores assigned to the system and organisational factors. However, the incident report identified the root cause was mismatched data between two different information technology (IT) systems. A suggestion for the primary change to make this

incident less likely to happen again was for IT systems that link up in real time to reduce multiple patient identities. The report concluded that since the introduction of new organisation-wide patient administration system there were no further incidents of this type. This indicates the scoring should have reflected the system and organisational problems more than the staff-related failings.

Figure 7.1: Factors identified for one change likely to reduce recurrence of the incident (970 responses)



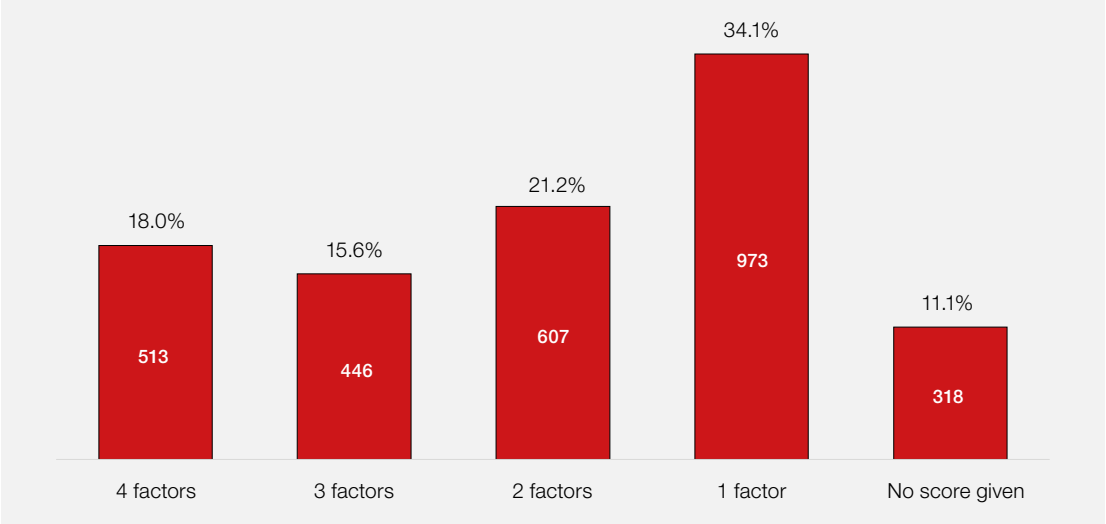
The HFIT study has demonstrated that blame is disproportionately attributed to people, rather than to system and organisational failings and this may be caused by various forms of cognitive bias (Tversky and Kahneman 1974) where something appears to be obvious after the event. Reporters should be aware of these biases and strive for impartiality when scoring the HFIT questions.

The introduction of the HFIT within the reports submitted to SHOT paved the way for incorporating human factors principles when reviewing these transfusion incidents. Improvement is an iterative process and the HFIT model will be reviewed and refined with the help of HFE experts to enable a better understanding of the submitted reports and help guide effective improvements in healthcare systems.

Assessment of variability in HFIT scoring

An analysis was made of how and whether incident reporters assigned scores to multiple contributing factors in 2019. The results are shown in Figure 7.2. Over a third of incidents (973/2857, 34.1%) were scored for a single contributory factor and the vast majority of these, 933/973 (95.9%) were given a score only for the individual staff member(s).

Figure 7.2: Assessment of whether multiple contributory factors were assigned HF scores



Conversely, 513/2857 (18.0%) incidents were given a score for all four contributory factors and in these cases the percentage totals scored for the four factors were more evenly spread, as shown in Table 7.1, which compares these scores to the totals for all incidents. As an example, the percentage score for individual staff member(s) was 33.0% when all four factors had been scored, compared to an overall percentage of 56.6% assigned to individual staff member(s) for all cases.

	Staff member	Environment	Organisation	Government/ regulatory	Totals
Total sum of scores assigned when all four factors were scored	3,186 (33.0%)	2,461 (25.5%)	2,261 (23.5%)	1,736 (18.0%)	**9,644 (100%)**
Total sum of all scores	17,467 (56.6%)	6,836 (22.1%)	4,682 (15.2%)	1,896 (6.1%)	**30,881 (100%)**

Table 7.1: Comparison of totals when the incident was scored for all four of the human and system factors with total sums of all scores

Over the 4 years of this study there has not been a major change in the distribution of scores given to the four human factors, as shown in Figure 7.3, although the trend across the 3 years is to assign slightly less responsibility to the staff members, especially if the educational material has been used.

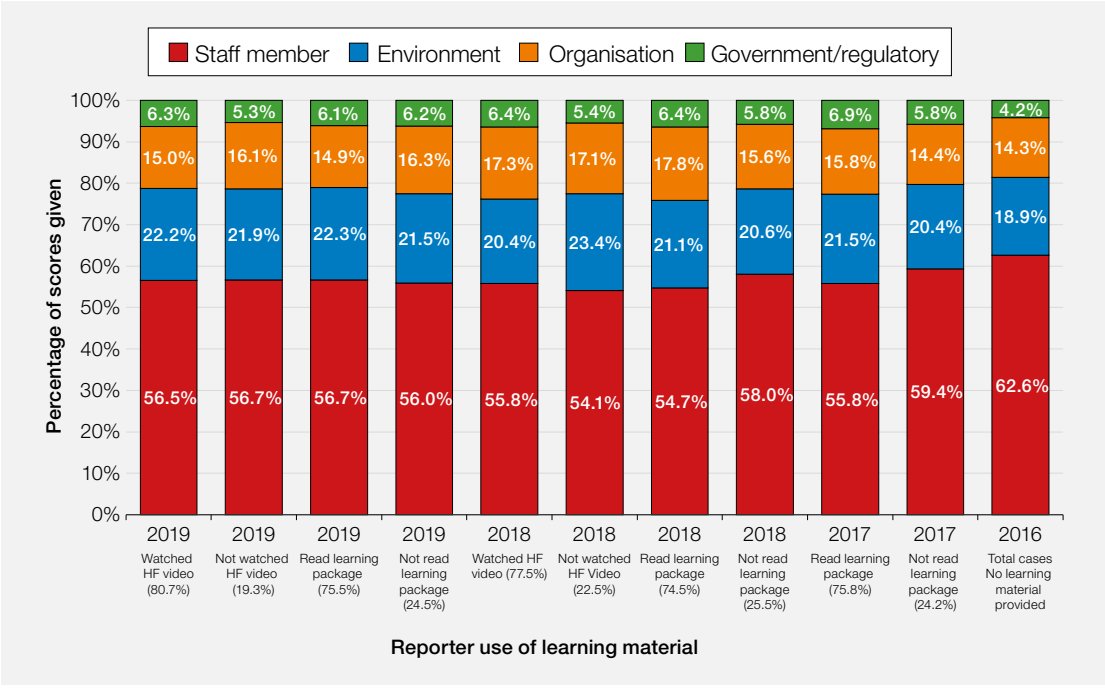


Figure 7.3: Evaluation of uptake of self-learning opportunity and comparative percentages of scores for human and organisational factors

Educational material associated with the HFIT

A major limitation of the HFIT is the reliance on many individuals throughout the UK to assign scores, so as part of the PhD research some self-learning material was produced to assist reporters with this task. In 57/2857 (2.0%) cases in 2019, the reporter selected that they were unable to access a video via their organisation's IT system, which was a substantial reduction from the 2018 data 102/2905 (3.5%) and may have made a contribution to the higher rate of uptake of viewing the video, which was 80.7% in 2019 compared to 77.5% in 2018. Overall, the video was viewed more often than the human factors self-learning tuition package was read in both 2019 (80.7%/75.5%) and 2018 (77.5%/74.5%). This suggests a video may be the preferred form of learning. Videos are the simplest way to express complicated ideas in a memorable way and people can recall information easily when they receive it from stories featured in videos especially animated ones. Learning methods must be engaging and immersive and information delivered in the visual form is easily understood and recalled. A second video was trialled (Systems Thinking 2017) as part of the PhD study to identify the Health Education England animation that is currently linked from the SHOT database (HEE 2017). There are other videos available online that may suit different local needs. Video-based education materials should be explored further and developed, with the aim of providing a package to be incorporated into reporting organisations' training for investigation of incidents.

Vein to vein audit

The National Comparative Audit of Blood Transfusion (NCABT) (NHSBT 2020) has launched a continuous voluntary audit of the complete transfusion process, known as the Vein to Vein audit, which includes two HF-related questions to be asked at each step:

- Q1. Please give a short outline of the biggest or most recent difficulty that you have faced when carrying out this procedure and what did you do about the issue?
- Q2. How supportive was your manager/department for how you solved the issue?

Early data from these questions have been published (Watt et al. 2019) and expanded considerably in the PhD thesis (Watt 2020). Excellent learning opportunities have been developed, so that results from these simple HF audit questions can be used to analyse the potential for resilience of each hospital's transfusion process.

Recommendation

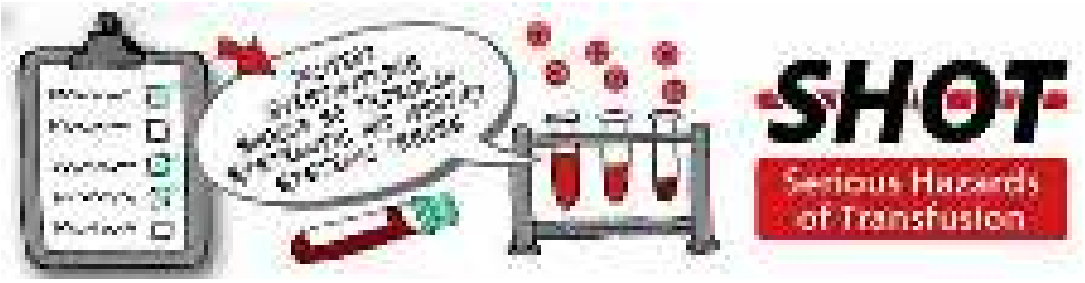
- Participation in the Vein to Vein audit is strongly encouraged and in particular hospital staff should use the human factors (HF)-related questions when carrying out local audits and feed back their results to the National Comparative Audit of Blood Transfusion (NCABT)

Action: Hospital transfusion teams and the NCABT

Trusts/Health Boards can register for National Comparative Audits and contact the audit team if interested in participating in the Vein to Vein audit (http://www.nhsbtaudits.co.uk/).

Conclusion

The enduring inclination of reporters to score individual error higher than other contributory factors is an example of fundamental attribution error (Ross 1977). This can be defined as a tendency to overestimate the importance of personal or disposition factors (i.e. people-related difficulties) relative to environmental influences and therefore to underestimate the influence of situational factors when explaining the behaviour of others. The theory postulates that we tend to explain someone's behaviour by attributing a cause. However, the tendency is to place undue emphasis on the internal characteristics of other people, e.g. their character or intention (Case 7.1), while overemphasising external factors, e.g. system and organisational problems, in relation to one's own behaviour. This particularly happens when the behaviour is negative. Therefore, incident investigators may benefit from trying to put themselves in the shoes of the individual staff member(s) that they perceive to be most culpable in the incident and then from that stance review the external system factors again in more detail.



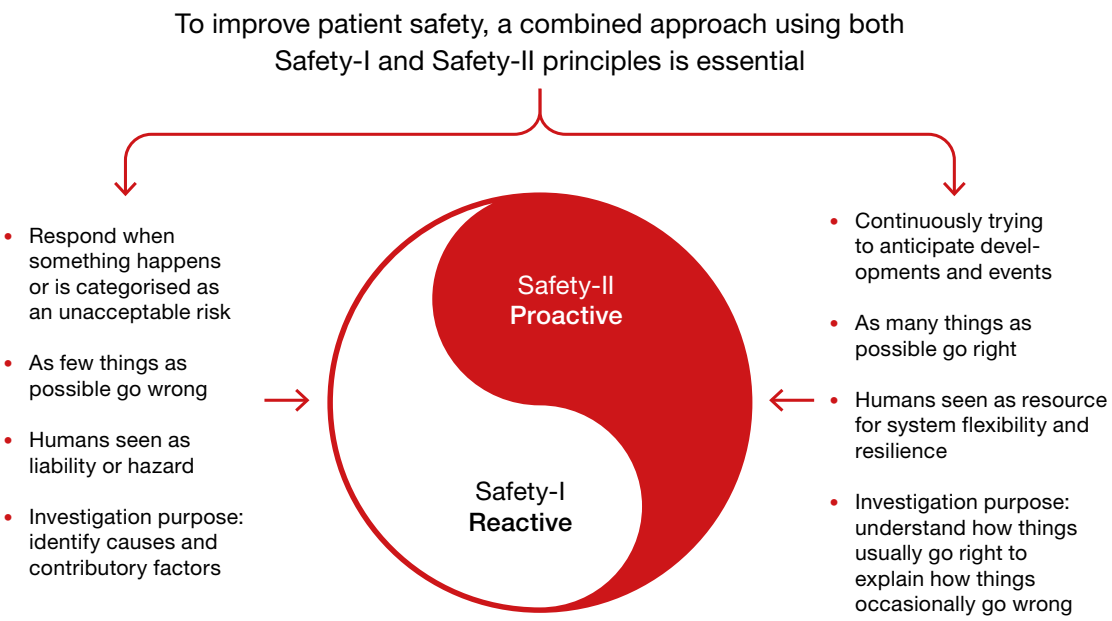


Figure 7.4: Overview of Safety-I and Safety-II

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8 Adverse Events Related to Anti-D immunoglobulin (Ig) n=413

Author: Courtney Spinks

Definition:

An adverse event related to anti-D immunoglobulin (Ig) is defined as related 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.

Key SHOT messages

- Cell-free fetal deoxyribonucleic acid (cffDNA) results were incorrect in 5 cases. Please report all such cases to SHOT
- There appears to be a misunderstanding of the need for routine antenatal anti-D Ig prophylaxis (RAADP) when a recent dose of anti-D Ig had been administered for a potentially sensitising event (PSE)
- Due to the potential for transcription errors on handheld records, clinical decisions must be based on blood results reviewed on an electronic interface
- Robust protocols and systems for refrigerator monitoring and traceability must be in place and adherence monitored as part of normal ward/department/Trust/Health Board assurance metrics

Abbreviations used in this chapter

cffDNA	Cell-free fetal deoxyribonucleic acid	**NICE**	National Institute for Health and Care Excellence
HSE	Handling and storage errors	**PSE**	Potentially sensitising event
Ig	Immunoglobulin	**RAADP**	Routine antenatal anti-D Ig prophylaxis

Recommendations

- Delivery suites should review early discharge procedures to avoid omission or late administration of anti-D immunoglobulin (Ig)
- In cases of early discharge, consideration should be given to administration of anti-D Ig on day two of delivery in the community

Action: Maternity units, maternity governance departments and hospital transfusion laboratories or pharmacy departments

Introduction

SHOT reports related to the provision of anti-D Ig totalled 413. Late administration or omission of anti-D Ig account for 271/413 (65.6%), the theme for these errors appears to be lack of knowledge amongst staff and about those of childbearing potential with D-negative blood groups, or insufficiently robust procedures. These cases should be viewed with concern due to the potential to develop immune anti-D.

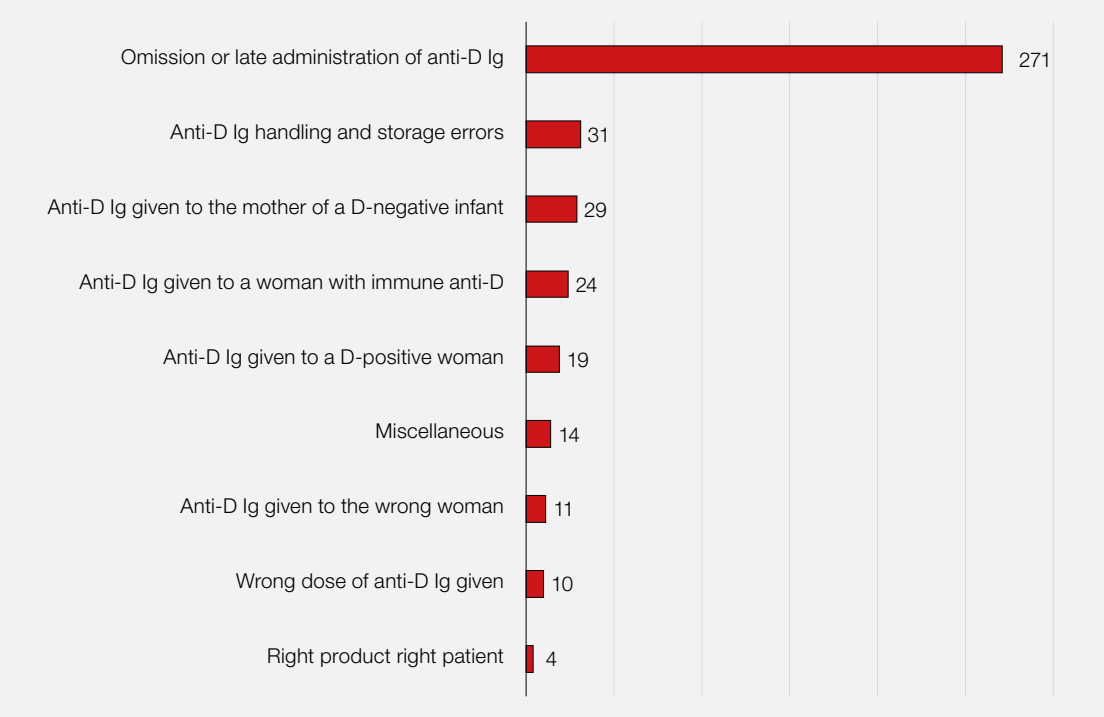


Figure 8.1: Distribution of anti-D Ig related error reports 2019 n=413

Death n=0

There were no deaths reported during 2019 related to errors in anti-D Ig administration.

Major morbidity n=0

There were no reported cases of immune anti-D following errors in clinical management of pregnancy in 2019. It should be noted that immune anti-D may not be evident until a subsequent pregnancy and the anonymity of SHOT reports is such that we cannot link cases of immune anti-D to a reporting year unless specified. **Nevertheless, all cases of alloimmune anti-D identified in pregnancy should be reported to SHOT.**

Omission or late administration of anti-D Ig n=271 (65.6%)

The three areas of care where late administration or omission of anti-D Ig are most implicated are management within 72 hours of a PSE 129/271 (47.6%), RAADP 63/271(23.2%) and at delivery 79/271 (29.1%). Whilst small numbers, there are reports where a pregnant person treated in the emergency department did not receive anti-D Ig 9/129 (7.0%) for a PSE.

There have been 8 reported cases of an incorrect medical decision to omit RAADP following a recent administration of anti-D Ig due to a PSE.

The submitted reports indicate that areas have tried to address the causes of these errors by using checklists or stickers on the front of the case notes, often the checklist is ticked but no action taken. Thomassen et al. (2011) describe the use of checklists as a tool to aid cognition, realising how prone humans are to short term memory loss. If used, a checklist should only be ticked as completed when the task has been completed. Simply ticking it, intending to complete the task negates the intended benefit.

In busy day case areas or delivery suites prompt discharge is appropriate but more robust procedures are required to ensure treatment within the 72-hour window. Delivery suites should consider administration on day two of delivery in the community. A discharge checklist with communication between teams is vital to ensure timely administration. Maternity or gynaecology/early pregnancy day case units should include administration of anti-D Ig for a D-negative birth parent as part of their care pathways. SHOT has produced an anti-D Ig administration aide memoir (https://www.shotuk.org/resources/current-resources/) to assist clinical teams when writing their guidelines and pathways.

There were 20 reports of non-attendance for administration of anti-D Ig, some people refused to wait for the injection or refused to return, these have been removed from the overall numbers as no error was made by the healthcare professionals, but this could be the tip of the iceberg. It does suggest that more robust pathways and more effective education of the risks of D-negative blood group in pregnancy may be required.

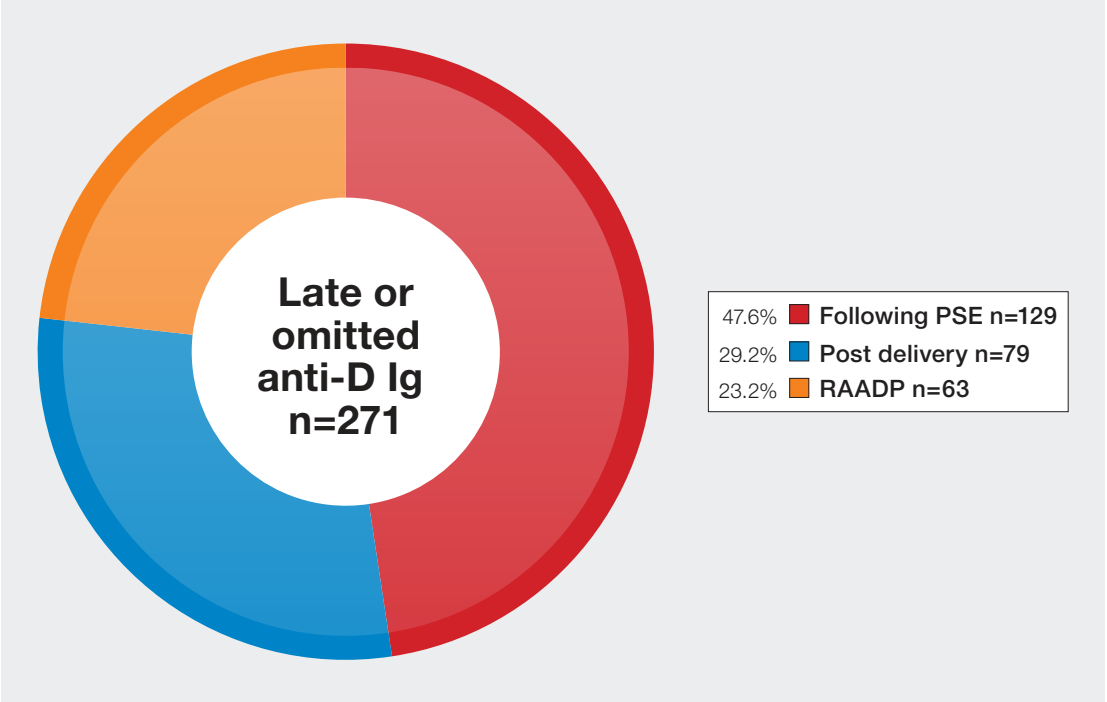
Case 8.1: Patient refused blood products on religious grounds

A woman informed her midwife at booking that she was a Jehovah's Witness and did not wish to receive blood products. This was documented. She was administered anti-D Ig despite this. There is no record of a discussion or documented consent in relation to the anti-D Ig.

This case illustrates the need for robust pathways and raises the question of whether all staff realise anti-D Ig is a blood product.

There were 10 cases where all antenatal appointments were attended, there was a recorded D-negative blood group and yet no RAADP was administered throughout the pregnancy.

Figure 8.2: The three main areas for late administration or omission of anti-D Ig 2019 n=271



Cell-free fetal deoxyribonucleic acid (cffDNA) n=5

There have been 5 reported cases of incorrect cffDNA results. Three were predicted D-negative and 2 D-positive. In each case the healthcare teams acted for the predicted results. All 3 cases re-checked the blood group results at birth, believing there to be a wrong blood in tube (WBIT) error. When results were consistent for the revised group the International Blood Group Reference Laboratory (IBGRL) was informed. Unfortunately, the samples were no longer available at the IBGRL to reference. SHOT will continue to monitor this and encourage reporting.

Overview of cases

Most errors occurred in the hospital setting and within normal working hours (08:00-20:00). Clinical staff were implicated in 340/413 (82.3%) cases. This would suggest that a review of care pathways and guidelines may be appropriate.

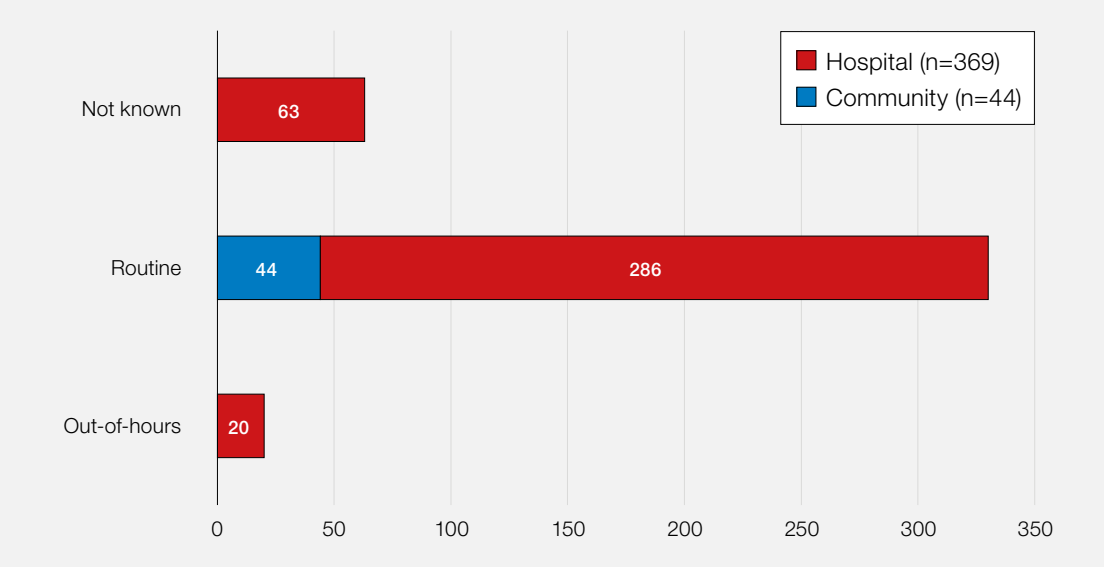


Figure 8.3: Location and time of errors associated with anti-D Ig administration

Recurring themes identified were:

- Lack of communication between hospital and community midwifery teams, particularly in relation to early discharge
- Anti-D Ig not being administered within 72 hours for both PSE and delivery
- Anti-D Ig being ordered from the laboratory but not administered. Largely associated with early discharge after a PSE or at delivery
- Checklists to prevent errors being ticked but not acted upon
- Lack of understanding among staff about when anti-D Ig is required

Manual transcription errors n=5

There were 5 reported cases where a manual entry of a blood group and D status into handheld records resulted in an omission of anti-D Ig. In each case the results were available on an electronic results system and easily accessible. Handheld records clearly have their place, but care must be taken when inputting results. When a clinical decision is based on blood results they should be reviewed on an electronic interface.

Handling and storage errors (HSE) n=31

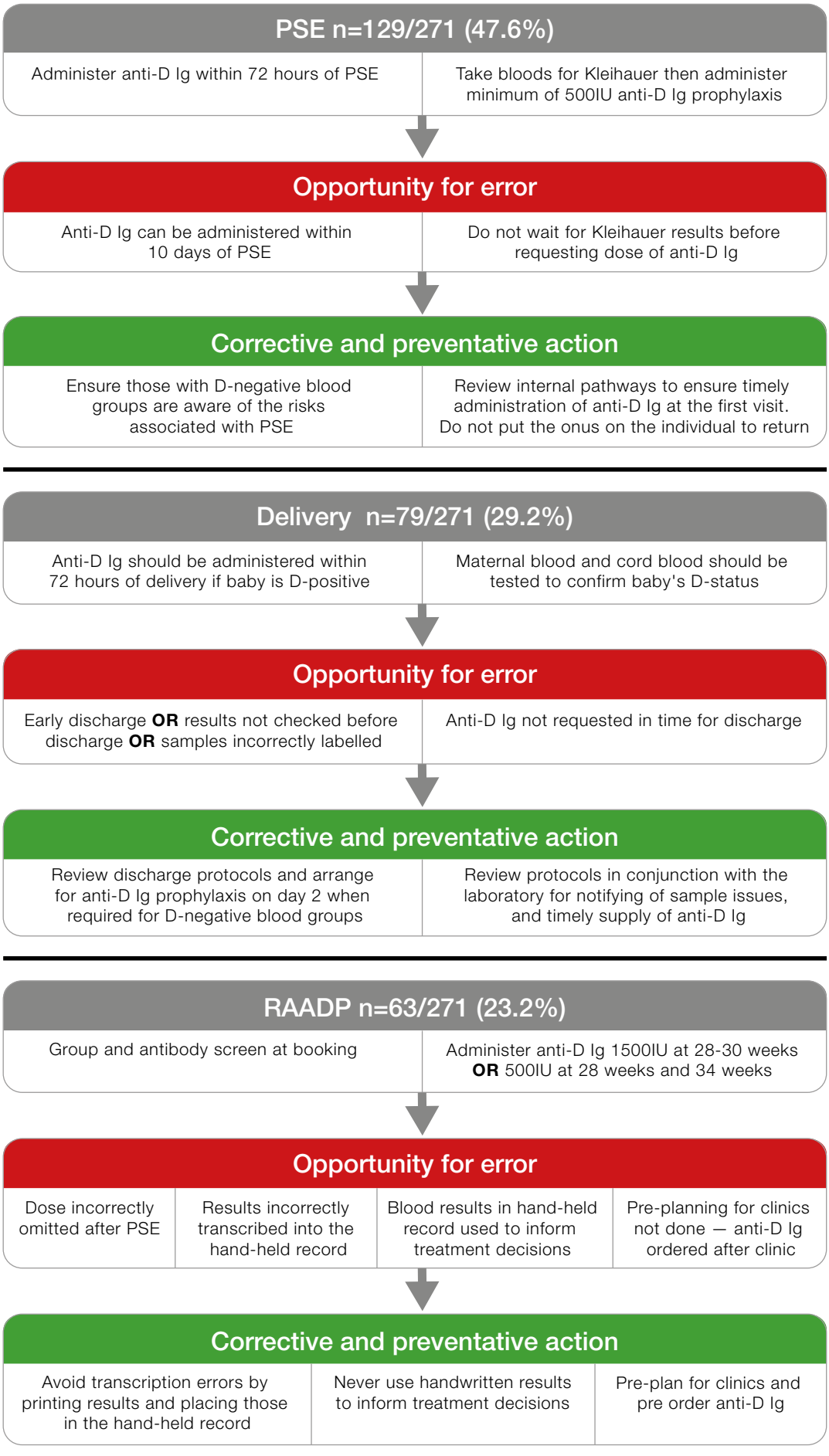
The number of HSE included in the report is misleading as there were 2 cases involving large numbers of individuals, 1 of 25 doses and the other 372. The multiple instances have not been included in the overall figures because the required traceability is not available.

The first was a laboratory error where anti-D Ig was inappropriately stored at refrigerator temperatures ranging from 8-9^{0}C (instead of the manufacturer's recommended 2-8^{0}C). Over 4 days anti-D Ig was issued and administered to multiple recipients.

The second was a refrigerator on a maternity unit with anti-D Ig dispensed and monitored by pharmacy. The refrigerator had been monitored daily by staff on the unit and the temperature recorded, but no action was taken when the refrigerator was recorded as being outside of controlled temperature continuously during a 3-month period. During this period 372 doses of anti-D Ig were issued, however there was no traceability to determine which refrigerator the anti-D Ig had been stored in. Approximately 50 recipients had delivered D-negative babies and the hospital intended to recall the remaining recipients who were cared for during this period for testing due to concerns about the efficacy of the anti-D Ig.

Robust protocols and systems for refrigerator monitoring and traceability must be in place and adherence monitored as part of normal ward/department/Trust/Health Board assurance metrics.

Figure 8.4: Overview of late administration or omission of Anti-D Ig



Learning points

- Handheld records can contain manual transcription errors of blood results and should not be used to make clinical decisions
- Routine antenatal anti-D Ig prophylaxis (RAADP) should be administered according to Trust/Health Board policy and in accordance with National Institute for Health and Care Excellence (NICE) guidance and not omitted if the woman has had a recent potentially sensitising event (PSE)

Near miss cases n=33

Near miss incidents involving the laboratory numbered 23 with the majority involving errors in sample receipt and registration. The remaining 10 clinical errors largely involved failure to follow standard operating procedures or were transcription errors.

IT-related anti-D Ig cases n=13

Further details of the IT-related reports can be found in the supplementary information on the SHOT website (https://www.shotuk.org/shot-reports/report-summary-and-supplement-2019/).

Conclusion

The overall number of reports is similar to 2018. SHOT has developed an aide memoire to remind staff when anti-D Ig should be administered, but it is incumbent on all maternity units and gynaecology early pregnancy units to review their care pathways and develop robust systems to address avoidable omissions or late administration of anti-D Ig.

References

Thomassen Ø, Espeland A, Søftelan E, et al. (2011) Implementation of checklists in health care; learning from high-reliability organisations. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3205016/ [accessed 08 June 2020].

9 Incorrect Blood Component Transfused (IBCT) n=329

Authors: Simon Carter-Graham and Victoria Tuckley

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 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 a 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).

Key SHOT messages

- SHOT reports should be as detailed as possible and prompt, effective responses to SHOT requests for further information are crucial to enable proper analysis of reports
- Collection of blood components remains a critical step in the transfusion process and robust procedures should be in place to ensure that necessary checks are made
- Information regarding specific requirements should be highlighted as an alert in electronic systems such as prescriptions, case notes, transfusion observation systems and laboratory information management system (LIMS). These systems should be updated regularly and be easily accessible to both clinical and laboratory staff
- A check of serology and blood components issued by lone workers at the next available opportunity may identify errors before the patient is put at risk
- When selecting O D-positive red cells for transfusion to O D-negative individuals it is important to check the patient for contraindications in addition to age and childbearing potential e.g. a history of anti-D or if the patient is transfusion-dependent
- It is essential that staff members are adequately trained and competency-assessed before they are expected to perform any task
- Further key SHOT messages related to laboratory practice are stated in Chapter 14, Laboratory Errors

Abbreviations used in this chapter

AAA	Abdominal aortic aneurysm
ABOi	ABO-incompatible
BMS	Biomedical scientist
BSH	British Society for Haematology
CAS	Central alerting system
CMV	Cytomegalovirus
COPD	Chronic obstructive pulmonary disease
CS	Component selection
DH	Department of Health
FFP	Fresh frozen plasma
GMP	Good manufacturing practice
Hb	Haemoglobin
HDU	High dependency unit
HSCT	Haemopoietic stem cell transplant
HLA	Human leucocyte antigen
IBCT	Incorrect Blood Component Transfused
ID	Identification
LIMS	Laboratory information management systems
MAU	Medical admissions unit
MHP	Major haemorrhage protocol
NHS	National Health Service
NM	Near miss
SRNM	Specific requirements not met
SRR	Sample receipt and registration
WCT	Wrong component transfused

Recommendations

- Staff should not undertake any procedures that they have not been fully trained and competency-assessed to perform

Action: Transfusion laboratory managers, ward managers

- Laboratory information management systems (LIMS) should prevent ABO-incompatible blood components being issued, especially in an emergency when the patient's blood group is unknown

Action: Transfusion laboratory managers, pathology quality managers, LIMS providers

- Laboratory staff should discuss requests with clinicians if they have any concerns over the appropriateness of the request

Action: Transfusion laboratory managers, hospital transfusion teams, medical educators

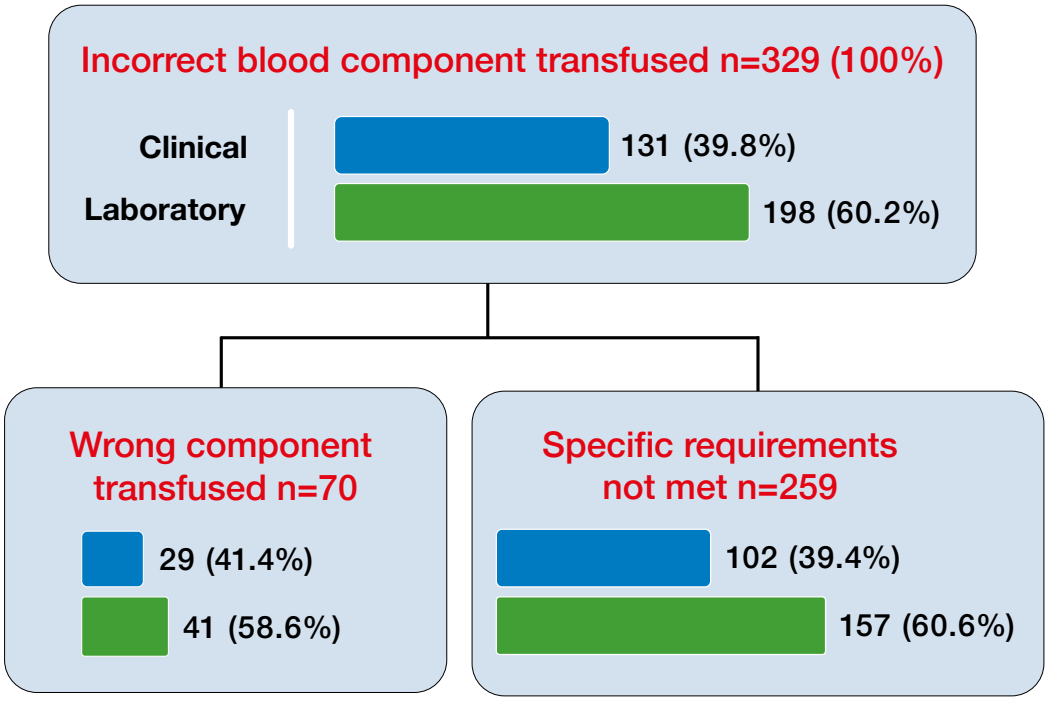


Figure 9.1: Overview of reports where an incorrect blood component was transfused in 2019 n=329

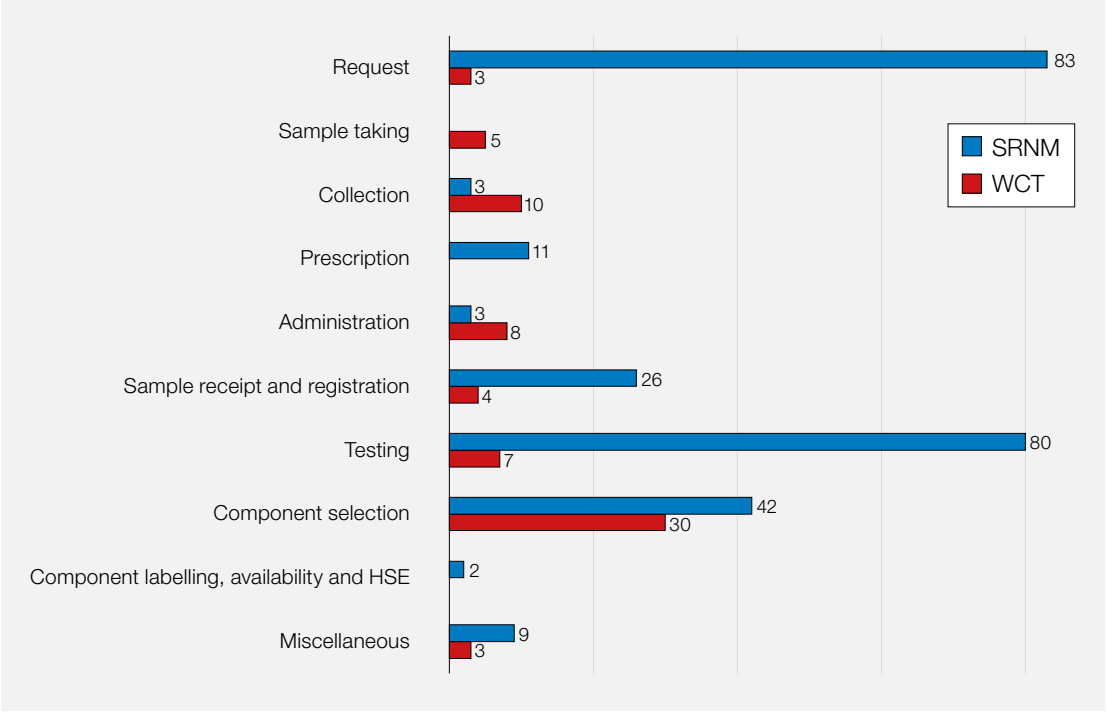
Introduction

IBCT events have the potential to cause major morbidity in patients and are often due to multiple errors in the transfusion process. These errors account for 329/3397 (9.7%) of all reports to SHOT in 2019 and this is an increase in the both number and proportion of reports from 2018 (272/3326 (8.2%)). The total number of WCT reports has slightly reduced in 2019 (78 in 2018 to 70 in 2019), however there has been a substantial increase in the number of specific requirements not met (SRNM) reports of over 33.5%, from 194 in 2018 to 259 in 2019.

The majority of SRNM errors occurred at the request step, 83/329 (25.2%) followed by the testing step, 80/329 (24.3%) as shown in Figure 9.2. The largest increase has been seen in the request, testing and component selection stages of transfusion, increasing by 11, 35 and 15 errors respectively. These are the key points in the transfusion process where specific requirements can be identified. Patient identification and other electronic systems to identify specific requirements should be updated regularly and should be easily accessible to both clinical and laboratory staff (BSH Jones et al. 2014). The recommendation for improved clinical and laboratory awareness, documentation and communication of specific requirements for transfusion was first highlighted in the Annual SHOT Report 2009 and was endorsed by the British Society for Haematology (BSH) (formerly the British Committee for Standards in Haematology) in 2010, however errors have persisted (Taylor et al. 2010, BSH Treleaven et al. 2010).

Collection and administration errors continue to be a major cause of clinical WCT, accounting for 18/29 (62.1%) of reports.

Figure 9.2: Total incorrect blood component transfused errors categorised by the step where the error occurred n=329



WCT=wrong component transfused; SRNM=specific requirements not met; HSE=handling and storage errors

Remarkably, the proportion of WCT events decreased with the urgency of the request. The vast majority of WCT occurred with routine requests, 42/70 (60.0%), followed by urgent 12/70 (17.1%) and emergency 10/70 (14.3%), see Figure 9.3. This illustrates that procedures should reflect work as done where at all possible so they are fit for use and take into account the factors which are likely to result in unsafe working.

Death n=0

There were no reported deaths in 2019 that were attributable to the transfusion.

Major morbidity n=1

There was a single case of major morbidity which occurred in the laboratory and resulted in sensitisation to the K antigen in a patient of childbearing potential (imputability not stated) Please see the online laboratory case studies in the supplementary information on the SHOT website (https://www.shotuk.org/shot-reports/report-summary-and-supplement-2019/).

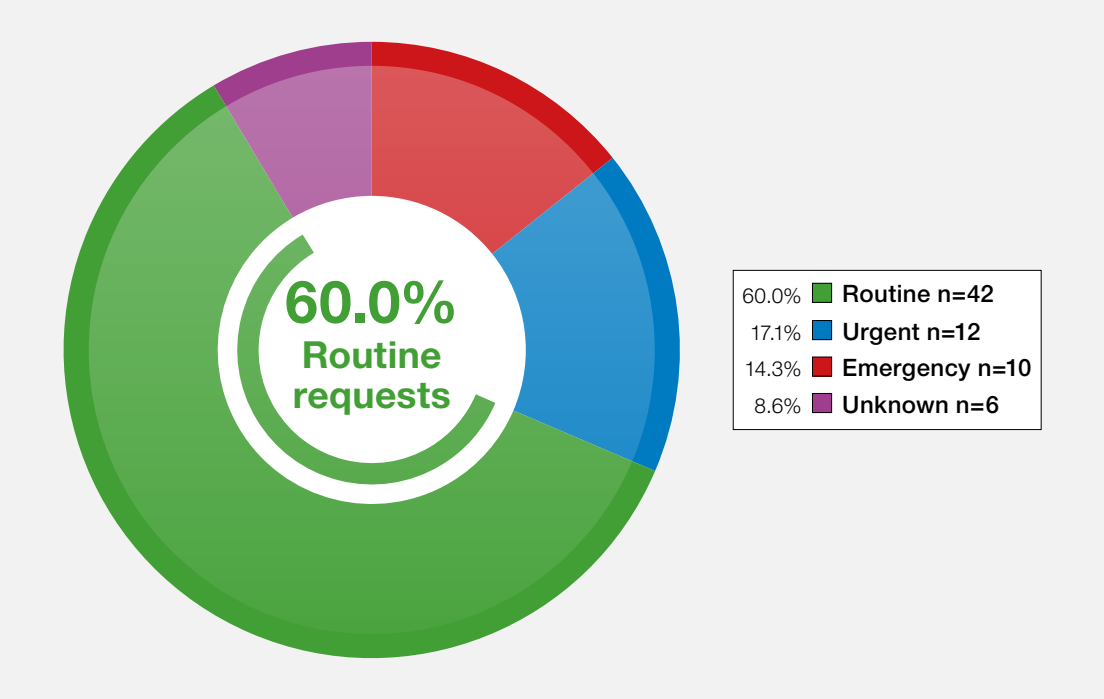


Figure 9.3: WCT errors categorised by urgency of request n=70

ABO-incompatible (ABOi) transfusions n=6

This is a National Health Service (NHS) Never Event for England (NHS England 2018), Wales (NHS Wales 2018) and Northern Ireland. In Scotland these cases would be reported as Red Incidents through the Scottish National Blood Transfusion Service. ABOi red cell transfusions have the potential to cause severe clinical consequences or death through intravascular haemolysis of donor and patient red cells.

In total there were 4 ABOi red cell transfusions (3 clinical errors and 1 laboratory error, Case 14.1, Chapter 14, Laboratory Errors), and 2 ABOi transfusions of fresh frozen plasma (FFP) (both laboratory errors). Table 9.1 provides an overview of each case as provided by the reporters.

Case 9.1: Group A red cells selected for major haemorrhage pack

During a major haemorrhage protocol (MHP) activation for a ruptured aneurysm a component selection error in the transfusion laboratory resulted in a unit of group A red cells being transfused to a group O patient. The patient had no known group at the time of selection, and the error was not detected at collection or bedside administration.

This case is discussed in detail as Case 14.1 in Chapter 14, Laboratory Errors.

Case 9.2: Collection error and failure to carry out positive patient identification (ID)

A patient in their 70s was admitted with abdominal pain following a road traffic collision. The patient had a past medical history of abdominal aortic aneurysm (AAA). The following morning the patient deteriorated and lost a massive amount of blood per rectum. This was subsequently identified as secondary to aorta-enteric fistula. Urgent blood transfusion was prescribed. Less than a minute after starting the transfusion it was noticed that the name on the blood bag didn't match the patient and the transfusion was immediately stopped. The blood collected from the satellite refrigerator had a different patient name on it. The nurse who collected the blood from the satellite refrigerator did not follow the correct procedure. Pre-administration checks were not fully completed as the blood pack

was not checked against the patient ID band. Of the four staff that were involved in the incident only one had their blood transfusion collection competency and theory learning up to date.

Table 9.1: ABO-incompatible transfusions key information n=6

Case number	9.1	9.2	9.3	9.4	9.5	9.6
Component transfused	Red cells Group A	Red cells Group A	Red cells Group A	Red cells Group AB	FFP Group O	FFP Group O
Patient group	Group O	Group O	Group B	Group O	Group A	Group A
Volume transfused	50mL - full unit	<50mL	50mL - full unit	<50mL	4 full units	1 full unit
Primary error	Component selection	Collection	Collection	Administration	Component selection	Component selection
When was the error detected	After the transfusion	Soon after the start of transfusion	During the transfusion	2 minutes into the transfusion	After transfusion of all units - upon investigation of delay	After the transfusion
Patient impact	No clinical reaction	No clinical reaction	Slight temperature rise	No clinical reaction	No clinical reaction	No clinical reaction
Urgency	Emergency	Emergency	Routine	Routine	Emergency	Unknown
In hours (08:00-20:00) Out-of-hours (20:00-00:00 or 00:00-08:00)	Out-of-hours	Out-of-hours	Out-of-hours	In hours	Out-of-hours	In hours
MHP	Yes	Yes	No	No	Yes	No
Department	Laboratory	HDU	Ward	MAU	Laboratory	Laboratory
Adult/paediatric	Adult	Adult	Adult	Adult	Adult	Paediatric
Type of administration check	2-person (dependency not stated)	2-person independent check	2-person independent check	2-person dependent check	2-person dependent check	Not stated
Bedside checklist available	Not stated	Not available in the Trust/ Health Board	Yes, not used	Not stated	Not available in the Trust/ Health Board	Not stated
Patient ID	Manual	Manual	Manual	Manual	Manual	Not stated
Root cause provided by the reporter	LIMS allows non O red cell issue in emergency	Incomplete bedside check	Incomplete bedside check	Bedside check away from patient	No rule in LIMS to prevent O FFP release in emergency	Assumptions and overriding LIMS flags
Contributing factors	Distraction by haematology pager. Over-complication of procedure	Bank nurse not familiar with the environment or caring for level 2 patients	Neither of the two nurses had been competency-assessed for blood transfusion	Multiple interruptions. Cramped busy conditions. No desk to use for documents	BMS rushing and multitasking	Handover involved, excessive workload
What controls are in place that should have prevented this	GMP working. Component labelling check. Bedside check	Competency training. Administration procedure	Competency training. Bedside checklist	Administration procedure	Component labelling check	LIMS flags. GMP working. Component labelling check

MHP=major haemorrhage protocol; HDU=high dependency unit; MAU=medical admissions unit; BMS=biomedical scientist; GMP=good manufacturing practice

Case 9.3: Bed number used as sole patient identifier

A man in his 50s had recently received a liver transplant. Two units of blood were prescribed due to his low haemoglobin (Hb). The blood transfusion was not considered to be urgent. Blood was ordered via the electronic ordering system, at the request of the nurse looking after the patient to the nurse in charge. The only information shared between the two nurses was the patient's bed number. The two nurses did not have any discussion to verify the patient's identity. One nurse then went alone to administer the blood but did not positively identify the patient as she believed that as she knew the patient well this was not necessary.

Case 9.4: Failure to carry out positive patient identification

A female patient in her 50s was admitted due to a declining Hb level of less than 70g/L and chronic obstructive pulmonary disease (COPD). Red cells were prescribed. Two nurses checked the red cells at the nurse's station and one of them took the unit to the wrong patient, did not carry out positive patient identification, and started the transfusion. A healthcare assistant noticed the transfusion was being given to the wrong patient, sought immediate advice and the transfusion was stopped two minutes after it started.

Case 9.5: Group O FFP selected in error for a major haemorrhage pack

During an MHP activation for intra-abdominal haemorrhage group O red cells and group O FFP were selected by the BMS prior to completion of patient blood grouping, the patient group was subsequently found to be A D-positive. The patient received four units of incompatible FFP and unfortunately passed away, however this was thought to be unrelated to the transfusion.

Case 9.6: Group O FFP incorrectly selected for transfusion of a neonate

Group O FFP was mistakenly selected for a group A neonate. The unit was selected by one BMS and issued by another who overrode LIMS flags believing the previous BMS had defrosted the correct unit.

Three ABOi events occurred during the major haemorrhage situation. This illustrates the requirements for such processes to be clearly defined within policies, regularly reviewed and ingrained within working culture so they hold up to situations with increased pressure (see key SHOT messages within Chapter 14, Laboratory Errors).

Three cases could have been prevented if LIMS systems were configured to prevent ABOi components being issued. This factor was not uniformly identified in the root cause analyses submitted; therefore an opportunity may have been missed to prevent further unsafe practice occurring.

A bedside checklist was not available or not used in 3 cases and information on the checklist was not available in the remaining cases. The number of ABOi red cell transfusions has reduced over the past 20 years, however this has not reduced since 2017 (Figure 9.4).

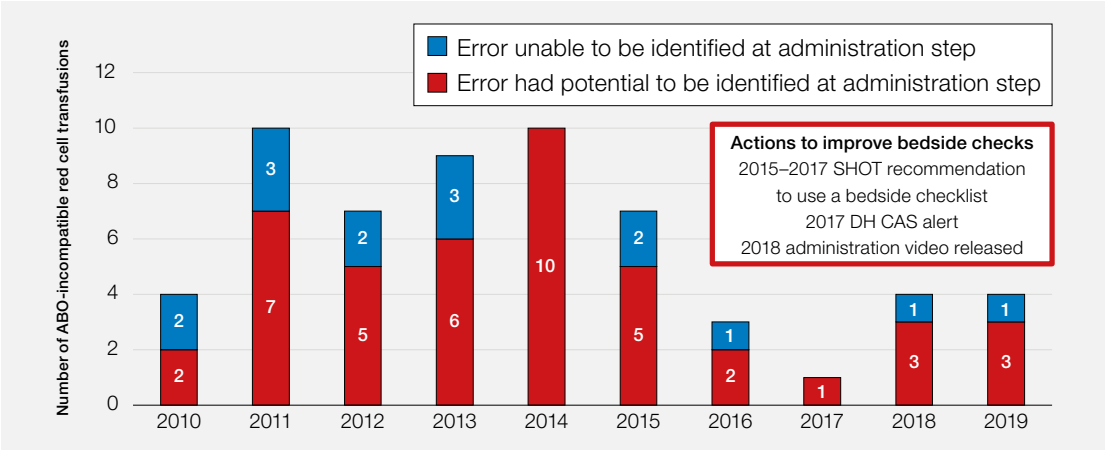


Figure 9.4: ABO-incompatible red cell transfusions from 2010-2019

DH=Department of Health; CAS=central alerting system

Clinical errors n=131

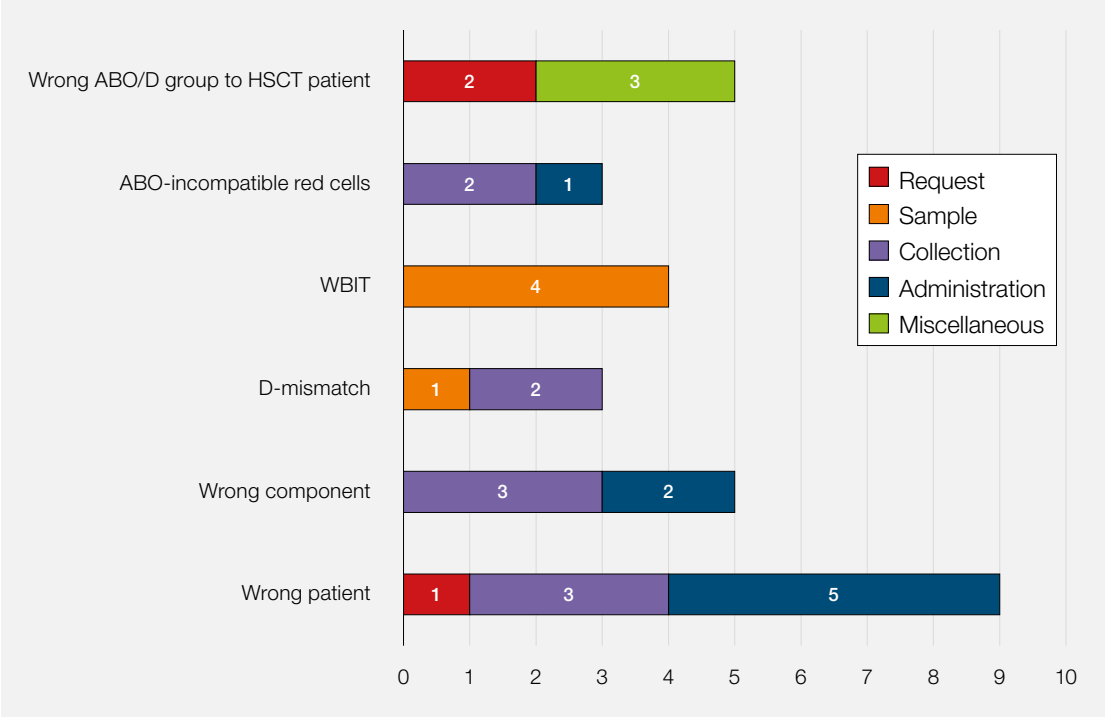
Despite repeated SHOT recommendations and the resulting central alerting system (CAS) alert: 'Safe Transfusion Practice: Use a bedside checklist' (Department of Health 2017), there were 37/131 (28.2%) reports where a checklist was not used to carry out the administration step of the transfusion process. In 19/37 (51.4%) of these cases it was reported that a bedside checklist was not used in that hospital.

There was a two-person administration check performed in 60/131 (45.8%) cases. Independent checking (two people doing the check independently) accounted for 47/60 (78.3%) reports. Where there was a dependent check (two people checking together) the number was 8/60 (13.3%). There were 5/60 (8.4%) where the type of check was not recorded.

Clinical WCT events n=29

Eleven of the 29 (37.9%) WCT errors occurred at the administration stage of the transfusion process, where positive patient identification was not carried out at the patient's bedside. There were 10/29 (34.5%) reports of the wrong component being collected from the storage site where the member of staff selected the wrong component and delivered it to the clinical area. In 6/29 (20.7%) the transfusions were emergencies, urgent in 5/29 (17.2%), routine/elective in 15/29 (51.7%) and 3/29 (10.4%) not recorded. In relation to time of day 9/29 (31.0%) were during normal working hours (8am-8pm), 3/29 (10.4%) out-of-hours and 17/29 (58.6%) where the time of transfusion was not reported.

Figure 9.5: Clinical errors resulting in IBCT-WCT categorised by stage the error occurred and patient impact n=29



HSCT=haemopoietic stem cell transplant; WBIT=wrong blood in tube

Clinical SRNM events n=102

There were 83/102 (81.4%) reports where the error occurred at the request step of the transfusion process. There were 85/102 (83.3%) reports where there was a failure to adhere to the requirement for irradiated components (Figure 9.6). In each of these cases the requirement was not recorded on the request due to errors such as lack of effective communication between shared care hospitals and lack of awareness or knowledge when the patient had an historical diagnosis requiring irradiated components. The requirement for cytomegalovirus (CMV)-negative components was missed in 7/102 (6.9%) of reports, followed by incorrect phenotype 5/102 (4.9%) and use of blood warmer 3/102 (2.9%). There are opportunities to detect omissions at several steps in the transfusion process, but only if staff complete their part of the process correctly. The use of an aide memoire for specific requirements on the reverse of written request forms, prescription forms, on electronic request systems or at the final bedside check may help reduce the numbers of SRNM reports.

Please see the 'Safe Transfusion Checklist' available on the SHOT website, https://www.shotuk.org/resources/current-resources/.

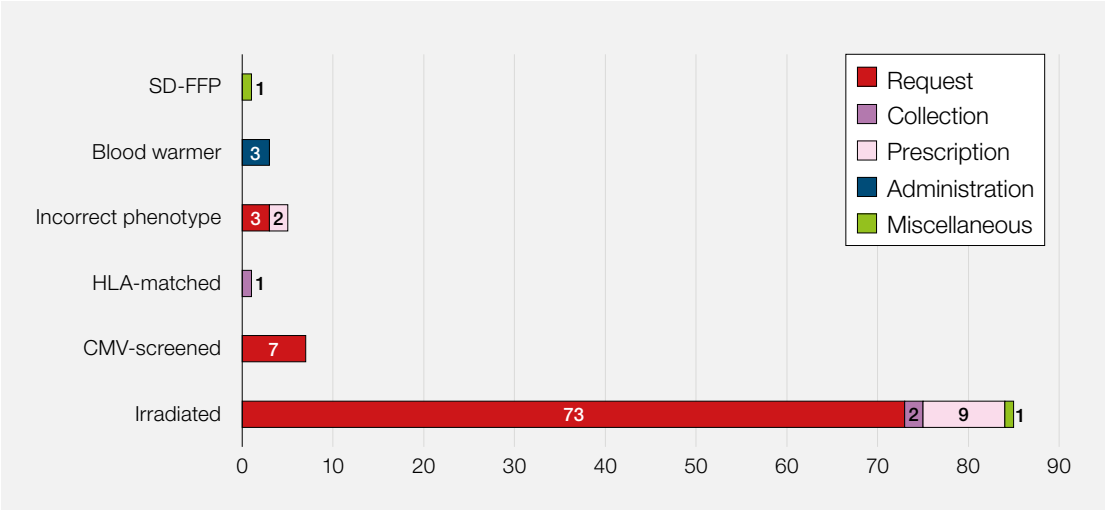


Figure 9.6: Clinical errors resulting in IBCT-SRNM categorised by patient impact and stage the error occurred n=102

SD-FFP=solvent detergent fresh frozen plasma; HLA=human leucocyte antigen; CMV=cytomegalovirus

Laboratory errors n=198

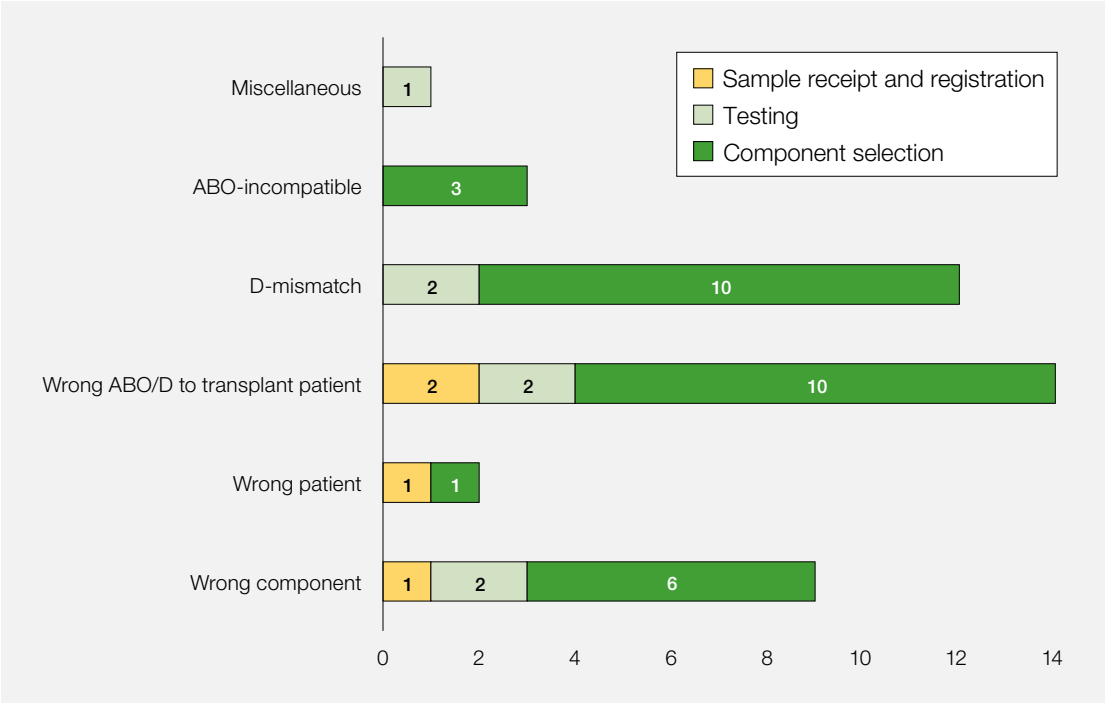
There has been a slight decrease in laboratory WCT events, however a vast increase in SRNM reports was noted in 2019. The majority of laboratory sample processing and component issue occurs during routine working hours. However, of those IBCT events where data regarding time of day the error occurred were provided (76), 3/17(17.6%) of WCT and 16/59 (27.1%) of SRNM occurred outside of routine working hours (20:00-08:00). This disproportionate rate of errors may indicate a higher burden of working and increased pressure on lone workers during non-routine hours. Many transfusion laboratories have a policy to second check component labelling and serology during routine hours, which cannot be maintained during lone working. A second check of lone worker serology and blood issues at the next available opportunity will help identify errors in a timely fashion and may prevent harm.

Laboratory WCT events n=41

Most laboratory IBCT-WCT events occur at the component selection (CS) step, 30/41 (73.2%). The highest number of WCT events in the laboratory remain transfusion of incorrect ABO and D in patients undergoing haemopoietic stem cell transplant (HSCT) or solid organ transplants 14/41 (34.1%) (Figure 9.7). The 12 HSCT incidents are discussed in more detail in Chapter 25, Summary of Reported Transfusion Incidents Related to Haemopoietic Stem Cell Transplants 2012-2019. A total of 10/14 (71.4%) transplant-related errors occurred at CS, however in 2018 most errors occurred at sample receipt and registration (SRR), 10/17 (58.8%). When the error occurs at the CS step, information about the patients' specific requirements is available and recorded in the LIMS, but not acted upon. This shows a gap within the processes implemented at the CS step, in addition to an incomplete component labelling check. These factors and recommendations are discussed further in Chapter 14, Laboratory Errors.

It is good blood stocks management to utilise D-positive components for males and for females over the age of 51 who are not transfusion-dependent and do not have immune anti-D, however policies should be specific on where exceptions exist, and the rationale behind these. There has been an increase in D-mismatch errors where the error occurred at the CS step, 10/12 (83.3%), with the majority of these, 8/12 (66.7%) resulting in transfusion of D-positive red cells to D-negative males, or females over the age of 51, who are transfusion-dependent. BSH guidance (BSH Milkins et al. 2013), states that *'D negative red cells should always be selected for ... transfusion-dependent D negative adults'.* Providing D-mismatched products in inappropriate situations can lead to adverse clinical outcomes, as further illustrated by Case 18.5 in Chapter 18, Haemolytic Transfusion Reactions (HTR), in which an elderly female suffered a delayed transfusion reaction following transfusion with D-positive red cells despite informing the clinical area of previous antibodies.

Figure 9.7: Laboratory errors resulting in WCT n=41



Laboratory SRNM events n=157

IBCT-SRNM are discussed in more detail in Chapter 14, Laboratory Errors. The majority, 63/157 (40.1%), of SRNM errors are categorised as procedural errors, however 35/63 (55.6%) have multiple contributing factors. This highlights the importance of having clear standard operating procedures as recommended in the 2018 Annual SHOT Report (Narayan et al. 2019). Most laboratory SRNM events are the result of incomplete testing (Figure 9.8). Incomplete testing includes cases where blood has been transfused prior to resolution of serological testing (e.g. antibody identification not completed, analyser not within quality control or incorrect testing methodology used).

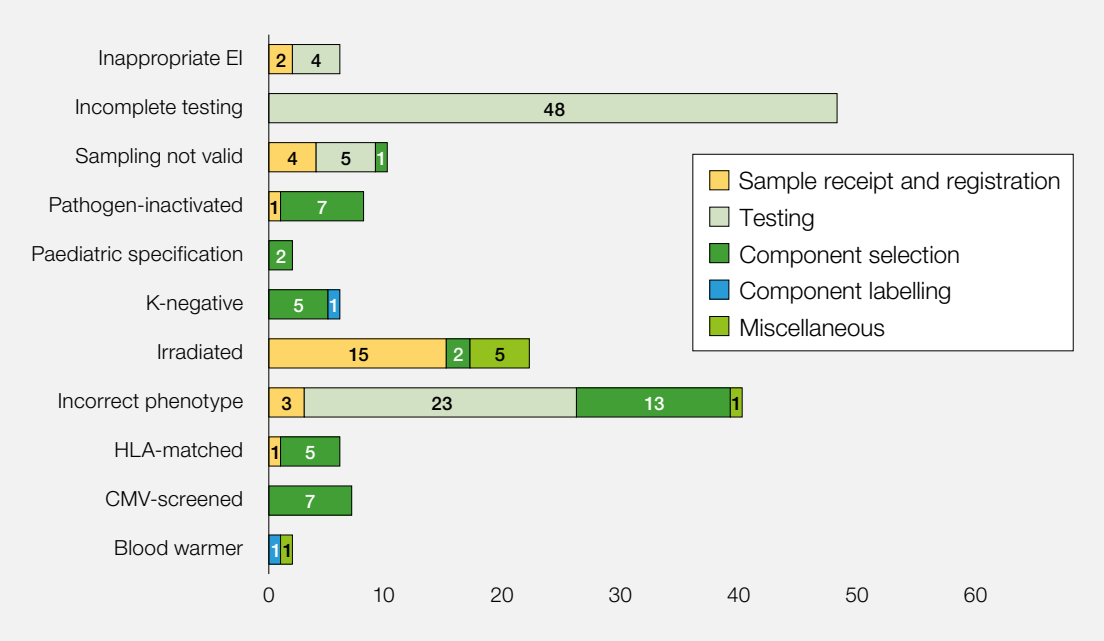


Figure 9.8: Laboratory errors resulting in SRNM n=157

EI=electronic issue; HLA=human leucocyte antigen; CMV=cytomegalovirus

Case 9.7: Incomplete interpretation of serology leads to transfusion of antigen-positive blood

During a nightshift, two units of red cells were requested for a patient with myelodysplastic syndrome and known alloantibodies (anti-K and anti-Ku[a]). The antibody panel showed additional reactivity, therefore BMS1 performed a secondary panel. Two units of crossmatch-compatible blood were issued without complete interpretation of the second panel. The following day whilst inputting the results into the LIMS, BMS2 noticed a positive reaction which was previously overlooked. Additional testing was performed which identified an anti-E antibody. One of the units issued and transfused was E-positive, however the patient suffered no adverse effects. The transfusion was a routine request and could have been performed during the next day shift.

The laboratory had four long term vacancies causing routine work to continue into non-routine shifts. The BMS performing initial testing was the sole BMS covering haematology and transfusion. They were inexperienced and had not received optimal training due to senior staff covering night and weekend shifts. The hospital management have now agreed to allow locums to cover vacancies.

All testing should be resolved prior to issue of red cells. Further advice from senior colleagues should be sought if in doubt.

Laboratory management have a responsibility to ensure all staff members are competent before exposing them to lone working.

Learning points

- All testing should be resolved prior to issue of red cells. Further advice from senior colleagues should be sought if in doubt
- Policies should be clear on the appropriate use of D-positive cells, and where D-negative cells should be used to prevent alloimmunisation

Near miss cases n=215 (106 clinical, 109 laboratory)

Definition:

A 'near miss' event refers to any error which if undetected, could result in the determination of a wrong blood group or transfusion.

There was a total of 21 near miss (NM) ABOi transfusions, 18/21 (85.7%) originating in the clinical area and 3/21 (14.3%) originating in the laboratory.

An additional 728 cases of near miss wrong blood in tube are not included here, but are discussed in detail in Chapter 12a, Near Miss – Wrong Blood in Tube (WBIT).

Clinical NM WCT n=78

The primary error in this category was made at the collection stage of the transfusion process in 55/78 (70.5%) a slight rise from 49 cases in 2018. Such mistakes were caused primarily by the staff member failing to carry out the correct checks at the storage facility. Most errors were made by registered nurses in 35/55 (63.6%) or by porters in 20/55 (36.4%). Many of such incidents were detected at the patient's bedside prior to administration in 32/55 (58.2%) with 16/32 (50.0%) identified by electronic systems and 13/32 (40.6%) by staff members (3/32 unknown).

There were 13/78 (16.6%) reports where the primary error occurred at the patient's bedside. These errors were mainly an attempt to give the component to the wrong patient in 12/13 (92.3%).

Clinical NM SRNM n=28

At the request step of the transfusion process there were 26/28 (92.9%) NM errors where the specific requirements were not recorded on the request. Most commonly poor communication was involved where the clinical area had not informed the laboratory of specific requirements. There were 2/28 (7.1%) reports where the primary error was at the collection of the blood product.

Laboratory NM WCT n=43, SRNM n=66

The highest proportion of laboratory NM-WCT errors had the potential to result in blood being administered to the wrong patient, 12/43 (27.9%) and the highest proportion of laboratory NM-SRNM events involved patients requiring irradiated blood, 27/66 (40.9%). The majority of laboratory NM events were detected by a successful bedside administration check, 16/43 (37.2%) of NM-WCT events and 27/66 (40.9%) NM-SRNM events. This highlights the importance of a complete and accurate bedside check in transfusion safety.

IT-related IBCT cases n=127

Further details of the IT-related reports can be found in the supplementary information on the SHOT website (https://www.shotuk.org/shot-reports/report-summary-and-supplement-2019/).

Conclusion

While transfusion practices have improved, preventable harmful events like ABO-incompatible transfusions continue to occur. Traditional prevention methods like use of checklists, two-person procedures, communication and ongoing training programmes, are effective but by themselves, cannot prevent such incidents completely. It could also be argued that by adding fail-safes we are creating more pressure and increasing the risk for error. Reasons for the errors have been repeatedly shown to be inattention, distraction, poor supervision, inexperience, high workload, and fatigue – all commonly seen in high pressure clinical and laboratory environments. It is time to look at a full systems approach which utilises the resources available in a way that makes it more difficult to make errors (Provana et al. 2020) and supports staff in the busy environments in which they work.

It must be recognised that humans are fallible and systems that solely rely on operator memory to prevent mistakes both increase cognitive load and are unlikely to be totally effective. For example, training programmes can be flawed in approach, costly, and must be regularly repeated to maintain efficacy. Checklists often fail in stressful and time-pressured situations despite best intentions. Moreover, for checklists to be effective, staff should be engaged and compliant with the process, checklists must be fit for purpose, simple to use and not be used as a tick box exercise. Technology (better LIMS, electronic patient identification systems) must help to engineer solutions which compensate for human

limitations, and the use of IT must be capable of reducing reliance on human interventions in making systems safer rather than adding to the burden (See the key recommendation from the 2017 Annual SHOT Report: Information technology (IT) systems have the potential to increase transfusion safety by minimising human input and should be considered for all transfusion steps (Bolton-Maggs et al. 2018)).

Finally, despite all the above measures, it is important to remember that patient care is ultimately delivered by humans who are having to work in increasingly complex and hurried environments. Care involves multiple team members, often across teams, working at a faster pace, with higher caseloads, and resource constraints. In most of the near-miss and safety events reported, cognitive factors such as channelled attention on a single issue, overconfidence or confirmation bias, inadequate vigilance, errors made based on inaccurate information, and distractions underlay many of them. For all safety critical steps, it is vital to make critical information more conspicuous, decreasing diversions of attention, and reducing the number of secondary tasks when staff are carrying out complex tasks. Hence, in addition to the measures described, the only satisfactory improvement tool in some cases may be to allow our colleagues to slow down and do less, have more time to think and therefore be able to deliver high quality patient care.

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10 Handling and Storage Errors (HSE) n=306

Authors: Diane Sydney and Victoria Tuckley

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.

Key SHOT messages

- Key SHOT messages from 2017 remain pertinent on **communication** and **do not assume, verify** (Bolton-Maggs et al. 2018)
- Routine processes such as daily checks are prone to inattention bias when staff assume no action will be needed. The potential impact of inaccurately recording laboratory data should be included during training

Abbreviations used in this chapter

AP	Associate practitioner	**HSE**	Handling and storage error
BMS	Biomedical scientist	**SOP**	Standard operating procedure

Introduction

There were 306 cases reported in 2019 with an increase of 15.9% from the 2018 Annual SHOT Report which contained 264 errors (Narayan et al. 2019). Clinical errors accounted for 199/306 (65.0%) and laboratory errors for 107/306 (35.0%). The variation between clinical and laboratory errors are illustrated in Figure 10.1.

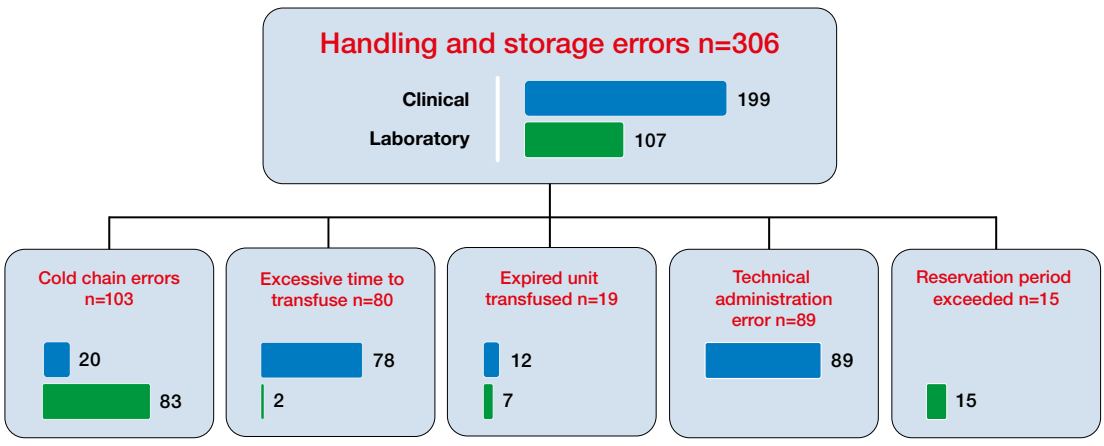

Figure 10.1: Breakdown of 2019 handling and storage error (HSE) reports n=306

Death n=0

There were no deaths reported that related to errors associated with HSE in 2019.

Major morbidity n=0

There were no HSE cases reported in 2019 that resulted in major morbidity.

Clinical errors

The number of clinical errors remains consistent with previous years, however there has been an increase in technical administration errors (89/199 (44.7%) in 2019 and 69/195 (35.4%) in 2018) and a reduction in excessive time to transfuse errors (78/199 in 2019 and 96/195 in 2018). Technical administration errors have been further categorised below in Table 10.1.

Technical administration error	Number of cases
Administration pump error	30
Incorrect giving set used	24
Transfusion details not recorded	21
Unit damaged/clotted	6
Drug added to unit	1
Excessively rapid rate	5
Miscellaneous	2
Total	**89**

Table 10.1: Clinical technical administration errors n=89

Laboratory errors

In most HSE categories the numbers remain consistent with previous annual reports; however, there has been a significant increase in the number of laboratory HSE errors from the 2018 Annual SHOT Report. The increase equates to 55.1%, with 107 errors compared to 69 in 2018. The overall number of laboratory errors has decreased slightly in 2019, therefore the increase in HSE is disproportionate to the overall level of laboratory incidents and signifies an area which requires improvement. A proportion of these cases were due to a single refrigerator failure effecting 23 patients. Despite this, the overall trend raises concern and may be reflective of the challenges within the laboratory setting. Two cases of excessive time to transfuse were attributed to laboratory practice, 1 case where the laboratory released a unit to clinical staff which had insufficient time to complete the transfusion after removal from cold chain storage, and a 2nd case where the laboratory provided incorrect guidance to clinical staff about the amount of time a unit had been outside of cold chain storage.

The greatest overall increase in laboratory HSE errors was seen within cold chain errors, 64/69 (92.8%) reports in 2018 has increased to 83/107 (77.6%) in 2019. The largest cause of cold chain errors identified was equipment failure 65/83 (78.3%), followed by inappropriate return to stock 8/83 (9.6%), inappropriate storage 5/83 (6.0%) and transport and delivery 5/83 (6.0%). Many equipment failures were not detected until days after the incident, indicating that quality management and daily checks are not universally embedded within laboratory culture. The SHOT laboratory learning point from 2018 remains pertinent, ‘alerts must be dealt with immediately’ and ‘must be included in protocol/procedure’.

Case 10.1: Poor communication and assumptions lead to a non-compliant component being transfused

Red cells were collected from the laboratory by the correct transportation method at 01:32, and subsequently returned to the laboratory unused at 03:03 which equates to 1 hour and 31 minutes after collection. In accordance with the hospital policy this would deem that the units would not be appropriate for transfusion and consequently they should have been discarded and fated as not suitable for use. The units were entered into quarantine to be checked by a senior member of the team as the biomedical scientist (BMS) on duty was unsure of the appropriate time limits for out of controlled temperature storage for the unit. However, there was no adequate communication

between the staff and the assumption was made by another BMS that the units in quarantine had been assessed and approved as cold chain compliant. They returned the units to stock and in turn issued them to another patient whom they were transfused to. Fortuitously the patient did not come to any harm.

Case 10.2: Ambiguous standard operating procedures (SOP) for temperature excursion puts 23 patients at risk

Red cells which had been stored in a refrigerator with a core temperature between 6°C and 7°C for 4 hours were transfused to 23 patients. The temperature rise began after the refrigerator was shut incorrectly at 22:00 but was able to lock without an airtight seal. A further rise in temperature occurred at 01:35 and prompted a call from the helpdesk to the BMS working within the transfusion laboratory, however this alert was not acted upon. It is also assumed that the refrigerator alerted locally but was muted. The BMS was covering both haematology and transfusion departments and acting on 'autopilot', they were further required to review an urgent malaria screen and were feeling unwell. The temperature excursion was also not acted upon by the associate practitioner (AP) performing daily checks of the paper temperature chart for the next two mornings. The AP expressed confusion over the different temperature ranges for blood and reagent refrigerators, and the difference between air and load temperature displays. Upon investigation, it was found that the information in the SOP regarding recording of refrigerator temperatures was incorrect. A second AP checked the refrigerator on day 3 but did not escalate concerns as the SOP stated to record any deviations which occurred within the past 24 hours. Many units which had exceeded temperature control were returned to stock and re-issued to patients. The temperature increase was discovered 4 days after the excursion, but fortunately no patients came to any harm. The root cause analysis (RCA) from this case listed three causes which were all related to the errors and omissions made by individuals, and none related to the systemic failures highlighted. The hospital has updated their SOP and competency assessments relating to refrigerator temperature monitoring. The hospital is now in the process of implementing an updated temperature monitoring system.

This case illustrated multiple systemic factors which require improvement. It is essential that instructions are clear and unambiguous. Human error should only be considered when all other system factors are excluded.

Learning points

- Staff should be mindful not to make assumptions, especially in busy environments, during the transfusion process and are reminded to communicate at all times to mitigate against errors
- Staff should only take part in the transfusion process if they have been deemed competent to do so. Competency is best gained by training all staff with every relevant standard operating procedure (SOP) or policy, no matter how simple the content may seem. This should provide opportunities for clarifying any confusion and avoiding misunderstandings
- It is essential that instructions are clear and unambiguous
- Human error should only be considered when all other system factors are excluded

Near miss HSE cases n=164

There were 164 near miss HSE cases, 86/164 (52.4%) originated in the clinical area and 78/164 (47.6%) in the laboratory. The near miss HSE cases primarily involved cold chain errors in 123/164 (75.0%) followed by 31/164 (18.9%) cases where expired units were almost transfused to patients, 5/164 (3.1%) cases where the reservation period had been exceeded, 4/164 (2.4%) classified as 'miscellaneous' and 1/164 (0.6%) where a technical administration error was spotted prior to transfusion.

IT-related HSE cases n=76

Further details of the IT-related reports can be found in the supplementary information on the SHOT website (https://www.shotuk.org/shot-reports/report-summary-and-supplement-2019/).

Conclusion

The findings overall remain consistent with previous years' Annual SHOT Reports. SHOT reinforces the message that all staff who participate in the handling and storage of blood and blood components throughout the transfusion process should adhere to the correct procedures that are outlined in guidelines and their local transfusion policy. Transfusion policies should be based on the most current published guidance available (BSH Robinson et al. 2018).

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11 Avoidable, Delayed or Under/ Overtransfusion (ADU), and Incidents Related to Prothrombin Complex Concentrate (PCC) n=279

Authors: Paula Bolton-Maggs and Simon Carter-Graham

Key SHOT messages

- Do not delay in asking for help from haematologists when grossly deranged coagulation results are reported. Isolated prolongation of the activated partial thromboplastin time (normal thrombin time and fibrinogen) in a male infant indicates factor VIII or IX deficiency and warrants urgent investigation because appropriate factor replacement may be lifesaving
- There is continued evidence of poor understanding and activation of major haemorrhage procedures resulting in delayed transfusion
- Prothrombin complex concentrate administration remains poorly understood. When indicated this should be infused within an hour
- Children continue to be at risk of errors in volumes transfused
- All staff responsible for any part of the transfusion process must be adequately trained to identify available components and their doses
- Poor communication remains an important feature in delayed transfusion and avoidable transfusion of O D-negative units

Abbreviations used in this chapter

APTT	Activated partial thromboplastin time
AV	Arteriovenous
BMS	Biomedical scientist
CQUIN	Commissioning for Quality and Innovation
CT	Computerised tomography
FFP	Fresh frozen plasma
GCS	Glasgow coma score
Hb	Haemoglobin
HSE	Handling and storage errors
ICH	Intracranial haemorrhage
ICU	Intensive care unit
INR	International normalised ratio
IT	Information technology
IV	Intravenous
MHP	Major haemorrhage protocol
MDT	Multidisciplinary team
NICE	National Institute for Health and Care Excellence
NM	Near miss
PCC	Prothrombin complex concentrate
POCT	Point-of-care testing
PT	Prothrombin times
QA	Quality assurance
SD-FFP	Solvent-detergent fresh frozen plasma
SOP	Standard operating procedure
TEG	Thromboelastography
TACO	Transfusion-associated circulatory overload

Overview of ADU cases

- **Delayed transfusion n=129** (an increase from 117 in 2018)
- **Avoidable transfusions n=99** (106 in 2018)
- **Under or overtransfusion n=35** (an increase from 15 in 2018)
- **Cases related to PCC n=16** of which 11 were delays (an increase from 9 in 2018)

Some PCC cases involved delays in provision and avoidable use but have been counted and analysed separately from those related to blood components in line with the standard SHOT reporting definitions.

Death n=4

Three of these related to delay, 2 due to a delay in red cells, and 1 to failure to give PCC in a timely manner. The 4th case was related to inadequate component transfusion in major haemorrhage associated with surgery.

Major morbidity n=4

Three cases were delays reported in relation to major haemorrhage and the 4th due to delay resulting from inter-hospital transfer.

Near miss (NM) cases n=12

Seven of these were avoidable transfusions. One was a child where a diagnosis of sickle cell disease/ trait was not considered prior to surgery.

There was 1 near miss related to delay in provision of blood, 2 related to overtransfusions, and 2 related to PCC (1 delay and 1 overtransfusion).

Information technology (IT)-related ADU cases n=25

Twelve cases were avoidable transfusions; 2 related to point-of-care testing errors and there were 3 instances where patients had apparently low platelet counts due to clumps; these results should not have been reported.

Eleven cases related to delays and 2 were overtransfusion related to pump errors.

Further details of the IT-related reports can be found in the supplementary information on the SHOT website (https://www.shotuk.org/shot-reports/report-summary-and-supplement-2019/).

11a Delayed Transfusions n=129

Definition:

Where a transfusion of blood or blood component was clinically indicated but was not undertaken or was significantly delayed or non-availability of blood components led to a delay with impact on patient care (not restricted to emergency transfusion).

Key SHOT messages

- Patients are put at risk when staff do not act appropriately in the event of major haemorrhage
- Isolated prolongation of the activated partial thromboplastin time (normal prothrombin time, thrombin time and fibrinogen) in a male infant indicates factor VIII or IX deficiency and warrants urgent investigation. Laboratory standard operating procedures (SOP) should reflect this and all biomedical scientists who work 'on call' should be appropriately trained to recognise this

Recommendations

- All hospitals should regularly review their major haemorrhage procedures to ensure communication lines and practice this with drills (NPSA 2010)
- Laboratory tests of haemostasis must be interpreted in the context of clinical findings as well as other laboratory test results. Appropriate timely actions will help to avoid unnecessary delays in diagnosis and enable potentially lifesaving treatment for patients with unexplained bleeding

Action: Hospital transfusion teams, consultant haematologists, laboratory managers

Introduction

The number of reported delayed transfusions has increased from 106 in 2018 to 129 in 2019. There were 83/129 (64.3%) reports where the primary error occurred in the clinical setting, 45/129 (34.9%) in the laboratory and 1/129 (0.8%) was caused by a delayed flight. In 63/129 (48.8%) reports the need for the transfusion was emergency/urgent, 36/129 (27.9%) were elective transfusions and in 30/129 (23.3%), this was not recorded. Poor communication between the clinical and laboratory settings and staff shortages were the main contributory factors in these cases. In addition, there were 11 delays in administration of PCC, and these are counted and considered in that section. Please see Chapter 11d, Incidents Related to Prothrombin Complex Concentrate (PCC) for further information.

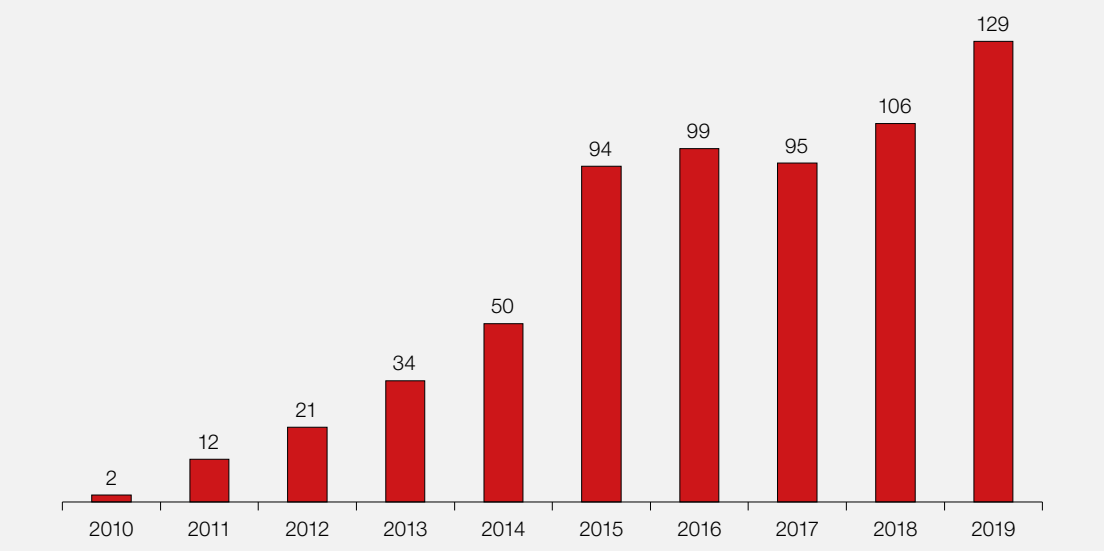


Figure 11a.1: Delayed transfusion reports by year 2010 to 2019

Death n=2

The delay was 'possibly' contributory to the patient's death in 2 cases.

A young man with bone marrow infiltration due to cancer (leucoerythroblastic blood picture) had a reported haemoglobin (Hb) 47g/L and was scheduled for a four-unit transfusion. He died two days later, not having received the planned transfusion. His Hb, prior to his death, was recorded on a point-of-care machine as 26g/L. The investigation noted that his life-expectancy was very poor, and it was unlikely that the transfusion would have made a difference.

A case that was not recognised by the reporter as a death related to delayed transfusion involved an elderly man with gastrointestinal bleeding with delayed diagnosis of a large duodenal ulcer. Clinical reviews and transfusions were repeatedly delayed with poor recognition of ongoing bleeding and transfers between departments. His Hb remained less than 60g/L over a prolonged period (17 hours) resulting in a cardiac arrest. At the inquest the coroner concluded that the recorded cause of death at 1b on the death certificate was 'haemorrhagic cardiac arrest'.

Learning point

- Gastrointestinal bleeding can be difficult to assess. Prompt recognition and timely management is imperative. Delays can contribute to patient death. Every second counts

A male infant in whom a diagnosis of haemophilia was delayed died from intracranial haemorrhage. This was due to an arteriovenous (AV) malformation and the clinicians did not think that an earlier diagnosis would have made a difference.

In a further case of delay, a woman in her 90s had delayed administration of PCC in relation to an intracranial bleed (this case is counted and described in Chapter 11d, Incidents Related to Prothrombin Complex Concentrate (PCC)).

Major morbidity n=4

Three cases were reported in relation to major haemorrhage.

A young man was admitted with major haemorrhage caused by a stabbing injury to his carotid artery. Red cells were rapidly available but the provision of fresh frozen plasma (FFP) was delayed (slow thaw) and platelets were not ordered urgently. The biomedical scientist (BMS) was lone working covering two departments leading to communication problems. The patient suffered a stroke which was attributed in part to delay in receiving plasma and platelets. A complete overhaul of the major haemorrhage policy and education of medical staff were undertaken.

An elderly man had severe gastrointestinal bleeding. There was delay in provision of blood components due to constraints in contacting the porter because of industrial action. Delay in correction of his coagulopathy resulted in admission to the intensive care unit (ICU).

A man in middle age was admitted as an emergency with serious gastrointestinal bleeding. There was delay in obtaining blood components for 1.5 hours after the major haemorrhage call due to lack of porters. This delay contributed to his deterioration requiring admission to the ICU with renal failure.

Case 11a.1: Inappropriate interhospital transfer in a patient with a falling Hb

An elderly woman was admitted after a fall (no fracture) 2 weeks from discharge following hip surgery (Hb 90g/L). She was found to have a popliteal vein thrombosis and was anticoagulated. Eight days later she was considered fit for transfer. However, her Hb had been falling and on the day of transfer was 58g/L. She was transferred at 12:00 before the blood results were reviewed. The hospital was experiencing winter pressure and the need to free up beds. Her condition deteriorated during transfer (National Early Warning Score (NEWS), 10), despite five hours at the second hospital, where electronic issue blood was available for the patient, she was returned to the emergency department at the first hospital for transfusion. After a delay of 45 minutes in the ambulance she was admitted at 18:00 (Hb now 46g/L). At this point the patient was showing signs of hypovolaemic shock. The first request form for crossmatched blood was sent to the laboratory without the required sample which further delayed the transfusion. When a second request for crossmatched blood was sent the laboratory staff were not informed of the urgency of the situation. The patient was transferred to a ward at 19:00; a blood transfusion had not been administered up to this point. The patient had a cardiac arrest at 22:00 and it was not until this point that she received a unit of emergency group O D-negative blood. Three additional crossmatched units were later made available and transfused. The patient survived and was eventually discharged home.

The internal review noted that 'the root cause of the incident was the most recent blood results for the patient were not reviewed prior to the patient transfer. A breakdown in communication, undefined control and command by the various teams involved in the patient's care led to fragmented management of the patient's clinical care'. A review of the transfer criteria/checklist for patients who are to be transferred between hospital sites was carried out to ensure patients are clinically fit and now includes a review of a patient's most recent bloods. At the time of the incident not all staff were aware of the major haemorrhage protocol, this highlighted learning and training needs. Staff are now aware of the major haemorrhage protocol and how it should be triggered. Staff training has been carried out for the administration of electronic issue blood. Provision of a 24/7 patient safety team including operational bed manager and critical care outreach team now provides organisational wide command and control for such unpredictable patient deterioration. The pressure on bed availability was a systems issue which contributed to the need for transfer.

Delayed transfusion associated with major haemorrhage n=16

Sixteen cases of major haemorrhage were associated with delay. One was not associated with activation of the major haemorrhage protocol (MHP), but 15 were. Six cases reported delay due to porter access, 2 due to pager failure. Overall, 6 reports cited issues with logistics and provision of components and 6 cited communication issues between the clinical area and the laboratory, but review of the cases showed several problems with communications affecting 15/16 cases. These are the same issues as identified in 2018. Eleven were emergency transfusions, 3 urgent and in 2 cases not specified. Six cases were in the emergency department or medical admissions unit, 4 in wards, 5 in theatre, recovery or ICU and 1 in obstetrics.

There was poor understanding of MHP; staff had not been trained and did not know what number to call. In 8 cases FFP provision was delayed. Further education about the time required to thaw FFP is required for clinical teams.

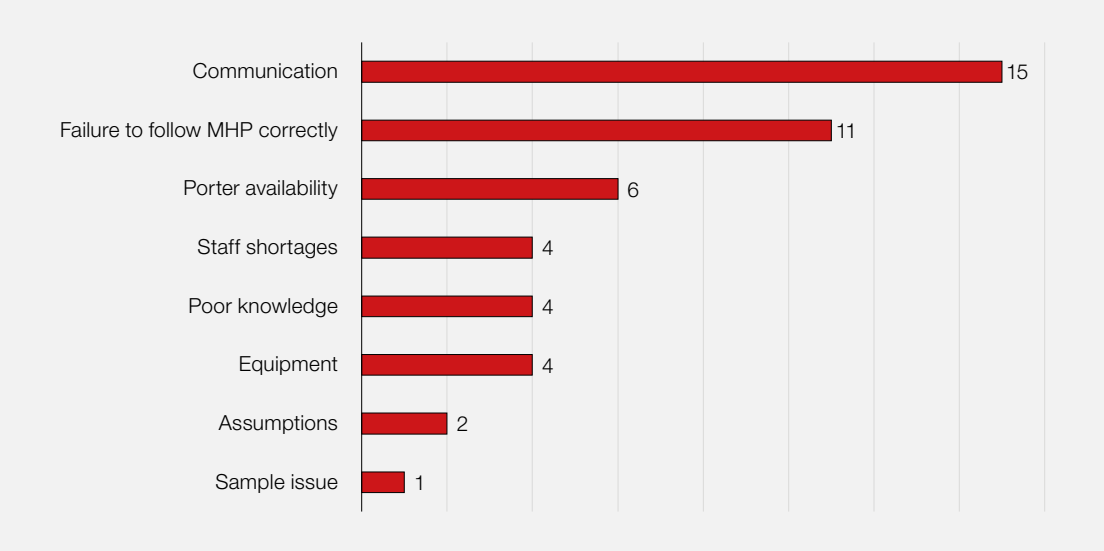


Figure 11a.2: Factors contributing to delayed transfusion in 16 cases

MHP=major haemorrhage protocol

There were delays in transportation of components between a hub with a transfusion laboratory and a specialist hospital with a surgical unit. A young man bled during elective surgery for malignant disease requiring platelets and plasma which took 1.5 hours to arrive (a distance of about 2 miles, usual transport time less than 10 minutes). The courier was delayed and could not be contacted. This patient received eight units of red cells, eight of FFP and two of platelets.

Illustrative cases

It is important that there are clear lines of investigation and accountability where multifactorial errors occur. One elective transfusion was delayed by several hours following a need for samples to be taken four times. After the first sample was sent the ward was told no request for blood had been made by the doctor. The second and third samples were rejected by the laboratory staff as the sample forms were not completed correctly. A fourth sample was sent, tested and blood was made available. The original request form was eventually found in the laboratory, meaning the first sample could have been tested after all. This caused a delay of 9 hours. There was no case review and no transfusion team input as the hospital had contracted out to a private laboratory provider. The fundamental reason for the delay in this case was the misplaced blood request form in the laboratory. A junior doctor involved with the inaccurate request form completions received training due to the subsequent sample errors.

Treatment with solvent-detergent treated FFP was delayed for a woman with acute myeloid leukaemia because the BMS did not know how to issue it – this case is discussed in Chapter 14, Laboratory Errors, Case 14.2.

Case 11a.2: Delayed treatment of gastrointestinal haemorrhage

A man in his 60s was admitted with chest symptoms and possible gastrointestinal bleeding. His Hb fell over 2 days from 115g/L to 96g/L on day 2, and 50g/L early the following morning when he had a cardiac arrest. Although the laboratory staff provided all components promptly there were misunderstandings with the medical staff who had not received adequate training, and communication was confused. The review considered that transfusion could have occurred earlier as the Hb was clearly falling.

Case 11a.3: Delayed treatment of severe anaemia

An elderly woman was admitted with anaemia, possibly due to bleeding. Her Hb was 45g/L and she was not adequately transfused over the next 6 hours and had a cardiac arrest. The patient was located in a busy and overflowing department and was moved several times during her stay which contributed to the delay. As a result of this incident changes to clinical practice have been implemented regarding the group-check sample rule (i.e. that in an emergency, O D-negative units can be obtained).

Case 11a.4: Missed diagnosis and delay in treatment of a child with haemophilia and intracranial bleeding

A male infant <6 months of age presented to hospital A with a history of falling down the stairs while in his mother's arms. The child was seen by a consultant and was noted to be unharmed, and there were no safeguarding concerns.

Six days later the infant re-presented at hospital A with an acute collapse. The computerised tomography (CT) scan showed an extensive intracranial bleed with mid-line shift. Two coagulation screens showed an un-clottable activated partial thromboplastin time (APTT) with normal prothrombin time (PT). No further investigations such as coagulation factor assays were performed. The infant had vitamin K administered before transfer to a tertiary centre, hospital B. He was transferred as a time critical transfer, details of the discharge summary and communication between hospitals was not available.

At hospital B the infant was electively intubated. Coagulation samples were sent to the laboratory ~8 hours following admission. His APTT was 101 seconds with normal PT and thrombin time. The BMS noted in the report that these were abnormal and requested a repeat, but the abnormal results were not discussed with a haematologist by either the laboratory or clinical teams. Solvent-detergent fresh frozen plasma (SD-FFP) was requested, and 3 units of SD-FFP were issued and transfused. This resulted in partial improvement in APTT to 47s but not full correction. After the third plasma transfusion, the results were discussed with a haematologist over 24 hours after admission to hospital B. A diagnosis of haemophilia A was made following specific blood tests for clotting factors (factor VIII found to be 7IU/dL). Factor VIII concentrate was administered 48 hours after admission, and 36 hours post APTT of 101s. The child also had a pulmonary haemorrhage and subsequently died from the intracerebral bleed. The case review noted that an intracranial arteriovenous malformation was the cause of bleeding. RCA identified lone BMS working overnight covering haematology/ blood transfusion with unclear SOP combined with lack of recognition of importance of isolated prolongation of APTT by clinical and laboratory staff as key factors and corrective and preventive action to address these were instituted.

There are several learning points from the case to help improve patient safety and care given in similar situations in the future with learning applicable to both clinical and laboratory teams. Essentially the diagnosis of haemophilia was delayed resulting in delayed institution of the right treatment.

An isolated prolonged APTT in a male infant (with normal PT and TT) is characteristic of severe haemophilia A (factor VIII) or B (factor IX deficiency). This requires urgent investigation, even outside core hours, as the correct replacement therapy can be lifesaving. This was missed in both the hospitals involved. At each hospital, no contact was made by either the clinical or the laboratory staff to immediately alert the haematology medical staff to seek advice or arrange factor assays. Intracranial haemorrhage is a recognised presentation of severe haemophilia at this age and although this child had an AV malformation, the previous history of a fall down the stairs 6 days prior has added significance. If the haemophilia had been known the child would have received prophylactic factor cover. Vitamin K is not indicated for treatment of an isolated prolonged APTT.

The BMS in the second hospital was under pressure, lone working on night shift covering haematology, coagulation and blood transfusion. Whilst coagulation results are often abnormal in patients in ICU, medical staff also failed to recognise the significance of isolated prolongation of APTT in a male infant with intracranial bleeding. The standard operating procedures (SOP) have been revised appropriately to clarify laboratory action when there is an isolated prolonged APTT and procedures for authorising FFP. Laboratory staffing has been reviewed with a plan to ensure that there are two qualified BMS at night with clear policy for escalation. The UK Transfusion Laboratory Collaborative standards (2014, being updated currently) set out the minimum standards for staff qualifications, training, competency and the use of information technology in hospital transfusion laboratories and compliance with these are accepted by both the United Kingdom Accreditation Service (UKAS)/Clinical Pathology Accreditation (UK) Ltd (CPA) and the Medicines and Healthcare products Regulatory Agency (MHRA) as evidence to support their inspection programmes for laboratories.

This case also demonstrates the importance of a comprehensive, full handover of complex patients between hospitals to ensure no relevant history or test results are overlooked. Education of clinical staff as well to be able to recognise red flags in interpreting basic haemostatic tests and the importance of timely management is vital.

Delay in requesting appropriate tests was a significant factor in this case. Clinical teams need to ensure that appropriate samples are sent based on clinical profile with correct tests requested, results followed up and actioned. Safe patient care is only possible when all staff involved work collaboratively with a shared responsibility. Coagulation screening is frequently performed in unwell patients, often inappropriately, and results are often misunderstood (Amukele et al. 2011, Samkova et al. 2012). Consultant and trainee haematologists will be able to assist in interpreting the results and taking appropriate actions. Figures 11a.3 and 11a.4 summarise the basic coagulation tests and their interpretation.

Learning points

- Severe abnormalities of coagulation in a bleeding patient require urgent discussion with a haematologist
- Severe bleeding disorders can present in neonates and early childhood in the absence of family history
- In the neonatal period and up to 6 months of life the interpretation of coagulation results can be complex and normal ranges appropriate for age and gestation should be used, thus underlining the need for early specialist input
- Laboratory coagulation standard operating procedures should state what action to take when there is an unexpected isolated prolonged APTT. There should be urgent discussion with a haematologist. Factor VIII and IX assays should be performed as an emergency so that the missing factor can be replaced. Fresh frozen plasma does not contain a sufficient concentration of the missing factor to correct haemophilia A or B and treat bleeding in this setting
- Communication between hospitals during patient transfer must be comprehensive and include all laboratory information including any pending results
- Clinicians must provide laboratory staff with relevant clinical information so that they provide appropriate interpretation of results and be open to challenge by laboratory staff
- A holistic systems approach to incident investigation, reviewing timelines and mapping events throughout the patient journey would help to identify missed learning opportunities

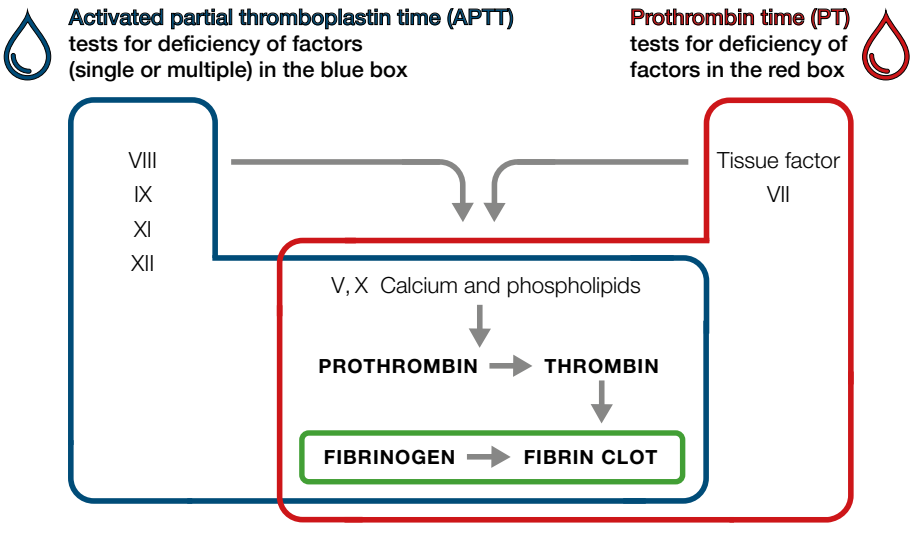


Figure 11a.3: Mechanisms of the coagulation screen to show which coagulation factors affect the standard tests

Figure 11a.4: Interpretation of the coagulation screen

Prothrombin time	Activated partial thromboplastin time	Thrombin time	Interpretation
Abnormal	Normal	Normal	Factor VII deficiency
Normal	**Abnormal**	Normal	Deficiency of FXII, XI, **IX, VIII** (single or multiple)
Abnormal	Abnormal	Normal	Deficiency in the common pathway, isolated V or X deficiency. Multiple factors e.g. liver disease, warfarin therapy

Notes: *many sick patients have disturbances of coagulation tests that* ***do not predict bleeding (and in some cases are associated with a thrombotic risk)****. These tests were introduced in the 1960s to screen for congenital factor deficiencies. The PT is very sensitive to FVII deficiency and is used for warfarin monitoring but note that the APTT will also be prolonged (because FIX is reduced) but to a lesser extent. The sample must be taken carefully (good venepuncture, free flow) to avoid activation and in the correct volume (as it is taken into a specific volume of anticoagulant citrate) to avoid erroneous and misleading results.*

Isolated prolongation of the APTT can be due to haemophilia A (FVIII deficiency) or B (FIX deficiency,) where the need for diagnosis and treatment is urgent. It is also prolonged in FXII deficiency (common but of no clinical significance) and factor XI deficiency (uncommon and usually not associated with serious bleeding). The thrombin time does not depend on other coagulation factors as thrombin is added to the test system. Many laboratories measure the amount of fibrinogen rather than the thrombin time. (Prolongation of standard coagulation tests can also be caused by inhibitors).

Vitamin K results in increased synthesis of factors II, VII, IX and X so will correct the PT but not FVIII, FXI, V or X deficiency. Normal ranges are different in childhood and any hospital with paediatric patients must use an age-appropriate normal range to avoid unnecessary investigation and treatment.

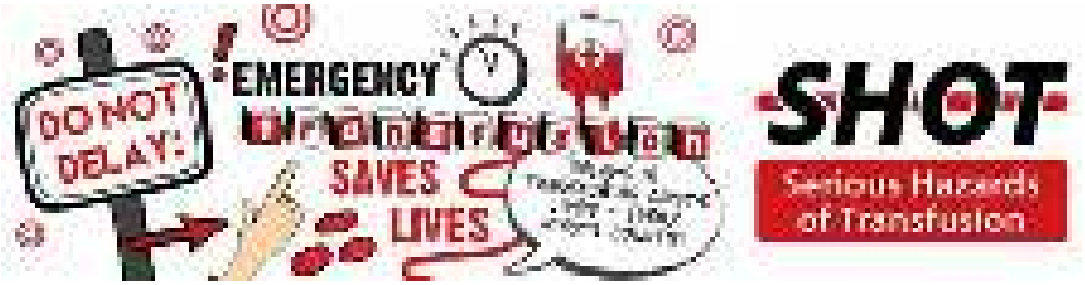
Near miss delays n=1

A major haemorrhage call was initiated for a patient with an obstetric bleed. Emergency group O D-negative red cells were not available from the two satellite refrigerators due to the need for temperature calibration but were rapidly released from the main laboratory. Laboratory staff had not informed clinical staff that no emergency units would be available from the satellite refrigerators.

Conclusion

The cases reported and described above are of extreme concern and demonstrate systemic shortcomings that should be urgently addressed. These include review of the porter services and emergency back-up arrangements. Where the use of refrigerators has to be suspended temporarily (or longer) for maintenance there must be clear communication of alternative procedures for emergencies.

The management of major haemorrhage continues to require improvement in many hospitals with attention to streamlining communication, training and drills.



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Avoidable Transfusions n=99

11b

Definition:

Where the intended transfusion is carried out, and the blood component itself is suitable for transfusion and compatible with the patient, but where the decision leading to the transfusion is flawed.

Key SHOT messages

- Group O D-negative units are being used when D-positive would be appropriate in more than 50% of cases
- Poor communication resulted in avoidable use of D-negative units when crossmatched or group specific units were available
- Haematinic deficiencies continue to be poorly recognised and managed inappropriately
- Take time to identify patients and label the sample correctly. This avoids the need for repeat samples

Recommendations

- Hospitals should review their use of O D-negative units and ensure that group O D-positive units are used in emergencies in older patients as advised by guidelines (NBTC 2019)
- Hospitals should promote the Choosing Wisely recommendations related to transfusion and note the NHS Commissioning for Quality and Innovation (CQUIN) safety indicators for preoperative anaemia prior to major surgery

Action: Hospital transfusion committees

Introduction

In addition to the 99 cases, there were 3 cases counted under ‘delays’ with avoidable transfusion, and 4 cases of avoidable PCC administration.

Death n=0

There were no deaths related to the transfusion in this category.

Major morbidity n=0

Avoidable transfusions

Many avoidable transfusions result from wrong results and poor communication. Hospital policies for use of O D-negative units need updating. Note that 23 patients developed transfusion-associated circulatory overload where they received excessive red cell volumes (more appropriately calculated according to weight) and they are reported in the Chaper 17b, Transfusion-Associated Circulatory Overload (TACO).

Avoidable use of group O D-negative units n=31

More than half of these patients (23/31, 74.2%) were adult men and women over 50 years of age. Twenty-two required urgent or emergency transfusion and could therefore have received group O D-positive units.

Learning point

- Group O D-negative red cells are in short supply. Hospitals should use the available toolkit, and transfusion policies should ensure that group O D-positive units are used in emergencies in older patients as advised by guidelines (NBTC 2019)

Crossmatched or group-specific units

In 10 cases crossmatched units were available, and in 5 cases group-specific units could have been given.

Learning point

- It may be useful to have a standard operating procedure for the issue of emergency blood that involves a check of previous pre-transfusion testing in all but the most dire emergencies. This may identify instances where crossmatched units were available

In 5 cases group O D-negative units were used because of delays obtaining crossmatched units due to earlier errors, particularly labelling errors leading to sample rejection and need for repeat samples. One preoperative crossmatch was missed due to failures of communication.

Case 11b.1: Panic at low haemoglobin (Hb) level results in avoidable use of group O D-negative blood

A patient in her 60s was readmitted with bleeding from arthroscopy sites. Her Hb had fallen to 67g/L from 87 four days previously. Her international normalised ratio (INR) was 7.7 (on warfarin for mitral and aortic valve replacements). She was not hypotensive or decompensated. The junior staff gave emergency O D-negative units against the advice of haematology staff. A sample was available in the laboratory and she could have received group-specific units. The INR was corrected using intravenous (IV) vitamin K.

Haematinic deficiencies n=9

Six patients (all female) with iron deficiency and 3 with vitamin B12 and/or folate deficiency received avoidable transfusions. One patient received an unnecessary unit of emergency O D-negative blood. Iron deficiency is common in pregnancy and could be detected as a result of the first blood test taken at the booking visit.

A woman with symptomatic iron deficiency, Hb 59g/L, had a delay in transfusion for several hours while the medical team tried to obtain intravenous iron from pharmacy, but this was not available out-of-hours. (This case is counted in delays). A single unit given in timely fashion would have been appropriate followed by IV iron.

Two men with anaemia and minimal symptoms were transfused inappropriately (one prescribed by a consultant) for B12 deficiency. In contrast one symptomatic woman in her 80s with B12 deficiency, Hb 32g/L, had a delay in transfusion of nearly 16 hours.

Five ‘choosing wisely’ recommendations have been published recently which promote a reduction in unnecessary transfusion (The Royal College of Pathologists 2020).

The NHS England CQUIN scheme for 2020-21 (NHS England 2020) will include a patient safety indicator focusing on the management of preoperative anaemia in patients awaiting major surgery. The overall aim is to ensure that at least 60% of patients are treated in accordance with National Institute for Health and Care Excellence (NICE) guidelines (NICE 2015). 'Major surgery' in this CQUIN includes cardiac surgery, colorectal resection, cystectomy, hysterectomy, hip and knee replacement, and open arterial surgery.

In order to qualify, there is an expectation that within 6 weeks prior to surgery patients will have:

1. Hb measurement to screen for anaemia AND
2. If anaemic, serum ferritin measurement AND
3. If iron deficiency anaemia diagnosed, appropriate oral or IV iron therapy started

Learning points

- Medical staff, particularly those working in emergency departments, need better education about anaemia, in particular how to recognise iron, B12 and folate deficiency which can often be treated with the missing vitamin alone, but when an elderly patient has severe symptoms a limited (usually single unit) transfusion may be indicated
- Primary care physicians have a responsibility to understand and manage haematinic deficiencies appropriately
- The transfusion-related 'choosing wisely' recommendations should be widely promoted, and patients should be encouraged to discuss the appropriateness of their transfusions

Platelet transfusions n=16

Five patients received inappropriate platelet transfusions after low counts were reported without film review. All had platelet clumping. Another patient received an unnecessary platelet transfusion prior to surgery as she was thought to be on clopidogrel, but this had been stopped 4 years previously.

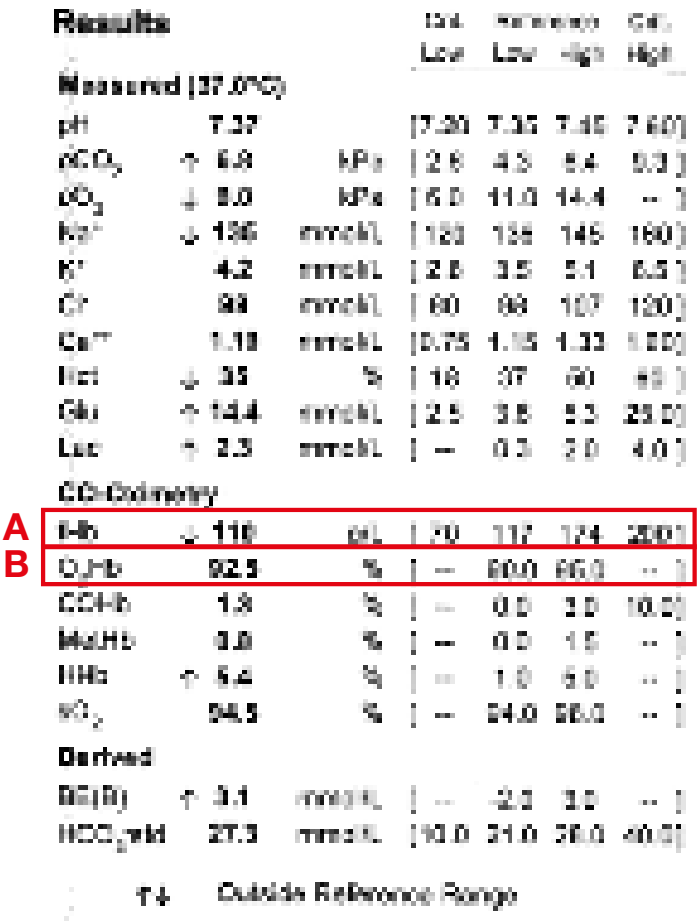
Learning point

- Unexpected low platelet counts should prompt film review and consideration of the possible diagnosis before platelet transfusion is triggered

Prescription for avoidable red cell transfusion based on wrong Hb results n=27

A variety of causes were described. Two patients were transfused on the basis of other patients' results due to 'wrong blood in tube' errors. Erroneous results from blood gas analysers were reported in 5 cases. In 1 instance the point-of-care haemoglobin machine gave a wrong result due to faulty control material. Causes included diluted samples and malfunction of a machine which required cleaning. In 1 case the blood gas printout was wrongly read taking the result for O_2Hb instead of the total Hb. The O_2Hb of 47% was misinterpreted by medical staff as a low Hb of 47g/L. The elderly patient had haematemesis. As a result of the erroneous interpretation, the MHP was activated but stood down when it was realised that the correct Hb was 134g/L (see Annual SHOT Report 2018 page 81 for a similar report last year (Narayan et al. 2019)).

Figure 11b.1: Example of a blood gas result illustrating the difference between total Hb (A) and O2Hb (B) (not the actual case described above)



Learning point

- Healthcare staff should ensure that they know how to read point-of-care test results from blood gas analysers where CO-oximetry results give several different haemoglobin (Hb) variants (e.g. methaemoglobin, carboxyhaemoglobin and reduced haemoglobin as 'HHb'). None of these are the correct or relevant Hb results. If a point-of-care result must be used the correct line is the total Hb, tHb

Plasma and cryoprecipitate transfusions n=6

Fresh frozen plasma (FFP) continues to be given inappropriately either for procedures that do not need it, or at levels of INR that do not need correction (4/6 cases). In 1 case cryoprecipitate was ordered but FFP given without prescription.

Case 11b.2: Use of the wrong haemorrhage protocol leads to inappropriate transfusion of cryoprecipitate

A woman in her 70s bled following an insertion of an intramedullary nail. Thromboelastography results were interpreted using the postpartum haemorrhage protocol and she received cryoprecipitate. The laboratory fibrinogen level was 2.2g/L. A level 2.0 to 3.0g/L would trigger replacement in postpartum bleeding but not in other non-obstetric bleeding. The transfusion was also not properly recorded.

Near miss cases n=7

Reasons included mix up of names (in 1 case the doctor was noted to be exhausted), asking for emergency O D-negative units when crossmatched units were available, failure to check Hb between units and requesting transfusion based on a diluted sample.

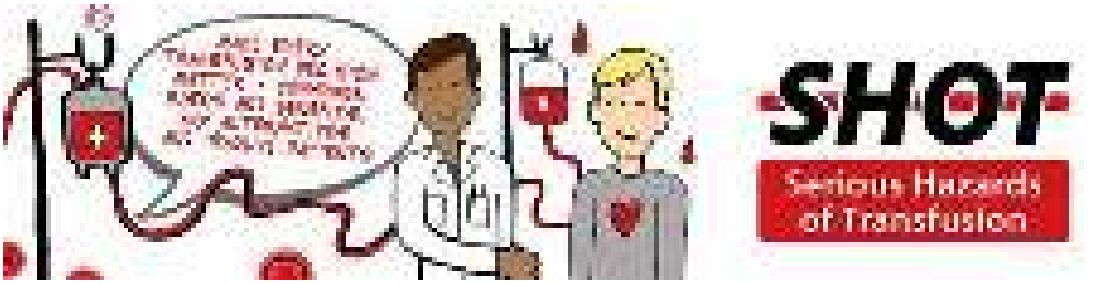
The most serious of these was failure to consider sickle cell disease or trait in an Afro-Caribbean child requiring surgery for a fractured femur. Staff had failed to follow their protocols, but transfusion was avoided, and a diagnosis of sickle trait made.

Conclusion

Many transfusions are unnecessary as illustrated above. All staff using point-of-care machines, particularly blood gas analysers, should ensure they understand the results.

Hospitals should follow Blood Service guidelines in relation to use of D-negative units:

The National Blood Transfusion Committee (England) recommends that 'D-negative adult males or women >50 years old with no known anti-D antibodies undergoing major haemorrhage and requiring a significant number of units (>8 units), may receive O D-positive red cells'. Also, 'hospitals should consider usage of O D-positive red cells for unknown adult male patients and women >50 years. The risk of an adverse outcome is likely to be low in this emergency setting and helps conserve O D-negative supply'. A toolkit and other resources are available (NBTC 2019; Carter-Graham et al. 2019).



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11c Under or Overtransfusion n=35

Definition:

A dose/rate inappropriate for the patient's needs, excluding those cases which result in transfusion-associated circulatory overload (TACO). Infusion pump errors leading to under or overtransfusion (if it did not lead to under/overtransfusion then it is reportable under handling and storage errors (HSE)).

Key SHOT messages

- Volume calculation of blood components in paediatric patients continues to be of concern
- Laboratory scientists should be empowered to question inappropriate requests with support from haematologists
- Point-of-care testing should be set up collaboratively with laboratory support using agreed protocols and standardisation, and hospitals should participate in national quality assurance programmes
- Correct cryoprecipitate dosing is important to avoid under or overtransfusion

Recommendation

- All medical staff, including consultants, who prescribe or authorise blood components must receive transfusion training in order to recognise components, their indications and appropriate volumes

Action: Hospital transfusion teams, hospital medical directors

Introduction

Thirty-five cases were reported in this category of which 30 were overtransfusions. Eleven of these 30 (36.7%) were in children, age range 13 days to 14 years.

Death n=1

An adult died with massive haemorrhage during surgery with inadequate component replacement. Death was considered to be 'possibly related' and is described below.

Case 11c.1: Haemorrhage during surgery with fatal outcome

A woman in her 40s with advanced rectal cancer bled during surgery. The patient started bleeding at varying rates in surgery at 14:00, until this increased at 16:00. There are conflicting reports of when the major haemorrhage protocol (MHP) was activated by the theatre team and the correct procedure was not followed. The biomedical scientist (BMS) reported that the team requested red cells and to withhold the fresh frozen plasma (FFP).

The patient was being monitored with thromboelastography (TEG) so samples were not sent to the laboratory for clotting. FFP was not required because the thromboelastogram was normal. Misinterpretation of Hb levels contributed and there was no documentation of blood loss during surgery. The patient became haemodynamically unstable and the first suggestion of coagulopathy was made at 3 hours from the start of surgery. A request for FFP was then made and haematology contacted for advice. In total she received 26 units of red cells, but only six of plasma, two of platelets, two pools of cryoprecipitate and fibrinogen concentrate once the coagulopathy was evident, but she unfortunately died 3 hours later during the surgery.

This hospital had not followed the recommendations of the National Patient Safety Agency Rapid Response Report (NPSA 2010). Following this case, the MHP was reviewed, and training instituted. New standard operating protocols were established for TEG, for intraoperative blood loss, and quality processes were developed for point-of-care testing.

Learning point

- Hospitals using thromboelastography (TEG) should participate in national quality assurance to increase reliability of their results (https://www.neqascoag.org/point-of-care-poc/point-of-care-programmes/rotem-teg-testing/). Three samples are sent out per year
- The results of bedside testing technologies, such as thromboelastography, should only be interpreted by those with adequate training and knowledge of the specific platform. They should be used in conjunction with patient's clinical symptoms and other testing parameters

Major morbidity n=0

No patients suffered major morbidity. One adult received more red cell units than necessary in the course of elective caesarean section for placenta accreta. A fall in blood pressure during the operation was thought to be due to occult bleeding. Her post-transfusion Hb was 171g/L and she received 10 days of low molecular weight heparin.

It is difficult to criticise transfusion in this case of surgery with a high risk of bleeding. This could be considered a reasonable clinical decision.

Illustrative cases

Paediatric cases n=11

In 11 paediatric cases of overtransfusion (2 of platelets, 9 of red cells) errors were made in calculation of volumes required or pumps were set incorrectly. In 2 instances parents of regularly transfused children (both with haemoglobinopathy) noticed that the transfusion was excessive.

In another case the need for transfusion in a child weighing 3kg was discussed at the multidisciplinary team (MDT) meeting. Although a doctor said '300mL' when the correct dose was 30mL; the rest of the team agreed. Nobody realised this was 10 times the volume required, and the electronic prescribing system had no inbuilt rules to prevent a prescription of such a large volume for a 3kg child. See Case 22.5 in Chapter 22, Paediatric Cases.

Errors in doses of blood components due to lack of knowledge

Case 11c.2: Prescription of five times the correct dose of cryoprecipitate

A young woman was admitted as an emergency with a diagnosis of myeloma with spinal cord compression. During admission she developed marked haemoptysis with evidence of deranged coagulation. Following transfusion of FFP, she was prescribed '10 units' of cryoprecipitate and received seven of these. The correct dose was two units (two pools of five). There was confusion between the locum doctor, who had no experience of prescribing cryoprecipitate, and the haematology

registrar, and this prescription was not challenged either by the laboratory or the nursing staff. It was clear that all staff groups required education about the correct dose of cryoprecipitate.

Case 11c.3: Overdose of platelets

A man in his 80s with a platelet count of 15x10^9/L received four adult therapeutic doses of platelets prescribed by a consultant, where one dose would have been appropriate. The request of 1 'mega' unit was interpreted as being 4 normal therapeutic units and all were transfused. The use of 'non-conventional' terminology by the requesting clinician was compounded by failure to clarify what was required for the patient by several people involved in this incident. The patient made a complete recovery.

Learning points

- All staff involved in transfusion must have mandatory transfusion training which should include identification of all blood components, and instruction about appropriate dosing particularly in paediatrics. The adult cryoprecipitate dose was changed from five single units to pools of five in 2006. A mobile application 'Blood Components' is available to assist blood component dosage (NHS 2018)
- Laboratory staff should be encouraged to challenge inappropriate requests with support from their clinical haematologists

Near miss cases n=2

One of these was a neonate for whom the wrong volume of red cells was prescribed but recognised before transfusion. In the 2nd case red cells were ordered and prescribed for a woman who did not need them.

Conclusion

Paediatric transfusion continues to be a cause for concern. Transfusion training should ensure that clinicians authorising transfusions understand the use of all blood components including indications, monitoring, recognising and managing adverse reactions. Point-of-care testing (POCT) equipment, such as thromboelastography, are proven, powerful technologies that can turn around accurate results in a timely manner. However, their use requires trained staff competent to carry out tests accurately, interpret results correctly and take appropriate action promptly. A quality assurance (QA) programme encompassing training, personnel, equipment, appropriateness of testing, pre-analytical, analytical and post analytical aspects of POCT from sample collection to documenting the final result, is key to the delivery of an accurate and reliable POCT programme (BSH Mooney et al. 2019). Finally, all transfusion decisions must be made after carefully assessing the risks and benefits of transfusion therapy. Clinical and laboratory staff must work collaboratively and in a co-ordinated fashion to be able to deliver individualised, holistic, patient-centred care. This was a key SHOT recommendation in 2018.

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Incidents Related to Prothrombin Complex Concentrates n=16

11d

Definition:

Reporters are asked to report any issues with the prescription and administration of prothrombin complex concentrate. This includes delays in administration, inappropriate prescription or problems with administration.

Key SHOT message

- Serious bleeding in patients on warfarin puts their lives at risk. Rapid assessment is required and treatment with vitamin K and prothrombin complex concentrates (PCC) should be administered within 60 minutes and before the patient is transferred between departments or wards

Recommendations

- Hospital policies for administration of prothrombin complex concentrates (PCC) where intracranial haemorrhage is suspected or confirmed should ensure that this treatment is given within 60 minutes
- Teaching about PCC should be included in transfusion training for all staff

Action: Consultant haematologists, hospital transfusion teams

Introduction

PCC allows rapid reversal of warfarin in the context of major or life-threatening bleeding (including intracranial bleeding) usually within 10-30 minutes, but has a transient effect related to the half-life of the factors. Complete longer-term reversal of warfarin requires treatment with vitamin K in addition. Other indications for use of PCC should be discussed with a consultant haematologist and locally agreed protocols followed. It is important to note that PCC is a blood product and therefore unacceptable to some, e.g. Jehovah witnesses. This requires discussion, as some patients who refuse blood components and are bleeding may agree to receiving this.

PCC contains four coagulation factors (II, VII, IX and X). These are the factors that are lowered by warfarin therapy so infusion of these (marketed in the UK as Beriplex® and Octaplex®) results in very rapid correction of the international normalised ratio (INR) in patients on warfarin and is indicated for treatment of bleeding in these patients, particularly for intracranial haemorrhage (ICH).

Sixteen cases were reported in 2019, an increase compared with previous years (12 in 2016; 5 in 2017; 9 in 2018). These are elderly and vulnerable patients, all more than 60 years and 11 more than 80 years of age.

There were 11 cases of delayed administration, 4 in patients with ICH. PCC administration was avoidable in 4 cases; in another case a patient received fresh frozen plasma (FFP) when they should have been treated with PCC. In addition, 2 cases of near miss were reported.

Death n=1

In 1 case delay in treatment with PCC possibly contributed to death.

A woman in her 80s with a mechanical heart valve, treated with warfarin, fell at home sustaining a fractured humeral head. She also had mild anaemia but no evidence of intracranial bleed on admission. Subsequently she was hypertensive and recovering slowly but developed a reduced Glasgow coma score (GCS). An urgent brain computerised tomography (CT) scan showed spontaneous ICH. The neurosurgeons did not want to manage this surgically. They advised reversal of anticoagulation with vitamin K which was given immediately and PCC which was delayed for 5 hours. The patient died as a result of the bleed 5 days later. The delayed PCC administration resulted from confusion about prescription (electronic) and ordering (from the transfusion laboratory). The junior doctor had ordered it but not prescribed it. The system has now been changed to ensure there is no ambiguity.

Major morbidity n=0

There were no cases where major morbidity resulted from PCC errors.

Common features

Review of the cases demonstrated misunderstandings about administration such as a wrong rate and contents of vials added to normal saline. However, the instructions that come with the product are clear and should be followed. Delays were introduced by patient transfers between departments.

Delayed administration of PCC n=11

Miscommunication between the emergency department (ED) and wards to which patients were subsequently admitted resulted in delayed treatment in 5 cases with serious bleeding. These delays ranged from 2.5 to 24 hours.

A patient with ICH did not receive PCC for 10 hours although they had received intravenous vitamin K in the ED. Review of this case resulted in a change to hospital policy. Where ICH is suspected in a patient on warfarin 1000IU of PCC can be administered before the INR is known and before the head CT scan.

In another instance the hospital had insufficient stock to treat 2 patients who each required 3000IU.

Inappropriate administration of PCC n=4

In 1 case a patient had consumed rat poison and was given PCC but all coagulation tests were normal. A 2nd patient with gastric bleeding was given 500IU in preparation for surgery. This had not been prescribed and the surgery did not take place.

A patient on the coronary care unit developed gastrointestinal haemorrhage. The coagulation tests were abnormal with INR 7.4 and activated partial thromboplastin time (APTT) was ‘unrecordable’. He was not on warfarin and it is unclear why the coagulation tests were so abnormal. A discussion between the junior doctor, medical registrar and consultant haematologist resulted in administration of 3000IU PCC, this is contrary to guidance for the use of PCC (NICE 2015).

The abnormal results could have been caused by poor sampling either from a heparinised line or dilution.

Case 11d.1: An asymptomatic patient with very high INR received PCC

An elderly lady with no bleeding but a history of falls was on warfarin for atrial fibrillation. Her INR was very high, 16.2, and she received vitamin K and 3000IU of PCC as an outpatient as prophylaxis on the advice of the Patient at Home team.

This is a balance of risks. The guidelines for a high INR without bleeding recommend the following:

Asymptomatic patients with an INR of ≥ 8.0 should receive 1–5 mg of oral vitamin K (1B). The INR should be rechecked the following day in case an additional dose of vitamin K is required (Makris et al. 2012). In this instance the physician thought the risk of fall (and potential for serious harm

added to by age) was sufficient to warrant reversal, particularly as the patient was at home. Guidelines are not rules. Many hospitals would report an INR of 16 simply as >10. The management here was rational but did not follow guidelines.

Learning point

- Delayed treatment often results from transfer of patients from the emergency department to wards. If prothrombin complex concentrate (PCC) is indicated, it should be given before the patient is transferred

Near miss cases n=2

An elderly man was prescribed PCC to run over a prolonged period of several hours, but this was noted and corrected prior to infusion.

In the 2nd case (transplant surgery) the anaesthetist calculated a dose greater than required (2500IU rather than 2250IU) and then requested a further dose of 1000IU about 4 hours later. This was not appropriate as the maximum recommended dose in 24 hours for this product in these circumstances is 2500IU. The standard operating procedure for PCC was ambiguous and required revision. Medical staff are likely to be unfamiliar with the protocol which in this case was kept in the laboratory. The laboratory biomedical scientist should have challenged the request but was not up to date in competency assessment. The request for the additional dose was brought to the attention of the consultant haematologist who liaised with the medical staff and cancelled it.

Conclusion

PCC is usually required for emergency treatment of bleeding in patients on warfarin. It is usually stored in transfusion laboratories. There may be confusion about location and how to administer this resulting in delay. Patients with ICH should receive PCC within an hour of the decision being made.

SHOT is aware that this is an under-reported area. NHS Trusts and Health Boards are encouraged to regularly review use of PCC and identify areas for improvement.

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12 Near Miss (NM) Reporting n=1314

Author: Courtney Spinks

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.

Abbreviations used in this chapter

ADU	Avoidable delayed or under/overtransfusion	**ID**	Identification
BMS	Biomedical scientist	**Ig**	Immunoglobulin
DOB	Date of birth	**LIMS**	Laboratory information management system
EPI	Electronic patient identification	**NHS**	National Health Service
EPR	Electronic patient record	**NM**	Near miss
Hb	Haemoglobin	**RBRP**	Right blood right patient
HCA	Healthcare assistant	**SRNM**	Specific requirements not met
HSE	Handling and storage errors	**WBIT**	Wrong blood in tube
HSIB	Healthcare Safety Investigation Branch	**WCT**	Wrong component transfused
IBCT	Incorrect blood component transfused		

Near miss events continue to account for a large proportion of the events/reactions reported to SHOT (1314/3397, 38.7%) however the number of reports included, and the proportion of total reports has decreased this year, n=1314 in 2019, compared to n=1451 in 2018.

Near miss events do not cause harm but if undetected have the potential to do so. Investigations into the cause of near misses will enable a more proactive approach to safety. Potential system failures and hazards can be identified and corrected before harm or injury occurs. Recognising and reporting near miss incidents can significantly improve transfusion safety and enhance the safety culture within healthcare.

The long-term aim of an incident reporting system, such as SHOT, is to help reduce incidents that result in harm while moving towards increased reporting of near miss events for future learning.

Discussion of near miss errors in other categories

Near miss cases have been reviewed and discussed in each relevant chapter for this report, and Table 12.1 shows the chapters that include near miss events according to SHOT definitions.

Categorisation of all near misses according to SHOT definitions		Discussed in chapter	Number of cases	Percentage of cases
Incorrect blood component transfused (IBCT)	Wrong component transfused (WCT)	Chapter 9	849	64.6%
	Specific requirements not met (SRNM)	Chapter 9	94	7.2%
Handling and storage errors (HSE)		Chapter 10	164	12.5%
Right blood right patient (RBRP)		Chapter 13	162	12.3%
Adverse events related to anti-D immunoglobulin (Anti-D Ig)		Chapter 8	33	2.5%
Avoidable, delayed or under/overtransfusion (ADU)		Chapter 11	12	0.9%
Total			**1314**	**100%**

Table 12.1: Possible outcomes from near miss incidents if not detected

Wrong blood in tube (WBIT) incidents make up 728/849 (85.7%) of all WCT near miss events and have been analysed and reported separately in this chapter.

12a Near Miss – Wrong Blood in Tube (WBIT) n=728

Author: Pamela Diamond

Definition:

- **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**

Key SHOT messages

- Obtaining correct patient details on admission and on registration is paramount to avoid incorrect merging or generation of multiple patient records. There must be robust methods for ensuring that the correct wristband is generated and worn by the right patient. All subsequent treatments and analyses depend on this
- Minimum identification criteria must be sufficient to uniquely identify the patient
- Pre-transfusion sampling policies must be in place based on best practice. Staff should be trained to these policies and deemed competent before performing the stipulated tasks

Recommendations

- Involve the patient in their own care by allowing them to confirm their identity, where possible. This will prevent errors
- Ensure there are robust checking procedures in place on application of the wristband and appropriate, subsequent positive patient identification, whether manual or electronic

Action: Ward managers and clinical educators

- There should be policies in place to detail the procedures for amending patient records

Action: NHS Trusts/Health Boards

Introduction

Wrong blood in tube (WBIT) continues to represent the largest proportion of near miss events (728/1314, 55.4%). Although this is the lowest figure since 2014 (Figure 12a.1), it would be optimistic to hope that this may be the beginning of a downward trend in the number of WBIT incidents reported.

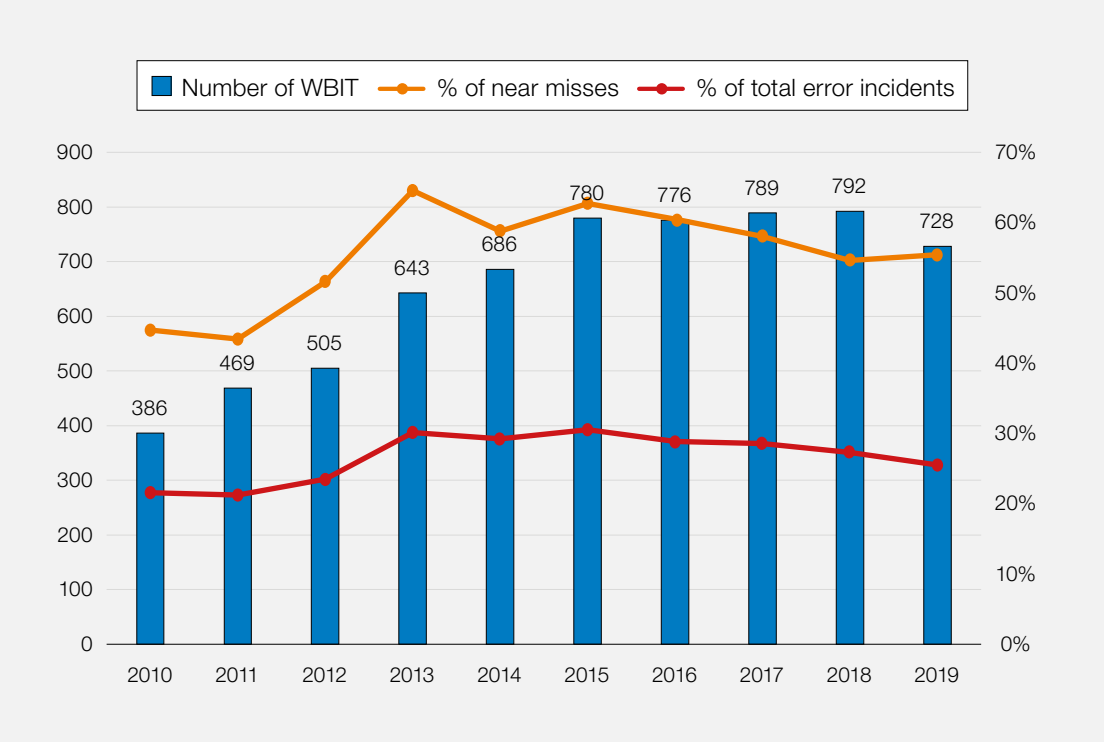


Figure 12a.1: Reports of WBIT 2010 to 2019

ABO-incompatibility

The known group of the patient and the incorrectly attributed group as a result of a WBIT were included in 569/728 (78.2%) of reports. The breakdown of these groups may be seen in Table 12a.1.

Table 12a.1: Incorrectly attributed group as a result of a WBIT

Patient group	Group attributed to patient if not detected as a WBIT					
	Group A	Group B	Group AB	Group O	Compatible	Incompatible
Group A	34	31	12	113	147	43
Group B	39	5	5	34	39	44
Group AB	11	5	1	8	25	0
Group O	160	45	16	50	50	221
Totals	**244**	**86**	**34**	**205**	**261**	**308**

In 88/728 (12.1%) cases the reports did not state the group and, for 71/728 (9.8%) of reports, no groups were determined due to non-testing of samples, prior warning being given by the ward or the hospital transfusion laboratory was informed of discrepancies in other laboratory investigations or clinical details.

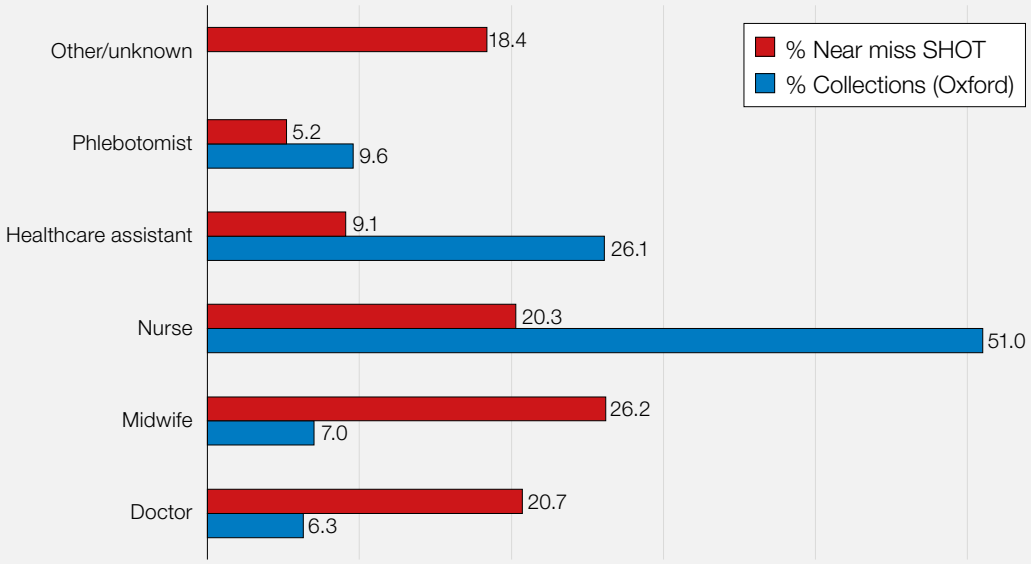
If blood had been required and the error gone undetected, in 261/569 (45.9%) cases the red cell transfusions would have been compatible, however, 308/569 (54.1%) could have resulted in an ABO-incompatible red cell transfusion with potentially life-threatening complications.

Inadequate or inappropriate anti-D immunoglobulin (Ig) prophylaxis

There were 253/728 (34.8%) of WBIT samples taken from pregnant women. Of these, 188/253 (74.3%) were WBIT where groups were identified, 113/253 (44.7%) there was no difference in D status. In 30/253 (11.8%) the patient would have been incorrectly identified as D-negative. The remaining 45/253 (17.8%) would have been wrongly grouped as D-positive.

Who takes the samples?

Figure 12a.2: Staff groups responsible for taking the WBIT samples reported to SHOT (n=728) compared with staff groups who take transfusion samples in Oxford Hospitals November 2019 to January 2020 (n=17593)

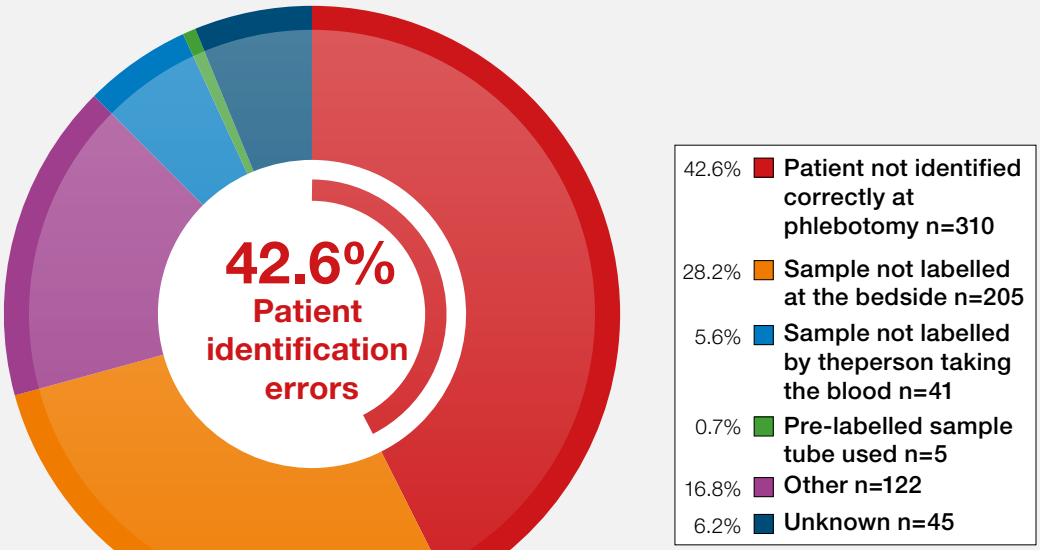


Denominator data have been supplied by the Oxford University Hospitals NHS Foundation Trust. Midwives and doctors continue to be over-represented, whereas phlebotomists and nurses and healthcare assistants are under-represented following comparison against the percentage of transfusion samples taken by the equivalent staff group in Oxford hospitals.

What goes wrong?

Primary sampling errors

Figure 12a.3: Primary sampling errors



Patient not identified correctly at phlebotomy

Guidelines have been developed (NICE 2012) however the performance of healthcare professionals does not always follow recommended clinical practice. This may be due to extra constraints placed on the staff member or lack of awareness and training.

The most common reason stated for WBIT events was a failure to identify the patient correctly at phlebotomy 310/728 (42.6%).

Studies have shown that involving the patient in their own care can lead to improvement in professional practice (Fonhus et al. 2018, Bolz-Johnson et al. 2020).

Case 12a.1: Incorrect information given by care home

Patient A was admitted to hospital from a care home, however the care home gave hospital staff incorrect details of Patient B who has dementia. Patient A told the staff his correct name and date of birth (DOB) but was ignored due to incorrectly informed staff assuming the patient had dementia. A member of the radiology department staff queried the patient's identification details but were told that the patient was 'just confused'. Due to departmental pressures, Patient A was not clerked by a doctor for more than 5 hours after admission. It was at this point the doctor noticed that the patient was not confused, and the medications were for a completely different patient. The details were checked with the lucid patient, who was confirmed as Patient A. The blood samples taken from Patient A were identified as 'wrong blood in tube' as the blood group did not match that on record for Patient B and all results were removed from Patient B's record.

This case demonstrates the importance of prompt and accurate patient clerking. Fortunately, no harm came to the patient, but there is real risk in assuming all previous information provided is complete and not performing an accurate evaluation of the patient with fresh eyes.

It is important to ensure that the minimum patient identification criteria are sufficient to uniquely identify the patient, and that local processes for pre-transfusion sample taking are clear. Responsibility for the incident should not be attributed to the sample taker for not following the correct procedure or policy if this policy is not available, or if staff have not been trained and competency-assessed.

Learning point

- Minimum patient identification criteria should be sufficient to uniquely identify the patient

Patients with the same name and date of birth can't happen?

Case 12a.2: Incorrect selection and editing of patient address leads to WBIT

A biomedical scientist (BMS) in the transfusion laboratory was contacted by the ward to alert them that a group and save sample had been labelled incorrectly. The patient was admitted as an emergency with suspected myocardial infarction and under pressure to rapidly admit the patient, a healthcare assistant (HCA) selected an incorrect patient from the electronic patient record (EPR). This incorrect record had the same forename, surname and DOB as the admitted patient, however, the address did not match so this was edited by the HCA. When addressograph labels and identification (ID) bands were printed, the correct forename, surname, DOB, and address were present but the hospital numbers were incorrect. The group and screen sample was taken during an emergency procedure by a doctor - it was witnessed by a nurse who then labelled the sample, using an addressograph label, as the doctor was scrubbed and unable to label it themselves.

The patient was asked to confirm their ID, which matched the ID band, however the error in hospital number remained undetected. When relatives arrived the details were checked and the HCA realised their error.

Case 12a.3: Incorrect wristband and subsequent failure to positively ID patient leads to WBIT

A surgical patient was booked into the EPR under an incorrect record, which differed only by hospital number and year of birth. An incorrect wristband was generated and applied to the patient. Two group and save samples were taken from the patient by two different members of staff who both used request forms containing the incorrect details, and did not note a discrepancy when asking the patient for their DOB. The error was not initially detected by the laboratory as the details on the samples matched the request forms. The error was discovered when a third sample was taken later in the day which was labelled with the patient's correct details and generated the same blood group and positive antibody screen result.

It is important that full positive patient identification is performed when taking blood samples as records may be very similar.

Electronic identification systems

The use of electronic patient identification (EPI) systems has been shown to result in a lower incidence of WCT and near misses such as WBIT compared to manual processes (Murphy et al. 2019).

The Healthcare Safety Investigation Branch (HSIB) recommend (Recommendation 2019/46) that hospitals should take steps to ensure '*the adoption and ongoing use of electronic systems for identification, blood sample collection and labelling'* (HSIB 2019).

However, 57/728 (7.8%) of incidents mentioned EPI and resulted in WBIT. This was either due to a system being used incorrectly or being present in the department but not used because it was not working properly or staff had not been appropriately trained.

Sample labelling errors

There were 205/728 (28.2%) reports where the sample was not labelled at the bedside. The reason 'other' was listed in 122/728 cases (16.8%) these included; registration errors 8/122 (6.6%), the use of pre-labelled sample tubes 5/122 (4.1%), historical errors being discovered 3/122 (2.5%) and possible identity fraud 2/122 (1.6%).

Case 12a.4: Failure to check wristband at registration and subsequent failure to positively ID patient leads to WBIT

A patient was admitted to the ambulatory care unit with a haemoglobin (Hb) of 61g/L and was clerked as another patient with the same name but different DOB, address and hospital number. Two crossmatch samples were taken by the same assistant practitioner 23 minutes apart as the patient was previously unknown to the blood transfusion laboratory (one sample using EPI and the second being handwritten). The patient grouped as B D-positive on both samples and blood was prepared. Upon completing bedside verbal administration checks on an inpatient ward, the nurse found that the patient's DOB did not match either the wrist band or the blood compatibility label. The blood was immediately returned to the laboratory, the patient was readmitted under the correct details and received two units of red cells the following morning.

Case 12a.5: WBIT due to multiple patient records and incorrect merging

A WBIT incident was queried when a sample for group and screen was received for a patient who had a previous group recorded as B D-positive but tested as A D-negative. A prior WBIT incident had been investigated 3 years previously when the sample received also grouped as A D-negative. This patient's record had been amended multiple times and had six different hospital numbers and two different National Health Service (NHS) numbers present. Investigation found that the patient record had been merged incorrectly 3 years previously and none of the suspected samples were WBIT incidents.

Learning point

- Transfusion requirements must be considered when creating policies and procedures for merging patient records on the laboratory information management system (LIMS). Errors will continue to occur unless those performing record merges have the appropriate knowledge

Conclusion

Regardless of whether patient identification is manual or electronic, it is imperative that this is correctly determined. This is the simplest way of involving the patient in their own care and can prevent adverse clinical outcomes. Appropriate minimum identification criteria should be established and adhered to. Registration and merging of patient records should be standardised with a policy in each healthcare setting to reduce the risks associated with incorrectly merging records. If electronic systems for patient identification are available, they should be utilised correctly by appropriately trained staff.

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13 Right Blood Right Patient (RBRP) n=216

Authors: Diane Sydney and Victoria Tuckley

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 transfused (IBCT).

Key SHOT messages

- To minimise right blood right patient (RBRP) errors the emphasis must be to ensure that there is accurate patient identification throughout the transfusion process
- Staff should continue to utilise the bedside checklist as part of the administration process
- SHOT laboratory message (2018) remains pertinent: All laboratory staff must complete annual good manufacturing practice (GMP) training (European Commission 2015)

Abbreviations used in this chapter

DOB	Date of birth	**LIMS**	Laboratory information management system
GMP	Good manufacturing practice	**PID**	Patient identification
IBCT	Incorrect blood component transfused	**RBRP**	Right blood right patient
ID	Identification		

Introduction

There were 216 cases reported in 2019 with no increase in the overall error rate from the 2018 report (Narayan et al. 2019). Clinical errors accounted for 153/216 (70.8%) with laboratory errors 62/216 (28.7%) and 1/216 (0.5%) where the location of the primary error could not be determined with the information that was received. The variation between clinical and laboratory errors is illustrated in Figure 13.1.

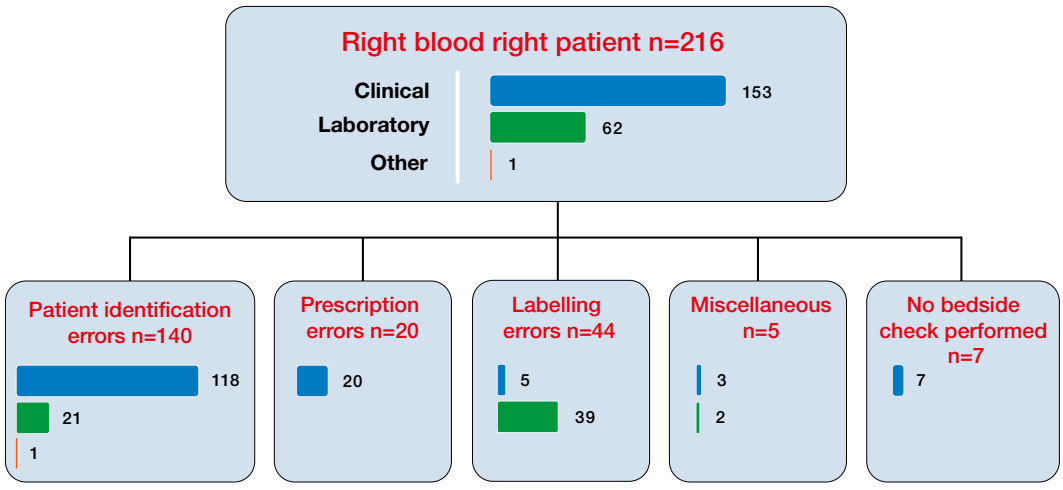

Figure 13.1: Breakdown of 2019 RBRP reports n=216

Patient identification (PID) errors

PID errors accounted for 140/216 (64.8%) and remain the main cause of errors in RBRP as shown in Table 13.1. These PID errors continue to occur in all parts of the transfusion process. This includes clinical staff incorrectly writing patients details, omitting key demographics during the completion of the request form and sample labelling and these errors subsequently not being detected by the laboratory. In the laboratory this includes staff not transcribing and entering data correctly into the laboratory information management system (LIMS) during booking in of a sample.

Table 13.1: Patient ID errors in 2019 n=140

Area/location	PID error	Number of reports
Clinical n=118	Incorrect ID in relation to 4 key identification data points*	96
	No wristband/ID band	6
	Wrong details on wristband/ID band	15
	Incorrect address	1
Laboratory n=21	Demographic data entry errors in relation to 4 key identification data points*	20
	Incorrect unidentified patient protocol followed	1
Other n=1	Demographic data entry errors in relation to 4 key identification data points*	1
Total		**140**

**First name, last name, date of birth (DOB), unique identifier (BSH Robinson et al. 2018)*

Case 13.1: Patient with dementia has multiple names

A request for two units was received by the laboratory, at the sample receipt and registration stage the form and sample details matched correctly. The laboratory issued two units of crossmatched blood into the issue refrigerator. The first unit was transfused to the patient, however when collecting the second unit the nurse realised that the surname was the incorrect spelling for the patient. The nurse informed the laboratory and a further new sample and request form was sent to the laboratory. On further investigation it was identified that the patient's name had been changed multiple times on the electronic patient record system and it was only when the patient's relatives were contacted that the correct spelling was identified. The patient had dementia and was unable to confirm the correct details.

This case outlined a failure to ascertain the correct patient details leading to multiple records for the patient. Whilst this was only a single report, with an ageing population this type of error may become more prevalent in future years.

Use of checklists at administration

Despite previous SHOT recommendations and the resulting central alerting system (CAS) alert: 'Safe Transfusion Practice: Use a bedside checklist' (Department of Health 2017), the pre-administration bedside checklist is still not universally implemented. On review of the 2018 and 2019 data it would appear that the use of bedside checklists has increased, but the alert is not being adhered to by all. The number of reports stating that no checklist was available decreased from 43/216 (19.9%) in 2018 to 10/216 (4.6%) of reports in 2019. However, the number of reports (216) has remained the same for both reporting years. Checklists should continue to be used as this will aid the administration process and prevent errors.

Learning points

- Ensure that staff verify patient details for patients who are incapacitated
- All staff must use a bedside checklist at administration

Near miss RBRP cases n=162

There were 162 near miss RBRP incidents, 87/162 (53.7%) where the error originated in the laboratory and 75/162 (46.3%) in the clinical area. Near miss errors associated with PID were the biggest group with 94/162 (58.0%), followed by labelling errors 67/162 (41.4%), the remaining 1 case was a prescription error. The number of near miss RBRP events has decreased from 2018 when there were 202 errors.

IT-related RBRP cases n=42

Further details of the IT-related reports can be found in the supplementary information on the SHOT website (https://www.shotuk.org/shot-reports/report-summary-and-supplement-2019/).

Conclusion

RBRP errors do not cause harm but are indicators of a prevalent problem which could result in harm or death to a patient. It is essential that these incidents are captured and reviewed as they contain valuable learning opportunities, which may enable a systemic issue to be identified and appropriate action implemented, prior to patient harm. To minimise errors the emphasis must be to ensure that there is accurate patient identification throughout the transfusion process from sampling to the final bedside check by all staff groups. Regardless of the number of initiatives which have been developed with the aim of mitigating errors, the reviewed cases highlight a failure of correct bedside checking and attention to detail when entering patient information onto the LIMS. These are critical steps in the process to prevent the patient being transfused with incorrect blood.

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Laboratory Errors n=796 (495 errors and 301 near miss)

14

Authors: Victoria Tuckley, Heather Clarke and Peter Baker

Key SHOT messages

- Many mistakes may be the result of distorted decision making or cognitive bias. Processes should be designed to account for these biases by drawing attention to safety critical steps
- Regular monitoring of quality system outputs is required. If omissions or inaccuracies are detected these require immediate corrective and preventative action (CAPA) to prevent potential patient harm
- Laboratory staff should be comfortable working within routine procedures – these procedures should be safe and fit for use, especially in high-pressure situations

Abbreviations used in this chapter

AAA	Abdominal aortic aneurysm
ABOi	ABO-incompatible
AML	Acute myeloid leukaemia
BMS	Biomedical scientist
BSQR	Blood Safety and Quality Regulations
CAPA	Corrective and preventative action
CL	Component labelling, availability and handling and storage
EQA	External quality assessment
FTSUG	Freedom to speak up guardian
HSE	Handling and storage errors
IBCT	Incorrect blood component transfused
IT	Information technology
LIMS	Laboratory information management systems
MHP	Major haemorrhage protocol
MHRA	Medicines and Healthcare products Regulatory Agency
QMS	Quality management system
RCA	Root cause analysis
SD-FFP	Solvent-detergent fresh frozen plasma
SOP	Standard operating procedure
SRNM	Specific requirements not met
SRR	Sample receipt and registration
UKAS	United Kingdom Accreditation Service
UKNEQAS	UK National External Quality Assessment Scheme
UKTLC	UK Transfusion Laboratory Collaborative

Recommendations

- Laboratory staff should have knowledge of the clinical requirements of transfusion to work collaboratively to deliver cohesive patient-centred care
- All lone workers should be adequately supported through their training and competency assessment to ensure they are equipped with adequate skills and knowledge. Laboratory management have a responsibility to ensure all staff members are competent before exposing them to lone working

- Escalation procedures for lone workers must be clear and defined, with specialist support being accessible at all times (UK Transfusion Laboratory Collaborative Standard 3.6)
- Laboratory information management systems (LIMS) should be robust and used to their full functionality, preventing ABO-incompatible (ABOi) units being assigned to the patient record, and thus issued, especially in an emergency when the patient's blood group is unknown

Action: Transfusion laboratory managers, transfusion practitioners, hospital transfusion teams

Introduction

The number of events reported by the laboratory accounts for 796/3397 (23.4%) of all accepted SHOT reports in 2019 and is a slight reduction on the 885/3326 (26.6%) reports in 2018. Almost half of all laboratory reports (373/796, 46.9%) involved component labelling, availability and handling and storage (CL) (Figure 14.3 and 14.5). Similar to clinical errors, laboratory errors have the potential to cause patient harm, and have caused patients to suffer major morbidity in 2019. The transfusion laboratory is in a unique position as it provides results which influence patient care, but also provides a therapeutic product for the patient, therefore when errors occur there is arguably greater potential impact on the patient. Transfusion laboratories may wish to use the 'Laboratory exit check' to ensure that errors which occur at this step are recognised before they have the opportunity to impact on patient safety (Figure 14.1).

It is also essential that the transfusion laboratory works cohesively with other pathology disciplines. Testing errors within haematology and coagulation continue to impact on transfusion safety, in particular cases of avoidable and undertransfusion. Where results are potentially spurious, these should not be made available to the clinical area as misinterpretation can lead to inappropriate patient care. Please see the online laboratory case studies in the supplementary information on the SHOT website (https://www.shotuk.org/shot-reports/report-summary-and-supplement-2019/). Laboratory staff should feel empowered to discuss requests with clinicians which they feel are inappropriate. The National Institute for Health and Care Excellence (NICE) and the British Society for Haematology have clear guidance regarding the indications for blood transfusion and laboratory staff have the knowledge to assist their clinical colleagues in making informed choices (NICE 2015; BSH 2018).

Appropriate actioning of results is essential to allow everyone involved in the care of the patient to make informed clinical decisions (see Case 11a.4 in Chapter 11a, Delayed Transfusions and repeated in Case 22.2, Chapter 22, Paediatric Cases).

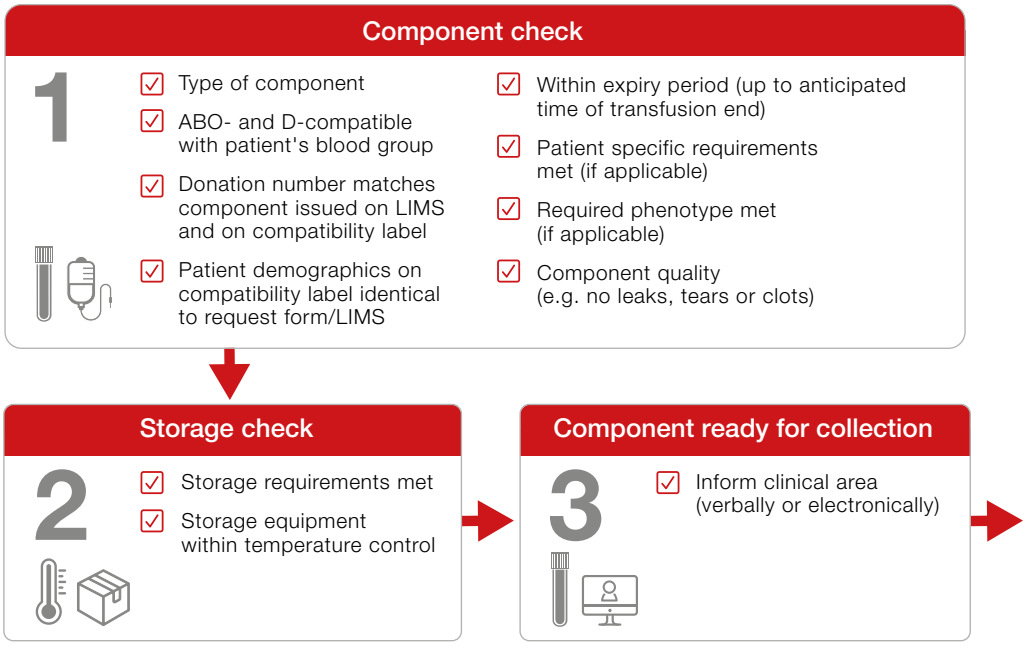


Figure 14.1: Laboratory component labelling and exit check

Major morbidity n=2

Laboratory errors continue to have severe consequences for the patient. In 2019 there were 15 deaths reported, though none were directly related to blood transfusion (imputability 0, excluded or unlikely). Two further cases were reported with major morbidity. One case included sensitisation to the K antigen, please see the online laboratory case studies in the supplementary information on the SHOT website (https://www.shotuk.org/shot-reports/report-summary-and-supplement-2019/). The other case of major morbidity occurred due to delays in the major haemorrhage setting (imputability 1 possible). There were also 8 cases reported where minor/moderate morbidity occurred.

ABO-incompatible transfusion (ABOi) n=3

Laboratory errors contributed to 3 ABOi transfusions in 2019. All cases were due to component selection errors, 1 of which is discussed in Case 14.1. Two of these errors occurred during a major haemorrhage situation. ABOi cases are discussed in further detail in Chapter 9, Incorrect Blood Component Transfused (IBCT).

Case 14.1: Patient blood group O D-positive transfused a unit of group A D-positive red cells in error

Following activation of the major haemorrhage protocol (MHP) for a ruptured abdominal aortic aneurysm (AAA) patient when their blood group was unknown, a biomedical scientist (BMS) selected four units of group A red cells instead of O for pack one. This was collected and taken to theatres where one unit was transfused. The patient's sample then arrived and was processed and grouped as O D-positive and the error was then realised. All remaining units were immediately recalled. Initial assessment of the patient showed no adverse reaction, but laboratory investigations showed evidence of haemolysis postoperatively, renal function declined minimally and then improved. There was evidence of intravascular coagulopathy with low platelets. All indicators improved with conservative treatment and there were no clinical sequelae directly related to the ABOi transfusion. The patient recovered and was discharged home a week later.

Root cause analysis (RCA) identified that the LIMS produces an alert where the ABO blood type of the patient is known but does not prevent or alert issue of red cells that are not group O in an emergency setting where patient blood group is unknown.

The LIMS should be robust and used to its full functionality, preventing ABOi units being assigned to the patient record, and thus issued, especially in an emergency when the patient's blood group is unknown.

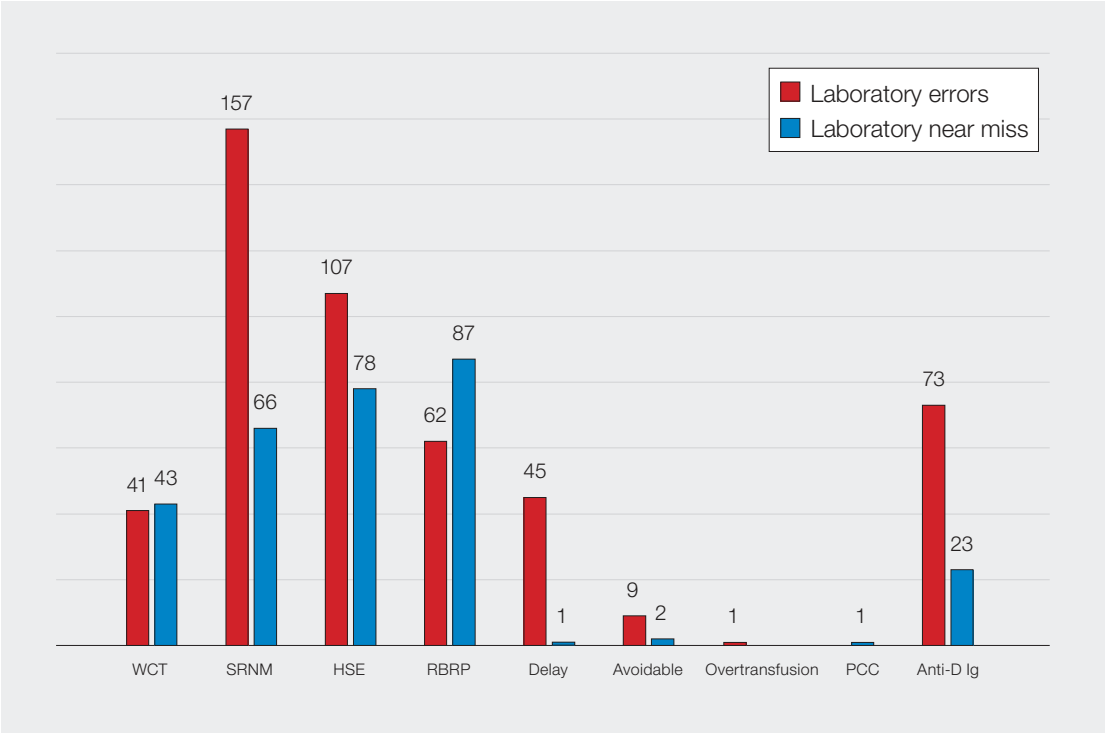
SHOT 2017 recommendation 2- All available information technology (IT) systems to support transfusion practice should be considered and these systems implemented to their full functionality. Electronic blood management systems should be considered in all clinical settings where transfusion takes place. This is no longer an innovative approach to safe transfusion practice, it is the standard that all should aim for (Bolton-Maggs et al. 2018).

Trends in error reports

The highest proportion of errors occur within the IBCT-specific requirements not met (SRNM) category, with testing errors within this category showing a marked increase from 45/114 (39.5%) in 2018 to 80/157 (51.0%) in 2019 (Narayan et al. 2019). Furthermore, the number of handling and storage errors (HSE) error reports has almost doubled from 69/530 (13.0%) in 2018 to 107/495 (21.6%) in 2019. A proportion of the HSE errors, 23/107, were due to a single incident affecting 23 patients and is described as Case 10.2 in Chapter 10, Handling and Storage Errors (HSE). However, excluding these 23 cases there was still an overall increase of 15 incidents.

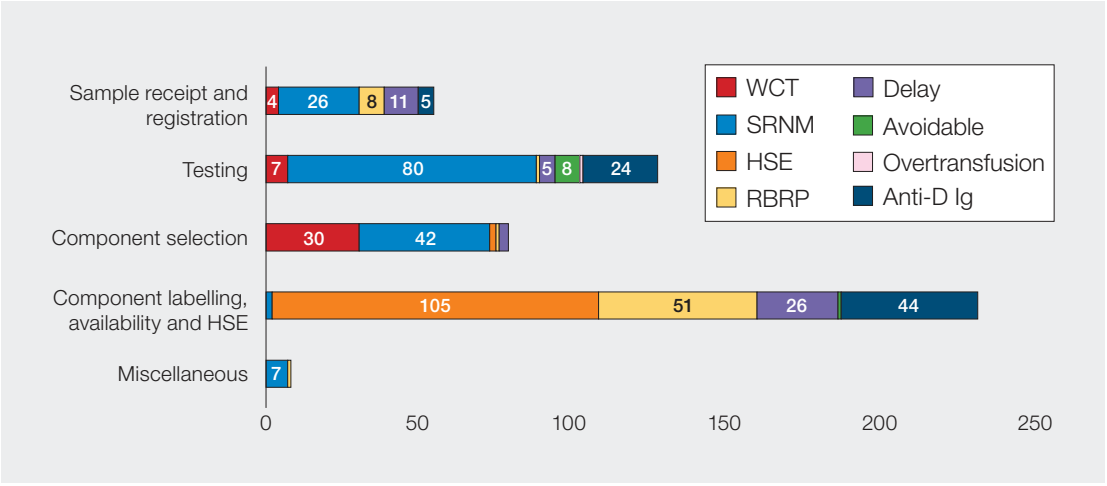
It is of concern that similar patterns and themes are observed in laboratory reports, and that learning from previous SHOT recommendations does not seem to have been embedded within laboratory culture. A safety-II approach to incident investigation and review of laboratory procedures could help identify potential gaps which can be rectified, and also areas of success which may be able to be applied elsewhere (Hollnagel et al. 2015).

Figure 14.2: Laboratory incidents and near misses by category of outcome n=796



WCT=wrong component transfused; SRNM=specific requirements not met; HSE=handling and storage errors; RBRP=right blood right patient; PCC=prothrombin complex concentrate; Ig=immunoglobulin

Figure 14.3: SHOT laboratory data showing at which stage in the transfusion process the primary error occurred n=495



WCT=wrong component transfused; SRNM=specific requirements not met; HSE=handling and storage errors; RBRP=right blood right patient; Ig=immunoglobulin

Numbers <4 are too small to be annotated on the figure: Testing: RBRP=1, overtransfusion=1; Component selection: HSE=2, RBRP=1, Delay=3; Component labelling, availability and HSE: SRNM=2, avoidable=1; Miscellaneous: RBRP=1

Training and competency assessment

Thorough training and competency assessment of staff is essential to prevent errors. However, for this to occur competency assessments need to be fit for purpose. Competency assessments are not infallible, and many laboratory incidents involve staff members who have been deemed competent (Mistry et al. 2019) This illustrates that demonstrating the ability to follow instructions alone may not be enough. Training and competency assessments must reflect work as done (Provana et al. 2020) and incorporate the non-technical aspects of the procedure (e.g. quality and working environment) to ensure staff are fully equipped to handle real life scenarios. Staff must not be exposed to lone working before they are safe to do so.

Case 14.2: Delay in transfusion of solvent-detergent fresh frozen plasma (FFP) in a bleeding acute myeloid leukaemia (AML) patient

A phone call was received from a ward requesting three units of SD-FFP for an actively bleeding AML patient. The BMS on a night shift was unable to issue the units because they had not been shown how to issue this product. The BMS attempted to issue the product on the LIMS, but failed as they were entering the incorrect code for the product and group – creating an alert for ABO-incompatible transfusion. They called the ward to inform them that they were unable to issue the SD-FFP. The plasma was not issued until the day staff arrived which was then 3.5 hours since the requesting phone call was received.

On investigation, training and supervision of the BMS had occurred prior to lone working on night shifts. Laboratory documentation detailed the specific issuing codes, but this information was not contained in the SOP. Formal training and competency assessment to issue SD-FFP had not been provided, and the process had only been talked through.

There were no reported consequences or adverse events for the patient.

All procedures and processes must have an easily accessible standard operating procedure (SOP) that can be retrieved and followed when needed. It is imperative that all laboratory staff are fully trained and competency assessed before being permitted to work unsupervised especially when lone working.

For further laboratory related case studies please see 'Case studies from the SHOT Annual Report 2019' available on the SHOT website https://www.shotuk.org/resources/current-resources/.

Robust and effective competency assessment requires UPTAKE of a collaborative assessment process between management and staff members (Figure 14.4).

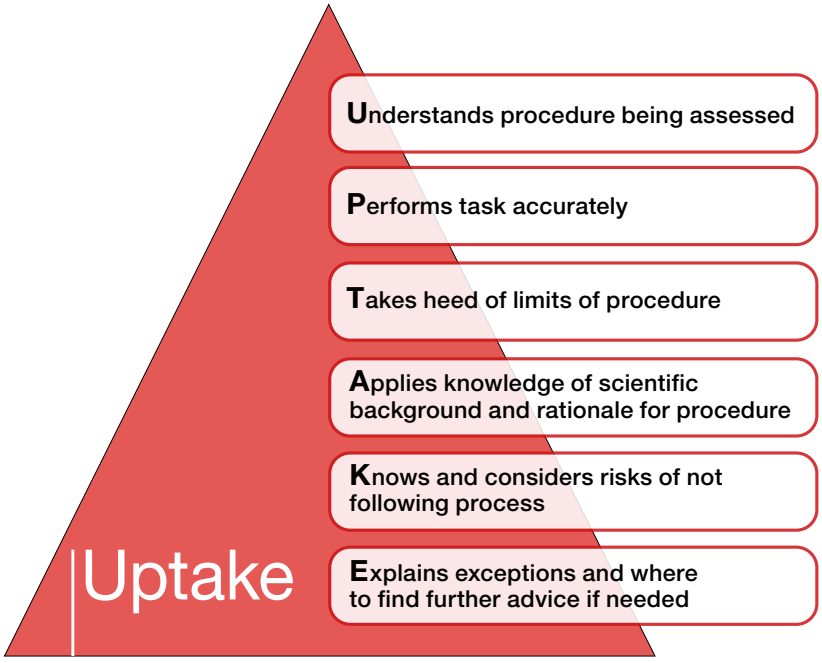


Figure 14.4: UPTAKE areas to be covered in a robust competency assessment

The use of IT in the laboratory

IT has become integral to the day-to-day working in the laboratory. However, there is always further scope to improve the functionality and interoperability of IT within the hospital to increase the safety of these systems. For example, LIMS must allow access to relevant results for other disciplines and have interoperability with other electronic systems in the hospital, such as patient clerking/identification systems to ensure the full patient picture is taken into account. This is of particular importance for laboratories working within pathology networks.

Addressing alert fatigue

Laboratory transfusion staff can get overwhelmed by multiple alerts resulting in 'alert fatigue' i.e. tendency to ignore notifications when they become too frequent and hence potential for errors and impact on transfusion safety. Staff can overcome alert fatigue, identify and respond to critical issues in real time, and reduce risk continuously over time if these alerts can be transformed into relevant and actionable intelligence. A structured, proactive approach is suggested to address this by using the following practices:

1. Regularly review and reduce redundant alerts
2. Make all alerts contextual and actionable
3. Ensure appropriate escalation and that correct individuals and teams are notified
4. Apply human factors principles when designing alerts (e.g., format, content, legibility, and colour of alerts). Consider having tiered alerts according to severity, consistently throughout laboratories, so that attention is drawn to those more clinically consequential thus allowing staff to maintain situational awareness and responsiveness
5. Improve the culture of safety in transfusion by creating a shared sense of responsibility between users and developers, paying careful attention to safe IT implementation, and engaging leadership in IT planning, implementation, and evaluation

For further details on IT-related errors please see Chapter 15, Errors Related to Information Technology (IT).

Sample receipt and registration (SRR) n=100 (including 46 near misses)

The majority of SRR errors occur when available information on LIMS is not heeded. Distractions should be kept to a minimum at booking in, as this is the first opportunity to prevent mistakes potentially impacting on a patient's wellbeing.

Learning point

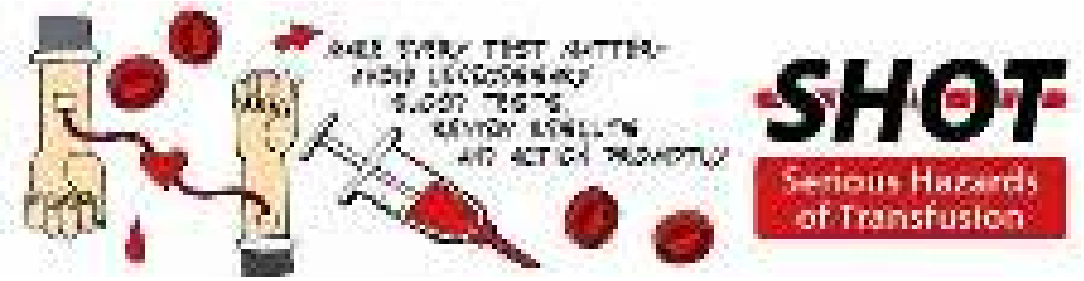
- Staff booking in samples must follow good manufacturing practice (GMP) working and must not be distracted

Testing n=158 (including 32 near misses)

Many testing errors demonstrate incomplete knowledge; however, the majority of staff had passed competency assessment. Staff must be supported and have appropriate knowledge before being asked to issue components.

Learning point

- A robust competency assessment must be completed prior to performing laboratory tasks. Always raise concerns if unsure of a process



Component selection n=147 (including 69 near misses)

Many patients are being issued units which do not meet their recorded phenotypic requirements (including patients of childbearing potential receiving K-positive units). These errors may result in major morbidity. LIMS should have antibody information easily accessible and should raise an alert flag to check when appropriate.

Learning point

- Laboratory and quality management should review their laboratory information management systems (LIMS) to ensure specific requirements are visible at all key points of the transfusion process. They should work with LIMS providers to rectify any issues uncovered

Component labelling, availability and handling and storage errors n=373 (including 144 near misses)

Component labelling is a key step within the laboratory and requires extra vigilance. This is the last chance for the laboratory to detect and rectify any error before components are made available to clinical staff.

Learning point

- Laboratory staff should stop and objectively review all component labelling prior to release to the clinical area. Never assume and always check previous steps have been performed correctly

A learning point from the 2018 Annual SHOT Report still requires further implementation – 'Alerts must be dealt with or escalated immediately, and steps that need to be taken must be included in a robust protocol/procedure' (Narayan et al. 2019).

Near miss cases n=301

The highest proportion of laboratory near misses are RBRP events, 87/301 (28.9%). In 74/87 (85.1%) this involved transposition or failure to apply compatibility labels. This shows a lack of attention to detail at the labelling step in the laboratory, which is then being identified at the bedside administration check. A simple check in the laboratory prior to release could prevent these errors which, undetected, could cause patient harm.

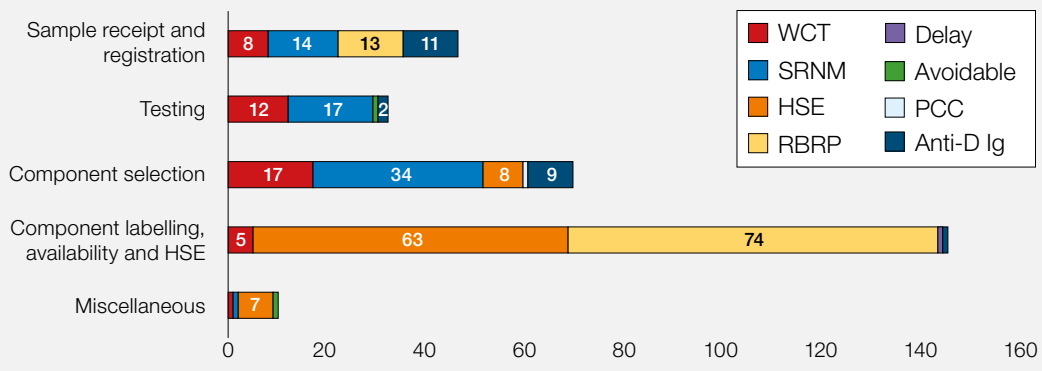


Figure 14.5: SHOT near miss laboratory errors showing at which stage in the transfusion process the primary error occurred with outcome n=301

WCT=wrong component transfused; SRNM=specific requirements not met; HSE=handling and storage errors; RBRP=right blood right patient; PCC=prothrombin complex concentrate; Ig=immunoglobulin

Numbers <2 are too small to be annotated on the figure. All segments with no data label=1

Case 14.3: Non-irradiated cells issued for a patient with a history of Hodgkin lymphoma due to convoluted LIMS procedure

A patient in his 80s, with a history of Hodgkin lymphoma, in ICU required a red cell transfusion. The request sent to the laboratory clearly indicated the requirement for irradiated blood and this information was inputted on the patient's record on LIMS, however a secondary step of adding this requirement to the product issue page was not completed. Non-irradiated blood was issued remotely through Hemobank 80®. The requirement for irradiated blood was overlooked at collection, however it was identified by the healthcare support worker and nurse at the patient's bedside. The laboratory was contacted and a new unit of blood issued via Hemobank 80®.

Only one of the two members of laboratory staff involved in the issue of the blood had completed their competency assessment, and the other was a new starter (a large volume of staff turnover was also listed as a contributory factor). The investigation also noted that the application of flags in LIMS is not uniform and has caused confusion. Some flags are for information only, whilst others require direct action; for some flags a single step is required to apply this to the patient record and others require the two steps. Furthermore, the information regarding specific requirements on the clinical patient record does not link to the LIMS. The laboratory management team are investigating the possibility of altering the irradiated flag on LIMS to prevent remote issue of blood but cannot currently change the system of recording specific requirements.

This case illustrates the importance of having clear procedures within the laboratory, that staff must be trained correctly prior to performing procedures, the value which would be added through interoperability of electronic systems and the critical nature of the bedside check.

Conclusion related to laboratory reports

Laboratory errors continue to occur despite reflective best practice guidance each year in the Annual SHOT Report. To make positive change within laboratories it is essential that investigations look beyond the staff involved as being the only reason for the error. Policies and procedures need to be as simple as possible, whilst still containing all relevant technical information, to ensure that staff have access to concise instructions and information at all times. Furthermore, it is imperative that when these laboratory processes are reviewed, they are robust enough to address current challenges and guidelines. The standard of transfusion knowledge and education within laboratories is becoming a prevalent source of error, and poor practice (cutting corners) should be identified and corrected as soon as possible, before it results in errors. A more in-depth knowledge of the clinical aspect of transfusion for laboratory staff may be of benefit, so as to make laboratory staff aware of their important role in the transfusion process and of the potential consequences to the patient when things go wrong.

Many of the errors reported in this chapter are reportable to both SHOT and the MHRA. Incident/near miss reporting is a key requirement of any QMS, and thorough investigation and identification of the root causes are vital to ensure good quality CAPA are implemented. When developing corrective actions, addressing errors whilst understanding the human factors involved will provide benefits in the long term. It will prevent errors from occurring and ensure safe laboratory practices and also the safe provision of blood components for transfusion. Evidence from the reporting of errors can be further used to ensure laboratories are provided with the correct resources. However, laboratory managers and staff may also need to identify innovative and novel ways of utilising their existing resources more effectively. The pathology services continue to be under intense pressure in a climate where the workforce is stretched and under-staffed, therefore it is even more vital that vigilance and duty of care are upheld to ensure safe transfusion and patient safety.

Recommended resources

Empowering laboratory staff to improve appropriate use of red cells in adults
https://hospital.blood.co.uk/patient-services/patient-blood-management/single-unit-blood-transfusions/

Patient Safety Network: Alert fatigue in healthcare
https://psnet.ahrq.gov/primer/alert-fatigue

Atlassian: Understanding and fighting alert fatigue
https://www.atlassian.com/incident-management/on-call/alert-fatigue

UK Transfusion Laboratory Collaborative: 2019 survey
https://www.shotuk.org/wp-content/uploads/myimages/UKTLC-2019-summary-final.pdf

Medicines and Healthcare products Regulatory Agency (MHRA) / inspectors report

Author: Chris Robbie

SHOT and the MHRA have independently assessed 2019 reports according to their specific remits, and the findings and advice are complementary. Reporters should look beyond 'human error' as the cause of error and investigate thoroughly to identify quality management system (QMS) improvements that address the human factors that lead to error. Whether addressing error covered by the scope of the Blood Safety and Quality Regulations (BSQR) or broader hospital transfusion safety, laboratories and clinical areas must work together, making best use of their limited resources to achieve component and patient safety (BSQR 2015).

A detailed analysis and commentary on MHRA data can be found in Chapter 26, Medicines and Healthcare products Regulatory Agency Report.

UK Transfusion Laboratory Collaborative (UKTLC): Culture Concerns

Author: Rashmi Rook, Chair UKTLC

During 2019, there has been worrying and distressing information provided to the UKTLC organisations both verbally and via various surveys on a prevalent 'blame culture' affecting our laboratory teams. (UK Laboratory Culture Survey 2019).

- Reports about staff being identified and criticised in front of colleagues when involved in MHRA/ SHOT reportable incidents
- Laboratory staff being taken through formal disciplinary actions when involved in MHRA reportable errors
- Staff unable to discuss with senior managers any potential patient and staff safety concerns due to previous negative behaviours

- False data being submitted to close-out inspection findings (United Kingdom Accreditation Service (UKAS)/MHRA) or provided on the annual Blood Compliance submission

If you are aware of any of the above issues or are affected by these, then please seek appropriate advice. In England, all Trusts have appointed a 'freedom to speak up guardian' (FTSUG), who has a direct line of communication to the executive team (NHS Providers). In Scotland concerns should be escalated to an Independent National Whistleblowing Officer, in Wales the 'freedom to speak up safely' scheme is available and in Northern Ireland those with concerns should contact the designated person as per local whistleblowing policy. Alternatively, please raise any concerns with UKTLC or through the MHRA whistleblowing scheme.

Part of any quality improvement program relies on each of us being freely able to voice concerns and work in an environment which is open and transparent without fear or blame. A 'psychologically safe' place where staff can ask questions and raise concerns without being ridiculed, teams make improvements together, different views are respected, and everyone enjoys working and learning together even with the daily challenges we face.

Quality improvement activities lead to a heightened recording of errors, mistakes, incidents and quality failures, and reporting of these within the QMS framework proactively addresses them. There must be an understanding across the pathology leadership teams that heightened awareness and reporting is a sign of a *good quality culture* and something to be proud of, rather than criticising the staff involved and supressing 'bad' news.

Senior laboratory and pathology management, including quality managers, transfusion practitioners, and pathology IT managers should ensure that as part of their continuing professional development responsibilities they have awareness, understanding and can apply the following concepts to effectively carry out their roles and maintain patient and staff safety:

- Human factors/situational awareness
- Root cause analysis, errors management, trend analysis
- Process mapping and designing improvements
- Lean and Kaizan/visual awareness
- Continual improvement processes
- Compassionate leadership
- Good supervision skills
- QMS procedures
- Accreditation and regulatory standards
- Change management

Pathology teams must work together and primarily build quality into all tasks by removing the barriers that create extra work and pressures on our staff and affects morale. Our people have the right to work with pride, know they are doing a good job as safely as possible, and to meet the ever-increasing demands and challenges within this amazing profession.

The following recommendations were made in the report 'A promise to Learn - A commitment to act' (National Advisory Group on the Safety of Patients in England, 2013) which remain pertinent to the discussion on safety culture in the laboratory:

- Drive out fear from an organisation as this is toxic to safety and improvement so that everyone may work effectively for our patients and hospitals
- Break down barriers between departments. People from different departments within a hospital must work as a team

- We should continually and forever reduce patient harm by embracing wholeheartedly an ethic of learning
- Mastery of quality and patient safety sciences and practices should be part of initial preparation and lifelong education of all healthcare professionals, including managers and executives
- Make sure pride and joy in work, not fear, infuse healthcare

The updated UKTLC minimum standards for staff qualifications, training, competency and the use of information technology in hospital transfusion laboratories are due to be published in 2020.

UK National External Quality Assessment Scheme (UKNEQAS)

Author: Claire Whitham

Participation in external quality assessment (EQA) offers the chance to learn from errors. The errors made in EQA exercises can be viewed as 'free lessons', as appropriate corrective action can be taken before the error occurs with a clinical sample.

Two common themes emerged in 2019 in relation to phenotyping. The first was related to following 'instructions for use' for reagents or testing methods, and the second to the selection of appropriate cells for use as a positive control.

During exercise 19R5, nine laboratories recorded a total of 12 incorrect phenotype results for M and/or N. Two of these laboratories recorded the improbable phenotype M-N- for Donor W. When performing phenotyping it is important that a positive control using cells with the weakest normal expression of the antigen is used (e.g. heterozygous M+N+ cells); the strength of these results should be reviewed before reporting. If an improbable phenotype result (e.g. M-N-) is obtained consideration should be given to repeat testing prior to reporting. Using cells with apparent homozygous expression for a control can result in missing any sensitivity issues with a reagent and lead to false negative phenotyping results being reported; any suspected sensitivity issues should be reported to the reagent supplier.

During 19R8, 12 laboratories recorded a false negative reaction vs. anti-Jk^{b} for one or both of the two Jk(a+b+) donors in the exercise, with five of these obtaining a negative reaction vs. both Donors W and Y. Ten of these laboratories were able to retest after the closing date. On repeat testing, five obtained a ≥2+ reaction, one a 1+ reaction, three an equivocal reaction (that they would not have reported in clinical practice) and one a negative reaction. Nine of the ten repeating the testing were using the same reagent that had seen sensitivity issues previously, as discussed in reports for exercises 18R2 and 18R8; this included the four obtaining either weak or negative results on repeat. Two of the nine using this reagent identified the cause of the original false negative reactions as a failure to follow the manufacturer's prescribed method; the remaining seven could not identify the cause; these include those obtaining a reaction of <2+ on repeat testing.

As with all testing it is important that manufacturer's instructions are followed and that the limitations of reagents in use are considered. Commercial phenotyping reagents generally give 'strong' reactions with antigen positive cells, and it is advisable to repeat tests and question results where a weaker than expected reaction is obtained with either the positive control or with an individual test. Phenotyping interpretations should not be made on equivocal results, and for clinical samples consideration given to referral of these tests.

Institute for Biomedical Science - commentary on pathology networks

Author: Anne Lockhart

Pathology networks have a huge part to play in supporting the future of healthcare, including service change and redesign and improving quality. They contribute to the provision of safe and sustainable

services for the future, which respond to user needs, future requirements and ensure compliance with national guidelines.

Two key challenges faced by transfusion laboratories in delivering a safe and effective service in a pathology network are inadequate IT resource and staffing.

A standard LIMS is a key enabler for pathology consolidation, allowing samples to be processed anywhere in the network, without the additional manual intervention that can lead to delays or quality problems. Separation of the LIMS and patient administration system across a network makes peripheral blood management data collection more difficult. Standardisation of IT gives the potential to allow for effective benchmarking across all laboratories and creates opportunity for systematic harmonisation of transfusion laboratory practice e.g. training, competence, standard operating procedures and equipment.

There remains a great risk that these changes will also result in the loss of staff and expertise from transfusion laboratories, with many staff nearing retirement opting to leave. This poses a risk to service, with the additional complexities of recruitment, training and adopting new technologies. The issue of losing staff is compounded by the need to cope with the change management aspects, so you need more staff than usual not less. Most of these changes envisage reductions in staff and these changes are enacted as quickly as possible without thinking about how the changes are going to be delivered while still coping with routine work.

It is important that throughout, organisations have robust workforce plans, which should be reviewed and updated to allow for continual delivery of service whilst ensuring the correct level of expertise. There are many opportunities for both biomedical and clinical scientists to adopt new advanced roles, which not only allow networks to progress, but also deliver a high-quality service through developing staff to work at their top capability.

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Errors Related to Information Technology (IT) 15

Authors: Megan Rowley, Jennifer Davies and Alistair McGrann

Definition:

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

Cases selected include 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. Where the corrective and preventive action suggested in response to errors included IT solutions, these have been included.

Key SHOT messages

- At a local level it remains vital that information technology (IT) systems are configured correctly, regularly validated and robust processes are in place for accurate and timely manual input of specific requirements. The deployment and operation of IT systems within transfusion practice should be aligned with National Health Service (NHS) digital and NHSX digital, data and technology framework (NHS Digital 2016, DHSC 2018, Scottish Government 2018)

Abbreviations used in this chapter

ADU	Avoidable, delayed and under/overtransfusion
BSH	British Society for Haematology
DOB	Date of birth
GP	General practitioner
HSE	Handling and storage errors
IBCT	Incorrect blood component transfused
ID	Identification
IT	Information technology
IUT	Intrauterine transfusion
LIMS	Laboratory information management systems
NHS	National Health Service
NM-IT	Near miss information technology
PDA	Personal digital assistant
RBC	Red blood cell
RBRP	Right blood right patient
SD-FFP	Solvent-detergent fresh frozen plasma
SRNM	Specific requirements not met
UKTLC	United Kingdom Transfusion Laboratory Collaborative
WCT	Wrong component transfused

Recommendations

- Clinical and laboratory transfusion practice must be aligned within the hospital and with National Health Service (NHS) digital strategies
- SHOT's wealth of data relating to information technology (IT) issues should be used to inform future digital solutions

Action: SHOT, United Kingdom Transfusion Laboratory Collaborative (UKTLC), transfusion/pathology IT leads within Trusts and Health Boards

Background

It is now 38 years since the introduction of the first LIMS. Keeping focus on the primary aims of IT systems in healthcare is vital to ensure they are deployed in a manner that fully exploits their capability to improve healthcare delivery (Murphy et al. 2019).

There are two primary aims for IT systems. Firstly, improving the ergonomics of clinical tasks by allowing automation within defined parameters with the aim of driving a reduction in human error and improvement in speed and efficiency. Secondly, allowing the collection and storage of large volumes of detailed and accurate information in a manner that allows for easy manipulation and scrutiny with the purpose of generating both clinical and managerial insights. These two aims are intrinsically linked; a failure to improve ergonomics and automation will lead to 'workarounds' and manual steps that degrade the safety of IT systems and hence the quality and reliability of the information gathered. To fully realise these two aims, systems need to be interoperable with data from one clinical system being readily transferrable and usable in others.

SHOT has repeatedly demonstrated the persistent adverse safety consequences of the failure to achieve interoperability. An absence of interoperability creates the requirement for manual data entry which SHOT has demonstrated is a source of error. The interoperability of systems both within NHS hospitals and between NHS institutions remains limited and is held back by a lack of standardisation of data formatting and data exchange.

Clinical information standardisation is a key part of the NHS digital, data and technology framework (NHS Digital 2016) reflecting the fact that it underpins system interoperability with wide reaching benefits to the healthcare system as a whole. The specific challenges for improving the safety of IT in transfusion are well aligned with this framework.

Introduction

In 2019 there were 283 (270 excluding anti-D immunoglobulin (Ig) administration errors) reports included in this chapter drawn from the primary reporting categories as shown in Table 15.1 and these are categorised in Table 15.3 (available on the SHOT website) according to the errors and the reason for the error based on the reporter's classification and the author's interpretation.

For the first time the IT errors in the near miss reporting category (NM-IT) have been analysed and are included in this chapter. For all other IT errors and associated learning points and recommendations, please see the supplementary information on the SHOT website (https://www.shotuk.org/shot-reports/report-summary-and-supplement-2019/) for the relevant chapters given in Table 15.1.

Errors related to flags, alerts and warnings remain the commonest source of error and are summarised below for all reporting categories.

Table 15.1: Source of cases containing errors related to information technology

Primary reporting category	Number of cases 2019
Incorrect blood component transfused-wrong component transfused (IBCT-WCT)	25
IBCT-specific requirements not met (IBCT-SRNM)	102
Right blood right patient (RBRP)	42
Avoidable, delayed and under/overtransfusion (ADU)	25
Handling and storage errors (HSE)	76
Total	**270**
Anti-D Ig	13
Total including anti-D Ig	**283**

IT flags, alerts and warnings n=122

Warning flag in place but not heeded n=40

There were 18 reports where a unit had expired or was out of temperature control and the warning was not heeded. There were 7 reports of WCT and 14 of SRNM. One warning related to the requirement for a blood warmer.

Warning flag not updated or removed in error n=29

This category is where information on the LIMS should have been updated and wasn't or where a flag was removed in error. In 4 cases wrong blood was transfused, 21 reports related to SRNM and 4 units were expired or out of temperature control.

Failure to use flags and/or logic rules n=53

These incidents would have been prevented if the LIMS or other system had the warning flags activated or logic rules put in place.

Further details of the IT-related reports can be found in the supplementary information on the SHOT website (https://www.shotuk.org/shot-reports/report-summary-and-supplement-2019/).

Near miss IT events n=155

The numbers of NM-IT events reported for the 2019 reporting year compared to the previous three years (2016, 2017 and 2018) are shown in Table 15.2. The number of cases reported shows variation for all categories from 2016 to 2019. The cases described below are for 2019 only.

Primary reporting category	No. of reports 2016	No. of reports 2017	No. of reports 2018	No. of reports 2019
ADU	0	3	1	1
Cell salvage	0	0	0	1
Anti-D Ig	4	16	5	13
HSE	1	8	15	20
SRNM	44	52	36	35
WCT	37	66	65	42
RBRP	23	36	28	43
Total	**109**	**181**	**150**	**155**

Table 15.2: Source of NM-IT cases 2016-2019

RBRP NM-IT n=43, and WCT NM-IT n=42

Discrepancies in patient details were noted due to errors of manual entry in electronic systems, data mismatches within unlinked systems, transcription errors and transposition of compatibility labels on components. Electronic tracking systems proved invaluable in preventing errors at collection and administration, as noted in the cases below. In 23 of the WCT and 6 of the RBRP events the error was prevented by an electronic tracking system, however, it is notable that the tracking system appears to be used as the primary patient check, rather than a confirmation step.

Case 15.1: Incorrect replacement identification (ID) band used to scan components prior to administration

Administration checks for solvent-detergent fresh frozen plasma (SD-FFP) were performed by two nurses at the bedside. The ID band on the patient had eye-readable patient details however the barcode was worn and could not be scanned by the BloodTrack® system. A new ID band was printed, however the nurse had not realised there were previous ID bands in a queue. They selected the incorrect patient's ID band to scan away from the bedside using the personal digital assistant (PDA) linked to BloodTrack®, however the system alerted to prevent transfusion of an incorrect unit to the wrong patient. The correct patient subsequently received an SD-FFP transfusion as indicated.

Case 15.2: Patient details mismatched on two unlinked IT systems

A request for red blood cell (RBC) transfusion was received in the laboratory, however the date of birth on the request form and blood sample received from the general practitioner (GP) did not match the LIMS. It did match the information on the GP patient ID system (summary care record (SCR)) and the LIMS was updated by laboratory staff. When attempting to issue the unit, it was scanned into Blood360® which held information from the patient's previous transfusion, and the unit was automatically quarantined due to a mismatched date of birth (DOB). The details on Blood360® are updated manually, and this step had not been completed. The ward was contacted to ascertain the correct DOB, and the patient confirmed the DOB on Blood360® was correct, but incorrect on the patient ID system and pathology LIMS system. A new sample was requested from the ward to provide blood for the patient and the GP practice contacted to inform them of the error.

SRNM NM-IT cases n=35

The majority of SRNM NM-IT cases related to the issue of non-irradiated components, most of these due to the laboratory not being informed of the specific requirement. Despite this, IT systems assisted in prevention of error at collection (Case 15.3) and by provision of checklists at administration. The importance of correct application of IT flags is demonstrated in Case 15.4 where non-irradiated blood was issued via a blood refrigerator.

Case 15.3: Irradiated red cells not issued for a baby with previous intrauterine transfusion (IUT)

A woman with history of IUT at a different hospital in the Trust presented for a planned caesarian section. A unit of neonatal emergency red cells, which had not been irradiated, was removed from a satellite refrigerator in advance of the procedure to be given to the infant immediately following birth. Even though the woman had been admitted 12 hours prior to the procedure, the transfusion laboratory had not been informed of admission, or delivery plan. The laboratory team were alerted to the removal of neonatal emergency cells by an alarm on BloodTrack® and contacted the clinical area to assist in the emergency haemorrhage. They were subsequently able to access the woman's transfusion records, prevent this incorrect unit being transfused and provide a component with the correct specification for the infant.

Case 15.4: Failure to complete all steps required to attach a flag to the LIMS

The specific requirements section on the request form stated that the patient required irradiated blood. An irradiated warning flag was put onto the patient's laboratory record on WinPath® by the transfusion laboratory staff. However, within this LIMS a second step is necessary - the specific requirement section on the 'product issue page' must also be populated for each sample during the booking-in process. On this occasion this step was omitted in error and therefore there was no message to the HaemoBank80® remote issue refrigerator to prevent the issue of non-irradiated blood.

HSE NM-IT cases n=20

HSE NM-IT events included failure to act on alerts, failures in temperature monitoring systems and storage of blood components in non-designated refrigerators. IT systems, in some cases were able to identify and prevent errors.

Case 15.5: Incorrect storage of red cells identified by electronic tracking system

A unit of blood was correctly collected from the transfusion laboratory issue refrigerator and put into the ward satellite refrigerator using an electronic tracking system. During collection from the satellite refrigerator it was noted that the unit was not present. The blood was then found in a chemotherapy storage refrigerator next to the satellite blood refrigerator. The unit was initially quarantined pending investigation and then discarded.

Learning points

- Electronic blood-tracking systems identify errors in transfusion practice and should be implemented for storage, collection and administration of blood components. Staff appear to be becoming more reliant on these systems to perform the primary patient identification, particularly at administration, and should be reminded that bedside information technology (IT) systems acts as the *confirmatory* step
- IT systems are increasingly used within hospital practice to support patient safety (Davies et al. 2018). For them to perform this role they must be configured correctly, used appropriately by staff and interfaced
- Flags within the laboratory information management system (LIMS) should not be easily overridden by laboratory staff and their application should not be complex or multifaceted
- There should be robust processes in place for communication of specific requirements to the laboratory to allow timely application of flags to the LIMS

Conclusion

NHS Digital and NHSX are in the process of developing digital strategies and solutions to address the myriad of standalone systems and inherent failures or barriers. SHOT and the wider transfusion community have an opportunity to work with these teams, use the knowledge and data that we have and develop a fully functioning IT solution to enhance transfusion practice.

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SAFETY
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REACTIONS IN PATIENTS

16 Febrile, Allergic and Hypotensive Reactions (FAHR) n=288

Authors: Janet Birchall and Jayne Peters

Definition:

The reactions assessed are isolated febrile type (not associated with other specific reaction categories), allergic and hypotensive reactions occurring up to 24 hours following a transfusion of blood or components, for which no other obvious cause is evident.

Key SHOT messages

- It is fundamental for all staff involved in transfusion practice to understand the basic mechanism of reactions so that immediate treatment and future management is rational rather than traditional
- Reporters are informed if SHOT experts change the reaction classification submitted. Such a process allows challenge, learning and a more skilled work force within hospitals to improve both the understanding and management of patients experiencing reactions
- For febrile reactions alone, give paracetamol
- For allergic reactions, steroids will have no immediate effect. Give an antihistamine as first line; give adrenaline if anaphylaxis is suspected

Abbreviations used in this chapter

BSH	British Society for Haematology
FAHR	Febrile, allergic and hypotensive reactions
FFP	Fresh frozen plasma
HLA	Human leucocyte antigen
HTR	Haemolytic transfusion reaction
HTT	Hospital transfusion teams
IHN	International Haemovigilance Network
ISBT	International Society for Blood Transfusion
IV	Intravenous
PAS	Platelet additive solution
SABRE	Serious adverse blood reactions and events
SD	Solvent detergent
TACO	Transfusion-associated circulatory overload
TAD	Transfusion-associated dyspnoea
TTI	Transfusion-transmitted infection

Summary of key recommendations from previous years

- Pooled platelets suspended in platelet additive solution (PAS) are associated with a reduction in allergic response (BSH Estcourt et al. 2017). Hospitals should consider preferential use of readily available pooled platelets suspended in PAS in patients with a history of allergic reactions. If reactions continue, despite antihistamine cover, then platelets re-suspended in 100% PAS can be supplied

Action: Hospital transfusion teams (HTT)

- Give appropriate targeted treatment and if needed, preventative cover for future transfusion (BSH Tinegate et al. 2012), as indicated below:

Reaction	Treatment	Prevention of recurrent reactions
Febrile	Paracetamol	Paracetamol 60 minutes before anticipated time of reaction
Allergic	Antihistamine (steroid should not be used routinely) If anaphylaxis, adrenaline is essential	If previous reaction with apheresis platelets try pooled platelets in PAS; If reactions continue, give pre-transfusion antihistamine; If reactions continue, consider washed platelets/red cells; for fresh frozen plasma (FFP) try a pooled component e.g. solvent-detergent (SD) treated plasma

Table 16.1: Targeted treatment for febrile and allergic transfusion reactions

Action: HTT

Previous recommendations for all years can be found on the SHOT website: https://www.shotuk.org/shot-reports/previous-recommendations/.

Introduction

Reactions are classified according to the International Society for Blood Transfusion/International Haemovigilance Network (ISBT/IHN) definitions, which are summarised below in Table 16.2, available online (ISBT/IHN 2011) and have been adopted by the British Society for Haematology (BSH) (BSH Tinegate et al. 2012).

	1 = Mild	2 = Moderate	3 = Severe
Febrile-type reaction	A temperature ≥38°C and a rise between 1 and 2°C from pre-transfusion values, but no other symptoms/signs	A rise in temperature of 2°C or more, or fever 39°C or over and/or rigors, chills, other inflammatory symptoms/signs such as myalgia or nausea which precipitate stopping the transfusion	A rise in temperature of 2°C or more, and/or rigors, chills, or fever 39°C or over, or other inflammatory symptoms/signs such as myalgia or nausea which precipitate stopping the transfusion, prompt medical review AND/OR directly results in, or prolongs hospital stay
Allergic type reaction	Transient flushing, urticaria or rash	Wheeze or angioedema with or without flushing/urticaria/rash but without respiratory compromise or hypotension	Bronchospasm, stridor, angioedema or circulatory problems which require urgent medical intervention AND/OR, directly result in or prolong hospital stay, or **anaphylaxis** (severe, life-threatening, generalised or systemic hypersensitivity reaction with rapidly developing airway and/or breathing and/or circulation problems, usually associated with skin and mucosal changes)
Reaction with both allergic and febrile features	Features of mild febrile **and** mild allergic reactions	Features of both allergic and febrile reactions, at least one of which is in the moderate category	Features of both allergic and febrile reactions, at least one of which is in the severe category
Hypotensive reaction		Isolated fall in systolic blood pressure of 30 mmHg or more occurring during or within one hour of completing transfusion **and** a systolic blood pressure 80 mmHg or less in the absence of allergic or anaphylactic symptoms. No/minor intervention required	Hypotension, as previously defined, leading to shock (e.g. acidaemia, impairment of vital organ function) without allergic or inflammatory symptoms. Urgent medical intervention required

Table 16.2: Classification of reactions

Death n=0

Major morbidity n=72

The ISBT/IHN classification of a severe reaction has been used to define major morbidity.

Reactions are categorised in Table 16.3. This included no hyperacute cases associated with confirmed IgA deficiency.

Table 16.3: Classification of FAHR in 2019

	Moderate	Severe	Total
Febrile	127	19	146
Allergic	58	41	99
Mixed allergic/febrile	29	11	40
Hypotensive	2	1	3
Total	**216**	**72**	**288**

NB: in 24 of the 72 reactions classified as severe this was primarily because the patient was admitted/kept in overnight

The percentage of severe reactions remains similar to previous years at 72/288, 25.0%. Many, largely febrile-type, reactions continue to be difficult to classify because of insufficient information, the ISBT/IHN grade of reaction not being used and because of the difficulty in distinguishing true transfusion reactions from symptoms and signs associated with the patient's underlying condition. In 112/288 (38.9%) cases, the type of reaction initially reported was reclassified according to the information provided (Table 16.4). Any changes were communicated back to the reporters.

Table 16.4: Reclassification of FAHR in 2019

		Confirmed FAHR category			
		Anaphylaxis/allergic	Febrile	Mixed febrile/allergic	Hypotensive
Reported category on SABRE	Anaphylaxis/allergic	87	30	28	-
	Febrile	3	78	1	-
	Mixed febrile/allergic	4	12	8	-
	Hypotensive	1	4	-	3
	Other/FAHR	3	6	2	-
	Other	1	11	1	-
	Other/TACO	-	1	-	-
	Other/TAD	-	1	-	-
	Other/HTR	-	2	-	-
	TTI	-	1	-	-
	Total	**99**	**146**	**40**	**3**

SABRE=serious adverse blood reactions and events online reporting system

TACO=transfusion-associated circulatory overload; TAD=transfusion-associated dyspnoea; HTR=haemolytic transfusion reaction; TTI=transfusion-transmitted infection

Correct category	**176**	**61.1%**
Changed category	**112**	**38.9%**

Hyperacute reactions n=0

Two cases of confirmed IgA deficiency (<0.0005g/L) were reported in 2019. One case had confirmed anti-IgA antibodies. Neither case demonstrated the typical hyperacute transfusion reaction which we have previously associated with this diagnosis.

Type of reactions by component

This remains similar to previous reports; see Figure 16.1. Red cells are usually associated with febrile-type reactions 121/152 (79.6%) whereas plasma and platelets more commonly cause allergic reactions

(18/24, 75.0% and 54/97, 55.7%). There were 6 reactions associated with SD-FFP. It is notable that despite an almost certain increase in the use of virally inactivated components the number of reactions remains low.

The number of days' shelf life remaining at the time of the reaction if only one component was transfused were analysed. Analysis was limited to red cell and platelet units as plasma is usually stored frozen. Reactions were associated with older units with 71/93 (76.3%) of red cells having less than 20 days shelf life and 43/65 (66.2%) of platelets having less than 3 days shelf life. There was no significant difference if allergic reactions and febrile reactions were considered separately. It is accepted that until data on the age of blood at the time of use is available this may simply reflect that the majority of units are given towards the end of shelf life.

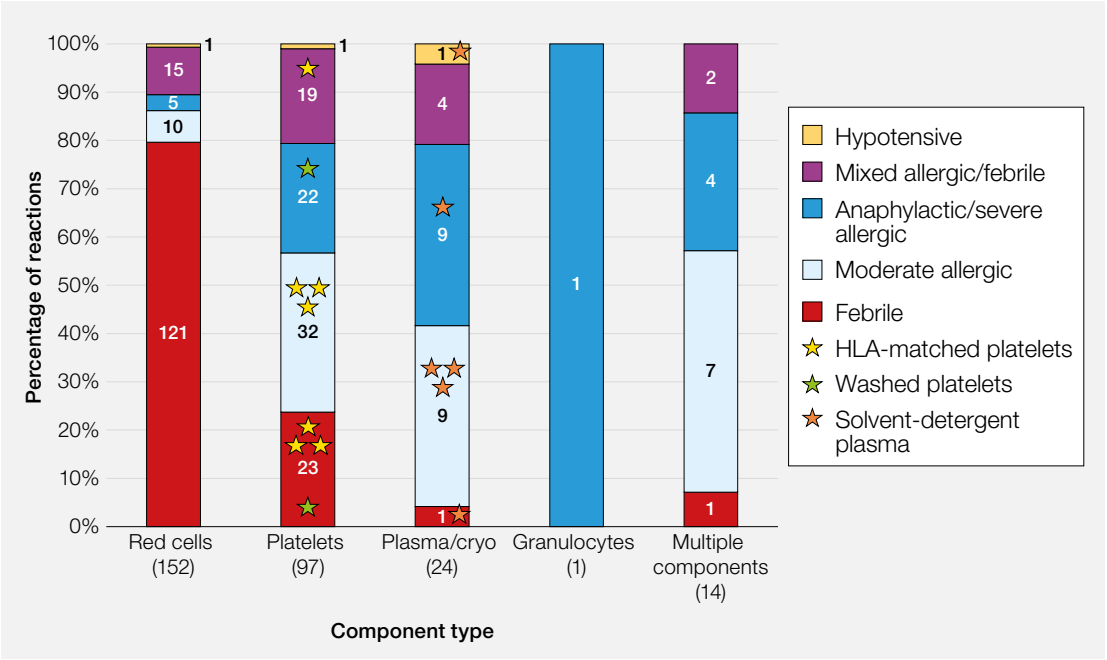
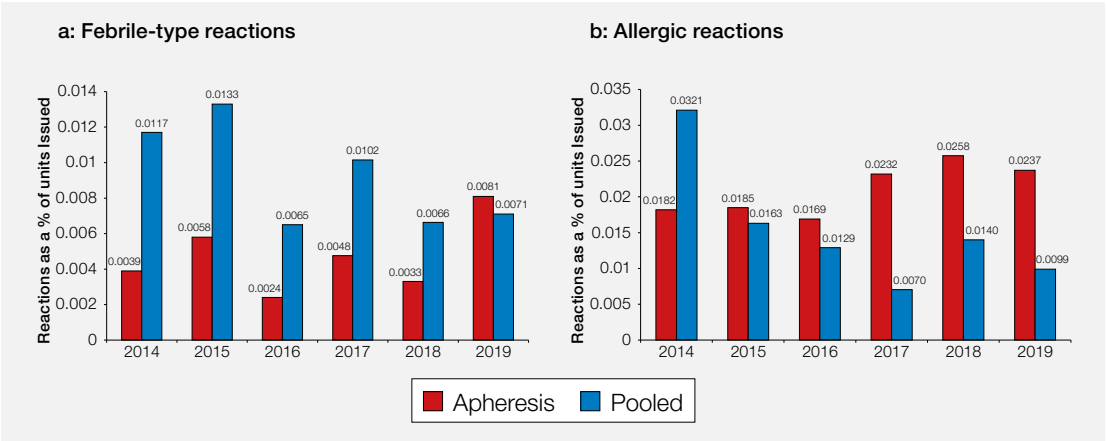


Figure 16.1: Reactions by component type

HLA=human leucocyte antigen; cryo=cryoprecipitate

The incidence of allergic reactions linked to pooled platelets (suspended in PAS) continues to be lower than the incidence of allergic reactions linked to apheresis platelets and, as previously reported, this is likely associated with the reduction in plasma content. This year there was little difference in the incidence of febrile reactions with pooled platelets compared to apheresis. Overall, there were fewer reactions reported with pooled platelets than apheresis platelets (0.02% and 0.03% respectively) and the incidence remains consistent. Reactions to platelets are at least in part caused by release of substances from the platelets themselves and therefore cannot be completely eliminated (Garraud et al. 2016, Maurer-Spurej et al. 2016). (Figures 16.2a and 16.2b).



Figures 16.2: Percentage of reactions to apheresis and pooled platelets 2014 to 2019

Analysis of reactions remains comparable to previous years in the following characteristics (Table 16.5).

Table 16.5: Characteristics of FAHR

Age distribution	84% of patients were aged 18 years or over
Gender	50% male and 50% female cases
Urgency of transfusion	*64% were given routinely
Timing of transfusion	*39% occurred within standard hours
Location	63% were on wards and 16% in outpatient/day case units

**Lower % of transfusions than in previous years likely associated with more cases reported as unknown*

Treatment of reactions

An antihistamine with or without steroid continues to be used inappropriately to treat reactions with only febrile/inflammatory-type symptoms and/or signs; see Table 16.6. In addition to no evidence of benefit, the use of steroids may further immunosuppress already immunocompromised patients and increase the risk of side effects such as infection.

Subsequent management

The use of antihistamine with or without steroids to treat a subsequent pure febrile reaction may be reducing, although the single largest management category included treatment not stated or premedication. In some, avoidance of transfusion was advised and included use of a lower haemoglobin threshold, intravenous (IV) iron, and the discontinuation of prophylactic platelet transfusion (Table 16.7).

Table 16.6: Treatment of febrile reported reaction

Year	Number	Medication stated	Antihistamine and/or steroid
2019	146	130/146 (89.0%)	62/130 (47.7%)
2018	103	88/103 (85.4%)	39/88 (44.3%)
2017	140	121/140 (86.4%)	46/121 (38.0%)
2016	124	102/124 (82.3%)	51/102 (50.0%)
2015	142	101/142 (71.1%)	57/101 (56.4%)
2014	144	97/144 (67.4%)	42/97 (43.3%)

Table 16.7: Planned treatment of subsequent febrile reactions

Year	Number where treatment stated	Antihistamine +/- steroid stated
2019	42	7/42 (16.7%)
2018	27	8/27 (29.6%)
2017	22	5/22 (22.7%)
2016	21	9/21 (42.9%)
2015	9	7/9 (77.8%)
2014	24	9/24 (37.5%)

Illustrative cases

Three cases were selected where transfusion may have been avoided.

Case 16.1: Febrile reaction occurring with platelets given for an erroneous result

A patient in her 80s was admitted for symptoms relating to a pulmonary embolism. She was prescribed two units of platelets for a low platelet count (reported as 29x10^9/L). During the second unit she developed rigors, a fever of 39.2°C and an elevated heart and respiratory rate. The laboratory had noted platelet clumping and had revised the report on the system however the medical team had already acted on this initial result.

Caution should be taken when acting on unexpected blood results.

Case 16.2: Severe allergic reaction when given platelets to reverse aspirin

A patient in his 70s was transfused two doses of platelets in theatre. He was undergoing surgery for an acute subdural haematoma and platelets were given as he was on aspirin. Fifteen minutes after his second dose, the patient developed a rapid rash covering his body and hypotension unresponsive to vasopressors. The patient was treated for anaphylaxis and rapid stability was achieved.

Evidence for use of platelets to reverse aspirin effects is lacking.

Case 16.3: Avoid unnecessary transfusion

A female in her 60s was found to have a haemoglobin of 48g/L when routine blood tests were carried out at her general practice surgery. She experienced severe rigors, back pain, breathlessness and felt very cold 15 minutes after being transfused a unit of red cells for symptomatic anaemia. Paracetamol alone was used to treat this reaction. Future management will be with IV iron.

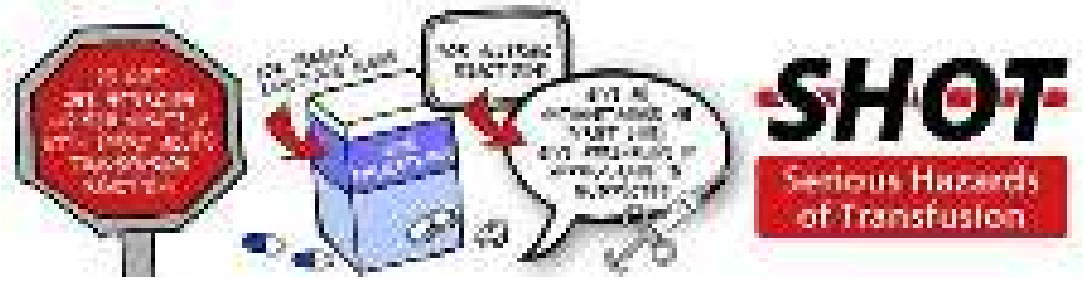
Although this demonstrates appropriate management of a febrile transfusion reaction, iron deficiency anaemia should be treated with iron in the absence of haemodynamic instability (Royal College of Pathologists 2020). All patients presenting with iron deficiency anaemia should be investigated for an underlying cause.

Conclusion

Over a third of cases reported in this chapter were re-classified according to the information provided. Nearly half of pure febrile reactions were given an antihistamine and/or a steroid inappropriately.

It is important to reiterate that there is a need to differentiate the signs and symptoms of separate reaction types, a pure allergic reaction is not associated with fever and finally treatment with an antihistamine and/or steroid should be limited to reactions with allergic features. It is recognised that in a sick patient with acute symptoms identifying different reaction types is difficult. It is encouraging to note that when future medication was stated for reactions classified as purely febrile only 16.7% stated the inappropriate use of a steroid and/or antihistamine, compared to 77.8% in 2015.

The incidence of allergic reactions to apheresis platelets compared to pooled platelets (suspended in PAS) remains higher. Although the incidence is unlikely to change, it will be interesting to note any changes in reaction reporting in 2020 following publication of the Department of Health and Social Care document 'Risk assessment of the transmission of vCJD by blood components' which states that apheresis platelets are no longer preferentially recommended for patients born after 1995.



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Pulmonary Complications n=163 17

Author: Puneet Malhotra with contributions from members of the pulmonary Working Expert Group (WEG)

Key SHOT messages

- Pulmonary complications of transfusion remain a leading cause of transfusion-related mortality and morbidity, contributing to over 50% of transfusion-related deaths reported to SHOT from 2010 to 2019
- When compared to blood use in various National Health Service (NHS) Trusts/Health Boards, a degree of under-reporting is apparent

Abbreviations used in this chapter

ARDS	Acute respiratory distress syndrome	**NBTC**	National Blood Transfusion Committee
BNP	Brain natriuretic peptide	**NT-Pro BNP**	N-terminal-pro brain natriuretic peptide
IHN	International Haemovigilance Network	**TACO**	Transfusion-associated circulatory overload
ISBT	International Society of Blood Transfusion	**TAD**	Transfusion-associated dyspnoea
LAH	Left atrial hypertension	**TRALI**	Transfusion-related acute lung injury
NHS	National Health Service	**WEG**	Working Expert Group

Recommendations

- All cases with pulmonary complications up to 24 hours post transfusion should be reported to SHOT with as much information as possible to ensure adequate inference and effective learning

Action: All SHOT reporters, National Blood Transfusion Committee (NBTC), hospital transfusion teams

- Risk assessment of all patients needing transfusions will help institute appropriate, timely mitigating actions to prevent or reduce the severity of pulmonary complications. Prompt recognition with appropriate investigations and accurate diagnosis will help improve morbidity and mortality

Action: All staff involved in transfusion

Introduction

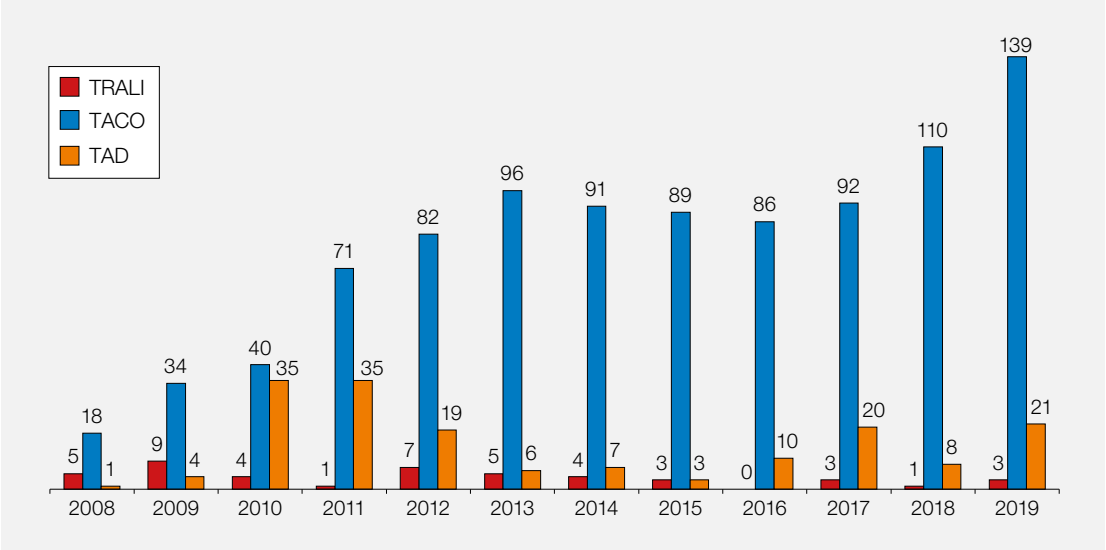
Pulmonary complications of transfusion remain a leading cause of transfusion-related mortality and morbidity, contributing to over 50% of transfusion-related deaths reported to SHOT from 2010 to 2019 (Narayan et al. 2019). There are two well-recognised pulmonary complications of transfusion: transfusion-related acute lung injury (TRALI) and transfusion-associated circulatory overload (TACO). In 2019, updated consensus criteria for the definition of both these conditions were published (Vlaar et al. 2019, Wiersum-Osselton et al. 2019). Cases submitted to SHOT that do not meet these criteria, but where there is a temporal relationship between the patient's respiratory deterioration and blood transfusion are included in the transfusion-associated dyspnoea (TAD) category.

The TAD category serves as an important repository for cases of uncertain cause, highlighting potential challenges distinguishing clinically between TACO and TRALI. An important contributing factor in some cases is a lack of adequate clinical information to confidently categorise patients as either TACO or TRALI. Therefore, for the purposes of data analysis, the pulmonary WEG of SHOT has decided in 2020 to sub-classify TAD cases as:

- TAD-C: cases where adequate clinical information was available
- TAD-IC: cases where clinical information was inadequate

SHOT accepted 163 reports of pulmonary complications in 2019; this was the highest annual number received to date. The majority of pulmonary complication reports are of TACO (139 in 2019), a year on year increase (92 in 2017, 110 in 2018) which may be due to enhanced awareness following the recommendation from SHOT to implement a TACO checklist (Bolton-Maggs et al. 2016), together with publicity from the 2017 UK national comparative audit of TACO (Morton et al. 2017). The number of confirmed TRALI cases has reduced since 2003 following the change to production of frozen plasma exclusively from males as a risk-reduction measure. The number of reported TAD cases has varied over recent years and this probably reflects a combination of incomplete submitted data for individual cases and revisions of the definitions for the pulmonary complications. All categories are explored in detail in the next three chapters.

Figure 17.1: Reports of pulmonary complications by year 2008-2019



TRALI=transfusion-related acute lung injury; TACO=transfusion-associated circulatory overload; TAD=transfusion-associated dyspnoea

Updated definition of TRALI

The 2004 consensus definition of TRALI was revised in 2019 (Vlaar et al. 2019) based on current evidence, and to harmonise with the updated Berlin definition of acute respiratory distress syndrome (ARDS) (Ferguson et al. 2012). In the redefinition, the term 'possible TRALI' was dropped to remove the ambiguity of whether 'possible' meant the extent to which the symptoms met the case definition, or the extent to which the blood transfusion was responsible for the reaction (imputability). New terminology was proposed: TRALI type 1 (without an ARDS risk factor), and TRALI type II (with an ARDS risk factor or with mild existing ARDS). In cases with an ARDS risk factor and respiratory deterioration over the 12 hours preceding the transfusion, if the ARDS risk factor was deemed as causative (rather than the transfusion), the cases were classified as ARDS. In this revision, TRALI is a clinical diagnosis not requiring the detection of cognate white blood cell antibodies. The authors recommended adoption into haemovigilance systems for international standardisation, however this will require validation and further collaborative work with international haemovigilance organisations.

Updated definition of TACO

Application of the International Society of Blood Transfusion (ISBT) definition for TACO (ISBT/IHN 2011),

led to recognition that several cases categorised as TACO by clinicians and endorsed by haemovigilance systems did not meet the ISBT criteria (Wiersum-Osselton et al. 2019). This prompted the development of a standardised surveillance definition for TACO by a joint working group from the ISBT haemovigilance working party, the International Haemovigilance Network (IHN) and AABB with wide international consultation. SHOT was a key contributor and collaborator in this work.

Circulatory overload is associated with left atrial hypertension (LAH) and the presence of LAH is a discriminator between TACO and TRALI but demonstrating evidence of this is difficult. Both echocardiography and serum brain natriuretic peptide (BNP) or NT-pro brain natriuretic peptide (NT-Pro BNP) are potentially useful investigations but are currently infrequently performed. BNP/NT-Pro BNP can often be performed on the same sample type as that used for compatibility testing, allowing convenient retrospective testing of pre- and post-transfusion blood samples.

Recent data from SHOT show that only 9.1% (10/110) of reported cases of TACO had an echocardiography report provided, and only 2.7% (3/110) had a NT-Pro BNP performed (Narayan et al. 2019). BNP or NT-Pro BNP is a potentially useful surrogate for LAH: a normal level excludes TACO and is therefore a valuable negative predictor. An increase to 1.5 times the pre-transfusion level supports TACO (Li et al. 2009; Zhou et al. 2005). The pre-transfusion level is often raised as heart failure is a risk for TACO, and therefore the extent of change is important. However, there are some limitations: NT-Pro BNP levels are unreliable in critically ill patients and in renal failure due to impaired renal clearance and hypoxic vasoconstriction (Klanderman et al. 2019), limiting its usefulness in this population.

The new TACO haemovigilance definition relies on the 'additional criteria' to demonstrate features of circulatory overload and this is important when echocardiography and BNP/NT-Pro BNP may not be available to provide evidence of LAH. The additional criteria (excluding BNP/NT-Pro BNP) rely on demonstrating indirect evidence of circulatory overload by the presence of unexplained cardiovascular changes (hypertension, tachycardia, enlarged cardiac silhouette (if reported), and new peripheral oedema), or evidence of fluid overload. These parameters also have limitations in delineating pulmonary complications of transfusion. Unanticipated changes in cardiovascular status can occur in both TRALI and TACO, though hypotension is more commonly seen in TRALI. Changes in blood pressure and heart rate are non-specific and may be confounded by the patient's underlying condition. Fluid balance and response to diuretics (especially volume of diuresis, which may be impaired by renal failure) are generally not well recorded. Fever has been shown to be present in both TACO and TRALI in approximately 30% of TACO cases (Bolton-Maggs et al. 2017; Parmar et al. 2017), suggesting an inflammatory component in both, and is therefore also a non-discriminatory clinical sign.

Most patients classified as TAD are very unwell with multiple ongoing issues. Some cases had features suggestive of TACO or TRALI but not enough reported detail to meet the SHOT criteria and hence included under TAD. International collaborative work is essential to help improve our understanding of the pathophysiology of this group of complications and that may help identify appropriate risk reduction measures in the future. SHOT is also evaluating the impact of the recent updated definition of TRALI on the reporting strategy for pulmonary complications and the potential for re-categorisation of cases previously classified as TAD.

Conclusion

National reporting of transfusion complications and annual publication of the data is a valuable resource enabling better recognition, production of guidelines and safer transfusion practice. SHOT recommends reporting any cases where patients develop respiratory distress during or up to 24 hours after transfusion. It is important to differentiate a 'surveillance definition' from a 'clinical diagnosis'. A combination of diagnostic testing and the patient's response to treatment may suggest a clinical diagnosis. A surveillance definition is used in haemovigilance and provides a standardised method of categorising the reaction in the patient. While they are based on similar data, they fulfil different purposes.

There is an urgent need to ensure international harmonisation of classifying pulmonary transfusion reactions, especially TRALI and TAD, to allow for uniform comparisons, improve understanding of these complications and enhance transfusion safety. An international collaborative including representatives

from SHOT is planning to develop a universal reporting form for respiratory transfusion reactions which will help to make comparisons of reaction rates between various haemovigilance systems.

Recommended resources

SHOT Bite No. 11: Respiratory symptoms during transfusion
https://www.shotuk.org/resources/current-resources/shot-bites/

SHOT educational video about pulmonary complications post transfusion can be accessed at this link:
https://www.shotuk.org/resources/current-resources/videos/

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Transfusion-Related Acute Lung Injury (TRALI) n=3

17a

Author: Tom Latham

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, in the absence of circulatory overload or other likely causes, or in the presence of human leucocyte antigen (HLA) or human neutrophil antigen (HNA) antibodies cognate with the recipient.

Key SHOT message

- An updated terminology and criteria for redefinition of transfusion-related acute lung injury (TRALI) has been proposed by an international collaborative group in 2019, focussing on TRALI as a clinical diagnosis and does not consider the underlying pathophysiology. Work is ongoing to investigate whether the proposed changes will be suitable for use in haemovigilance practice

Abbreviations used in this chapter

CT	Computerised tomography
ECMO	Extracorporeal membrane oxygenation
FAHR	Febrile, allergic and hypotensive reactions
FFP	Fresh frozen plasma
HLA	Human leucocyte antigen
HNA	Human neutrophil antigen
NT-BNP	N-terminal-pro B-type natriuretic peptide
TACO	Transfusion-associated circulatory overload
TAD	Transfusion-associated dyspnoea
TRALI	Transfusion-related acute lung injury
UCT	Uncommon complications of transfusion

Recommendation

- Reporters should include an assessment of whether respiratory status was stable in the 12 hours prior to transfusion for all pulmonary complications of transfusion, to aid classification according to the revised consensus definitions

Action: All SHOT reporters

Introduction

There were 3 confirmed cases of antibody-positive TRALI this year. In total, 18 cases were reported as suspected TRALI. Of these, 5 cases were transferred to transfusion-associated dyspnoea (TAD), 5 cases to transfusion-associated circulatory overload (TACO), 2 cases to febrile, allergic and hypotensive reactions (FAHR) and 1 to uncommon complications of transfusion (UCT). In the remaining 2 cases, 1 has been deferred to the next Annual SHOT Report as serology results are in progress and 1 was withdrawn.

The cases in this year's Annual SHOT Report are primarily classified using the SHOT nomenclature (Table 17a.1), which takes into account both the clinical history and the presence of leucocyte antibodies. In

2019, the consensus redefinition of TRALI (Vlaar et al. 2019) was proposed by an international working group, to which SHOT provided representation (Table 17a.2). This redefinition was intended to update the earlier Canadian consensus criteria. A mapping between the SHOT nomenclature and the redefinition is provided in Table 17a.1.

Table 17a.1: SHOT criteria for assessment of TRALI cases

Classification	Definition	Mapping to consensus redefinition
Highly likely	Cases with a convincing clinical picture and positive serology	TRALI type I + positive serology
Probable	Cases with positive serology but other comorbidities which could independently cause acute lung injury or fluid overload	TRALI type II + positive serology
Equivocal	Cases with positive serology in the clear presence of lung injury due to other causes or fluid overload	ARDS or 'TRALI/TACO cannot be distinguished' + positive serology
Antibody-negative TRALI	Cases with a convincing clinical picture where serology is not available or negative	TRALI type I + absent or negative serology
Unlikely - reclassify as TAD	Cases where the history and serology were not supportive of the diagnosis. These cases are transferred to TAD	TRALI type II or 'TRALI/TACO cannot be distinguished' + negative or absent serology

Table 17a.2: Consensus redefinition criteria for TRALI

TRALI Type I—Patients who have no risk factors for ARDS and meet the following criteria:

a. i. Acute onset
   ii. Hypoxemia (P/F ≤ 300* or SpO_2 < 90% on room air)
   iii. Clear evidence of bilateral pulmonary edema on imaging (e.g., chest radiograph, chest CT, or ultrasound)
   iv. No evidence of LAH† or, if LAH is present, it is judged to not be the main contributor to the hypoxemia
b. Onset during or within 6 hr of transfusion‡
c. No temporal relationship to an alternative risk factor for ARDS

TRALI Type II—Patients who have risk factors for ARDS (but who have not been diagnosed with ARDS) or who have existing mild ARDS (P/F of 200-300), but whose respiratory status deteriorates§ and is judged to be due to transfusion based on:

a. Findings as described in categories a and b of TRALI Type I, and
b. Stable respiratory status in the 12 hr before transfusion

* If altitude is higher than 1000 m, the correction factor should be calculated as follows: [(P/F) × (barometric pressure/760)].
† Use objective evaluation when LAH is suspected (imaging, e.g., echocardiography, or invasive measurement using, e.g., pulmonary artery catheter).
‡ Onset of pulmonary symptoms (e.g., hypoxemia—lower P/F ratio or SpO_2) should be within 6 hours of end of transfusion. The additional findings needed to diagnose TRALI (pulmonary edema on a lung imaging study and determination of lack of substantial LAH) would ideally be available at the same time but could be documented up to 24 hours after TRALI onset.
§ Use P/F ratio deterioration along with other respiratory parameters and clinical judgment to determine progression from mild to moderate or severe ARDS. See conversion table in Appendix S2 to convert nasal O_2 supplementation to FiO_2.

Table 2. New consensus TRALI definition from Vlaar et al. (2019)

Death n=0

There were no deaths this year. Figure 17a.1 shows TRALI cases from 2003-2019, classified using the criteria introduced in the 2016 Annual SHOT Report (Bolton-Maggs et al. 2017). The use of male donors only for fresh frozen plasma (FFP) was implemented in 2003. Cases are recorded as deaths if death was at least 'possibly' related to transfusion (imputability 1 or greater).

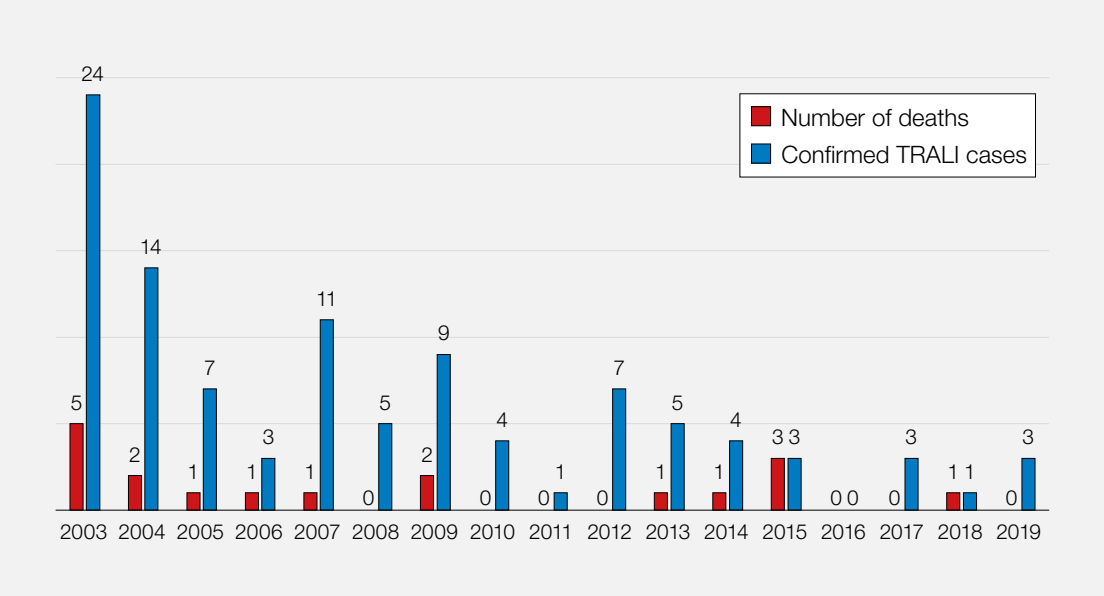

Figure 17a.1: Number of confirmed TRALI cases and deaths at least possibly related to TRALI by year of report

Major morbidity n=3

There were 3 cases of major morbidity, all related to the need for ventilation. Cases are presented in detail below in order to illustrate application of the consensus redefinition criteria and show how they relate to the SHOT nomenclature.

Case 17a.1: Probable TRALI - Acute lung injury following cardiac surgery with cognate antibodies in red cells from a female donor without history of pregnancy

A female patient in her 20s, undergoing cardiac surgery was transfused four units of red cells and two pools of platelets for intraoperative bleeding. 30 minutes after coming off bypass, she became hypoxic with increased difficulty ventilating. Pink frothy fluid was aspirated on bronchoscopy and chest X-ray showed severe pulmonary oedema. There was no respiratory improvement with diuretics. She required extracorporeal membrane oxygenation (ECMO) and 15 days ventilation.

Serological investigation identified HLA antibodies cognate with recipient HLA A2, DR11 and DR17 in one red cell donor. It is notable that the donor had no history of pregnancy. The case has been classified as 'probable TRALI' as it is impossible to rule out major haemorrhage as a cause of the lung injury. In the consensus redefinition this would fit 'TRALI type II' as timing and acute lung injury criteria are met, but there is an alternative risk factor for lung injury present (cardiac surgery).

Case 17a.2: Probable TRALI - Acute deterioration in a patient with sepsis with cognate antibodies in both red cell units

A female patient in her 60s with myelodysplasia was admitted with fever and weight loss and had bronchopneumonia on a computerised tomography (CT) scan on admission, treated with intravenous antibiotics. She received a two-unit red cell transfusion for anaemia and was found unconscious 15 minutes after the second unit started with hypoxia and hypotension. Chest X-ray showed florid pulmonary oedema; post-transfusion N-terminal-pro B-type natriuretic peptide (NT-BNP) was borderline at 200pg/mL. She required 48 hours of ventilation and inotropic support but subsequently made a full recovery. Echocardiogram showed good left ventricular function but a vegetation on her mitral valve; she was subsequently confirmed as having infective endocarditis, for which she received an extended course of antibiotics.

Serological investigation showed multiple HLA class II antibodies in the donor of the first unit (HLA DR 4,15, 51; cognate with recipient) and class I antibody (HLA B60; cognate with recipient) in the second unit. The case has been classified as 'probable TRALI' as she had pre-existing lung disease and it is impossible to rule out sepsis or endocarditis compromising her ability to handle the volume of transfusion. In the consensus redefinition this would fit 'TRALI type II' as there are alternative risk factors for lung injury present (sepsis).

Case 17a.3: Equivocal TRALI - Cognate antibodies from female platelet donors in a patient with multiple possible reasons for lung injury

A male patient in his 50s, 40 days post allogeneic transplant for myelofibrosis had had a complicated admission with influenza, suspected pneumocystis pneumonia and bacteraemia, but was clinically improving on the day of reaction though still on oxygen. He was transfused two pooled units of platelets prior to Hickman line insertion and then became acutely hypoxic and breathless immediately after the procedure. CT scan was reported as 'There is widespread mixed interstitial and intra-alveolar air space shadowing suggesting an evolving bilateral pneumonic process. The appearances are more confluent, than on the previous chest X-ray. The appearances are not typical of acute pulmonary oedema.' He required ventilation for 48 hours and was treated with multiple antibiotics but made a full recovery.

Serological investigation of the female donors contributing to the platelet pools revealed HLA A2 antibodies in one platelet donor and HLA Bw4 in the second platelet donor cognate with both the recipient's original HLA type and the stem cell donor's HLA type. One donor had no history of pregnancy or transfusion. The case has been classified as 'equivocal TRALI' as the timing and serology are compatible but there are other possible causes (which the imaging favours). The case arguably does not meet the criteria for TRALI in the consensus redefinition as it does not meet the criterion of 'clear evidence of bilateral pulmonary edema on imaging.'

Analysis of cases

Classification of cases using SHOT and revised consensus nomenclature

Table 17a.3: Classification of 2019 cases referred as suspected TRALI

Probability	Number of cases
Highly likely	0
Probable	2
Equivocal	1
Antibody-negative	0
Unlikely - transferred to other categories	15

Table 17a.3 includes notified cases which have been transferred to other categories but not cases which have been withdrawn or deferred.

Table 17a.4: Classification of 2019 cases using revised consensus definitions

Consensus redefinition classification	Number of cases
TRALI type I	0
TRALI type II	2
Not TRALI	1

Table 17a.4 includes only cases classified as TRALI. There may be cases in both TAD and TACO categories which could be classified as TRALI type II or 'TRALI/TACO cannot be distinguished' under the consensus definition.

Cumulative serological data

Analysis of reports of 191 complete TRALI investigations between 2001 and 2019 inclusive has shown that the specificities of concordant antibodies were as follows:

Table 17a.5: Concordant donor antibodies 2001 to 2019 inclusive

HLA class I alone	HLA class II alone	Both HLA class I and HLA class II	Granulocyte specific antibody (+/- HLA antibodies)	None identified
22/191 (11.5%)	36/191 (18.9%)	29/191 (15.2%)	19/191 (9.9%)	85/191 (44.5%)

Commentary

The number of cases due to antibody-mediated TRALI in this year's Annual SHOT Report remains relatively stable. All cases this year had antibodies which could not have been prevented by existing TRALI reduction measures. The occurrence of HLA antibody-associated TRALI associated with red cell transfusion from female donors with no history of pregnancy or transfusion demonstrates that targeting screening to females with history of pregnancy or restricting donors with antibodies to red cell donation is unlikely to completely prevent antibody transmission.

The publication of the revised consensus criteria is the major change this year. How do the revised criteria contribute to haemovigilance? The new criteria do appear workable in terms of being able to classify cases, and the 'TRALI type II' concept does group together an identifiable clinical phenomenon of unwell patients who develop a respiratory deterioration following transfusion. It remains unsatisfactory that TRALI is defined purely as a syndrome of clinical features based on arbitrary cut-off points.

Underlying the new diagnostic criteria, the authors offer a fundamental concept of TRALI as 'post-transfusion pulmonary oedema caused by increased endothelial permeability.' This is certainly a well-defined concept, but is a true redefinition which fundamentally alters the haemovigilance implications of TRALI. There is a difference in terms of preventative approaches between cases where biologically active agents in the transfusion contributed to endothelial injury (which are thus in the domain of safety of blood components), and cases where pre-existing endothelial permeability reduced the ability to tolerate the fluid load associated with the transfusion (which is a clinical matter for prevention).

The long-term aim would be a classification of post-transfusion lung injury based on aetiology, but this is not currently possible. Leucocyte antibodies are an established causative agent, although neither necessary nor sufficient for a TRALI diagnosis. It remains important to consider the presence of leucocyte antibodies and the imputability of their relationship with the reaction to monitor the effectiveness of preventative strategies based on antibody reduction.

Nevertheless, it will be important to align case reporting with the new definitions to aid international comparison. The initial priority is to formally review how the redefinition is applicable in practice; a review of historical pulmonary complication cases is proposed both for SHOT and internationally. It is proposed that SHOT will continue to report antibody-associated cases as a sub-category.

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17b Transfusion-Associated Circulatory Overload (TACO) n=139

Author: Sharran Grey

With thanks to Harriet Lucero for case assessments January-August 2019

Definition:

TACO is defined as acute or worsening respiratory compromise and/or acute or worsening pulmonary oedema during or up to 12 hours[†] of transfusion, with additional features including cardiovascular system changes not explained by the patient's underlying medical condition; evidence of fluid overload and a relevant biomarker[¥].

[†]SHOT accepts cases up to 24 hours
[¥]see Table 17b.2 for details of required and additional criteria for a surveillance diagnosis

Key SHOT message

- Patients who develop respiratory distress during or up to 24 hours following transfusion where transfusion is suspected to be the cause must be reported to SHOT. The transfusion-associated circulatory overload (TACO) definition criteria can be used as guidance but this should not be restrictive. SHOT experts can transfer cases between categories

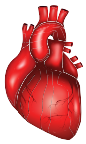
Abbreviations used in this chapter

CPAP	Continuous positive airway pressure	**IHN**	International Haemovigilance Network
Hb	Haemoglobin	**ISBT**	International Society for Blood Transfusion
NT-BNP	N-terminal-pro B-type natriuretic peptide	**TACO**	Transfusion-associated circulatory overload

Recommendations

- A formal pre-transfusion risk assessment for transfusion-associated circulatory overload (TACO) should be undertaken whenever possible for all patients receiving blood transfusion (especially if older than 50 years or weighing less than 50kg) and mitigating actions taken, as TACO is the most commonly reported cause of transfusion-related mortality and major morbidity
- Use weight-adjusted red cell dosing to guide the appropriate number of units required for all non-bleeding adult patients, ideally using tools which also highlight inappropriate transfusion (Grey et al. 2018, NCA 2017)

Action: All staff authorising transfusion

TACO Checklist	Red cell transfusion for non-bleeding patients	If 'yes' to any of these questions
	Does the patient have a diagnosis of 'heart failure' congestive cardiac failure (CCF), severe aortic stenosis, or moderate to severe left ventricular dysfunction? Is the patient on a regular diuretic? Does the patient have severe anaemia?	1 • Review the need for transfusion (do the benefits outweigh the risks)?
	Is the patient known to have pulmonary oedema? Does the patient have respiratory symptoms of undiagnosed cause?	2 • Can the transfusion be safely deferred until the issue can be investigated, treated or resolved?
	Is the fluid balance clinically significantly positive? Is the patient on concomitant fluids (or has been in the past 24 hours)? Is there any peripheral oedema? Does the patient have hypoalbuminaemia? Does the patient have significant renal impairment?	3 • Consider body weight dosing for red cells (especially if low body weight) • Transfuse one unit (red cells) and review symptoms of anaemia • Measure the fluid balance • Consider giving a prophylactic diuretic • Monitor the vital signs closely, including oxygen saturation

Due to the differences in adult and neonatal physiology, babies may have a different risk for TACO. Calculate the dose by weight and observe the notes above.

TACO=transfusion-associated circulatory overload

Figure 17b.1: TACO pre-transfusion checklist

Introduction

A new surveillance definition for TACO was published in 2019 (Wiersum-Osselton et al. 2019) which was the culmination of several years of collaborative work between the International Haemovigilance Network (IHN), AABB, and the International Society of Blood Transfusion (ISBT). The new definition identifies a higher percentage of cases previously designated as TACO by haemovigilance systems compared to the former ISBT definition (ISBT/IHN 2011). This work represents a significant advance in this area and is intended to form the basis for internationally consistent reporting of TACO. It is also intended to promote the clinical recognition of TACO, while recognising the need for further research into preventative measures and mitigations and aspires to the improved understanding of patho-aetiology, and methods to distinguish the pulmonary complications of transfusion.

SHOT experts were key participants in this work, and early adopters of the new definition. The criteria for the new definition have been used to assess the TACO cases reported to SHOT in 2019 (Table 17b.2).

Death n=9

TACO resulted in patient death in 9 reported cases (all adults).

Major morbidity n=33

TACO remains the leading cause of transfusion-related combined mortality and major morbidity. There was 1 paediatric patient this year that suffered major morbidity.

Table 17b.1: Demographic overview of cases reported in 2019

Demographic	Number of reports
Deaths (imputability 3 - certain)	0
Deaths (imputability 2 - probable)	6
Deaths (imputability 1 - possible)	3
Major morbidity outcome	33
Age*	Range: 27 days to 103 years Median: 76 years
Gender	Female=75 Male=64
Medical specialties with highest number of cases*	Haematology=26 Acute medicine=23, general medicine=23 Emergency medicine=9, trauma and orthopaedics=9
Bleeding patients (indication code R1 or 'massive bleeding' indicated)	20
Non-bleeding patients (other indication codes or not stated)	119

**Data provided in 138/139 cases*

Commentary

TACO is more commonly reported in elderly, non-bleeding patients, but is seen across all age groups and is consistent with the data from previous years. There were 4 cases in the under-18 age group: 1 neonate and 3 paediatric cases (age 1-3 years). Haematology and adult medical specialties are again the most common specialties where TACO is reported and this should be considered when delivering TACO education and mitigation plans.

Analysis by definition criteria

Cases reported in 2019 were assessed using the surveillance criteria in Table 17b.2. It should be noted that the criteria are for the purposes of reporting and surveillance, and do not constitute a clinical diagnosis for the purpose of real-time interventions for the medical management of a patient presenting with respiratory compromise during or following transfusion. However, the surveillance criteria should promote recognition of TACO.

Table 17b.2: TACO surveillance definition (adapted from Wiersum-Osselton et al. 2019)

Patients classified with TACO (surveillance diagnosis) should exhibit at least one required criterion* with onset during or up to 12 hours after transfusion (SHOT continues to accept cases up to 24 hours), and a total of 3 or more criteria i.e. *A and/or B, and total of at least 3 (A to E)

*** Required criteria (A and/or B)**

A. Acute or worsening respiratory compromise and/or
B. Evidence of acute or worsening pulmonary oedema based on:
– clinical physical examination, and/or
– radiographic chest imaging and/or other non-invasive assessment of cardiac function

Additional criteria

C. Evidence for cardiovascular system changes not explained by the patient's underlying medical condition, including development of tachycardia, hypertension, jugular venous distension, enlarged cardiac silhouette and/or peripheral oedema
D. Evidence of fluid overload including any of the following: a positive fluid balance; clinical improvement following diuresis
E. Supportive result of a relevant biomarker, e.g. an increase of B-type natriuretic peptide levels (BNP) or N-terminal-pro brain natriuretic peptide (NT-pro BNP) to greater than 1.5 times the pre-transfusion value

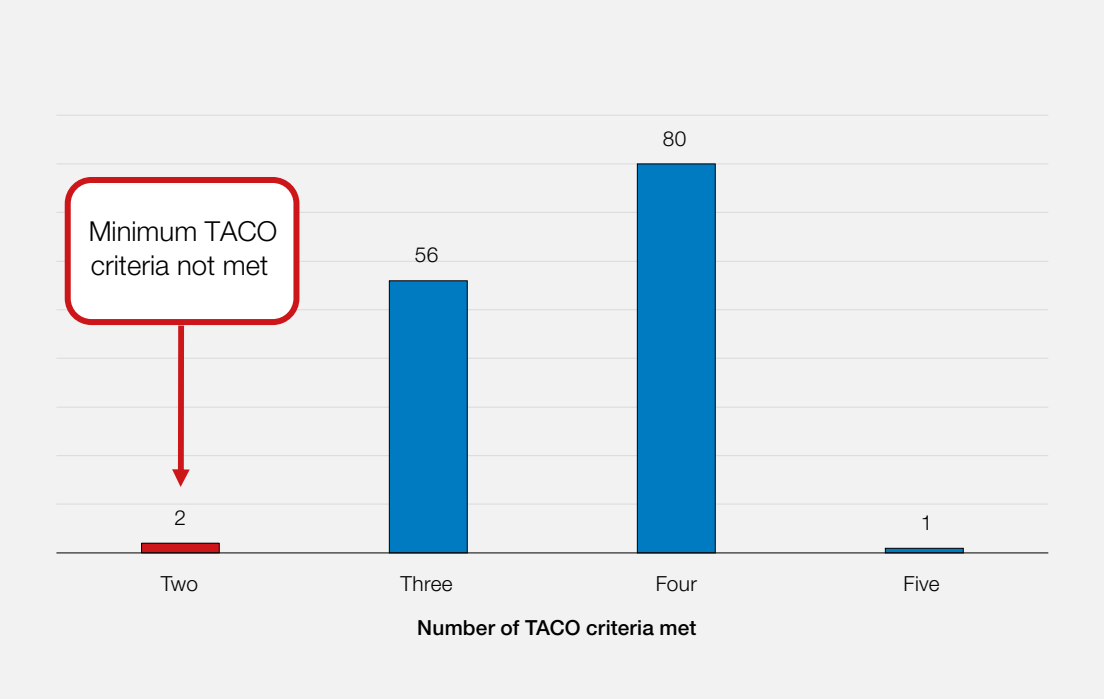


Figure 17b.2: Number of surveillance criteria versus number of accepted TACO cases

TACO=transfusion-associated circulatory overload

There were 2 cases that scored only two criteria but were nevertheless accepted into the TACO category as a pulmonary complication as they were otherwise clinically persuasive cases. One case had developed pulmonary oedema with temporal association with transfusion but lacked cardiovascular system changes and data relating to fluid balance and diuretic therapy was not available. The other case had worsening of respiratory symptoms following transfusion but due to lack of vital sign observation data and as diuretic therapy was withheld in this dying patient, some data for the assessment were not available. Only 1 case had all five criteria as NT-pro BNP had been tested. See the 2018 Annual SHOT Report, p.143 (Narayan et al. 2019) for further information on the utility of this test in demonstrating left atrial hypertension in the differential assessment of pulmonary complications of transfusion.

Use of the TACO checklist

The TACO risk assessment recommendation was introduced in the 2015 Annual SHOT Report (Bolton-Maggs et al. 2016). A question regarding the use of the TACO risk assessment and mitigating actions was added to the SHOT reporting questionnaire for the 2019 reporting year. An overview is shown in Figure 17b.3. The analysis shows that a TACO risk assessment was only performed in 22/139 (15.8%) cases of reported TACO. A TACO risk factor was identified in 18/22 (81.8%) of cases but only 11/18 (61.1%) of these cases had mitigating actions assigned.

Further review of these cases showed that in 1 case there was no evidence of the mitigating actions being performed and in 4 cases they were only partially performed, with only 6 having evidence of being performed in full. Of these 6 cases there was evidence that additional mitigations could have been taken: 2 improved with diuretic treatment indicating that pre-transfusion prophylactic diuretics may have prevented the TACO episode; 1 case could have had weight-adjusted red cell dosing/a single unit; and 1 case had iron deficiency anaemia with TACO developing during the second unit and therefore a single unit of red cells with intravenous iron could have prevented TACO. In 4/22 (18.2%) cases where a TACO risk assessment was performed, no risks were reported and therefore no mitigating actions assigned. However, on review of these cases there was evidence in the report that in 3 cases there were clear risk factors for TACO (positive fluid balance in 2 cases and heart failure in 1) resulting in a missed opportunity to assign mitigating actions.

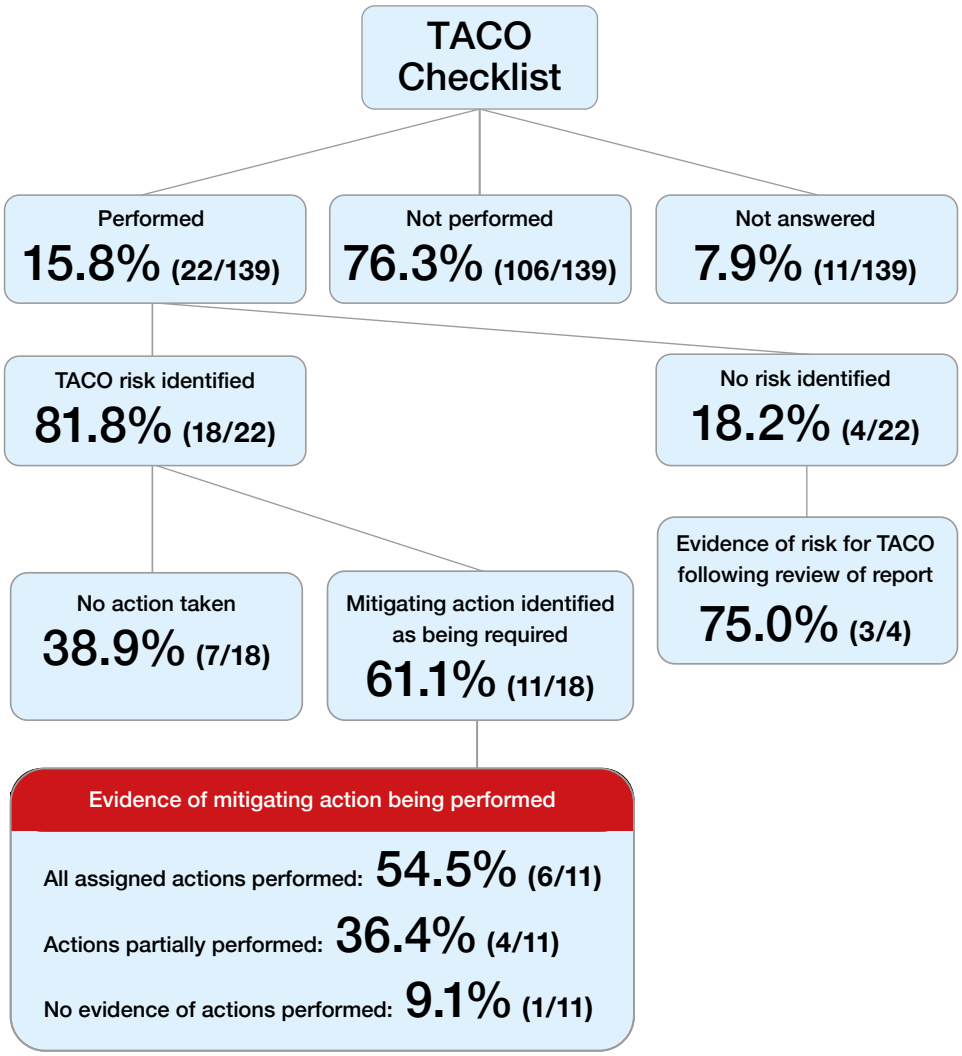


Figure 17b.3: Use of the TACO checklist to identify patients at risk of TACO and implementation of mitigations

TACO cases with evidence of excessive red cell volume to meet the target haemoglobin (Hb)

The recommendation for weight-adjusted red cell dosing for non-bleeding patients was introduced in the 2017 Annual SHOT Report (Bolton-Maggs et al. 2018). Analysis of the 2019 data shows that this is not implemented in practice and is contributing to a significant level of overtransfusion in reported cases of TACO.

There were 61 cases where the patient was not bleeding and both the body weight and pre-transfusion Hb level were reported. Thirty-two of these cases also had a post-transfusion Hb level reported. In 10/32 (31.3%) cases their post-transfusion Hb target was exceeded (post-transfusion Hb range 103-150g/L). The number of red cell units transfused was reported in 35 cases. There were 23/35 (65.7%) cases that received more than the calculated weight-adjusted dose resulting in 6/23 (26.1%) exceeding their post-transfusion Hb target.

Case 17b.1: Omitted TACO checklist leading to overtransfusion and TACO

A female patient in her 70s weighing 54kg developed anaemia following orthopaedic revision surgery (Hb 67g/L). She had a number of risks for TACO: positive fluid balance (1215mL), and the pre-transfusion chest X-ray report was suggestive of possible infection and heart failure, however a TACO checklist was not performed before the transfusion. She was transfused two units of red cells. Following the second unit she developed shortness of breath, crackles on chest auscultation, hypoxia, tachycardia and an increase in blood pressure. The post-transfusion chest X-ray report confirmed findings were consistent with heart failure, fluid overload and possible infection.

She was transferred to the critical care unit for continuous positive airway pressure (CPAP) ventilation. Her respiratory status improved following treatment with diuretics, nitrates and fluid restriction. Her post-transfusion Hb was 108g/L.

This case highlights a missed opportunity to identify this patient as being at risk of TACO and to take mitigating actions. If the checklist had been performed before the transfusion it would have identified possible heart failure and positive fluid balance as risks for circulatory overload. Although a fluid balance measurement was already in place, albeit not identified as a risk, other mitigations could have been considered such as prophylactic diuretics and weight-adjusted red cell dosing. Based on a post-transfusion target Hb of 80-100g/L, this patient with low body weight only required 280mL (one unit) to meet her target Hb. A weight-adjusted dose may have avoided TACO and overtransfusion in this case.

Learning points

- In non-bleeding patients an excessive volume of red cell transfusion to meet a target haemoglobin (Hb) level remains a significant factor in cases of transfusion-associated circulatory overload (TACO). This can be minimised by weight-adjusted red cell dosing, and medical management of anaemia where possible

  [target Hb (g/L) - pre-transfusion Hb (g/L)] x weight (kg) x 0.4mL red cells = volume of red cells (mL) required to meet target Hb
  (The volume of a unit of adult-specification red cells is 220-340mL)

  Calculation taken from Norfolk (2013)

- A significant number of reported TACO cases do not appear to have had a TACO checklist performed, and/or TACO risk reduction measures were not implemented where risk was identified. This should be embedded into the procedure for the request and authorisation of transfusion

Conclusion

TACO is in many cases a preventable complication of transfusion but remains the leading cause of transfusion-related mortality and major morbidity. More cases than ever were reported to SHOT in 2019, but TACO continues to be under-reported. The majority of TACO cases have a recognised risk factor for circulatory overload and although there are now well-established recommendations and tools to mitigate TACO in patients with risk factors, analysis of the data unfortunately shows these are not being implemented in clinical practice, and opportunities are being missed to protect patients. There is more to learn about the pulmonary complications of transfusion which will undoubtedly advance patient safety in the future, but in the meantime we should improve practice with what we already know and have available now.

Recommended resources

Example of weight-adjusted red cell dosing implemented in clinical practice
www.rcdcalculator.co.uk

SHOT Bite No. 11: Respiratory symptoms during transfusion
https://www.shotuk.org/resources/current-resources/shot-bites/

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Transfusion-Associated Dyspnoea (TAD) n=21

17c

Author: Shruthi Narayan

Acknowledgements: All members of the pulmonary Working Expert Group (WEG)

Definition:

TAD is characterised by respiratory distress within 24 hours of transfusion that does not meet the criteria for transfusion-related acute lung injury (TRALI) or transfusion-associated circulatory overload (TACO) or allergic reaction. Respiratory distress in such cases should not be adequately explained by the patient's underlying condition (International Society of Blood Transfusion (ISBT) definition).

Key SHOT messages

- Pathophysiology of transfusion-associated dyspnoea (TAD) is still not known and with no definite diagnostic criteria, our understanding is evolving
- Cases submitted are reviewed by SHOT experts including pulmonologists to determine imputability, causality and categorisation
- Further international collaboration in this area will help identify causal and contributory factors and identify appropriate risk reduction measures

Abbreviations used in this chapter

AML	Acute myeloid leukaemia	**ISBT**	International Society of Blood Transfusion
ARDS	Acute respiratory distress syndrome	**NIDDM**	Non-insulin dependent diabetes mellitus
COPD	Chronic obstructive pulmonary disease	**TACO**	Transfusion-associated circulatory overload
CPAP	Continuous positive airway pressure	**TAD**	Transfusion associated dyspnoea
CXR	Chest X-ray	**TRALI**	Transfusion-related acute lung injury
FAHR	Febrile, allergic and hypotensive reactions	**WCC**	White cell count
IHN	International Haemovigilance Network	**WEG**	Working Expert Group

Recommendation

- Patients who develop respiratory distress during or up to 24 hours following transfusion where transfusion is suspected to be the cause must be reported to SHOT

Action: All staff involved in transfusion

Introduction

TAD is a pulmonary complication post transfusion that cannot be classified as TACO or TRALI, nor can it be ascribed to patient's pre-existing diseases. The underlying risk factors and aetiopathogenesis

are still unknown. Although such reactions are not very common, knowledge about them can prevent serious complications. Early recognition and prompt supportive treatment is beneficial. Appropriate risk reduction strategies are only possible once we understand these reactions better.

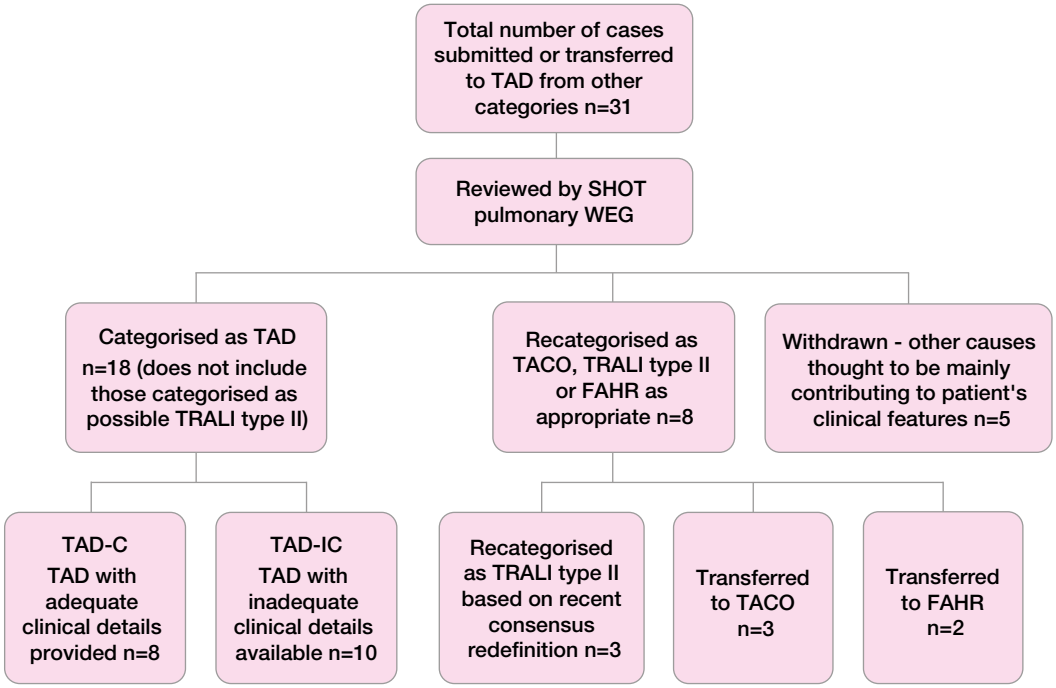
There has been significant international collaborative work relating to pulmonary complications post transfusion, most notably with TACO and TRALI. A new surveillance definition for TACO, published in 2019 (Wiersum-Osselton et al. 2019), was the culmination of several years of collaborative work between the International Haemovigilance Network (IHN), AABB, and the ISBT. The new proposed revised consensus criteria for TRALI (Vlaar et al. 2019), the term 'possible TRALI' has been dropped. The terminology of TRALI type I (without an acute respiratory distress syndrome (ARDS) risk factor) and TRALI type II (with an ARDS risk factor or with mild existing ARDS) has been proposed. It suggests that cases with an ARDS risk factor that meet ARDS diagnostic criteria and where respiratory deterioration over the 12 hours before transfusion implicates the risk factor as causative should be classified as ARDS. According to this, TRALI remains a clinical diagnosis and does not require detection of cognate white blood cell antibodies. While this may help in clinical differentiation, this needs validating with real-life case scenarios to understand the implications to haemovigilance especially from the perspective of appropriate risk reduction preventative measures.

SHOT has recruited two experts from pulmonary medicine as part of the pulmonary WEG and all reported cases from 2019 were reviewed by the group. Interpretation was limited in several cases by the available clinical information including results from relevant investigations. The group applied the new proposed TRALI consensus definitions to those cases reported under TAD to see if it helped re-categorise these reactions. There were 3 cases categorised as TRALI type II which were non-immune TRALI. They are detailed below.

Those that are included under TAD were subdivided based on adequacy of the clinical information available, TAD-C (those with complete or adequate clinical information) and TAD-IC, those with inadequate information. As is usual, there were a few transfers between categories (febrile, allergic and hypotensive reactions (FAHR), TACO, TRALI, etc.) reflective of the challenges involved in interpreting these complex cases. All cases are included in order to build up the series of cases over time. A deep dive into all cases of TAD reported to SHOT over the years is being planned soon to identify common themes. TAD represents cases with atypical or overlapping entities with varying severity of reaction and impact on patients, and with currently unexplained pathophysiology.

The following figure summarises the categorisation and transfer of these cases.

Figure 17c.1: Summary of transfers and categorisation of cases included under TAD



Death n=1

Case 17c.1: TAD-IC

A man with known chronic obstructive pulmonary disease (COPD) in his 80s admitted with suspected sepsis with leucocytosis (white cell count (WCC) >30x10^9/L) developed acute dyspnoea with no wheeze/rash and deteriorated suddenly during red cell transfusion with tachypnoea and tachycardia, hypoxia (O_2 saturations 78%) temperature 37.7°C with bilateral transmitted sounds. He was not reported to have any concomitant cardiac or renal disease. Due to sudden deterioration, investigations could not be completed to ascertain cause.

In view of sudden onset dyspnoea, paucity of clinical information and temporal correlation with transfusion, this has been included in the TAD-IC category.

Major morbidity n=4

In 2019 there were 4 cases included as major morbidity. These include 1 case categorised as TAD-C (Case 17c.2), and the 3 cases of TRALI type II described below were admitted to intensive care as a result of the transfusion.

Case 17c.2: TAD-C

A patient in her 80s was admitted with symptomatic anaemia and a 3-week history of worsening breathlessness and leg oedema. Other co-morbidities included acute on chronic renal failure (stage 3), non-insulin dependent diabetes mellitus (NIDDM), hypertension, cardiac failure with oedema. She was reported to have become more breathless 3 hours after the start of a unit of packed red cells with tachypnoea and desaturation: her oxygen saturation (on 10L O_2) dropped from 91% to 87%. Chest X-ray (CXR) showed an area of developing consolidation.

While there were clinical risk factors for TACO, she was in a negative fluid balance, on regular diuretics with minimal or no response to repeat diuretics and bronchodilators. Chest infection could be contributory and has been included here to highlight the need to monitor such complex patients during transfusions due to the potential for sudden deterioration in clinical status necessitating prompt supportive measures and appropriate treatment. The patient needed continuous positive airway pressure (CPAP) and oxygen support and recovered from this episode.

TRALI type II as per redefinition consensus criteria n=3

Case 17c.3: Imputability-2 (Probable)

A young patient in his 30s diagnosed with acute myeloid leukaemia (AML) on induction chemotherapy developed rigors within 2 hours of platelet transfusion, with a rise in temperature of 2.4°C, tachycardia, desaturation, and wheeze. The CXR showed ARDS with progression from the previous one.

This case was initially reported under TRALI and investigated for antibodies but not all donors responded when contacted. The patient had haemoptysis on the morning of the incident and eventually died due to non-transfusion related causes.

Case 17c.4: Imputability-1 (Possible)

A woman in her 70s with pre-existing COPD and asthma became hypoxic, tachypnoeic and tachycardic within 1.5 hours of platelet transfusion. Cultures were negative, serology was negative and CXR showed bilateral ground glass appearance. The patient recovered following treatment with steroids, antihistamines and supportive measures.

Case 17c.5: Imputability-1 (Possible)

A patient in her 40s following surgery for breast carcinoma required massive transfusion, needing several blood components desaturated to 68% with hypotension, no evidence of fluid overload and bilateral patchy infiltrates on CXR. There was no evidence of cardiac, renal or respiratory disease and the donor antibody screen was negative. The patient needed CPAP support and recovered.

Learning point

- Clinicians should report all cases of post-transfusion pulmonary complications to the transfusion service so that further investigation can allow for further classification of such cases. There are cases where such distinction may not always be possible

Conclusion

Most patients classified as TAD are very unwell with multiple ongoing issues. Some of these had features suggestive of TACO or TRALI but not enough reported detail to meet the SHOT criteria and hence included here. The pathophysiology of this group of complications requires further elucidation (Badami et al. 2015). There is some evidence that patients with sepsis are more at risk of respiratory complications following transfusion (Roubinian 2018), a reminder that every transfusion, particularly of platelets, a rich source of biological response modifiers, (Garraud et al. 2013; Garraud et al. 2016), should be reviewed to ensure it is indicated. There is still much work that needs to be done to understand cases reported under TAD, this is limited by the clinical information available and co-morbidities.

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Haemolytic Transfusion Reactions (HTR) n=49

18

Authors: Tracey Tomlinson and Anicee Danaee

Definitions:

Acute haemolytic transfusion reactions (AHTR) are characterised by fever, a fall in haemoglobin (Hb), rise in bilirubin and lactate dehydrogenase (LDH) and a positive direct antiglobulin test (DAT). They generally present within 24 hours of transfusion.

Delayed haemolytic transfusion reactions (DHTR), occur more than 24 hours following a transfusion and are associated with a fall in Hb or failure to increment, rise in bilirubin and LDH and an incompatible crossmatch not detectable pre transfusion.

Hyperhaemolysis is characterised by more severe haemolysis than DHTR, with haemolysis affecting the transfused red cells and the patient's own red cells; there is a decrease in Hb to below pre-transfusion levels, which is often associated with a reticulocytopenia. It may be triggered by a new red cell alloantibody, but frequently no new red cell antibody is identified. Hyperhaemolysis can be divided into acute and delayed hyperhaemolysis.

Key SHOT messages

- Hyperhaemolysis remains a major cause of transfusion-related morbidity, however as the identification and management primarily takes place outside of the transfusion team these cases may not be reported to SHOT
- All clinicians involved in the transfusion process must have an awareness of the signs and symptoms of hyperhaemolysis. Any suspected cases should be followed up, investigated and reported to SHOT to allow better data capture of this reaction type
- When selecting O D-positive red cells for transfusion to O D-negative individuals it is important to check the patient for contraindications in addition to age and childbearing potential e.g. a history of anti-D or if the patient is transfusion dependent
- The serological investigation of a haemolytic transfusion reaction (HTR) should always include a direct antiglobulin test (DAT) and if positive, an eluate should be performed

Abbreviations used in this chapter

AHTR	Acute haemolytic transfusion reactions
DAT	Direct antiglobulin test
DHTR	Delayed haemolytic transfusion reactions
ED	Emergency department
Hb	Haemoglobin
HTR	Haemolytic transfusion reactions
IAT	Indirect antiglobulin test
IBGRL	International Blood Group Reference Laboratory
IVIg	Intravenous immunoglobulin
LDH	Lactate dehydrogenase
LISS	Low ionic strength saline
MHRA	Medicines and Healthcare products Regulatory Agency
RCI	Red Cell Immunohaematology
Sp-ICE	Specialist Services electronic reporting using Sunquest's Integrated Clinical Environment

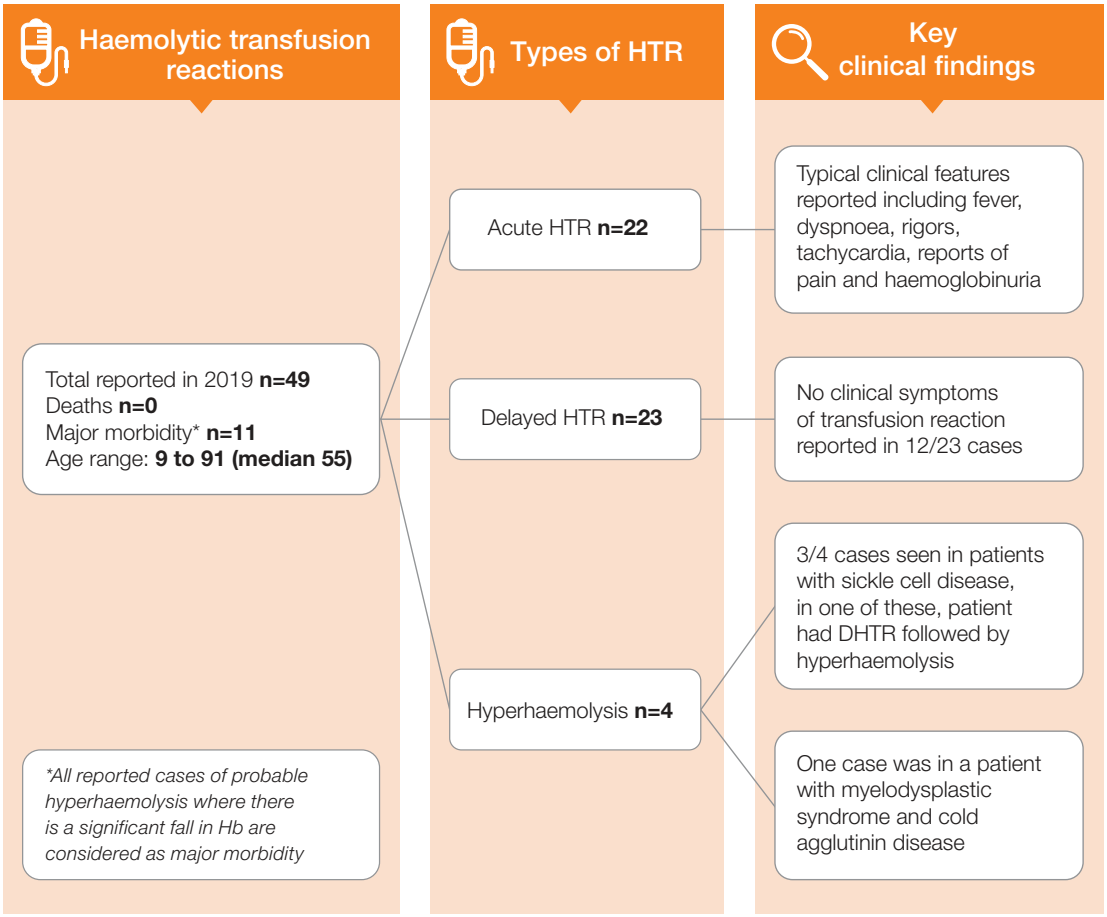
Recommendation

- Clinical teams involved in the transfusion process should have training in the SHOT reporting system and understand the need to work with the transfusion team to ensure all adverse events related to transfusion are reported

Action: Hospital transfusion teams

Number of cases n=49

Figure 18.1: Overview of HTR cases n=49



The total number of reactions reported is greater than previous years with increases in both the number of acute and delayed reactions. This may indicate an increase in awareness. In contrast to previous years only 1 reaction this year was the result of the emergency transfusion of known antigen-positive blood.

Death n=0

There were no patient deaths reported as a result of the transfusion reaction.

Major morbidity n=11

There were 11 cases reported in which the patient suffered major morbidity.

Hyperhaemolysis n=4

Four cases of hyperhaemolysis syndrome were reported and in contrast to previous years all patients made a full recovery.

Case 18.1: Hyperhaemolysis in a patient with myelodysplastic syndrome and cold agglutinin disease

A haematology patient with a provisional diagnosis of myelodysplastic syndrome was transfused one unit of red cells due to a Hb 64g/L. The patient immediately experienced symptoms of a transfusion reaction including fever, hypotension, nausea and dyspnoea. The transfusion was stopped and the post-transfusion Hb dropped to 54g/L. The patient was transfused another four times over the following 7 days, each time with hydrocortisone cover. However, each transfusion resulted in similar reactions, although the symptoms were less severe. At this point a decision was made to stop transfusion and to treat the patient with intravenous immunoglobulin (IVIg) and erythropoietin. The patient improved and the Hb began to rise over the following 3 weeks with the Hb stabilising at 86g/L 7 weeks after the initial reaction.

Hyperhaemolysis can be divided into acute and delayed hyperhaemolysis. Acute hyperhaemolysis usually occurs within 7 days of transfusion and the DAT is usually negative. Delayed hyperhaemolysis usually occurs more than 7 days post transfusion and the DAT is often positive. In contrast to a classical delayed haemolytic transfusion reaction, in delayed hyperhaemolysis both patient and transfused red cells are haemolysed (Danaee et al. 2015). Two of the hyperhaemolysis cases reported to SHOT occurred within 7 days of the transfusion episode and are therefore characterised as acute (1 occurred 5 days post transfusion and 1 at the time of transfusion). Another case occurred 8 days post transfusion, and the fourth case was originally reported as a DHTR but the patient subsequently went on to develop hyperhaemolysis.

The true number of cases of hyperhaemolysis occurring in sickle cell patients is believed to be much higher than that reported to SHOT. The diagnosis of hyperhaemolysis remains a challenge. As there are often no changes in the serological profile in these cases, the transfusion practitioner and transfusion laboratory may not be made aware of the reaction and the case managed entirely by the clinical team. Clinical staff may therefore need educating in the importance of reporting such cases to SHOT and the Medicines and Healthcare products Regulatory Agency (MHRA) to allow the development of a better understanding of the syndrome.

Robust data collection will also help medical professionals to assess the usefulness of new and emerging treatments for hyperhaemolysis, such as the anti-interleukin 6 receptor (IL6R) humanised monoclonal antibody tocilizumab (Watanabe et al. 2016).

Learning point

- It is important that all clinicians involved in the transfusion process have an awareness of the signs and symptoms of hyperhaemolysis and that any suspected cases are followed up, investigated and reported to SHOT to allow better data capture of this reaction type

Clinical and laboratory signs and symptoms

Acute haemolytic transfusion reactions n=22

The clinical symptoms most often reported in acute transfusion reactions include haemoglobinuria, fever, dyspnoea, rigors, tachycardia and reports of pain. These match the major symptoms described in textbooks.

Delayed haemolytic transfusion reactions n=23 (excluding potential cases of hyperhaemolysis)

No clinical symptoms of a transfusion reaction were reported in 12/23 delayed haemolytic transfusion reaction cases submitted to SHOT. This is comparable to other years. Where clinical symptoms were reported the most common symptom was that the patient reported feeling unwell post transfusion. This suggests that hospitals have responded to the recommendation made in the 2015 Annual SHOT

Report that patients are informed of the possible symptoms of a HTR and that patients are responding to this and following up any concerns with their healthcare professionals (Bolton-Maggs et al. 2016).

As in previous years, delayed haemolytic transfusion reactions were more frequently diagnosed based on the laboratory indications, most commonly by the development of a positive DAT. The laboratory diagnosis is usually made as a result of a decreased Hb and increased bilirubin result in combination with a positive DAT. In a majority of cases the LDH, blood film, and ferritin levels are not reported therefore the values given may not be representative of the true picture.

Figure 18.2: Laboratory investigation of haemolytic transfusion reactions

Key findings from laboratory investigations reported in HTR

- DAT post transfusion was not available in 4 cases
- In 25 cases the DAT was not repeated on the pre-transfusion sample. 16/25 of these cases were due to the sample being no longer available in DHTR however in 6 cases of AHTR no pre-transfusion DAT was tested
- In 8/49 haemolytic reactions reported no eluate had been tested despite the patient developing a positive DAT post transfusion, and in 5 of these cases the patient also had a new antibody detectable in the post-transfusion sample

In transfusion reactions, red cell antibodies may be identified in the eluate which are not detectable in the plasma. This is due to the free antibody binding to the corresponding antigen on the transfused cells. Elution tests to identify these antibodies can help confirm the specificity of the individual antibodies implicated in the reaction.

Case 18.2: Anti-Jk^{b} detected in eluate post transfusion

The patient reported feeling unwell 30 minutes into the transfusion of the second unit. The transfusion was stopped, and a transfusion reaction investigation performed. Both pre- and post-transfusion samples demonstrated a non-specific pan reactive antibody detectable in Biovue® and low ionic strength saline (LISS) tube indirect antiglobulin test (IAT). No underlying antibodies were detected in either sample however an eluate on the post-transfusion sample demonstrated the presence of anti-Jk^{b}.

Learning points

- A direct antiglobulin test (DAT) is a vital component of a transfusion reaction investigation and local policies should be written to include this requirement
- In cases where the post-transfusion DAT becomes positive an eluate can be a useful tool both to confirm the specificity of an implicated antibody and detect antibodies which are not detectable in the plasma

Antibodies implicated in haemolytic transfusion reactions

AHTR due to preformed antibodies

In 4/22 acute transfusion reactions an antibody was detected in the pre-transfusion sample following investigation, despite the initial antibody screen being negative. In 3 of these cases anti-Wr^{a} was identified and in the 4th a weak anti-E. In a further 2 cases an antibody was identified in a sample previously reported as a non-specific alloantibody.

Case 18.3: Patient visiting from abroad with multiple antibodies

A Ghanaian national visiting the UK was admitted to hospital in sickle crisis. The initial antibody screen was positive, and samples were sent to the Blood Service for investigation. The Red Cell Immunohaematology (RCI) laboratory was unable to identify the antibody and samples were sent to the International Blood Group Reference Laboratory (IBGRL) for further investigation. Two units of crossmatch-compatible blood were issued by the Blood Service and transfused prior to the IBGRL investigation being completed. Following transfusion, the patient required urgent treatment for bleeding in the brain and had evidence of haematuria however this was initially attributed to the sickle crisis. IBGRL subsequently reported anti-D, anti-E and anti-Js^{b}. The units which had been transfused were negative for the D and E antigens but were both Js^{b} positive. The patient had stated that she had an antibody, but she did not know which one.

DHTR due to preformed antibodies

In 20/23 DHTR, antibodies were detected in the post-transfusion sample which were not detectable in the pre-transfusion sample. Of the remaining 3 cases, 2 were due to the transfusion of blood which was positive for an antibody which was also detected in the pre-transfusion sample. A further case was reported in which the pre-transfusion antibody screen was negative, however the patient had informed the clinical area of a history of antibodies.

Case 18.4: Patient with anti-E, -C^{w}, -S, -Jk^{a} and -k

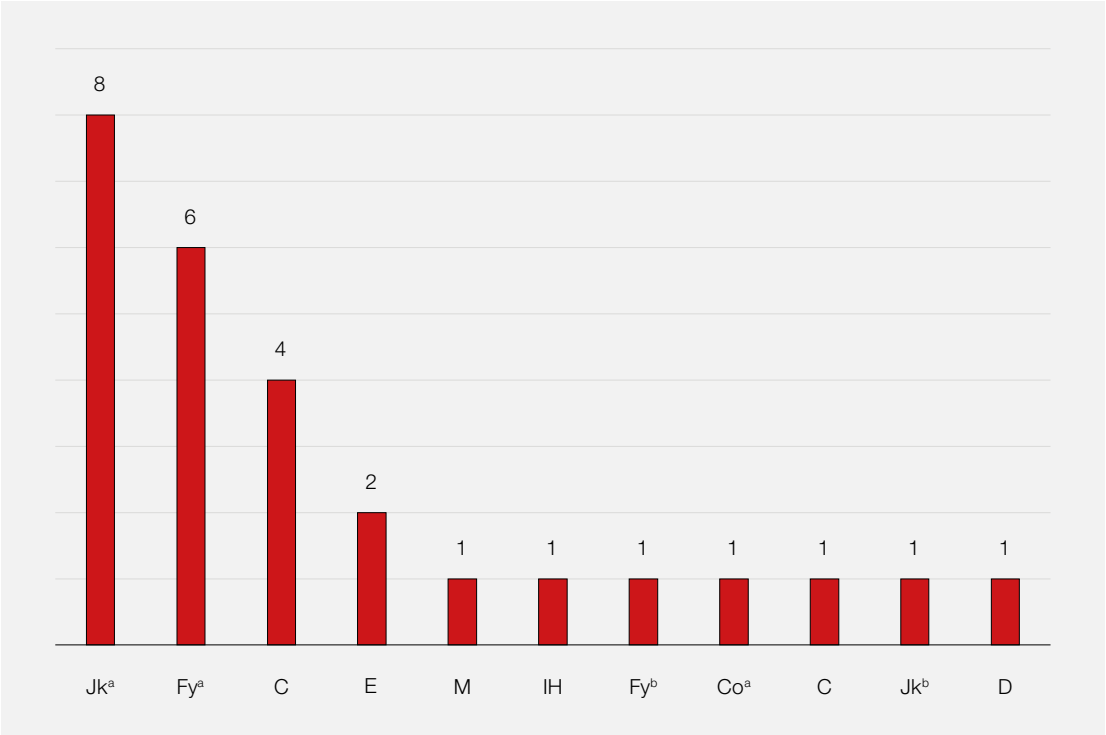
A patient required urgent transfusion for chronic anaemia after presenting at hospital with Hb 31g/L. The patient had a known history of anti-E, -C^{w}, -S, -Jk^{a} and -k, however no red cells units of this specification were available at the Blood Service or the frozen blood bank. The anti-Jk^{a} was not detectable in the sample therefore following discussion between the consultant haematologists at the hospital and Blood Service it was decided to transfuse units which were Jk^{a}-positive but negative for all detectable red cell antibodies. The patient's Hb initially rose post transfusion however 6 days later the Hb had dropped by 18g/L, the DAT had become positive and anti-Jk^{a} was detectable in the post-transfusion sample.

Case 18.5: DHTR in an O D-negative female transfused with D-positive blood

A female patient in her 70s presented in the emergency department (ED) with an abdominal aortic aneurysm. The major haemorrhage protocol was activated. The patient's antibody screen was negative, and the patient was transfused with emergency D-positive blood. Six days later the patient experienced symptoms of a transfusion reaction including raised bilirubin, raised LDH, falling Hb, positive DAT and impaired renal function. Anti-D was detected in the post-transfusion sample and was also eluted from the patient's red cells. Following investigation, the patient informed the clinical area that she had developed an antibody in a previous pregnancy.

The antibody specificities implicated in the delayed transfusion reactions reported are shown in Figure 18.3. Anti-Jk^{a} remains the antibody most frequently implicated in delayed haemolytic transfusion reactions. In common with previous years this is followed by anti-Fy^{a} and anti-C.

Figure 18.3: Antibodies implicated in DHTR



It is important that lifesaving transfusion is not withheld due to a history of alloantibodies. In urgent clinical situations where suitable antigen-negative blood is not available it may be necessary to transfuse blood which is antigen-positive for the patient's confirmed antibody. Where the patient has multiple antibodies clinicians may have to decide which donor red cell antigen to ignore. The data from the SHOT reports on the antibody specificities most commonly indicated in HTR can provide a useful source of information to guide these decisions, with priority given to providing antigen-negative blood to those antibodies more frequently reported. Data from SHOT provides evidence of antibodies frequently involved in transfusion reactions, such as anti-Wr^{a} which in the last 4 years has been reported in 5 HTR cases. These data may be of use when reviewing and assessing the validity of current donation screening policies, and consideration should be given to extending screening to include antibodies to antigens not routinely tested, when relevant.

Learning points

- When selecting O D-positive red cells for the transfusion to O D-negative individuals it is important to check the patient for contraindications in addition to age and childbearing potential e.g. a history of anti-D or if the patient is transfusion dependent
- Patients should be asked whether they have antibodies as part of the pre-transfusion process and any information obtained relayed to the transfusion laboratory and acted on
- Patient databases such as Specialist Services electronic reporting using Sunquest's Integrated Clinical Environment (Sp-ICE) can provide vital antibody history for antibodies where the level has dropped below the detectable titre. Hospitals should have local polices to decide which patients to check on Sp-ICE

Other unusual cases

Two cases reported involved antibodies not generally considered to be clinically significant, however no alternative cause for the reactions could be identified.

Full details of these 2 cases can be found in the supplementary information on the SHOT website (https://www.shotuk.org/shot-reports/report-summary-and-supplement-2019/).

Conclusion

HTR are recognised as an important cause of transfusion-associated reactions and may be subclinical, mild, or fatal. DHTR and hyperhaemolysis continue to pose diagnostic and therapeutic challenges. HTR are largely preventable and adherence to established protocols for prompt identification and timely management, as well as reporting them, remain the cornerstone of management of HTR.

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19 Uncommon Complications of Transfusion (UCT) n=15

Author: Shruthi Narayan

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.

Serious reactions in this category are reportable to the European Union (EU) as 'uncategorised unintended responses'.

Key SHOT message

- It is important that uncommon and atypical complications seen in patients post transfusion continue to be reported to SHOT. This will help gain a better understanding of these complications, identify risk factors and develop risk reduction strategies

Abbreviations used in this chapter

COPD	Chronic obstructive pulmonary disease
DAT	Direct antiglobulin test
EU	European Union
NEC	Necrotising enterocolitis
PEA	Pulseless electrical activity
pRBC	Packed red blood cells
TANEC	Transfusion-associated necrotising enterocolitis
UCT	Uncommon complications of transfusion
UK	United Kingdom

Recommendation

- Reporters are encouraged to continue to report cases with unusual reactions to transfusion

Action: All staff involved in transfusion

Introduction

Cases with reactions reported in patients with temporal relation to transfusions and cannot be classified into other categories are reported infrequently and are included in this chapter. Often several other contributory factors can be identified that may have resulted in the patient's reactions. Reporting and reviewing these will help in our ever-evolving understanding of transfusion complications and will help improve patient safety in transfusion by implementing appropriate risk reduction measures.

Death n=2

There were 2 deaths reported in this category, both with imputability recorded as 'possible'.

Case 19.1: Transfusion-associated necrotising enterocolitis (TANEC)

This was a case of an extreme preterm neonate (24 weeks) in the neonatal intensive care unit with a previous bowel perforation, post haemorrhagic hydrocephalus and had received multiple transfusions. Around 2-2.5 hours into the second transfusion, the neonate developed clinical features suggestive of necrotising enterocolitis with vomiting, increasing nasogastric aspirates, worsening abdominal distention and respiratory deterioration requiring ventilation. This led to multiorgan failure and death.

Case 19.2: Multiple ongoing issues

A woman in her 60s was admitted with chronic obstructive pulmonary disease (COPD), cor pulmonale, alcoholic liver disease with gastrointestinal bleeding. She received one unit of red cells uneventfully and developed acute dyspnoea with no rise in temperature an hour into the second transfusion 2 days later. This was followed by sudden deterioration with a pulseless electrical activity (PEA) arrest. Pre- and post-transfusion compatibility testing showed negative direct antiglobulin test (DAT), negative antibody screen and crossmatch-compatible unit. The patient had begun to bleed spontaneously, and gastric re-bleeding was suspected. Resuscitation attempts failed.

Major morbidity n=1

Case 19.3: TANEC

This was a suspected case of TANEC in a preterm neonate who developed symptoms after approximately 25mL of a red cell transfusion and had bleeding per rectum approximately 90 minutes post transfusion with worsening tachycardia. The neonate underwent surgical removal of part of the ileum after being transferred to a tertiary care centre.

The imputability for this case was thought to be possibly related to the transfusion (imputability 1).

Transfusion associated necrotising enterocolitis

TANEC has been described as necrotising enterocolitis (NEC) that arises within 48 hours of a blood transfusion and is thought to be multifactorial in origin. Several cases have been reported to SHOT over the years and there are 2 reports from 2019. TANEC has been recorded in the United Kingdom (UK) in the very low birth weight neonatal population. While numerous observational studies appear to demonstrate an association between packed red blood cell (pRBC) transfusions and NEC, the limited numbers of randomised controlled trials do not support a causal relationship between pRBC transfusion and NEC. Results from a recent large multicentre observational cohort study reported that severe anaemia and not pRBC transfusion was associated with NEC. Further work is needed to clarify causation, pathophysiology, and possible mechanisms of prevention of TANEC (Gephart 2012; Patel et al. 2016; Hay et al. 2017 and Faraday et al. 2020).

Other cases n=12

A variety of cases ranging from nonspecific pains and headache following transfusion to isolated fever/chills and some with hypertensive reactions have been reported in the other cases included in this category.

Details of these cases can be viewed in the supplementary information on the SHOT website (https://www.shotuk.org/shot-reports/report-summary-and-supplement-2019/).

Learning point

- Patients experiencing signs and symptoms consistent with an acute transfusion reaction must be evaluated promptly and treated expeditiously

Conclusion

Transfusion reactions range from bothersome yet clinically benign to life-threatening reactions and can be acute or delayed. The nature of the reaction may not be immediately apparent, because many reactions begin with nonspecific symptoms such as fever or chills. In addition, patients receiving transfusions often have complex underlying clinical conditions, the symptoms of which may mimic a transfusion reaction. Thus, a patient experiencing signs and symptoms consistent with an acute transfusion reaction must be evaluated promptly and treated as expeditiously as possible to minimise the impact of the reaction. Input from specialist transfusion medicine colleagues from the relevant UK Blood Service may be needed.

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Transfusion-Transmitted Infections (TTI) n=2 (1 confirmed, 1 probable) 20

Authors: Joe Flannagan, Heli Harvala and Su Brailsford

Definition of a TTI:

A report was classified as a TTI if, following investigation:

- The recipient(s) had evidence of infection post 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(s) 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

These may be identified as a result of infection in the patient where transfusion is the suspected source or alternatively via lookback investigations. A lookback investigation is carried out if a donation is found to be positive for infection and retrospective testing finds a previous donation to also be positive at low levels below the detection level of screening.

Note that for the purposes of the European Union (EU) legislation, serious adverse reactions (SAR) are defined as any reactions in patients that are 'life-threatening, disabling or incapacitating, or which result in, or prolongs, hospitalisation or morbidity.'

These must be reported to the Medicines and Healthcare products Regulatory Agency (MHRA) (a legal requirement). This includes all confirmed transfusion-transmitted infections.

Key SHOT messages

- Any suspicion of a transfusion-transmitted infection (TTI) should be reported to the appropriate United Kingdom (UK) Blood Service as soon as possible for it to be fully investigated
- The UK Blood Services store a sample from every blood donation for at least 3 years. Further testing can be done on these samples during this time if a TTI is suspected
- All lookback investigations should be reported by the UK Blood Services to the infectious diseases expert on the SHOT Working Expert Group
- It is important that all healthcare professionals who consent patients for blood transfusion have up-to-date knowledge of blood donation screening and the small potential for TTI

Abbreviations used in this chapter

ALT	Alanine aminotransferase
BSH	British Society for Haematology
CMV	Cytomegalovirus
DNA	Deoxyribonucleic acid
EIR	Emerging Infection Report
EU	European Union
HAV	Hepatitis A virus
HBV	Hepatitis B virus
HCV	Hepatitis C virus
HEV	Hepatitis E virus
HIV	Human immunodeficiency virus
HTLV	Human T cell lymphotropic virus
JPAC	Joint UK Blood Transfusion and Tissue Transplantation Services Professional Advisory Committee
LFT	Liver function test
LGBT	Lesbian, gay, bisexual, and transgender
MHRA	Medicines and Healthcare products Regulatory Agency
MSM	Men who have sex with men
NAT	Nucleic acid testing
NHSBT	National Health Service Blood and Transplant
NIBTS	Northern Ireland Blood Transfusion Service
PHE	Public Health England
PTR	Post-transfusion reactions
RNA	Ribonucleic acid
SaBTO	Advisory Committee on the Safety of Blood, Tissues and Organs
SACTTI	Standing Advisory Committee on Transfusion Transmitted Infection
SAR	Serious adverse reactions
SNBTS	Scottish National Blood Transfusion Service
TTI	Transfusion-transmitted infections
UK	United Kingdom
vCJD	Variant Creutzfeld Jakob Disease
WBS	Welsh Blood Service

Introduction

This chapter describes suspected TTI incidents investigated by the UK Blood Services and reported to the National Health Service Blood and Transplant (NHSBT)/Public Health England (PHE) Epidemiology Unit in 2019.

The risk of a TTI in the UK remains very low. During 2019, 2 TTI investigations were concluded as probable or confirmed, neither of these were due to errors in donor selection or testing.

Annual reports from the Epidemiology Unit are available here: https://hospital.blood.co.uk/epidemiology-reports/.

Blood donation screening process

Every blood donation in the UK is screened for hepatitis B virus (HBV), hepatitis C virus (HCV), hepatitis E virus (HEV), human immunodeficiency virus (HIV) and syphilis. Human T cell lymphotropic virus (HTLV) is screened for in donations from new blood donors and other infections such as malaria are screened for depending on travel history of the donor. A separate bacterial screening process is also in place for platelets due to differences in the storage requirements for this blood product.

At the time of blood donation samples are collected for screening purposes. For the screening of viral nucleic acids (ribonucleic acid (RNA) or deoxyribonucleic acid (DNA)) the blood samples are pooled together in a batch of six, 16 or 24 prior to screening. If RNA/DNA is detected in that pool, then individual samples known to be in that pool are re-tested separately in order to identify a positive sample. All antibody and/or antigen testing is done using individual blood samples. If RNA/DNA is detected, or antibody result is repeatedly positive suggesting an infection, then the donation is discarded and the sample is sent to a reference laboratory for further testing to confirm the result. If a positive result is confirmed the donor will be notified, offered an opportunity to discuss these results in detail and referred to the appropriate medical care as necessary.

Testing and selection of donors update

No major changes to testing procedures or donor selection occurred in 2019. The HBV and HEV

screening processes are currently under review by Advisory Committee on the Safety of Blood, Tissues and Organs (SaBTO).

However, the UK Blood Services, PHE, Nottingham University and a range of stakeholders including patients and lesbian, gay, bisexual, and transgender (LGBT+) groups have been working together in the FAIR (For the Assessment of Individualised Risk) steering group. The aim of this group is to explore if a more individualised risk assessment approach to blood donor selection policy is possible whilst ensuring the safe supply of blood to patients. If the evidence shows that a more individualised blood donation risk assessment can be safely and practically introduced, it could mean that some people who are currently deferred for 3 months due to sexual-related risk, such as some men who have sex with men (MSM), could donate. The group hopes to report their research findings towards the end of 2020.

More information is available here: https://www.blood.co.uk/news-and-campaigns/news-and-statements/fair-steering-group/.

Summary of reports made to the NHSBT/PHE Epidemiology Unit in 2019

During 2019, UK Blood Services investigated 139 suspected bacterial incidents and 13 suspected viral incidents (Figure 20.1). From these, there has been:

- One confirmed HEV incident reported by NHSBT
- One probable HBV incident reported by NHSBT
- One near miss investigation into HEV reported by the Welsh Blood Service (WBS) from 2018
- In addition, four lookback investigations were reported in 2019 with no evidence of a TTI:
  - One lookback investigation into HEV reported by the Scottish National Blood Transfusion Service (SNBTS) in 2019
  - One lookback investigation into HEV reported by NHSBT in 2018
  - One lookback investigation into syphilis reported by NHSBT in 2018
  - One lookback investigation into HEV reported by SNBTS in 2018

Figure 20.1 includes all investigations in England, Wales, Scotland and Northern Ireland. In previous SHOT reports investigations in Wales, Scotland or Northern Ireland concluded as post-transfusion reactions (PTR) or not, were not included here.

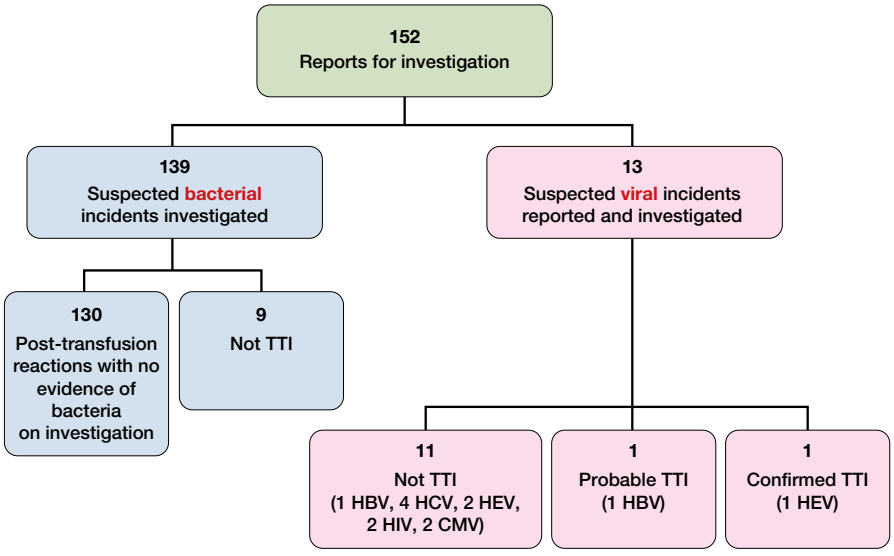

Figure 20.1: Outcome of UK reports of suspected TTI made to the NHSBT/PHE Epidemiology Unit in 2019

TTI=transfusion-transmitted infection; CMV=cytomegalovirus; HBV=hepatitis B virus; HCV=hepatitis C virus; HEV=hepatitis E virus; HIV=human immunodeficiency virus

Death n=1

A patient with confirmed transfusion-transmitted HEV died after being transfused in 2019 (Case 20.1).

Major morbidity n=1

A patient with probable transfusion-transmitted HBV developed chronic HBV following a transfusion in 2015 (Case 20.2).

Bacterial TTI reports 2019

In 2019, no reported suspected bacterial TTI investigations were concluded to be confirmed, probable or possible. All bacterial TTI investigations were concluded to be either PTR with no evidence of bacteria in the implicated or associated products or in the recipient, or not a TTI, with evidence of bacteria in either the products or the recipient(s) but not both. The four UK Blood Services all use the BacT/ALERT system for bacterial screening which has been successful in reducing the risk of bacterial TTI (McDonald et al. 2017). Sampling methods have recently become more consistent across the four Blood Services but some slight variation still exist, details of which are described in Table 20.1.

Bacterial TTI 1996–2019

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 detection on screening. There have been nine bacterial near misses, all but one in platelet components, reported to the unit between 2011 and 2019. Overall, out of a total of 44 bacterial transfusion-transmissions to individual recipients, 37 (34 incidents) have been caused by the transfusion of platelets, and 7 by red cells (Table 20.3) since reporting began in 1996.

Haemovigilance systems for bacterial TTI are passive and as such rely on clinical colleagues to report suspected TTI. Current British Society for Haematology (BSH) guidance recommends that patients are advised to report any symptoms that occur within 24 hours of transfusion (BSH Tinegate et al. 2012) although our experience suggests that patients with confirmed bacterial TTI become unwell very rapidly, often during transfusion.

Table 20.1: Bacterial screening methods used by the UK Blood Services

	Time of sampling (hour)	Volume sampled (mL)	Apheresis sample	Time at release (hour)	Length of screening
NHSBT	≥36	2 x 8	Post-split	6	Day 7
NIBTS	≥36	2 x 8	Pre-split	6	Day 9
SNBTS	≥36	2 x 8	Pre-split	6	Day 7
WBS	≥36	2 x 8	Post-split	12	Day 7

NIBTS=Northern Ireland Blood Transfusion Service

Viral TTI reports 2019

In 2019, there was 1 confirmed HEV and 1 probable HBV TTI reported by the NHSBT.

Case 20.1: Confirmed HEV TTI (Morbidity: major - death; imputability: 3 - confirmed)

In late September 2019, an apheresis platelet donation from a repeat donor was picked up on screening as HEV RNA positive with a viral load of 4,900IU/mL. An investigation was launched immediately and archive samples from previous donations were retrieved and tested for HEV RNA in individual sample testing. In the donor's previous donation from the beginning of September, HEV RNA was detectable but below the level of quantification at <36.13IU/mL. This low-level infection was not picked up by the original screening process done in pools of 24 with a detection limit of around 500IU/mL. The recipient of the positive donation was traced and found to be a patient in their 40s with aplastic anaemia, excessive alcohol use and portal hypertension (without cirrhosis) who had received the platelets shortly after the donation was made. Their portal hypertension was due to underlying liver problems and their anaemia was caused by a rare genetic mutation causing

bone marrow failure which was being treated with danazol. The platelets were given as a prophylactic treatment before a dental procedure as they had a low platelet count.

Two months after the identified transfusion the patient was diagnosed with HEV infection but was clinically well. They were monitored closely and remained stable with unchanged liver function tests (LFT) until mid-November. Around this time, the patient's viral load peaked at 29,200,000IU/mL and they were developing a good antibody response. However, this coincided with a sudden increase in bilirubin and alanine aminotransferase (ALT) levels and hence the patient was started on Ribavirin. Their liver function continued to decline from this point eventually leading to acute hepatitis with kidney failure. Sadly, the patient died at the end of November 2019. The viral load in the sample of the index unit was too low to perform sequence analysis but this was possible on the donor's subsequent donation in late September. Sequence obtained from the virus infecting the recipient was identical to that obtained from the donor. Based on this it was confirmed that blood transfusion was the source of the patient's HEV infection.

A second recipient of apheresis platelets from the donation in early September was also identified. The recipient was followed up for 6 months during which time there was no evidence of HEV infection.

Case 20.2: Probable viral HBV TTI (Morbidity: Major; imputability: 2 - probable)

In January 2019, a patient in their 70s with chronic HBV infection self-reported to NHSBT as they had been advised by a hospital that they might have acquired HBV from a blood transfusion in 2015. An investigation was initiated and it was confirmed that the patient received three units of red cells during surgery on their mitral valve in December 2015. No archived samples were available, but as all three donors had donated since, samples from their subsequent donations were retrieved. These samples were tested and results showed no evidence of infection in donor 1 and 3 however the sample from donor 2 contained antibodies for HBV core but was negative for DNA. These results indicate a past infection in donor 2. This donor originates from an area with high HBV prevalence, particularly for the HBV genotype identified in the recipient. The donor was resampled. A large volume was taken to increase the likelihood that any small levels of DNA would be detected, however no DNA could be detected here either. It is worth noting that it is possible for HBV transmission to occur without detectable DNA and that it was not possible to test a sample of the index unit for DNA.

Extensive investigations into other sources of infection had been conducted at the time of the incident by external bodies such as hospital and local public health teams, including screening of family members and staff. No other potential sources were identified in those investigations; NHSBT was not contacted at that time. Based on all the available evidence it was concluded that blood transfusion was the probable source of the infection but this could not be confirmed as it was not possible to genetically sequence the DNA detected in the donor sample. A later sample from the donor (when donated in October 2016), was traced back to a patient in their 80s. The patient was tested and found to be positive for anti-HBc antibodies indicating a past HBV infection. It is possible that they acquired the HBV infection via blood transfusion. The donor has since been removed from panel and the hospital and patient have been notified of the results of NHSBT's investigations.

Near miss viral HEV TTI

WBS screens blood donations for HEV in pools of 16 using nucleic acid testing (NAT) with a pre-defined manufacturer's cut-off level used to determine a positive or a negative result, some other UK Blood Services test in pools of 24. Towards the end of 2018 one such pool was screened by WBS and the result reported as negative, however a scientist noticed this pool was very close to the cut-off level and noted this as unusual. As a result, a hold was placed on the donation and each of the donations from this pool were screened for HEV individually and one was found to be positive for HEV RNA.

The donation was referred to the manufacturer who has tested the viral load in the donor and declared it to be below the 100% detection limit (218IU/mL). The donor sample was tested individually 16 times with results ranging from 9 to 150 IU/mL, with an average result of 58IU/mL, all of which were below the level claimed for 100% detection. This donation was never issued so no lookback was required. It should however be noted that an HEV transmission reported in the 2018 Annual SHOT Report (Narayan et al.

2019) as Case 20.4 describes a confirmed HEV TTI that was transmitted to an immunocompromised patient from a donation with similarly low levels of RNA to what was detected by WBS in this scenario.

Viral TTI 1996–2019

The patient may have been transfused many years prior to the year in which the incident is investigated and reported to SHOT because of the chronic nature, and therefore late recognition, of some viral infections.

Since 1996, 35 confirmed incidents of transfusion-transmitted viral infections have been documented in the UK, involving 42 recipients. Among these, HBV (n=12) and HEV (n=12) were the most commonly reported proven viral TTI. For HBV, this is partly because the 'window period' where an infectious donation from a recently infected donor cannot be detected by the screening tests is longer than for HCV or HIV, despite NAT screening of blood donations. All except two HEV transmissions were reported before the HEV RNA screening was introduced in April 2017 in the UK.

The UK was one of the first Blood Services to introduce HEV-screening; since that time over 1,000 HEV RNA containing donations have been successfully identified by screening and removed from the blood supply. The rate of HEV RNA detected among donors is greater than other viral infections because it is generally acquired through food, and there is no specific donor selection to minimise donations from those infected. This gives rise to an increased chance of non-detection of HEV RNA. Furthermore, as screening is performed in pools, it is recognised that donations containing a small amount of HEV RNA can be missed and HEV then potentially transmitted via blood transfusion.

In cases where CMV untested units were transfused to those who require CMV-negative components (e.g. in pregnant patients), further testing can be carried out by transfusion microbiology teams on archived samples from donations which are kept for 3 years post donation.

https://hospital.blood.co.uk/diagnostic-services/reporting-adverse-events/investigation-of-possible-transmission-of-non-bacterial-transfusion-transmitted-infection/.

Residual risk of HBV, HCV or HIV

The risks of a potentially infectious HBV, HCV or HIV window period donation not being detected on testing in the UK are very low at less than 1 per million donations tested (Table 20.2) (JPAC 2019).

Table 20.2: The estimated risk of a potentially infectious HBV, HCV or HIV window period* blood donation not detected on testing, UK 2016-2018

	HBV	HCV	HIV
Number per million donations	1.04	<0.01	0.04
95% confidence interval	(0.54-2.39)	(0.00-0.04)	(0.01-0.07)
At 1.9 million donations per year testing will miss a potentially infectious window period donation every:	6 months	90 years	15 years

**The window period is the time very early in the course of infection when tests in use do not detect the virus but there may be sufficient to transmit*

Far fewer TTI are observed in practice than the estimated risks in Table 20.2 indicate, partly because the estimates have wide uncertainty and the model used to calculate risk is based on the risk in all donations tested. The model does not incorporate pack non-use, recipient susceptibility to infection, or under-ascertainment/under-reporting, 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.

Parasitic TTI

There were no reported parasitic infections for investigation in 2019.

Emerging infections

The Epidemiology unit produces the Emerging Infection Report (EIR), a monthly horizon scanning list of emerging infections with potential to affect the UK blood and tissue supply. The Standing Advisory Committee on Transfusion Transmitted Infection (SACTTI) then risk-assesses the EIR and highlights whether further action is required by Joint UK Blood Transfusion and Tissue Transplantation Services Professional Advisory Committee (JPAC).

UK Blood Services have put cautionary safety measures in place in relation to the global COVID-19 outbreak. The Epidemiology unit, SACTTI and JPAC has been, and will continue to be, closely monitoring this outbreak, risk-assessing the potential impact on the safety of the UK blood supply and responding appropriately.

Variant Creutzfeld Jakob Disease (vCJD) 2019

There were no vCJD investigations in 2019.

vCJD 1996-2019

Three vCJD incidents (Table 20.3) 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. All these measures have been reviewed and endorsed by SaBTO (SaBTO 2013).

One of these measures, the provision of imported plasma for individuals born on or after 1st January 1996, was withdrawn in September 2019. This followed a recommendation by SaBTO based on evaluation of the risk of transmission of vCJD. Other risk reduction measures, such as leucodepletion, remain in place (SaBTO 2019).

Table 20.3: 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 2019 (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	Cryo
Pre 1996	-	-	1 (1)	-	-	-	2 (2)	-	-	-	**3 (3)**	3	-	-	-	-
1996	-	1 (1)	1 (1)	1 (1)	-	1 (3)	-	-	-	1 (1)	**5 (7)**	5	1	-	1	-
1997	3 (3)	-	1 (1)	1 (1)	-	-	-	-	1 (1)	2 (2)	**8 (8)**	6	1	1	-	-
1998	4 (4)	-	1 (1)	-	-	-	-	-	-	-	**5 (5)**	2	1	2	-	-
1999	4 (4)	-	2 (3)	-	-	-	-	-	-	‡ (1)	**6 (8)**	5	3	-	-	-
2000	7 (7)	1 (1)	1 (1)	-	-	-	-	-	-	-	**9 (9)**	1	5	3	-	-
2001	5 (5)	-	-	-	-	-	-	-	-	-	**5 (5)**	-	4	1	-	-
2002	1 (1)	-	1 (1)	-	-	1 (1)†	-	-	-	-	**3 (3)**	2	1	-	-	-
2003	3 (3)	-	1 (1)	-	-	-	-	-	1 (1)	-	**5 (5)**	1	1	3	-	-
2004	††	-	-	-	1 (1)	-	-	-	-	-	**1 (1)**	1	-	-	-	-
2005	2 (2)	1 (1)	1 (1)	-	-	-	-	-	-	-	**4 (4)**	1	3	-	-	-
2006	2 (2)	-	-	-	-	-	-	-	-	-	**2 (2)**	-	1	1	-	-
2007	3 (3)	-	-	-	-	-	-	-	-	-	**3 (3)**	2	1	-	-	-
2008	4 (6)	-	-	-	-	-	-	-	-	-	**4 (6)**	-	2	4	-	-
2009	2 (3)	-	-	-	-	-	-	-	-	-	**2 (3)**	1	-	2	-	-
2010	-	-	-	-	-	-	-	-	-	-	**-**	-	-	-	-	-
2011	-	-	1 (2)	-	1 (2)	-	-	-	-	-	**2 (4)**	2	-	-	2	-
2012	-	-	1 (1)	-	1 (1)	-	-	1(1)	-	-	**3 (3)**	2	-	-	1	-
2013	-	-	-	-	-	-	-	-	-	-	**-**	-	-	-	-	-
2014	-	-	-	-	2 (3)	-	-	-	-	-	**2 (3)**	1	-	-	2	-
2015	1 (1)	-	-	-	4 (5)	-	-	-	-	-	**5 (6)**	-	3	1	1	1
2016	-	-	-	-	1 (1)	-	-	-	-	-	**1 (1)**	1	-	-	-	-
2017	-	1 (1)	-	-	-	-	-	-	-	-	**1 (1)**	-	-	1	-	-
2018	-	-	-	-	1 (1)	-	-	-	-	-	**1 (1)**	-	-	1	-	-
2019	-	-	-	-	1 (1)	-	-	-	-	-	**1 (1)**	-	-	1	-	-
Number of incidents	**41**	**4**	**12**	**2**	**12**	**2**	**2**	**1**	**2**	**3**	**81**	-	-	-	-	-
Number of infected recipients	44	4	14	2	15	4	2	1	2	4	**92**	**36**	**27**	**21**	**7**	**1**
Death due to, or contributed to, by TTI	11	0	0	0	2	0	0	0	1	3	**17**					
Major morbidity	29	3	14	2	9	4	2	1	1	1§	**66**					
Minor morbidity	4	1	0	0	4	0	0	0	0	0	**9**					
Implicated component																
RBC	7	1	11	2	4	2	2	1	2	4	**36**					
Pooled platelet	21	2	1	-	2	1	-	-	-	-	**27**					
Apheresis platelet	16	1	1	-	3	-	-	-	-	-	**21**					
FFP	-	-	1	-	5	1	-	-	-	-	**7**					
Cryoprecipitate	-	-	-	-	1	-	-	-	-	-	**1**					

Note: Numbers in brackets refer to recipients, and probable incidents are excluded

Please note: No screening was in place for vCJD, human T cell lymphotropic virus (HTLV), hepatitis A virus (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

Please note: HCV investigations where the transfusion was prior to screening are not included in the above figure

** Year of transfusion may be prior to year of report to SHOT due to delay in recognition of chronic infection*

† The 2 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 Staphylococcus 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

For further information or alternative breakdown of data please contact the National Coordinator for Transfusion Transmitted Infections via the NHSBT/PHE Epidemiology Unit at epidemiology@nhsbt.nhs.uk.

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SAFETY
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SPECIAL CLINICAL GROUPS

21 Cell Salvage (CS) n=23

Authors: Sarah Haynes and Catherine Ralph

Definition:

Any adverse events or reactions associated with cell salvage (autologous) transfusion methods, including intraoperative cell salvage (ICS) and postoperative cell salvage (PCS) (washed or unwashed).

Key SHOT messages

- Cell salvage devices and consumables are classed as medical devices and so are covered by relevant organisational policies. In common with all medical devices, cell salvage machines and equipment have significant potential to cause harm when used incorrectly. Risks can be minimised through robust training, safe operation and management
- It is recognised that there is significant under-reporting of cell salvage incidents. Operators and all other staff involved with cell salvage are encouraged to report any equipment failures and all clinical incidents
- Procedures for checking, labelling, prescribing, administration, and monitoring of cell salvage red cells should be identical to that used when transfusing allogeneic blood. Policies should be in place to reduce the potential for human error in the journey of blood from machine to recipient

Abbreviations used in this chapter

ACE	Angiotensin converting enzyme	**PCS**	Postoperative cell salvage
CS	Cell salvage	**LDF**	Leucocyte depletion filter
ICS	Intraoperative cell salvage	**MHRA**	Medicines and Healthcare products Regulatory Agency
IV	Intravenous		

Death n=0

Major morbidity n=0

Twenty-three cases were reported; on review none were withdrawn, and 1 was transferred from the near miss reporting category. A single cardiac case was reported using cell salvage postoperatively, with the remaining cases related to the use of intraoperative devices.

There were 16 reports for female patients (15 adult, 1 paediatric) and 7 male (all adult).

As with previous Annual SHOT Reports, the small number of cases reported raises concerns around under-reporting of cell salvage incidents.

The majority of reports this year came from orthopaedics or trauma (14/23), whereas in previous years obstetric reports were the most frequently reported. It is possible less centres are using cell salvage during obstetric procedures, and those that do no longer use the leucocyte depletion filter (LDF). There was only 1 report of hypotension upon reinfusion with a LDF.

As in previous years (Figure 21.1), adverse events, notably equipment issues and human errors, predominate.

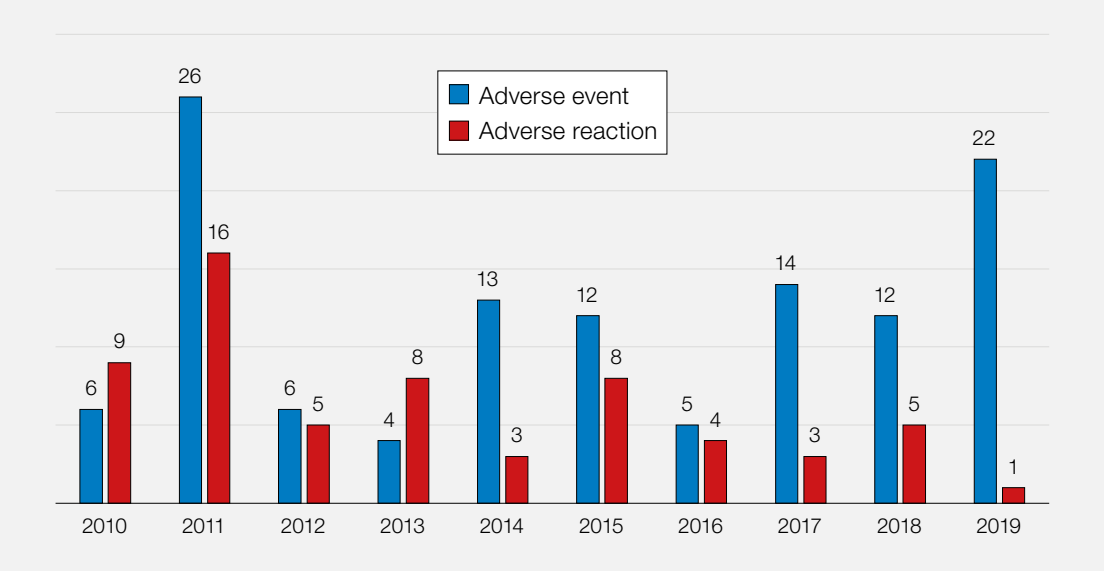


Figure 21.1: Cell salvage incidents by type of report 2010-2019

Cell salvage cases by speciality

There were 23 cases reported as shown in the table below.

Speciality	Elective	Emergency
Orthopaedic/trauma	9*	5
Obstetrics	3	0
Urology	2	0
Cardiac	0	1
Gynaecology	1	0
Vascular	0	1
Unknown	1	0
Total	**16**	**7**

**Includes 1 spinal case*

Table 21.1: Specialty for cell salvage reports

Types of cell salvage

The use of washed cell salvage techniques involved 22 intraoperative and 1 in the intra/postoperative setting. No reports were received for postoperative filtration cell salvage alone.

Cell salvage adverse events n=22

Equipment failure n=4

There were 2 incidents involving machine errors when processing the blood collection: in both cases the red cells were not reinfused. Only 1 was declared to be reported to the Medicines and Healthcare products Regulatory Agency (MHRA) under the Yellow Card Scheme. Interestingly, the MHRA had 3 reports in the same period which may or may not include the incident reported to SHOT. Operators recognised the machine errors and the final products were considered not to be of the usual standard. Neither patient required allogeneic blood transfusion. In the 3rd case machine failure occurred during an emergency aortic aneurysm repair resulting in just 200mL to reinfuse from a large blood loss. This machine fault was not reported to the MHRA despite a fault in a pump mechanism being identified requiring repair. The patient received three units of allogeneic blood which wouldn't have been necessary if all the blood loss had been processed. In another case, a fluid accounting issue consistently overestimated

the volume of processed red cells available to reinfuse. Despite only 1 case being detailed, the reporter stated that this was the 6th similar incident and the manufacturer had failed to identify any mechanical failure within the device or disposables used.

Learning point

- Operators, medical staff and theatre personnel must be vigilant and take joint responsibility for ensuring the quality of the cell salvage collection and processing before reinfusion

Operator errors n=9

Of the 9 adverse events attributed to operator error, 5 involved incorrect labelling, prescribing and administration. In 1 case a leucocyte depletion filter was not used where it might have been indicated.

Cell salvage operators and theatre staff must be aware that labelling, prescribing and administration of autologous blood must be performed as for allogeneic blood and undergo the same stringent bedside checking procedures. Autologous red cells are not tested for serology or transmissible infection and could do serious harm if transfused into the wrong patient.

There were 3 cases citing inadequate operator training, 1 when the operator was not trained or competent to use the machine, and 2 when contra-indicated substances were aspirated into the collection. A further case was reported due to a suspected machine failure that resulted from operator inexperience. Uncertainty that the machine was washing correctly resulted in cell salvage being possibly denied in 2 cases. Investigation revealed that alteration of the programming parameters had set the wash cycle to zero.

Learning points

- Operators, clinicians and theatre staff must have adequate training covering all aspects of the cell salvage process consistent with their role, including standards for labelling, prescribing and administering autologous red cells
- Training on trouble shooting with medical devices is imperative. Operators should be sufficiently familiar with devices and their standard programming parameters to check the device is fit for purpose when first switched on

Other adverse events n=9

There were 6 reports from one centre detailing contamination of the processed blood with black particles: 4 orthopaedic/trauma, 1 gynaecological and 1 obstetric. Whilst all machines were from the same manufacturer, there was no common denominator in terms of an individual device or consumable lot numbers. The affected salvaged red cells were not reinfused in 5 cases, in 1 case the disposable was changed and cell salvage continued without an issue. One patient received an avoidable transfusion of allogeneic blood whilst all were denied the potential benefits of an autologous reinfusion. In most cases the affected red cells were sent to the laboratory for analyses, the consumables retained and the manufacturer informed. Independent analysis revealed no components within the blood samples emanating from the disposables suggesting the particles were derived from the collected blood. The hospital continues to monitor the situation and operators are alert to this potential problem.

SHOT has received 3 similar reports of particulate matter contamination in 2011, 2012 and 2013. In 2 of these cases, reporters theorised that these particles where micro-clots associated with haemostatic products being aspirated into the blood collection.

One patient received autologous blood through a giving set which was not suitable for blood transfusion. In another non-intravenous (IV) grade saline had been aspirated into the blood collection. A decision was made to abandon cell salvage and the patient received two units of allogeneic blood intraoperatively. A further patient scheduled for spinal surgery was unable to receive cell salvage despite a request in advance, as there were no available staff.

Learning points

- Cell salvage operators and theatre staff should be vigilant and routinely check the appearance of the red cells prior to reinfusion and report any unusual appearance or potential contamination
- It is good practice to retain consumables and samples for analyses where quality issues are suspected

Cell salvage reactions n=1

Case 21.1: Hypotension on reinfusion with a filter and ACE inhibitors

A man in his 70s, with known coronary artery disease on angiotensin converting enzyme (ACE) inhibitors, underwent a cystectomy for bladder cancer. Cell salvage was used with citrate as an anticoagulant and a LDF for reinfusion. During heavy bleeding and cell salvage reinfusion the patient became very hypotensive. Following treatment with fluid, inotropes and calcium, this resolved. A second similar hypotensive episode occurred at the end of the procedure when the last bowl from the cell salvage machine was reinfused. The transfusion was stopped and the patient quickly stabilised. The patient went to intensive care intubated and ventilated. He was extubated the following day and went on to make a good recovery.

The reaction was thought to be possibly related to the reinfusion of cell salvaged blood.

Since SHOT started collating cell salvage incidents in 2010, the most reported adverse reaction has been hypotension (n=30). Although hypotension has been reported without the use of a specialised filter, usually the LDF is used with citrate as the anticoagulant. In this case, an additional contributing factor may have been the ACE inhibitors. There is some evidence suggesting that bradykinin, released from platelets exposed to the negatively charged LDF medium, accumulates and causes vasodilation due to ACE inhibitors reducing its metabolism (Iwama 2001).

The use of LDF in cancer surgery may reduce the risk of infusing malignant cells, although there remains some debate about the role of malignant cells in metastatic spread (Zaw et al. 2017). More research is needed and clinicians are advised to evaluate the relative risks and benefits for individual patients.

Learning point

- The use of leucocyte depletion filters (LDF), particularly in conjunction with citrate, may be associated with hypotensive reactions. Without denominator data, the relative incidence of this is not known. Clinicians should be aware of this potential and balance risks and benefits accordingly

Conclusion

Cell salvage is a valuable blood conservation method which is often under-utilised. All cell salvage operators must undertake initial and regular update training and be assessed as competent with documented training records. All hospitals where ICS and PCS are undertaken should report adverse events to SHOT. Staff should be aware that monitoring of patients is as important for the reinfusion of red cells collected by ICS or PCS as it is for allogeneic red cells and practitioners need to revisit previous Annual SHOT Reports particularly related to autologous transfusion to ensure historic incidents are not repeated.

Recommended resources

UK Cell Salvage Action Group
https://www.transfusionguidelines.org/transfusion-practice/uk-cell-salvage-action-group

References

Iwama H. (2001) Bradykinin-associated reactions in white cell reduction filter. *J Crit Care* 2001;**16(2)**:74-81.

Zaw AS, Bangalore Kantharajanna S, Kumar N. (2017) Is Autologous Salvaged Blood a Viable Option for Patient Blood Management in Oncologic Surgery? *Transfus Med Rev* 2017;**31(1)**:56-61.

Paediatric Cases n=132

22

Authors: Anne Kelly and Helen New

Definition:

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

Key SHOT messages

- It is essential that those who request laboratory tests understand the significance of test results. Unexpected results should be challenged or repeated to avoid acting on erroneous results
- Understanding the significance of abnormal coagulation in children and when to call for specialist interpretation is vital
- Errors in calculation of blood component volumes and specific requirements still occur. Induction training of paediatric staff should include specific requirements and safe blood prescribing
- Following the Advisory Committee on the Safety of Blood, Tissues and Organs (SaBTO) review (2019), recipients born after 1995 can now receive United Kingdom (UK) plasma (non pathogen-inactivated), and either apheresis or pooled platelets. This will therefore affect specific requirements not met (SRNM) reporting for next year

Abbreviations used in this chapter

ADU	Avoidable, delayed and under/overtransfusion
APTT	Activated partial thromboplastin time
BSH	British Society for Haematology
CMV	Cytomegalovirus
DAT	Direct antiglobulin test
FAHR	Febrile, allergic and hypotensive reactions
FFP	Fresh frozen plasma
Hb	Haemoglobin
HSCT	Haemopoietic stem cell transplant
HSE	Handling and storage errors
HTR	Haemolytic transfusion reactions
IBCT	Incorrect blood component transfused
Ig	Immunoglobulin
IT	Information technology
IUT	Intrauterine transfusion
IV	Intravenous
MB	Methylene blue-treated
NM	Near miss
PICU	Paediatric intensive care unit
PT	Prothrombin time
RBRP	Right blood right patient
SaBTO	Advisory Committee on the Safety of Blood, Tissues and Organs
SD	Solvent-detergent treated
SRNM	Specific requirements not met
TACO	Transfusion-associated circulatory overload
TAD	Transfusion-associated dyspnoea
TANEC	Transfusion-associated necrotising enterocolitis
TRALI	Transfusion-related acute lung injury
TTI	Transfusion-transmitted infection
UCT	Uncommon complications of transfusion
UK	United Kingdom
WCT	Wrong component transfused

Recommendations

- Errors in prescription of blood components continue to occur. Training of paediatric and neonatal staff involved in transfusion needs to be ongoing and occur at induction to new posts
- Dissemination of resources such as the 'bookmark' and awareness of the Blood Components mobile application (NHS 2018) and the British Society for Haematology (BSH) guidelines are vital (New at al. 2016)
- The SHOT paediatric video, available on the SHOT website (https://www.shotuk.org/resources/current-resources/videos/), should be viewed for key educational messages from the last 10 years of paediatric SHOT reports

Action: Transfusion practitioners and hospital transfusion teams

Introduction

Common themes for transfusion errors remain consistent over time in both children and neonates.

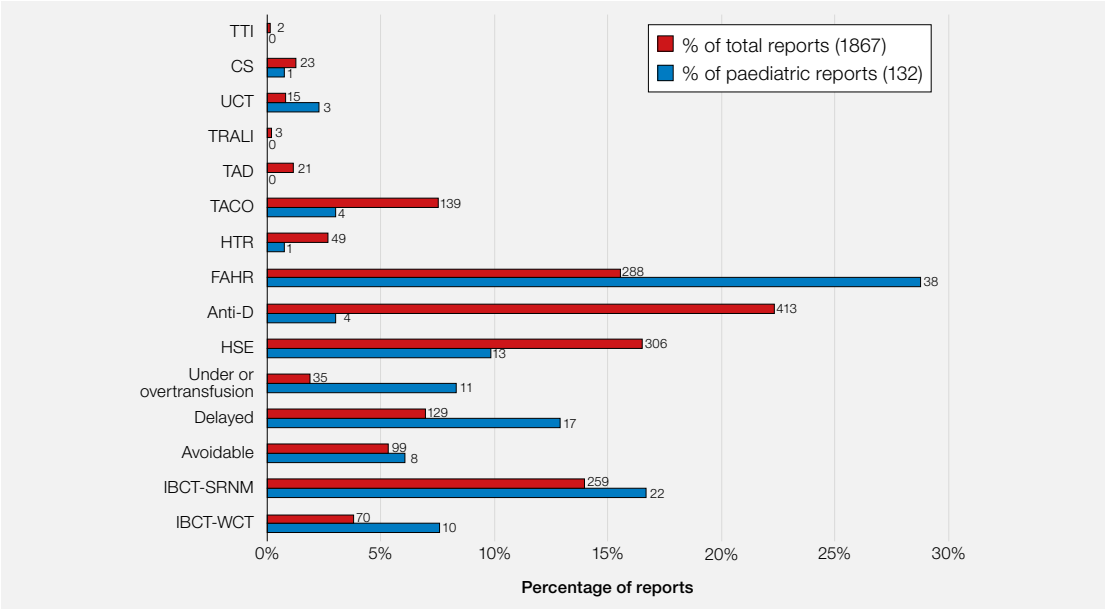
The number of reports is similar to last year (2018) at 132/1867 (7.1%), and if near miss (NM) and right blood right patient (RBRP) are included, 245/3397 (7.2%). The split between categories remains similar (Figure 22.1).

Paediatric cases continue to be over-represented as percentages of total reports in several categories, particularly in under and overtransfusion, 11/35 (31.4%) cases, Figure 22.1. Neonates are disproportionally represented in the incorrect blood component transfused (IBCT) category in comparison with other categories (Figure 22.2).

Overall numbers of paediatric reports whilst having increased since 2009 have been broadly stable in all age categories for the last 4 years. Interestingly the proportion of neonatal reports has dropped compared to a peak in 2015 (Figure 22.3).

The proportion of paediatric error reports primarily from the laboratory was 34/86 (39.5%) which is similar to last year. These were in the following categories: IBCT-wrong component transfused (WCT) n=5, IBCT-SRNM n=17, avoidable, delayed and under/overtransfusion (ADU) n=10, and handling and storage errors (HSE) n=2.

Figure 22.1: Percentages of paediatric and total reports in each category



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

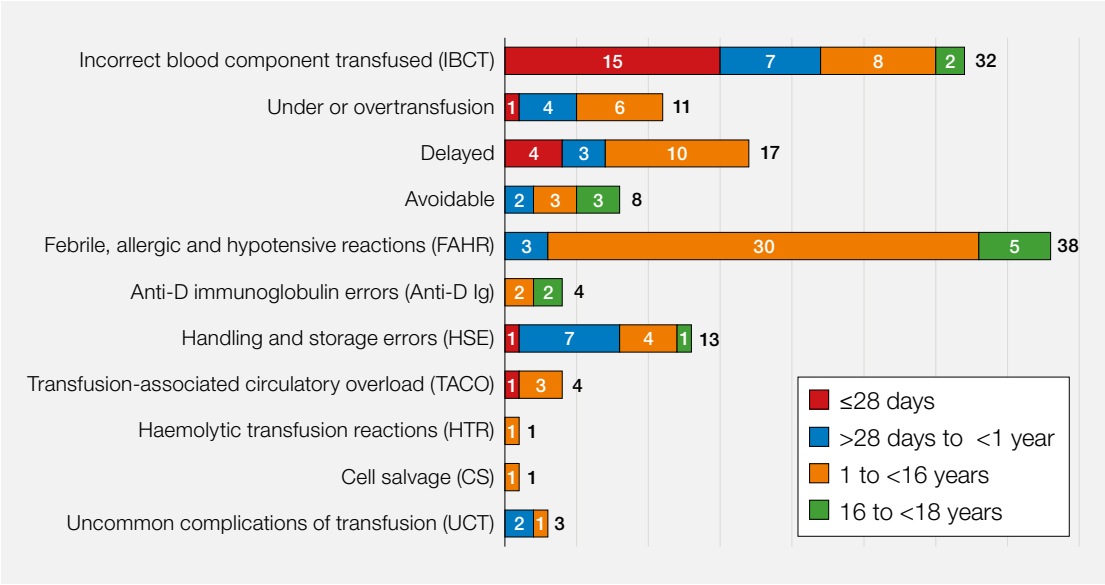


Figure 22.2: Summary of paediatric cases by category and age 2019

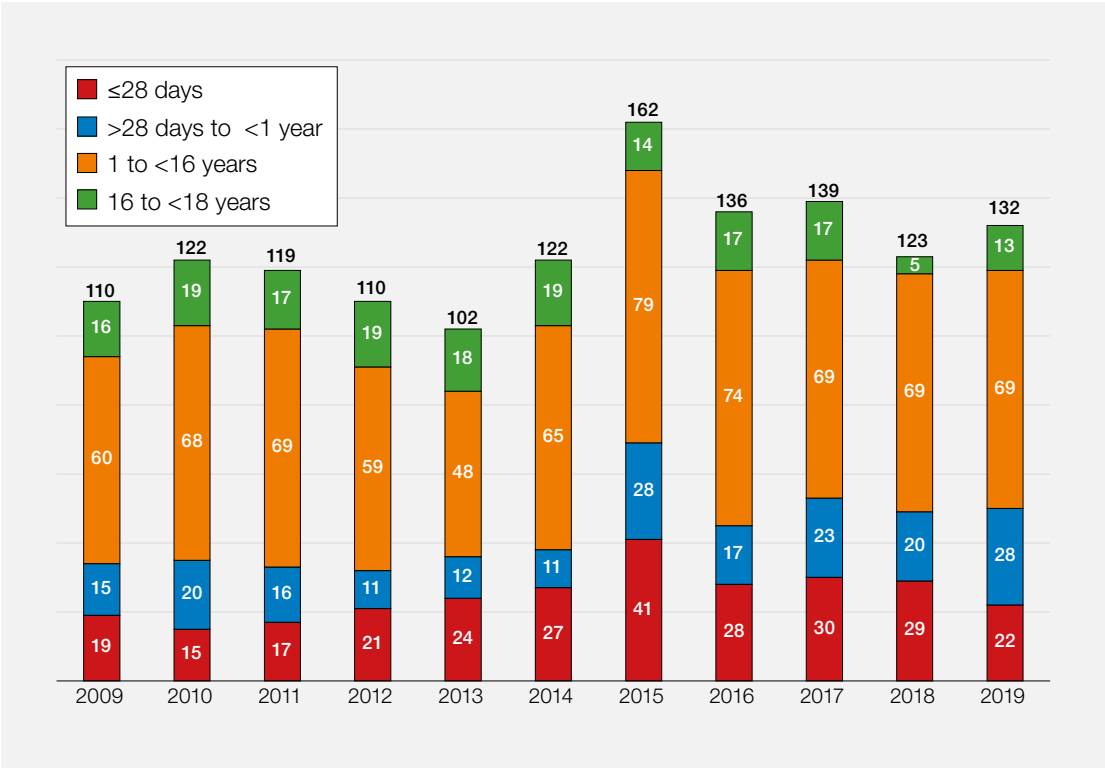


Figure 22.3: Trends in paediatric cases from 2009-2019

Death n=1

There was only 1 death that was determined to be possibly related to transfusion: a case of transfusion-associated necrotising enterocolitis (TANEC) (UCT category; imputability possible =1).

Case 22.1: A case of TANEC

A very preterm baby who was a few months of age, received two red cell transfusions for anaemia within 12 hours. The baby had had a previous bowel perforation. Around 2 hours after starting the second transfusion they developed increasing nasogastric aspirates and worsening abdominal distension. The baby died 24 hours later from multiorgan failure.

A notable ADU case is discussed below as although the recipient died of complications unrelated to the transfusion, the error raises important learning points (see also Case 11a.4 in Chapter 11a, Delayed Transfusions for further discussion).

Case 22.2: Failure to recognise importance of an isolated severely prolonged APTT in a male child leading to delay in appropriate treatment of an infant with haemophilia

A male infant <6 months of age was admitted to his local hospital 6 days after a fall down the stairs. Two coagulation screens showed an un-clottable activated partial thromboplastin time (APTT) with a normal prothrombin time (PT) and the patient was given vitamin K prior to transfer. This result was not communicated at the time to a haematologist. Further investigations, in particular coagulation factor assays, were not performed. The infant was transferred to a tertiary centre and the APTT was noted to be 101 seconds with a normal PT. The biomedical scientist noted in the report that these were abnormal and requested a repeat, but the abnormal results were not discussed with a haematologist. The infant was given fresh frozen plasma (FFP) with a partial improvement in APTT but not full correction. The results were not discussed with the haematology department until over 24 hours after admission, and the infant received three transfusions of solvent detergent (SD)-FFP. The infant was subsequently diagnosed with severe haemophilia A. He died of an intracranial bleed caused by an arteriovenous malformation.

This case illustrates the vital importance of understanding the significance of abnormal laboratory results and of early discussion with a haematologist. An isolated prolonged APTT in a bleeding infant should have triggered urgent further investigation (ideally factor assays). FFP does not contain sufficient factors VIII or IX to provide sufficient correction of levels in patients with haemophilia. Recombinant factor VIII would have been the appropriate treatment of the infant's Factor VIII deficiency in association with a bleed.

Learning points

- Severe abnormalities of coagulation in a bleeding patient require urgent discussion with a haematologist
- Severe bleeding disorders can present in neonates and early childhood in the absence of family history
- In the neonatal period and up to 6 months of life the interpretation of coagulation results can be complex and normal ranges appropriate for age and gestation should be used, thus underlining the need for early specialist input

Major morbidity n=14

There were 14 cases associated with major morbidity. There were 12 cases in the FAHR category which met the criteria for major morbidity. The other 2 cases were in TACO and UCT categories and are discussed in the relevant sections.

Error-related reports n=86

Incorrect blood component transfused (IBCT) n=32

IBCT wrong component transfused (WCT) n=10

There were fewer reports in this category (n=10) compared to the 2018 Annual SHOT Report (Narayan et al. 2019) where there were 17 cases.

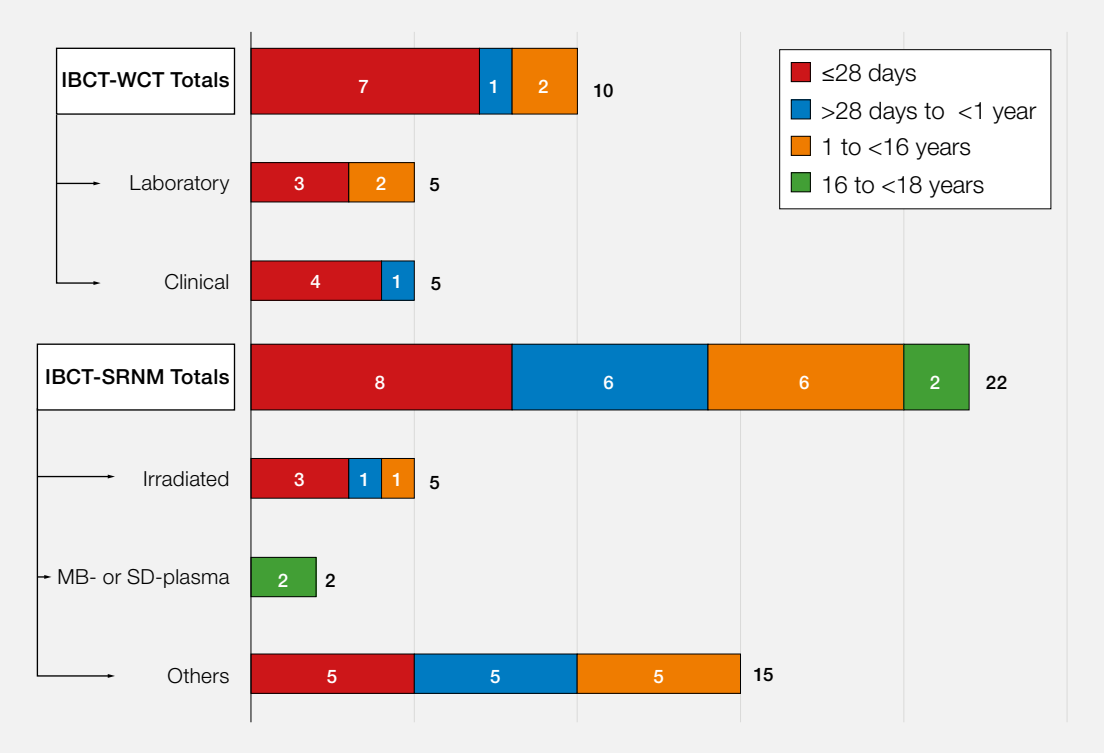


Figure 22.4: Breakdown of incorrect blood component transfused reports

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

IBCT-WCT clinical errors n=5

Adult emergency blood given to neonates n=2

There were 2 reports of adult specification red cell components given to neonates. The first was a newborn who received blood from an adult O D-negative red cell unit which was subsequently found to be cytomegalovirus (CMV)-positive. This child died from complications unrelated to the transfusion. The other case was a newborn baby who received 15mL of an O D-positive unit which was intended for the mother and was therefore not of neonatal specification. Fortunately, it was ABO and D-compatible as both mother and baby were B D-positive. Of note a 2-person bedside check did not detect the error and it was noticed by the transfusion laboratory.

Failure to communicate relevant medical history n=2

Communication errors were noted in 2 patients where the wrong specification component was given. One was a post liver transplant patient who should have only received group O components, but this was not communicated to the transfusion laboratory by the treating team. Therefore, they received a group B red cell unit. There were no significant clinical consequences.

Case 22.3: Failure to communicate history of haemopoietic stem cell transplant (HSCT)

A young child who was post HSCT for juvenile myelomonocytic leukaemia received group O platelets instead of group B. The transplant protocol and therefore the change in the child's transfusion requirements had not been shared with the hospital transfusion laboratory. There were no clinical sequelae.

Other n=1

A retrospective review uncovered that a pair of preterm twins had inappropriately had a single unit of FFP shared between them, which is contrary to guidelines.

Learning points

- Children who undergo either solid organ or stem cell transplantation may have a change in their transfusion requirements post transplant
- Communication between the transplanting team and the hospital transfusion laboratory is vital to ensure the correct components are issued
- Where care is delivered post transplant closer to children's homes (e.g. by paediatric oncology shared care units), there should be mechanisms in place to ensure that this information is shared between units

IBCT-WCT laboratory errors n=5

There were 5 errors in the laboratory category. Three of these involved issue of a D-positive component in error; 1 to a baby whose D-type was unknown, 1 to a female D-negative child and 1 to a D-negative patient whose group switched post HSCT.

The remaining cases were 1 occasion of administration of a group O component to a group A patient (FFP, with no haemolytic sequelae reported), and 1 occasion of administration of a group O component (cryoprecipitate) when the patient group was unresolved.

IBCT-specific requirements not met (SRNM) n=22 (17 laboratory; 5 clinical)

Failure to provide irradiated components n=5

Five children had received non-irradiated components due to a failure to communicate the need for irradiated components by the clinical team. Two of these were neonates who had received intrauterine transfusion (IUT) and of note there was no transfusion-associated graft-versus-host disease. SHOT has received 20 reports since 2007 where irradiation was missed for transfusion following IUT, with no adverse outcome. These errors usually occur due to failure in communication and often lead to significant anxiety for families and clinical staff. Of the other cases, 1 child had a previous HSCT, 1 had received Campath and 1 a purine analogue.

Learning point

- All staff involved in paediatric transfusions must be aware of the specific requirements for transfusions, especially in cases with previous intrauterine transfusions (IUT). Paediatric transfusion prescribing including choosing the right component should be the focus of ongoing education in hospitals and staff should be familiar with available guidelines. Effective communication is vital in preventing such incidents

Failure to provide appropriate blood for patients with sickle cell disease n=4

Sickle patients have specialised red cell requirements including the need for a baseline extended red cell phenotype and provision of Rh phenotyped, HbS-negative components. Four children did not have these requirements met.

Failure of pre-transfusion compatibility testing or component selection n=8

Of these cases, 6 were due to failure to perform an antibody screen on a maternal sample and upon subsequent investigation it was found that 5 mothers had previous known positive antibody screens (4 anti-M and 1 with both anti-Le^a and anti-Le^b). One of the babies with maternal anti-M was retrospectively noticed to have a significant drop in haemoglobin in the weeks following transfusion, possibly due to haemolysis. The other 2 cases were failure to provide antigen-negative red cells to children under 4 months of age with history of maternal antibodies.

Failure to provide imported plasma for a recipient born after 1995 n=2

Two teenagers received UK plasma (non-pathogen inactivated). Of note the requirement for non-UK plasma for patients born after 1995 has now been removed.

Other n=3

In 1 report, CMV-unscreened red cells were provided in error. Another child received pooled rather than apheresis platelets. In the 3rd case electronic issue was used in error for a post stem cell transplant patient.

Learning point

- Following the Advisory Committee on the Safety of Blood, Tissues and Organs (SaBTO) review (2019), recipients born after 1995 can now have United Kingdom (UK) plasma (non pathogen-inactivated) and either apheresis or pooled platelets. This will therefore affect specific requirements not met (SRNM) reporting for next year (SaBTO 2019)

Avoidable, delayed, under or overtransfusion (ADU) n=36

Avoidable n=8

There were 8 avoidable transfusions, with 5 due to misinterpretation of results. Of these 5 reports, 4 were due to lack of questioning of unexpected results and 1 was due to a transcription error (see Case 22.4). There were 2 cases where emergency O D-negative red cells were used when fully crossmatched units should have been given. In the final case a teenage patient received two units of FFP to correct coagulation results which were not sufficiently deranged to warrant correction.

Case 22.4: Transcription error resulting in transfusion based on erroneous results

A young infant who was unwell had a full blood count sent to the laboratory. The platelet count was telephoned through to the ward by a member of the laboratory team and was written down as 23.8x10^9/L. The child was unwell and it was presumed that the count was valid and so a platelet transfusion was given. Subsequently when the result was available on the computer it was seen that the true result was 238x10^9/L.

Learning points

- Platelet counts are not reported with decimal points
- When results are telephoned through from the laboratory to ward areas it is critical that the members of staff check that they have heard correctly. Results should be uploaded onto electronic format as soon as possible so that the ward staff can check them

Overtransfusion n=11

In total 11 patients received excessive volumes of component. Of these, 6 were related to failure to prescribe the correct volume, once again highlighting the importance of correctly calculating and prescribing in mL for babies and children. Electronic prescribing systems which incorporate prompts or reminders are ideally placed to avoid transfusion of excessive volumes in children.

Case 22.5: Prescription error of 10 times the required red cell volume

Red cell transfusion was prescribed for a 3kg infant (pre-transfusion Hb 79g/L): the volume was discussed in a ward round and 300mL was prescribed. An electronic system was used to prescribe the blood but there was no in-built error message to prevent prescription of such a large volume. 138mL (46mL/kg) was administered before the error was realised. Post-transfusion Hb was 141g/L.

Of the remaining reports, 2 were errors in setting the infusion pump and 1 was failure to communicate the pump settings at a change of staff. There was 1 error when an incorrect weight was used for the calculation of transfusion volume, and in 1 report national transfusion guidance was not followed where a non-bleeding adult sized teenager received three red cell units without any check of Hb between units.

Delay in transfusion n=17

One of these errors was the missed diagnosis of haemophilia resulting in a delay in the child receiving the appropriate recombinant coagulation factor. The other errors included 6 communication errors, 1 information technology (IT) error, 3 internal hospital logistics errors, 1 delay in cannulation, 4 equipment failures and 1 case where one of the samples from a pair of brothers was discarded in error as it was thought to be a duplicate.

Cell salvage (CS) n=1

In 1 case during cell salvage black particles were seen in the bag from the first processed bowl of red cells. This was linked to a series of other cases in the same centre and is discussed in more detail in Chapter 21, Cell Salvage (CS).

Handling and storage errors (HSE) n=13

Four errors were made setting infusion pumps, with 3 involving infants less than 6 months of age. There were 5 temperature-related errors, 4 resulting in failure of cold chain for red cells and 1 a failure of temperature control on a platelet incubator. There were 2 traceability failures where a retrospective review at a hospital could not determine whether 2 paediatric patients had received the component prescribed. Two related to timing: in 1 a red cell unit had expired by the time the transfusion was completed due to miscommunication between laboratory and clinical staff; in the other a child received a transfusion over 6 hours.

Anti-D Ig n=4

There were 4 cases in teenage girls who had delay in receiving anti-D Ig; 1 due to late booking of a pregnancy, 2 for delay in administration following a sensitising event, and 1 incorrect administration for a D-negative fetus. For more details of anti-D administration errors, see Chapter 8, Adverse Events Related to Anti-D Immunoglobulin (Ig).

Transfusion reactions n=46

Febrile, allergic and hypotensive reactions (FAHR) n=38

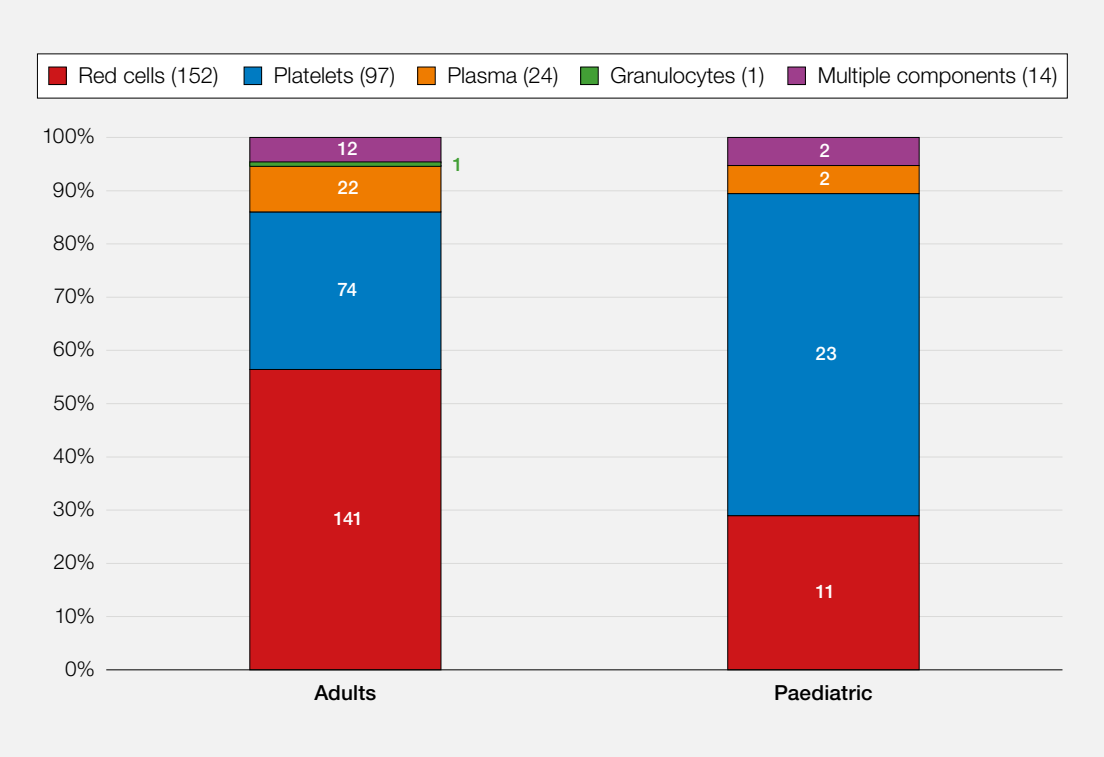
The number of reports has been fairly stable over the last 3 years. The majority (35/38) were in children >1 year of age. Once again there were no reports in the <28 day (neonatal) category a possible reflection of immunological immaturity or of difficulty in recognising reactions in this transfused patient group many of whom are sick preterm babies. The predominance of reactions to platelets can again be seen when compared to the adult data although does not necessarily indicate a difference in reaction rate in proportion to number of platelets transfused to the two groups (Figure 22.5a).

Of the reactions to platelet components (n=23) most (14/23) were allergic-type reactions and the rest were febrile (4/23) or a mixture of allergic and febrile (5/23). Three of the components were pooled platelet components the rest were apheresis.

There were 11 reports related to red cells. In 8/11 these involved fever, 2 were allergic, and 1 was a mixture of allergic and febrile features.

Two reactions were reported due to SD-FFP (Octaplas®).

The data for reaction by component type is summarised in Figure 22.5b below.



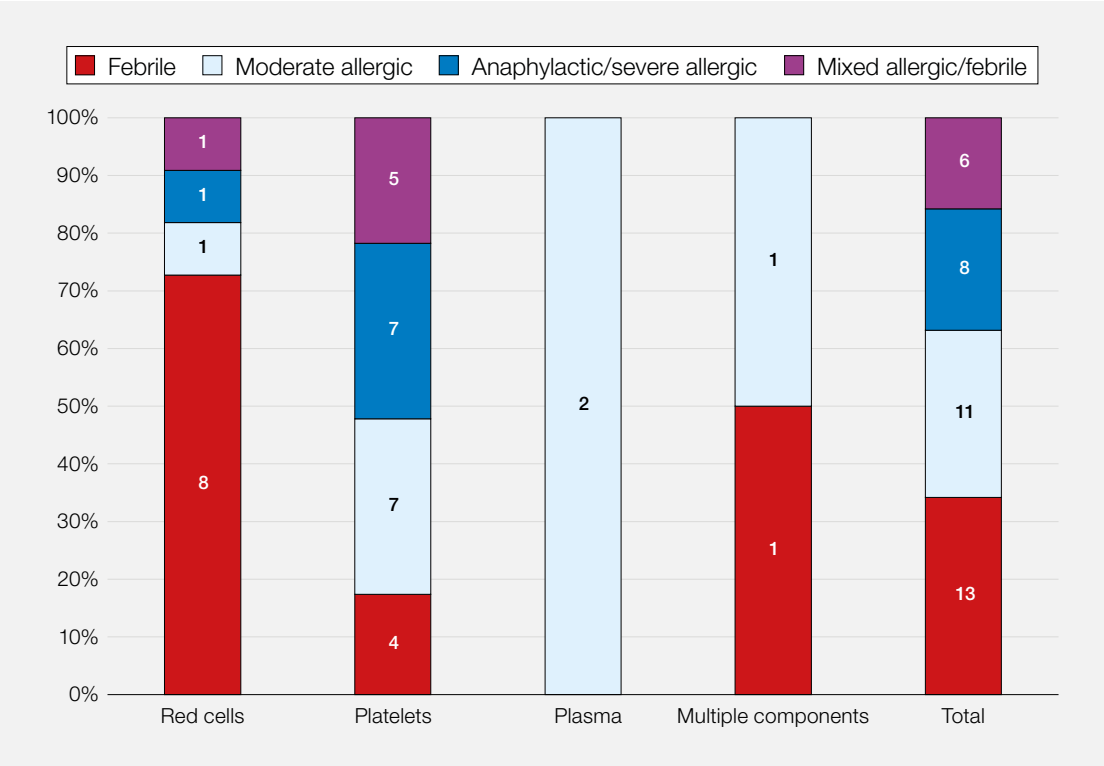


Figure 22.5: Paediatric febrile, allergic and hypotensive reaction (FAHR) reports

a. Comparison of proportions of adult and paediatric FAHR related to different components

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

Haemolytic transfusion reaction (HTR) n=1

There was 1 case of a haemolytic transfusion reaction in a child with acute lymphoblastic leukaemia, a rare occurrence in this population (see Chapter 18, Haemolytic Transfusion Reactions (HTR)).

Case 22.6: Acute haemolysis secondary to an anti-E in a child with acute leukaemia

A child with acute lymphoblastic leukaemia who had a negative pre-transfusion antibody screen was transfused with two units of red cells. Near the end of the second unit they developed rigors and dark urine. A positive direct antiglobulin test (DAT) and a strongly positive antibody screen was found in the post-transfusion sample. Anti-E was eluted from the patient's red cells. The pre-transfusion sample was then retested and a weak (1+) antibody was detected but only on the homozygous E-positive cells. The Rh type of the transfused units was subsequently confirmed and one unit was negative but the other unit was heterozygous (Ee). The child made a complete recovery with supportive care.

Learning points

- Acute transfusion reactions in children can take place in a variety of clinical settings
- Paediatricians and neonatologists need to be aware of the symptoms and signs of transfusion reaction and instigate appropriate management
- The hospital transfusion practitioner, haematology team and transfusion laboratory are key sources of advice in terms of management

Pulmonary complications of transfusion in neonates and children

Pulmonary complications of transfusion in babies and children are almost certainly under-reported. This may be an issue of education but there is also poor standardisation of definitions as discussed by Gauvin et al. (2020). Diagnosis is compounded by the complexities of the patients involved such as extremely preterm babies.

There were no cases of TAD or TRALI in patients <18 years reported in 2019.

Transfusion associated circulatory overload (TACO) n=4

There were 4 cases of TACO and 1 of these cases was associated with major morbidity. This was a child with complex cardiac disease (tetralogy of Fallot) who developed respiratory distress following a red cell transfusion. Symptoms did not resolve with intravenous (IV) frusemide and they were transferred to the paediatric intensive care unit (PICU) for respiratory support. In 3 patients the implicated component was red cells and 1 to platelets.

Case 22.7: Tachypnoea following a platelet transfusion

A young child with neuroblastoma received a 15mL/kg apheresis platelet transfusion prior to a procedure. They developed tachypnoea 6 hours following transfusion with drop in oxygen saturations to 92% on air. Chest X-ray showed pulmonary oedema. The child responded to frusemide. They had also received IV chemotherapy and hydration fluids the same day and therefore there was uncertainty as to the relative contribution of the platelet transfusion as the cause of the fluid overload.

Learning points

- Complexities of paediatric patients and even more so extreme preterm babies can make the diagnosis of transfusion-associated circulatory overload (TACO) very difficult
- A universal set of diagnostic criteria in children is lacking and risk factors are extrapolated from the adult population
- The SHOT ABCDE assessment of transfusion (see Figure 4.2 in Chapter 4, Key Messages and Recommendations) and risk factors such as fluid overload, low albumin, existing respiratory or cardiac dysfunction should be considered

Transfusion-transmitted infection (TTI) n=0

There were no cases of TTI in patients <18 years reported in 2019.

Uncommon complications of transfusion (UCT) n=3

There were 2 cases of TANEC in preterm babies, 1 resulted in death and is discussed at the beginning of this chapter (see Chapter 19, Uncommon Complications of Transfusion (UCT) for further commentary). The other resulted in major morbidity. The baby started bleeding per rectum 90 minutes post transfusion and required transfer to another hospital for a subtotal colectomy.

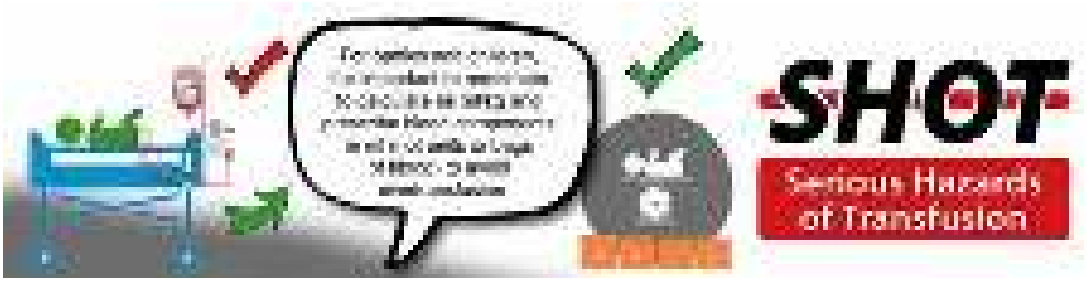
One young child developed severe back pain following red cell transfusion. There was no evidence of haemolysis.

Near miss (NM) n=53, NM–wrong blood in tube (WBIT) n=43, right blood right patient (RBRP) n=17

See relevant chapters (Chapter 12, Near Miss (NM) Reporting and Chapter 13, Right Blood Right Patient (RBRP)) for further details.

Recommended resources

The transfusion handbook has a useful summary of management of transfusion reactions
https://www.transfusionguidelines.org/transfusion-handbook/5-adverse-effects-of-transfusion/5-2-non-infectious-hazards-of-transfusion



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23 Haemoglobin Disorders n=46

Author: Joseph Sharif

Key SHOT messages

- Alloimmunisation is a significant complication in patients with sickle cell disease (SCD) and can lead to haemolytic transfusion reactions and difficulties with blood provision. Preventing alloimmunisation must be a priority
- Hyperhaemolysis is a unique and potentially fatal complication of transfusion. Identification and reporting of cases is essential and specialist advice should be sought for subsequent transfusion

Abbreviations used in this chapter

CMV	Cytomegalovirus	**IT**	Information technology
FAHR	Febrile, allergic and hypotensive reactions	**IVIg**	Intravenous immunoglobulin
Hb	Haemoglobin	**LDH**	Lactate dehydrogenase
HDU	High dependency unit	**SCD**	Sickle cell disease
HTR	Haemolytic transfusion reactions	**Sp-ICE**	Specialist Services electronic reporting using Sunquest's Integrated Clinical Environment

Recommendations

- All transfusions for sickle cell disease (SCD) should have a clear indication and should be authorised by the haematology team (BSH Davis et al. 2016)
- Patients anticipated to have transfusion should receive units that are CcEe and Kell-matched and antigen-negative for any corresponding clinically significant alloantibodies
- Any historical alloantibodies should be clearly documented in medical and transfusion records including national databases such as Specialist Services electronic reporting using Sunquest's Integrated Clinical Environment (Sp-ICE) in England

Introduction

There were 46 incidents reported this year in patients with SCD or thalassaemia. The most frequently reported incident was specific requirements not met, occurring in 14 cases. There were 8 reported cases of haemolytic transfusion reactions including 3 cases of hyperhaemolysis. There were no reported deaths directly related to complications of transfusion. There were 4 cases classified as right blood right patient and 2 cases relating to handling and storage.

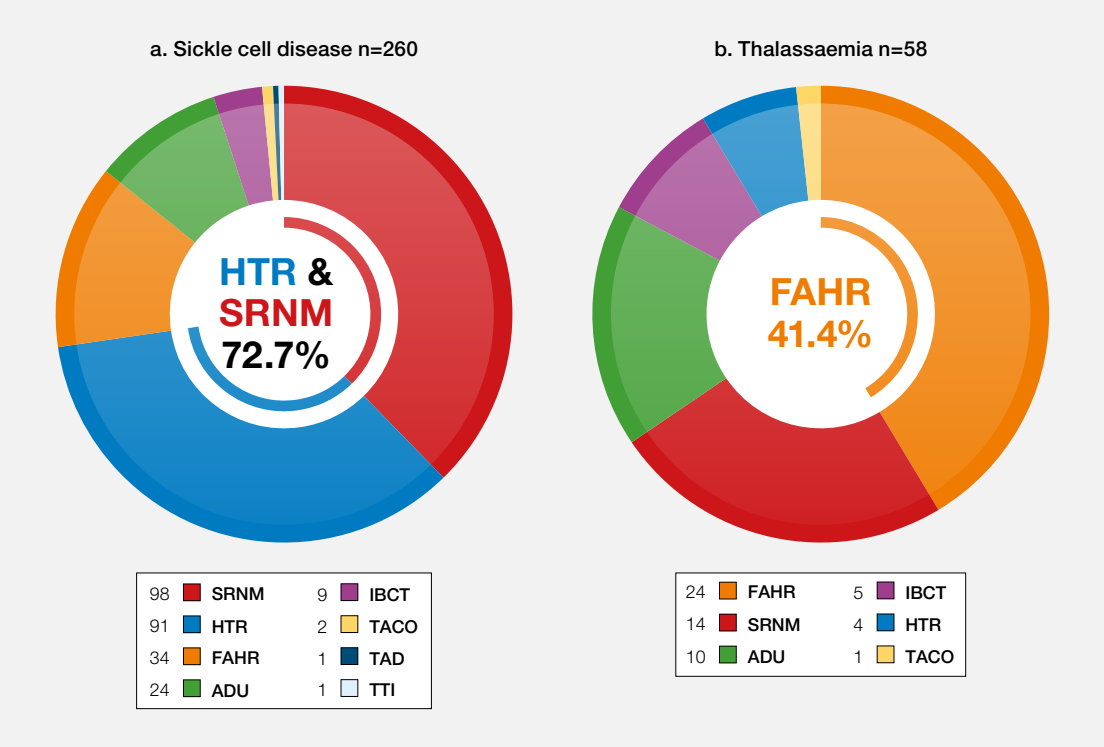

Figure 23.1: Cumulative data for adverse events in transfusion for patients with haemoglobin disorders 2010 to 2019

SRNM=specific requirements not met; HTR=haemolytic transfusion reactions; FAHR=febrile, allergic and hypotensive reactions; ADU=avoidable, delayed or under or overtransfusion; IBCT=incorrect blood component transfused; TACO=transfusion-associated circulatory overload; TAD=transfusion-associated dyspnoea; TTI=transfusion-transmitted infection

Avoidable, delayed and under or overtransfusion (ADU) n=9

There were 2 reports of overtransfusion, both occurring in children with thalassaemia, where an incorrect blood volume was administered due to errors in volume calculation or incorrect patient weight. There were 6 cases of delay in transfusion due to both clinical and laboratory errors. The delays were during elective transfusion in 5 cases with errors including problems or delays in sample processing. There was 1 reported avoidable transfusion.

Case 23.1: Overtransfusion in a child, identified by a parent during transfusion

A young patient with thalassemia attended for an elective transfusion. An incorrect volume was prescribed and administered. The large volume was noticed by the child's father who alerted the nurse. The transfusion was stopped after 45mL over the recommended volume had been transfused.

Case 23.2: Avoidable transfusion due to information technology (IT) failure and lack of awareness of indications for transfusion in SCD

There was an avoidable transfusion in a patient in their 60s with SCD who presented with heart failure. Due to an IT failure the clinical team did not realise that the current haemoglobin (Hb) value of 60g/L was his baseline level. A decision was made in the emergency department to transfuse the patient without seeking advice from haematology. It was later determined to be an unnecessary transfusion.

Case 23.3: Delayed transfusion following perioperative bleed due to decision to proceed with elective surgery

A man in his 50s with SCD was admitted for elective hip surgery. The surgical team requested blood on the day of surgery, but a sample had not been sent to the laboratory. The patient had a history of alloantibodies and the laboratory informed surgeons not to proceed with surgery as there would be a delay in blood availability. Surgery proceeded and was complicated by excess bleeding causing a drop in Hb from 90 to 52g/L. The patient was admitted to the high dependency unit (HDU) and monitored until blood was available later during the night. The patient made a complete recovery.

This case highlights that requirements for blood to be available for routine elective surgery should not be overruled in cases where crossmatched blood will not be possible at short notice.

Specific requirements not met (SRNM) n=14

Clinical causes n=6

There were 4 cases in which the clinical team did not clearly inform the laboratory of a diagnosis of SCD. This resulted in these patients not receiving extended Rh and Kell-matched units and not receiving HbS-negative units. Two pregnant patients with SCD did not receive cytomegalovirus (CMV)-negative units.

Laboratory causes n=8

Specific requirements were not met for SCD in 8 patients. In 5 cases the laboratory was informed of the diagnosis of SCD but did not provide extended Rh and Kell-matched or HbS-negative units. This resulted in 1 patient developing an anti-C alloantibody.

Three patients had historic alloantibodies that were not picked up by the laboratory; these patients received antigen-positive units. No subsequent adverse events were reported.

Case 23.4: Clinical pressure on the laboratory to release components before completing antibody investigations

A patient with SCD attended for an elective exchange transfusion. The laboratory suspected an antibody but required a further sample to complete the investigation. The laboratory stated they were under pressure to issue blood and so issued crossmatch-compatible units before completing antibody investigations. A second sample was collected post transfusion which identified an anti-Jk^b alloantibody.

This case could have resulted in a serious transfusion reaction. Laboratory staff should not be pressured to release blood for transfusion until they are satisfied it is safe to do so and should not deviate from standard operating procedures. Effective communication and co-ordination between clinical and laboratory teams are key to ensure safe and timely transfusions.

Wrong transfusion n=1

Case 23.5: Incorrect patient transfused due to failure to follow patient identification procedures

A young female with SCD attended for a red cell exchange transfusion on the haematology day unit. Due to a failure to correctly identify the patient, blood transfusion was commenced with the blood intended for another patient in the department. The error was noticed after 10mL of blood was transfused. By chance the incorrect transfusion was ABO-compatible and met all specific requirements for the patient. There were several issues which contributed to this error; the healthcare assistant collected multiple transfusions for different patients at the same time, the patient did not have a wrist band on, and patient identification policy was not followed.

Febrile, allergic or hypotensive reactions (FAHR) n=6

There were 4 cases of febrile reactions reported and 2 allergic reactions in patients with SCD and thalassaemia. One of the patients with SCD was treated for anaphylaxis.

Haemolytic transfusion reactions (HTR) n=8

There were 8 reports of haemolytic transfusion reactions all occurring in patients with SCD. At least 6 of the reactions occurred following an urgent or unplanned transfusion. There was 1 report of an acute haemolytic transfusion reaction in a patient reportedly being treated for a sickle cell crisis. (Case 18.3 in Chapter 18, Haemolytic Transfusion Reactions (HTR))

There were 7 cases of delayed haemolytic transfusion reactions of which there were 3 cases of hyperhaemolysis. Further details can be found in Chapter 18, Haemolytic Transfusion Reactions (HTR).

Case 23.6: Recurrent hyperhaemolysis following a series of transfusions in a patient with alloantibodies whose specific requirements were also not met

A patient in their late 20s with SCD and a history of anti-S and previous hyperhaemolysis had 2 transfusion episodes over a 2-month period for recurrent anaemia. The patient received intravenous immunoglobulin (IVIg) and corticosteroid prior to transfusion due to a history of hyperhaemolysis. The patient had a further transfusion episode for anaemia 1 month later without IVIg and corticosteroid cover and developed a further episode of hyperhaemolysis. It also transpired that specific requirements were not met with all transfusion episodes due to a flag being removed from the transfusion record. The patient subsequently developed anti-C alloantibody.

The decision to transfuse a patient with a history of hyperhaemolysis in SCD must be carefully balanced with the risk of recurrence which could be life-threatening. It is vital that all specific requirements for transfusion are met and expert advice should be sought for such complex cases.

Case 23.7: A case of hyperhaemolysis with no new alloantibody identified

A female patient in her 40s with SCD received two units of blood for acute chest syndrome. There was a history of previous alloimmunisation with anti-C and anti-S. One week later she presented with severe all over pain described as 'sickle pain' and dark urine. This was associated with an acute drop in Hb from 95g/L to 50g/L with a relative reticulocytopenia and markedly raised lactate dehydrogenase (LDH). The patient was treated for hyperhaemolysis. No new alloantibody was identified.

Uncommon complications of transfusion n=1

Case 23.8: Severe headache during transfusion

A male patient in his 20s with SCD developed a severe headache during an elective exchange transfusion. The exchange procedure was aborted after the fifth out of eight units planned. The patient was admitted for observation but made a complete recovery.

Near miss n=1

Case 23.9: Specific requirements not met detected at the bedside by a nurse

A teenage male with SCD attended for a red cell exchange transfusion. Units of the incorrect phenotype were ordered from the Blood Service, and the error was not initially identified at authorisation as the special requirement information had not been added to the correct module of the laboratory information management system. The error also went unnoticed during manual label checking, and C-positive units were issued when the patient should have received C-negative units. These errors occurred during a period of particularly high pressure in the laboratory; activation of the major haemorrhage protocol for a paediatric patient, printer failures and reduced staffing. The incorrect phenotype was noticed by the nurse at the bedside and the units were sent back to the laboratory before transfusion.

Conclusion

The most frequent adverse event reported was SRNM. Not providing extended Rh and Kell-matched units increases the risk of alloimmunisation. Many cases were due to lack of communication between clinical and laboratory staff as well as problems with IT systems.

A detailed history should be obtained for all haemoglobinopathy patients requiring transfusion including any prior alloimmunisation or transfusion reactions. Clear communication between clinical and laboratory staff is essential to ensure appropriate blood is provided.

All hospitals should have protocols for the management of acute complications of SCD. Specialist haemoglobinopathy teams should be involved in the management of all these patients and provide advice on transfusion.

Recommended resources

Red blood cell specifications for patients with hemoglobinopathies: a systematic review and guideline (Compernolle et al. 2018)
https://pubmed.ncbi.nlm.nih.gov/29697146/

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Immune Anti-D in Pregnancy n=54 24

Authors: Susan Robinson and Jane Keidan

Definition:

Cases of D-negative pregnant women who become sensitised and are found to have developed immune anti-D, which is detected during pregnancy, either at booking or later in the index pregnancy.

Key SHOT messages

- Cases of immunisation are still occurring even where current best practice is being followed
- Cases of alloimmune anti-D found for the first time in pregnancy should be reported to SHOT, aiming to provide a complete data set after delivery
- Obesity and delivery beyond 40 weeks remain as risk factors for sensitisation in cases which are otherwise ideally managed
- Although managed in accordance with current guidelines, postpartum fetomaternal haemorrhage (FMH) >4mL, is an emerging possible risk factor
- Following large FMH, every effort should be made to confirm all fetal cells are cleared, whilst balancing maternal contact and the upheaval of attending hospital repeatedly
- There is a continued need to audit the anti-D pathway and provide ongoing education to clinical staff and pregnant women, and tools to support best practice

Abbreviations used in this chapter

APH	Antepartum haemorrhage	**NHSBT**	NHS Blood and Transplant
BMI	Body mass index	**NICE**	National Institute for Health and Care Excellence
BSH	British Society for Haematology	**NIPT**	Non-invasive prenatal testing
cffDNA	Cell-free fetal deoxyribonucleic acid	**NPP**	No previous pregnancies
FMH	Fetomaternal haemorrhage	**PP**	Previous pregnancies
HDFN	Haemolytic disease of the fetus and newborn	**PPP**	Postpartum prophylaxis
Ig	Immunoglobulin	**PSE**	Potentially sensitising event
IT	Information technology	**RAADP**	Routine antenatal anti-D Ig prophylaxis
NHS	National Health Service	**UK**	United Kingdom

Introduction

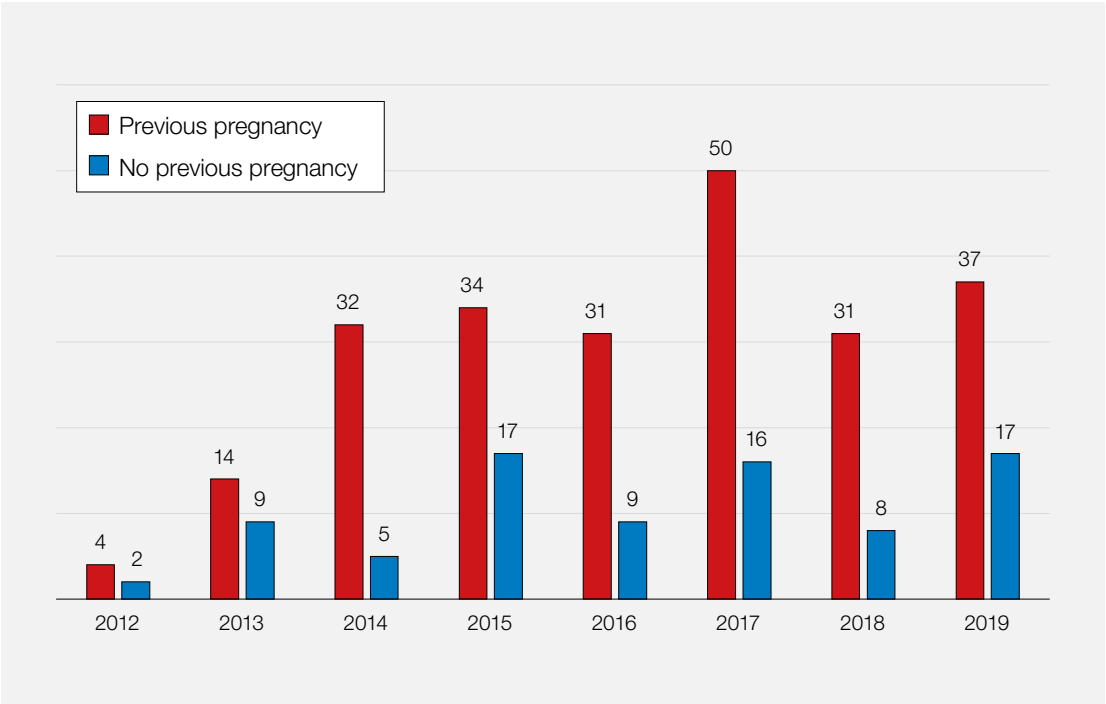
To improve understanding of the causes of continuing anti-D immunisations, since 2012 SHOT has been reviewing cases where immune anti-D has been detected for the first time in the current (index) pregnancy. The reporters are requested to provide data on booking weight, management of sensitising events during pregnancy and the administration of routine anti-D immunoglobulin (Ig) prophylaxis, both in the index pregnancy and the pregnancy immediately before the index pregnancy (if applicable).

Results

In 2019 a total of 54 cases were reported, 17 cases occurred in women with no previous pregnancies (NPP), and 37 in women with previous pregnancies (PP). It is reassuring to note that the downward trend in reporting has reversed this year, as the available data would suggest that anti-D immunisation in pregnancy remains under-reported (see the assumptions and calculation provided in the 2018 Annual SHOT Report (Narayan et al. 2019)).

Cumulatively SHOT now has useful data on 83 women with NPP and 233 women with PP.

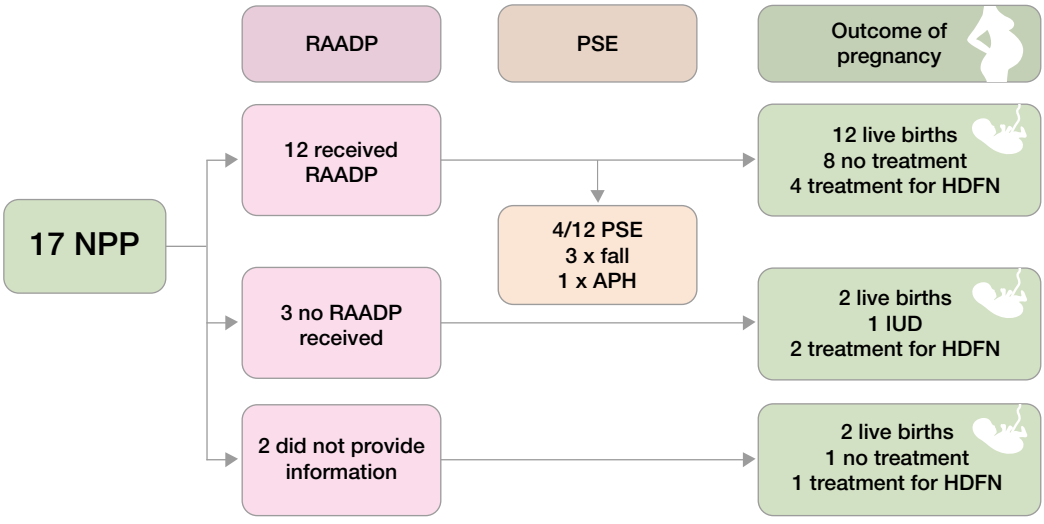
Figure 24.1: Number of reports of anti-D immunisation in pregnancy by year, 2012-2019



No previous pregnancy (NPP) n=17

For a detailed discussion of the NPP cases, and tables containing similar details to those published in previous Annual SHOT Reports, please see the supplementary information on the SHOT website (https://www.shotuk.org/shot-reports/report-summary-and-supplement-2019/).

Figure 24.2: Summary of 2019 NPP data n=17



Note: The 4 PSE cases did not result in treatment for HDFN

NPP=no previous pregnancy; RAADP=routine antenatal anti-D Ig prophylaxis; PSE=potentially sensitising event; APH=antepartum haemorrhage; HDFN=haemolytic disease of the fetus and newborn; IUD=intrauterine death

Illustrative cases

Case 24.1: Detection of alloimmune anti-D in the third trimester

A primiparous woman in her 20s, was booked at 19 weeks gestation (booking weight 70kg) and no alloantibodies were detected. A group and antibody screen was taken at 27 weeks and routine antenatal anti-D Ig prophylaxis (RAADP) given prior to the result being received. Alloimmune anti-D was detected, quantification 0.1IU/mL. The laboratory biomedical scientist and midwife checked the records with the woman to confirm this was prior to RAADP and no prophylaxis had been administered earlier in pregnancy. The peak quantification was 6.5IU/mL at 34 weeks. The baby was delivered at 37 weeks gestation and required phototherapy.

Alloimmune anti-D was detected at routine follow up at 27 weeks in a first pregnancy, with no prior potentially sensitising events (PSE). This case highlights the need to ensure antibody screening at 28 weeks to identify cases presenting for the first time in the third trimester.

Case 24.2: Ideal treatment

A primiparous woman in her late 20s, with a booking weight of 63kg was booked at 9 weeks gestation. She was D-negative, and no alloantibodies were detected. RAADP was given at 28 weeks, then, following a fall at 31 weeks gestation, received an additional 1500IU dose of prophylactic anti-D Ig within 24 hours. The FMH was <2mL. Serology was performed at 32 weeks gestation and detected anti-D, with a quantification of 0.1IU/mL. A further sample was taken at 40 weeks gestation; anti-D quantification 0.4IU/mL. A D-positive baby was delivered at 40 weeks and the baby required no interventions for haemolytic disease of the fetus and newborn (HDFN).

Ideal management may not always prevent sensitisation and further work is needed to explore this.

Case 24.3: Detection of low-level alloimmune anti-D with no reported cause

A teenager presented at 8 weeks gestation, with no prior transfusion or pregnancy history. Anti-D was detected with a quantification 0.1IU/mL, which did not increase during pregnancy. A D-positive baby was delivered at 39 weeks gestation, there were no PSE, and the baby required no interventions for HDFN.

The significance of this low anti-D quantification is unclear. Where alloimmune anti-D is detected in NPP at booking, there may have been a preceding 'undeclared', or even unknown, early pregnancy.

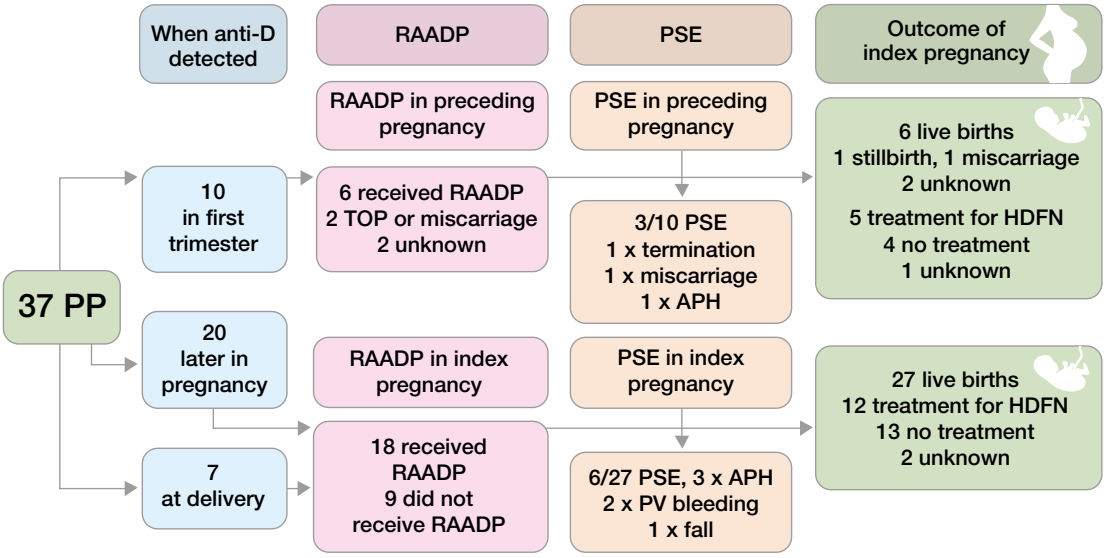
Previous pregnancies (PP) n=37

The index pregnancy in these cases refers to the current pregnancy i.e. the pregnancy in which alloimmune anti-D was first detected. Where alloimmune anti-D is detected at booking in the index (current) pregnancy, only the events in the preceding pregnancy are relevant to the sensitisation (assuming no other exposure to the D antigen occurred e.g. transfusion, an unlikely event in this demographic).

Where anti-D is detected later in the index pregnancy, the relative contribution of events in the previous and index pregnancy is less certain.

For a detailed discussion of the PP cases, and tables containing similar details to those published in previous Annual SHOT Reports, please see the supplementary information on the SHOT website (https://www.shotuk.org/shot-reports/report-summary-and-supplement-2019/).

Figure 24.3: Summary of 2019 PP data n=37



PP=previous pregnancy; RAADP=routine antenatal anti-D Ig prophylaxis; TOP=termination of pregnancy; PSE=potentially sensitising event; APH=antepartum haemorrhage; PV=per vaginum; HDFN=haemolytic disease of the fetus and newborn

Illustrative cases

Case 24.4: Large FMH where clearance of fetal cells was not checked

A woman in her 30s, gravida 2 para 1 (booking weight 48kg) had anti-D detected at 7 weeks gestation with a quantification of 7.2IU/mL, which peaked at a quantification of 23.3IU/mL. A cell-free fetal deoxyribonucleic acid (cffDNA) test at 16 weeks gestation predicted a D-positive fetus. A fetal intrauterine transfusion was given, and she delivered at 34^{+6}. Neonatal treatment for HDFN included phototherapy, immunoglobulin and exchange transfusion. In the preceding pregnancy vaginal bleeding occurred at 16 weeks gestation and she received 1500IU anti-D Ig. RAADP was given at 28 weeks gestation. She delivered at 35^{+6} by emergency caesarean section. A FMH of 79mL was confirmed by flow cytometry. She received 12000IU intravenous anti-D Ig, and the follow up FMH test at 48 hours showed 1mL fetal cells. She received a further 1500IU anti-D Ig, but it was not subsequently checked if the fetal cells had cleared completely.

In the preceding pregnancy, a large FMH occurred and was treated with anti-D Ig and follow up but did not check fetal cells were completely cleared, Subsequent sensitisation may suggest a non-linear pharmacokinetic relationship between a follow up FMH test in this setting showing <2ml fetal cells and the expectation that a further 1500IU anti-D Ig would clear the remaining fetal cells; other possibilities include chronic recurrent small FMH before delivery etc.

Case 24.5: Ideal management of large FMH

A woman in her 20s, gravida 2 para 1, booked at 8 weeks gestation, with a booking weight of 75kg. Anti-D was detected with a quantification of 0.3IU/mL. The peak quantification at 23 weeks gestation was 68.5IU/mL and an intrauterine transfusion was performed. The pregnancy was further complicated by maternal medical complications and resulted in a stillbirth. The previous pregnancy was booked at 9/40, RAADP was received at 29 weeks gestation, and she delivered at 40^{+1}. There was 16mL FMH, she received 3000IU anti-D Ig, and a follow up FMH test demonstrated complete clearance of fetal cells.

This case demonstrates even in cases where management is apparently ideal sensitisation may still occur.

Case 24.6: Delivery at 42^{+3} weeks in preceding pregnancy which was otherwise ideally managed

A woman in her 30s, gravida 2 para 1, booked at 9^{+5} weeks gestation, with a booking weight of 61.8kg. Anti-D was detected at booking with a quantification of 0.7IU/mL. Peak quantification in the pregnancy was 0.9IU/mL, and a D-negative infant was delivered. In the preceding pregnancy the woman received RAADP and experienced no PSE. However, she delivered vaginally at 42^{+3} weeks and the baby was D-positive. No test for quantitation of FMH was performed, and a standard dose of anti-D Ig was given into the deltoid within 24 hours of delivery.

The only risk factor in this case was delivery at 42^{+3} weeks in the preceding pregnancy.

Case 24.7: Home birth

A woman in her 20s, gravida 2 para 1, had no details available for her preceding pregnancy of booking weight or serology, RAADP administration, PSE or delivery except that it was a home delivery with no FMH test postpartum. Postpartum prophylaxis (PPP) was administered 3 days after delivery. In the index pregnancy, alloimmune anti-D was found at 10 weeks when the woman attended for termination of pregnancy.

The care offered to women who deliver at home should comply with best practice to avoid alloimmunisation.

Case 24.8: Obese, previous miscarriage, antepartum haemorrhage (APH) in index pregnancy

A woman in her 30s, gravida 2 para 1, experienced an early miscarriage at 5-6 weeks in her previous pregnancy. No anti-D Ig was given and was not indicated. She booked for the index pregnancy at 8^{+5} weeks gestation, with a booking weight of 97kg and body mass index (BMI) of 32. An APH occurred at 22 weeks, the flow cytometry was negative, and 1500IU anti-D Ig was given intramuscularly within 24 hours. Follow up testing at 25 weeks showed low level anti-D (0.1IU/mL) which was thought to be due to prophylactic anti-D Ig given to cover the APH. Blood Service advice was to continue with prophylactic anti-D Ig, so RAADP was given at 28 weeks and the anti-D level was monitored every 2 weeks. The level peaked at 2.9IU/mL at 38 weeks. A healthy D-positive baby was delivered and required no treatment for HDFN.

Despite optimal management of APH, an obese woman became immunised.

Case 24.9: Failure to inform the laboratory of a PSE

Woman in her 30s, gravida 2 para1, received RAADP in the preceding pregnancy at 29 weeks. She experienced spotting at 35^{+2} weeks, but the midwife did not inform the laboratory so no prophylaxis was issued or given. She was delivered by elective caesarian section at 38^{+1} weeks and received appropriate PPP. In the index pregnancy alloimmune anti-D was detected at 28 weeks (not present at booking) and the infant was born at 38^{+2} weeks and required phototherapy.

The midwife failed to take appropriate action when the woman reported spotting at 35 weeks.

Case 24.10: Twin pregnancy

A woman in her 30s had a preceding pregnancy that was ideally managed. In the index pregnancy she booked at 13 weeks with a twin pregnancy. Due to a hospital error she did not receive an appointment for RAADP. The twins were delivered at 36 weeks when the woman was found to have alloimmune anti-D of 0.75IU/mL. Despite the low titre, the infants required treatment for HDFN.

Twin pregnancies may be at increased risk of sensitisation as previously observed but in this case, there was also omission of RAADP due to hospital administration error.

Case 24.11: Obese woman with previously ideally managed caesarian delivery who developed immune anti-D at term in index pregnancy

A woman in her 30s, gravida 2 para 1, had a booking weight in the preceding pregnancy of 118kg (BMI 42.8). She received RAADP of 1500IU anti-D Ig into the deltoid muscle at 27 weeks gestation and delivered at 42 weeks by emergency caesarian section. No FMH test was performed, and she was given 1500IU anti-D Ig PPP into the deltoid. In the index pregnancy, alloimmune anti-D was

detected at delivery at 40 weeks. The woman had experienced an APH at 17 weeks for which she received 1500IU anti-D Ig into the deltoid. She also received RAADP into the deltoid at 28^{+6} weeks. The infant required no treatment for HDFN.

Despite receiving correct management in preceding and index pregnancies, the woman became immunised, possibly because her obesity made the anti-D Ig she received less effective.

Conclusions

The data this year, detailed online (https://www.shotuk.org/shot-reports/report-summary-and-supplement-2019/), continue to demonstrate issues around ideal management of D-negative women during pregnancy to prevent immunisation, including the correct management of FMH >4mL. Every effort should be made to confirm all fetal cells are cleared following a large FMH, whilst balancing maternal contact and the upheaval of attending hospital repeatedly. Subsequent sensitisation may suggest a non-linear pharmacokinetic relationship between a follow up FMH in this setting of <2mL and the expectation a further 1500IU anti-D Ig would clear the remaining fetal cells; other possibilities include chronic recurrent small FMH before delivery etc.

There are several other emerging questions on ideal management from the cumulative data including the increased risk in obesity, the increased risk of gestation beyond 40 weeks, the risks of immunisation in complex pregnancies with pathological placental circulation, the possible increased risk of immunisation in twin pregnancy, impact of cell salvage and the risks (if any) in medical termination with no instrumentation. Continued data collection on newly diagnosed cases of alloimmune anti-D may provide answers to these important outstanding questions.

Recent introduction of data collection on cffDNA highlights ongoing barriers to implementation and indicates a need to update and expand this section to include distinct response fields relating to:

- High-throughput non-invasive prenatal testing (NIPT) for fetal D genotype as recommended by the National Institute for Health and Care Excellence (NICE) as a cost-effective option to guide antenatal prophylaxis with anti-D Ig
- Fetal blood group D genotyping following the detection of maternal alloimmune anti-D

This will provide further clarity around current practice and identify potential errors which may include inappropriate testing, wrong blood in tube, laboratory testing and resulting errors, transcription of results and interpretation of results.

A United Kingdom (UK) audit is recommended to determine current practice in relation to screening for fetal D type and identify the barriers local services face. Whilst these data reflect UK centres who have submitted cases where sensitisation has been detected, only 1 appeared to have implemented screening. Following NICE recommendations in 2016 (NICE 2016), 58% of services identified in England have either commenced or plan to send samples to National Health Service Blood and Transplant (NHSBT) for cffDNA testing. However, to date the sample volumes received by NHSBT do not represent the anticipated volumes. This might be due to various reasons, which could include partial implementation at Trusts/Health Boards or reluctance of women to have the test, either for personal reasons or fear of genetic tests (personal communication NHSBT).

A further issue with regards to cffDNA reporting is access to the results within hospital information technology (IT) systems. A pilot is in progress to look at the electronic transfer of results for cffDNA to hospital IT systems to enable auditability of data, reduce transcription errors and improve the timely availability of results to clinical staff (personal communication NHSBT).

The British Society for Haematology (BSH) anti-D guideline writing group published an addendum to the website to address both NICE Guidelines NG126 (NICE 2019a) and NG140 (NICE 2019b).

The 2019 data suggest:

- Ideal management does not equal no sensitisation
- Delivery beyond 40 weeks may be a risk factor for sensitisation even when managed appropriately
- A postpartum FMH >4mL may be a risk factor for sensitisation even when managed appropriately
- Women who are obese may not be adequately 'protected' by standard doses of anti-D Ig
- The continued need to audit the anti-D pathway and provide ongoing education and tools to support best practice. Management is not always ideal

Further work needed

A national audit of new practices recently introduced in the management of D-negative pregnancies is recommended, to look at current practice in relation to high-throughput NIPT for fetal D genotype screening and identify the implementation barriers local services face and the pathways are in place to enable fetal blood group D genotyping following the detection of maternal alloimmune anti-D.

The data collected regarding cffDNA testing will be revised to distinguish data regarding high-throughput NIPT for fetal D genotype and fetal blood group D genotyping following the detection of maternal alloimmune anti-D.

A review of the cumulative data with regards to obesity, delivery beyond 40 weeks and FMH >4mL should be undertaken to see if the data provide enough evidence to modify current guidelines.

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25 Summary of Haemopoietic Stem Cell Transplant Errors 2012-2019

Authors: Shehana Wijethilleke, Paula Bolton-Maggs and Shruthi Narayan

Definition:

Transfusion incidents reported in patients undergoing haemopoietic stem cell transplant (HSCT) are included in this category.

This year, the HSCT-related transfusion errors reported to SHOT from 2012 to 2019 have been reviewed (numbers are counted in relevant error chapters). Solid organ transplants are not included in this analysis.

Key SHOT messages

- Communication is key: clinical teams should ensure the laboratory in both the transplant centre and shared care organisations, are fully informed about the transplant timetable, requirement for irradiated components and duration, and any change in ABO and D blood groups
- Patient involvement in all decision-making is encouraged and should include information about their specific transfusion requirements
- Laboratory staff should ensure the laboratory information management system (LIMS) is updated, and that all laboratory steps are properly checked to detect errors before they result in wrong transfusions

Abbreviations used in this chapter

ABOi	ABO-incompatible
BMS	Biomedical scientist
BSH	British Society for Haematology
CMV	Cytomegalovirus
CNS	Central nervous system
ED	Emergency department
Hb	Haemoglobin
HEV	Hepatitis E virus
HLA	Human leucocyte antigen
HSCT	Haemopoietic stem cell transplant
IBCT	Incorrect blood components transfused
IT	Information technology
JPAC	Joint United Kingdom Blood Transfusion and Tissue Transplantation Services Professional Advisory Committee
LIMS	Laboratory information management system
NHSBT	National Health Service Blood and Transplant
RBC	Red blood cells
SaBTO	Advisory Committee on the Safety of Blood, Tissues and Organs
SCH	Stem cell harvest
Sp-ICE	Specialist Services electronic reporting using Sunquest's Integrated Clinical Environment
SRNM	Specific requirements not met
TAGvHD	Transfusion-associated graft-versus-host disease
UK	United Kingdom

Recommendation

- National guidelines are needed that are suitable for both transplantation and transfusion professionals that cover the procedures necessary for managing transfusions for transplant patients (repeated from the 2016 Annual SHOT Report (Bolton-Maggs et al. 2017))

Action: British Society for Haematology Transfusion Task Force

Introduction

Approximately 40-50% of HSCT are ABO-incompatible (ABOi) (Worel 2008). Such incompatibility may be major, where alloagglutinins in the recipient's plasma have the potential to react with donor red cells (e.g. recipient group O and donor group A), or minor, where alloagglutinins in the donor plasma react with recipient red cells (e.g. recipient group A, donor group O). Bidirectional incompatibility includes both major and minor mismatch, with the presence of alloagglutinins in both the recipient and donor plasma which can react with donor and recipient red cells respectively (e.g. recipient group B and donor group A).

Major and minor incompatibility each occur in approximately 20-25% of transplants, and bidirectional incompatibility in 5% (Worel 2008). The ABO and D group transfusion requirements of these patients change over time with the clinical course of the transplant. Poor communication between clinicians and the laboratory may result in serious errors in transfusion.

The British Society for Haematology (BSH) has published guidance on the irradiation requirements for cellular component transfusion in patients at risk of developing transfusion-associated graft-versus-host disease (TAGvHD). This includes patients undergoing allogeneic and autologous transplant (and their donors to avoid transfusion of viable leucocytes) (BSH Treleavan et al. 2010). In 2016 the Advisory Committee on the Safety of Blood, Tissues and Organs (SaBTO) recommended that transplant patients receive hepatitis E virus (HEV)-screened cellular blood components (SaBTO 2016) and screening of all donors for HEV has been in place across the United Kingdom (UK) since 2017.

Findings from the 8-year analysis

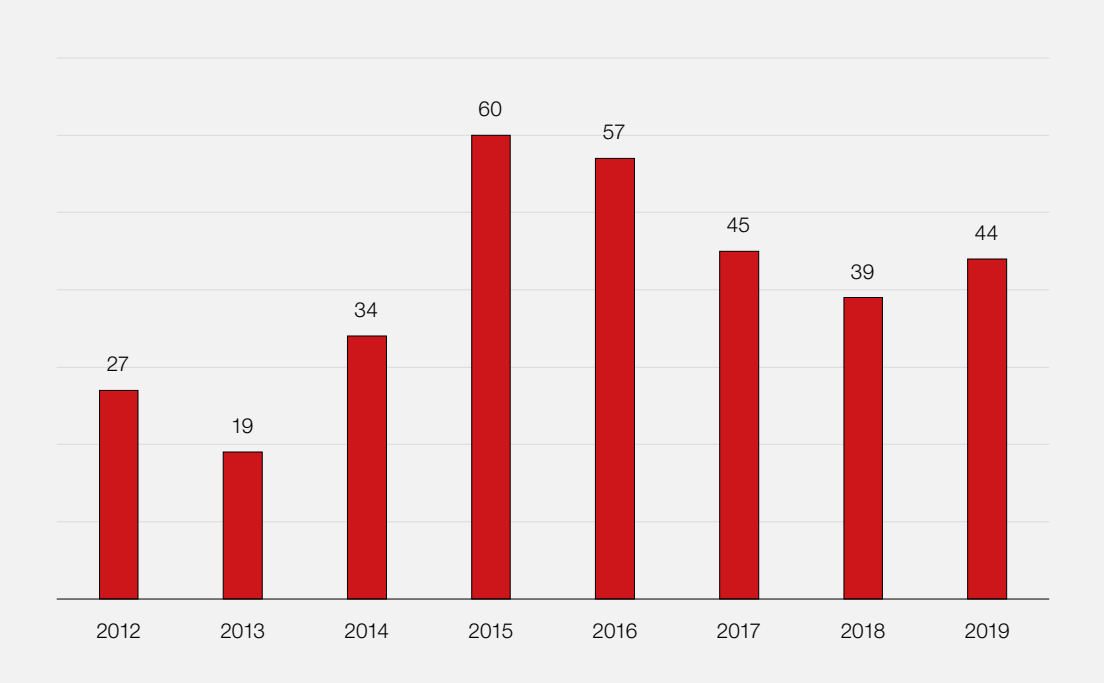
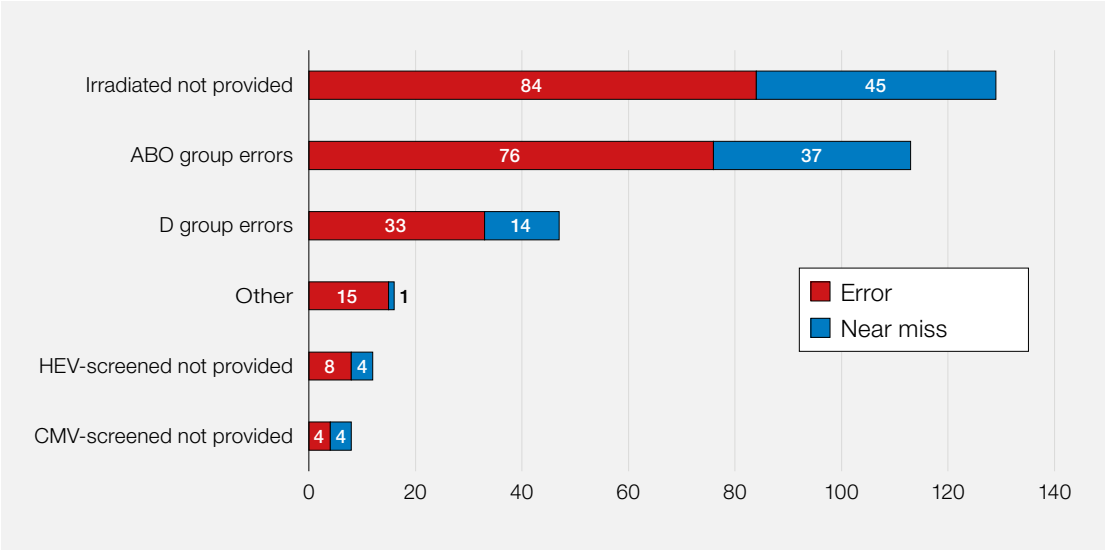


Figure 25.1: Total cases of incorrect ABO, D and specific requirement not met (SRNM) HSCT-related transfusion errors reported to SHOT 2012-2019; n=325

Most transplant-related errors result in incorrect blood components transfused (IBCT), or SRNM. Near miss errors are those detected prior to transfusion of the component. The most common errors are failure to provide irradiated cellular components and transfusion of the wrong ABO group, Figure 25.2.

Figure 25.2: Numbers of errors according to type 2012-2019 (including near miss) n=325



HEV=hepatitis E virus; CMV=cytomegalovirus

'Other' includes inappropriate electronic issue, failure to supply human leucocyte antigen (HLA)-matched components and a case where a neonate was given the wrong component

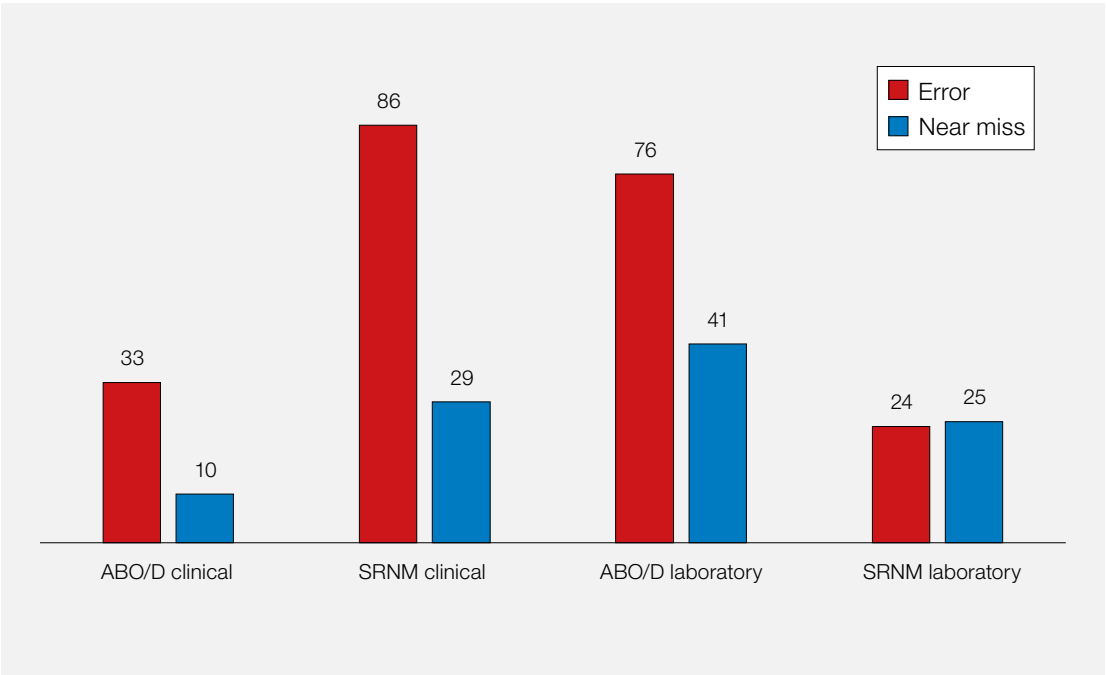
Of irradiated not provided errors, 6 included failure to also supply HEV (1 of these was near miss); 2 included failure to also supply CMV-screened products (1 of these was near miss)

ABO and D errors

Source of error (laboratory or clinical)

Errors occur in the clinical area and/or the transfusion laboratory. Most ABO and D errors originate in the laboratory, whereas failure to meet specific requirements is mostly caused by clinical error, particularly failure to inform the laboratory that irradiated cellular components are required (Figure 25.3). This pattern is also reflected in near miss events. Figure 25.4 indicates what kinds of errors were made. It is important to note that several ABO and D incidents were detected prior to transfusion often by vigilant clinical staff at the bedside.

Figure 25.3: Source of the HSCT-related error n=324*



**Excludes 1 case of wrong component transfused to a neonate*

SRNM=specific requirements not met

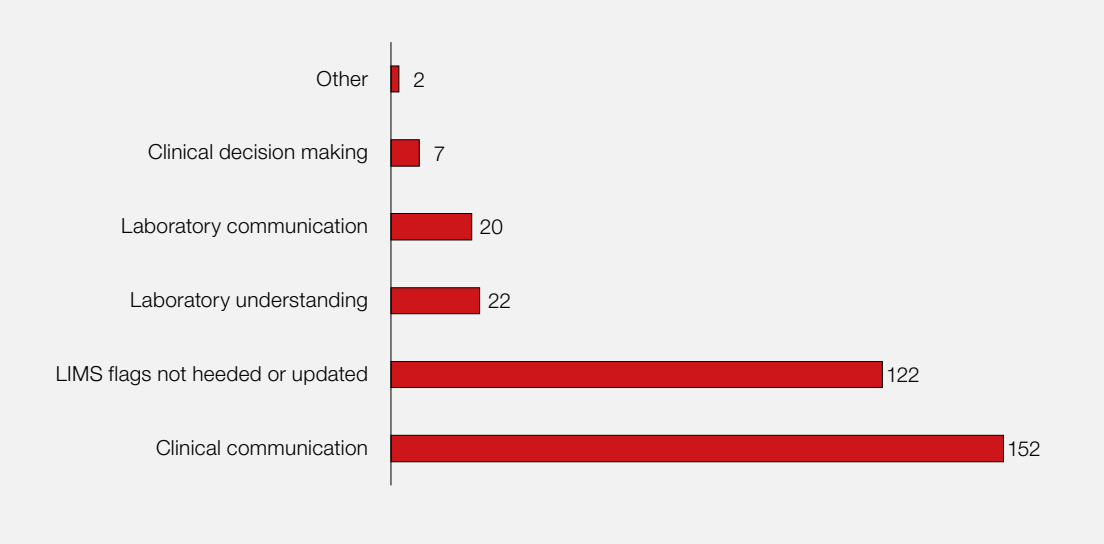


Figure 25.4: Types of error, includes ABO/D and SRNM n=325

LIMS=laboratory information management system

Laboratory errors are caused by inappropriate use of the LIMS, either failure to update the LIMS, or failure to heed LIMS warning flags.

Case 25.1: Incorrect ABO group transfused: failure to heed LIMS flag

A transplant protocol was received by the transfusion laboratory lead on Day -9 stating that the patient was scheduled for allogenic stem cell transplant on Day 0. A flag was set on the LIMS on Day -9 to indicate the transfusion requirements. The patient's blood group was A D-negative and the donor was O D-negative. In this case, the patient should have been transfused with group O D-negative red cells to match the donor group. The specific requirements flag was changed according to the protocol, so that the patient would immediately start receiving the appropriate group blood components if required. On Day +6, a request for red cells was received. The biomedical scientist (BMS) did not check the specific requirements correctly and ordered group A D-negative blood, instead of O D-negative. A second BMS performing the crossmatch failed to check the specific requirements, which clearly stated the red cell blood group for transfusion. The patient grouped as A D-negative and, as the crossmatch was compatible, a unit of red cells (group A) was issued to the patient. This was transfused to the patient without any noticeable reaction.

Most clinical errors are caused by communication failures. Errors also occur due to lack of understanding by transfusion laboratory staff.

Case 25.2: SRNM: failure by clinical team to update the specific requirements form

On Day +9 following an autologous HSCT for primary central nervous system (CNS) lymphoma, a patient's blood transfusion status form was found to incorrectly state that the patient did not require irradiated cellular components. This form should have been updated with the 'irradiated' status flag 1 week prior to the patient's peripheral stem cell harvest (SCH) 3 months earlier. Consequently, in the 7-day period prior to SCH the patient was transfused with two units of non-irradiated red cells. When stem cells were reinfused on Day 0 the patient was put at risk of TAGvHD. The patient received further units of non-irradiated red cells post transplant before the error was detected.

Shared care

Communication failure between hospitals which share the care of transplant patients is a recurring theme over the last 8 years. For example, when a patient is transplanted at a transplant centre, the information about the transplant, changes in ABO/D group and specific transfusion requirements may not be communicated to the local hospital or its transfusion laboratory. The transplant may have taken place several months or years before and specific transfusion requirements in the post-transplant period may vary. It is also important to keep the primary care team informed.

Case 25.3: SRNM due to poor communication as a result of shared care between hospitals

A patient had received a HSCT in August. In September, the patient attended a different hospital and a request was made for red cell and platelet transfusion from the emergency department (ED) due to low haemoglobin (Hb) and platelets. Details of the previous transplant were not provided to the laboratory and irradiated blood components were not issued for this patient; one unit of non-irradiated blood was transfused to the patient before the requirements were known by the laboratory. The patient also had HLA antibodies and required HLA-matched platelets; standard platelets were issued (but not transfused) due to lack of information available at the time of the request.

Wrong ABO-group transfusions

Tables 25.1 and 25.2 show transfusion of the wrong ABO or D group reported in 2018 and 2019.

Table 25.1: ABO and D transfusion errors in HSCT patients 2018 n=18

	ABO/D	Component	Gender	Patient group	HSCT donor group	Component group transfused	Error
Clinical	ABO	RBC	M	A D-positive	O D-positive	A D-positive	Laboratory not informed
	ABO	RBC	M	A D-positive	O D-positive	A D-positive	Laboratory not informed
	ABO	RBC	F	A D-negative	O D-positive	A D-negative	Laboratory not informed
	ABO	RBC	F	A D-negative	O D-negative	A D-negative	Laboratory not informed
	ABO	Platelets	M	O D-positive	A D-positive	O D-positive	Transplant protocol not available to laboratory staff
	D	Platelets	M	O D-positive	O D-negative	O D-positive	Laboratory not informed and shared care
Laboratory	ABO	RBC	F	A D-negative	O D-negative	A D-negative	Wrong component selected in laboratory and not detected at check nor at bedside
	ABO	RBC	F	A D-positive	O D-positive	A D-positive	BMS did not heed patient history
	ABO	RBC	NK	A D-positive	O D-positive	A D-positive	BMS did not heed patient history; 4 years post transplant. Group A units were crossmatch compatible
	ABO	RBC	M	A D-positive	O D-positive	A D-positive	BMS did not heed patient history on LIMS
	ABO	RBC	M	A D-negative	O D-negative	A D-negative	BMS missed LIMS flag
	ABO	RBC	F	B D-negative	O D-positive	B D-negative	LIMS not updated
	ABO	RBC	M	AB D-positive	B D-positive	A D-positive	Failure to heed patient record
	ABO	RBC	F	A D-positive	B D-positive	A D-positive	Selection error by locum BMS
	ABO	RBC	M	B D-positive	O D-positive	B D-positive	Failure to heed LIMS and inappropriate electronic issue
	ABO	Platelets	M	B	O	O D-positive	Data entry on LIMS
	D	RBC	F	O D-positive	O D-negative	O D-positive	Data entry on LIMS
	D	RBC	M	O D-positive	O D-negative	O D-positive	Communication error in shared care

RBC=red blood cells; NK=not known

Table 25.2: ABO and D transfusion errors in HSCT patients 2019 n=16

	ABO/D	Component	Gender	Patient group	HSCT donor group	Component group transfused	Error
Clinical	ABO	RBC	M	A D-positive	O D-positive	A D-positive	Laboratory not informed
	ABO	Platelets	M	O D-positive	B D-positive	O D-positive	Transplant protocol not available to laboratory staff
	D	RBC, Platelets	F	B D-positive	O D-positive	O D-positive	New blood status form not completed (second transplant)
	D	RBC, platelets	F	B D-positive	B D-negative	B D-positive	Incorrect donor blood group on allograft form
Laboratory	ABO	RBC	F	B D-positive	O D-positive	B D-positive	Blood group misinterpreted post allograft leading to selection and issue of the incorrect group red cells
	ABO	RBC	F	B D-positive	O D-positive	O D-positive	Incorrect interpretation of blood group by BMS
	ABO	RBC	M	A D-positive	O D-positive	A D-positive	Selection error
	ABO	Plasma	M	O D-positive	Not known	O D-positive	Failure to heed LIMS
	ABO	Platelets	M	O D-negative	A D-positive	O D-negative	Failure to heed LIMS
	ABO	Platelets	M	O D-positive	O D-positive	A D-positive	Failure to heed patient history
	D	RBC	M	O D-positive	O D-negative	O D-positive	Incorrect interpretation of blood group by BMS
	D	RBC	M	B D-negative	B D-positive	B D-positive	Failure to follow post-transplant transfusion protocol on LIMS (patient had partial engraftment post transplant)
	D	RBC	F	A D-positive	A D-negative	A D-positive	Failure to heed LIMS
	D	RBC	M	B D-negative	B D-positive	O D-positive	Failure to heed LIMS
	D	Platelets	M	A D-positive	O D-negative	A D-positive	Failure to heed LIMS
	D	Platelets	F	A D-positive	A D-negative	A D-positive	Selection error

Impact of errors

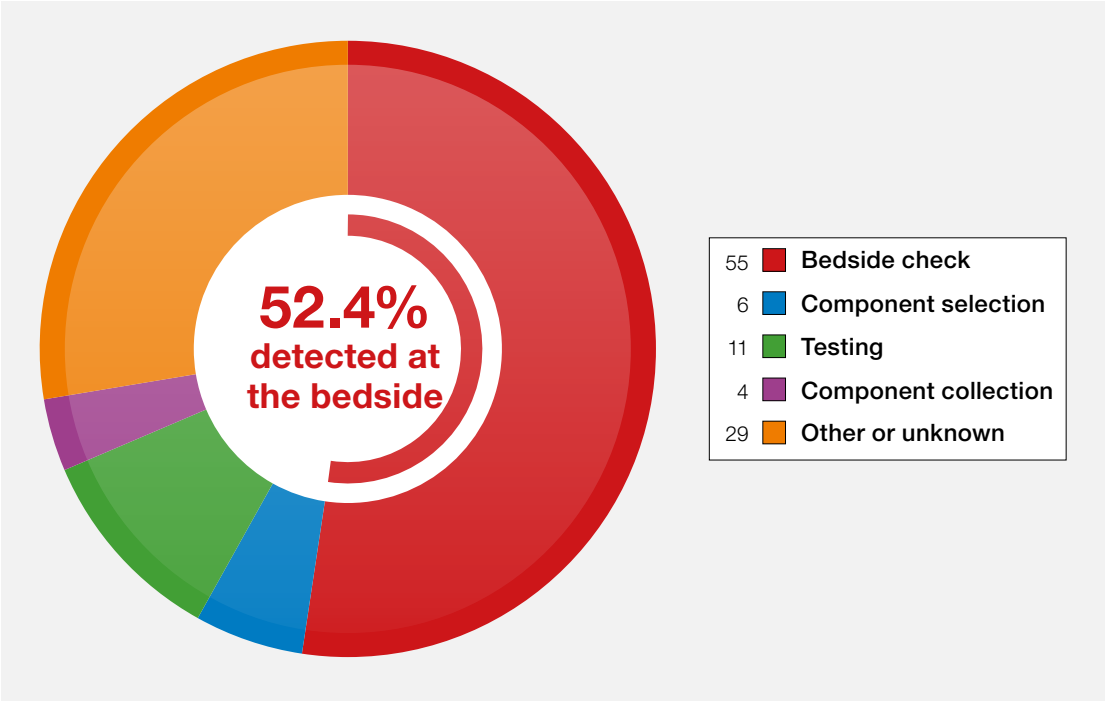
A single adverse reaction was reported as a result of transfusion-related incidents. A mild haemolytic reaction probably associated with passenger lymphocyte syndrome was followed by full recovery. The patient was transfused group A red cells (original recipient group) instead of group O (HSCT donor group) 10 days following HSCT. The error was attributable to the LIMS not being updated with blood group changes.

No deaths in transplant patients were attributable to any transfusion errors.

Near miss errors

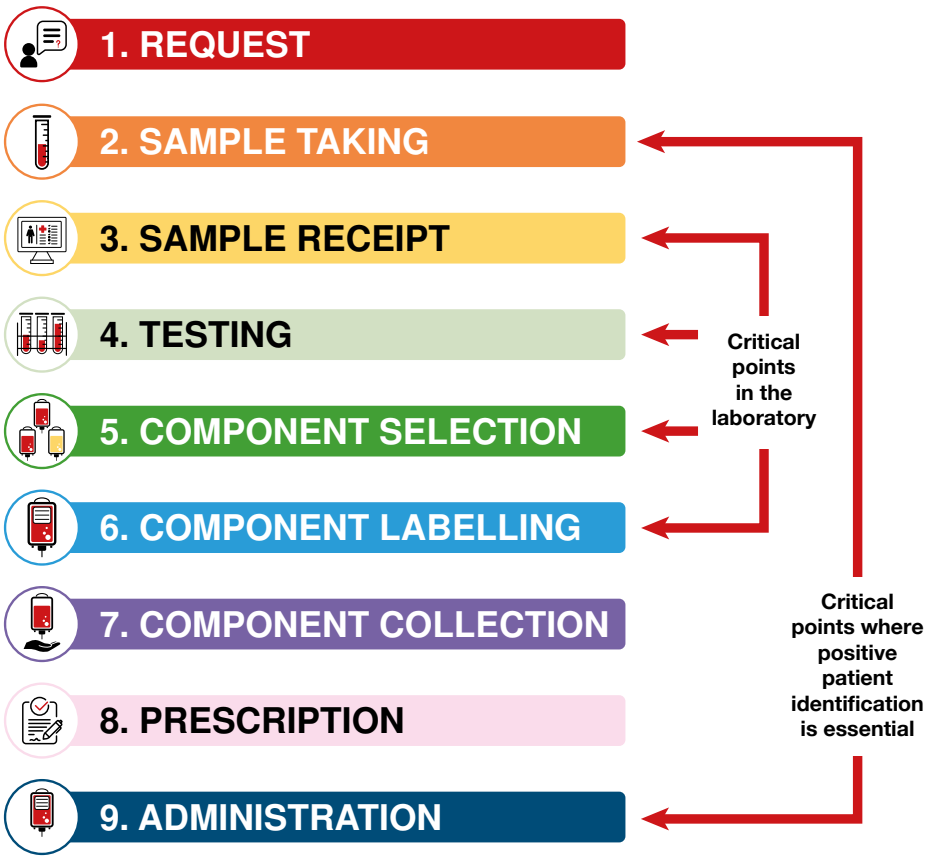
Near miss incidents may be detected at various points prior to transfusion. The most common checkpoint where errors are detected is at the bedside, as shown in Figure 25.5. This illustrates the importance of accurately completing the bedside check and reinforces the need for nursing staff to know about ABO and D compatibility, and for transplant patients to have clear information about which groups are to be transfused at what time point over the course of the transplant period. On 1 occasion the error was detected by the patient.

Figure 25.5: Point of detection of near miss incidents n=105



The nine-step transfusion pathway has several checkpoints where errors may be detected (Figure 25.6). It is notable that where the first error occurred in the laboratory there were several additional steps where the mistake could have been detected either by the BMS at checking within the laboratory, or at the time of transfusion with the bedside checks. In 2018 there was 1 error followed by 3 further opportunities to detect it, 5 cases with 4, and 1 case with 5 opportunities. This demonstrates the importance of each member of staff doing their own checks thoroughly and not relying on the safety of a previous step.

Figure 25.6: The nine-step transfusion pathway



*Note: Once a decision to transfuse is made, the authorisation or prescription may be written at variable times during this sequence, but **must be checked at the final stage.***

Other points of detection include the patient or a relative informing the clinical team of the patient's requirement for irradiated blood.

Recurrent sources of error can be identified for HSCT patients, Figure 25.7. Such errors can be viewed as a cycle where failure to correct one can cause subsequent failures in others. Over time some patients may lose their transplant and the blood group reverts to their original group. Good communication between clinical and laboratory staff is essential.

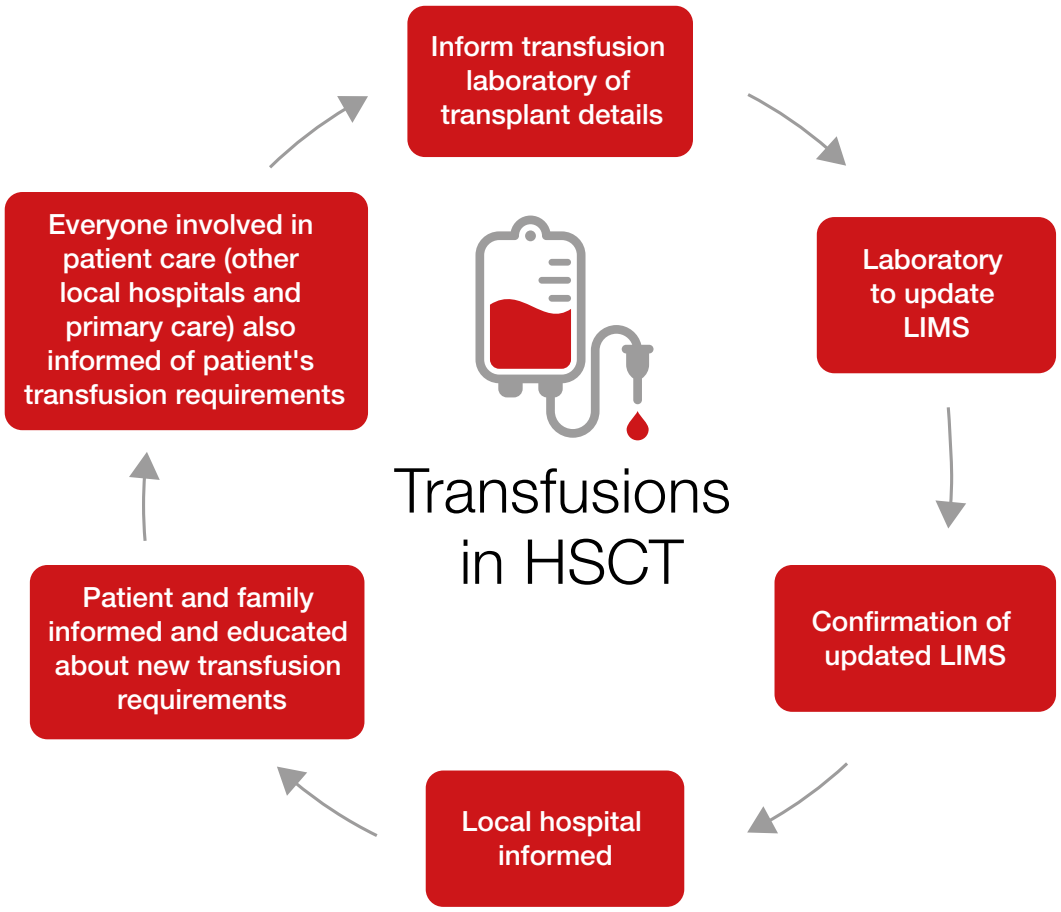


Figure 25.7: Important steps in ensuring safe transfusion practice in HSCT

HSCT=haemopoietic stem cell transplant; LIMS=laboratory information management system

Conclusions

Most transfusion-related errors in HSCT patients are either failure to administer irradiated components putting the patient at risk of TAGvHD, or transfusion of ABO-mismatched red cells. However, whether there are any other short- or long-term effects on the transplant itself are not known. There is evidence to suggest that ABOi HSCT are associated with acute haemolysis, delayed engraftment, and pure red cell aplasia (Staley et al. 2016) and so it is reasonable to question whether ABOi component transfusion in these patients can have similar effects.

The two main causes of transfusion errors are poor clinical communication and failure to heed or update the LIMS system in the laboratory. These causes are a common theme in many other areas of transfusion practice, and steps must be taken to reduce such errors. Errors in clinical communication are further compounded by the shared care of patients between the transplant centre and the patient's local hospital, which necessitates the need for effective transfer of information between centres.

Shared care of patients between the local hospital and transplant centre must be improved to ensure ongoing safe care.

Embedded in many transplant protocols is the requirement to inform the laboratory staff of the patient's impending transplant and associated change in transfusion requirements, particularly ABO and D group

changes. Transfusion laboratories are not always informed in a timely manner, resulting in delays in updating the LIMS and failure to follow instructions. More robust procedures are required to ensure this information is appropriately forwarded to the laboratory and updated in the patient's electronic history. This is echoed by The Joint United Kingdom Blood Transfusion and Tissue Transplantation Services Professional Advisory Committee (JPAC), which advises that a clear post-transplant transfusion policy should be developed for all transplant patients and circulated to clinical and laboratory teams involved in their care. JPAC acknowledges previous Annual SHOT Reports which show component selection errors are common for patients who have changed blood group following HSCT (JPAC 2014).

Every transplant programme issued to the laboratory and clinical staff needs to be time specific, such that when ABO changes occur throughout the course of the transplant, all clinical and laboratory teams are reminded of these changes.

Appendix 25.1 gives a proposed checklist for transfusion in transplant patients. The introduction of databases such as Specialist Services electronic reporting using Sunquest's Integrated Clinical Environment (Sp-ICE) by National Health Service Blood and Transplant (NHSBT) in England allows laboratories to access patient transfusion data from hospitals which have opted in and includes warnings for those with red cell antibodies or specific requirements.

There is also confusion in some areas about transfusion in ABO-mismatched HSCT. This is likely compounded by the complex transfusion schedule that exists for ABO-mismatched transplants in relation to changes in the ABO and D group (Schrezenmeier et al. 2019). These SHOT data show that transfusion of the wrong ABO or D group in ABO-mismatched transplants continues to be a problem. The importance of training for both clinical and laboratory teams in centres which perform HSCT should not be underestimated.

How can such errors be avoided?

When a patient is undergoing an ABO-mismatched HSCT, transfusion of red cells of their own ABO group could be contraindicated. For example, if the patient is blood group A D-positive and their donor is O D-negative, the correct group of red cells to transfuse is O D-negative. This group is compatible with both donor and recipient and the red cells will not be haemolysed by either donor or recipient's anti-A or anti-B at any stage of engraftment. Most LIMS cannot prevent issue of components of the patient's own ABO group, so laboratory users must rely on flags or text warnings to state e.g. 'give O NEGATIVE red cells only' (if this LIMS feature is possible) in order alert them to the requirement.

One busy teaching hospital with a large transplant service (more than 100 allografts and more than 200 autologous HSCT in 2018) reported this type of error to SHOT many times. This led them to seek an information technology (IT) solution and they wrote a specification for their LIMS supplier. After working with their developer to discuss and approve the design, they developed a solution and installed it as a LIMS update on their test system for them to configure and validate. The solution enabled them to configure for every permutation of donor and recipient ABO and D group, which groups of red cells can be selected, preventing selection of any other group including the patient's own group where applicable. This improvement achieved three main benefits to patient safety and to their service:

- It prevented further errors of this type
- It allowed safe use of groups other than O when appropriate, therefore conserving group O red cells
- For any of these patients (without alloantibodies) electronic issue became possible and so enabled a more rapid response for day case transfusions

HSCT patients require extensive transfusion support post transplant, and transfusion errors can be avoided with better communication between all the clinical teams and laboratory teams involved in the patient's care. This must include local hospitals involved in the shared care of the patient. Accurate, timely communications, vigilant staff and effective patient education will help ensure appropriate actions and safer transfusions in these patients.

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Action	Tick
Ensure individualised protocol readily available to clinical and laboratory teams regarding the transfusion requirements pre-, peri- and post-transplant	
Check that the transfusion laboratory has received the protocol and confirmation has been received that LIMS has been updated with the changes	
Check that the specific transfusion requirements for each patient are documented and easily accessible to all ward staff (e.g. front of notes, ward office whiteboard)	
Confirm that local hospital/haematology team are informed of change in transfusion requirements in written format	
Ensure that the discharge summary details specific transfusion requirements with an indication for how long these are required and that this information is easily accessible to other departments that may be responsible for the patient's care e.g. emergency departments	
Provide patient with an alert card showing they have received a HSCT and which details their specific transfusion requirements	

Appendix 25.1: Example of a checklist for HSCT to ensure good communication between clinical and laboratory teams

Acknowledgements

The Steering Group take this opportunity to thank the following individuals and organisations for their contributions without which the publication of this 23rd Annual SHOT Report would not have been possible:

- The Blood Services of the United Kingdom for funding and support
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  - Central Planning Team, NHSBT
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- Fahim Ahmed, SHOT Office Administrator
- ARC-UK Technologies for design and production of the report
- Hospital transfusion teams for submitting case reports to the scheme

Medicines and Healthcare products Regulatory Agency (MHRA) Report on Blood Safety and Quality Regulation (BSQR) in 2019

26

Author: Chris Robbie

Key MHRA messages

- In accordance with the requirements of the good practice guide (GPG) (Council of Europe, 2018) reporting establishments must improve their formal arrangements for investigating deviations and non-conformances. Identifying human error as the root cause should be justified only after having ruled out other improvements to the quality management system (QMS)
- The Blood Safety and Quality Regulations (BSQR) cover both laboratory and clinical activity relating to the quality and safety of blood and blood components
- All staff involved in transfusion must work together to prevent errors at source and use resources appropriately. Detecting errors made in the clinical areas requires allocation of significant laboratory resource

Abbreviations used in this chapter

BCR	Blood compliance reports
BE	Blood establishments
BSQR	Blood Safety and Quality Regulations
BMS	Biomedical scientist
CAPA	Corrective and preventive action
CATPD	Component available for transfusion past de-reservation
CCE	Component collection error
CLE	Component labelling error
CMT	Compliance Management Team
CMV	Cytomegalovirus
DEE	Data entry error
ECAT	Expired component available for transfusion
EI	Electronic issue
EU	European Union
FR	Failed recall
GPG	Good practice guide
HBB	Hospital blood banks
HD	Handling damage
HSCT	Haemopoietic stem cell transplant
IAG	Inspection Action Group
IAT	Indirect antiglobulin test
IBCA	Incorrect blood component accepted
IBCI	Incorrect blood component issued
IBCO	Incorrect blood component ordered
IVDR	In Vitro Diagnostic Regulations
LIMS	Laboratory information management system
NBTC	National Blood Transfusion Committee
PTTE	Pre-transfusion testing error
QMS	Quality management system
RC	Root causes
RCA	Root cause analysis
SABRE	Serious adverse blood reactions and events
SAE	Serious adverse event
SAR	Serious adverse reaction
SOP	Standard operating procedures
SPE	Sample processing error
UNSPEC	Unspecified
URS	User requirement specification

Summary

An increase in the number of serious adverse reaction (SAR) reports has increased the total number of reports confirmed to the MHRA on the serious adverse blood reactions and events (SABRE) system in 2019. Assessment of the serious adverse event (SAE) reports has demonstrated a reduction in SAE that have resulted from hospital blood transfusion laboratories, but an increase from blood establishments (BE) and hospital areas outside of the laboratory. Assessment of the root causes (RC) has demonstrated an increase in the number of reports where improvements to the QMS have been identified and a reduction in the numbers where staff have been made solely accountable for slips and lapses. All data correct as of 22nd January 2020.

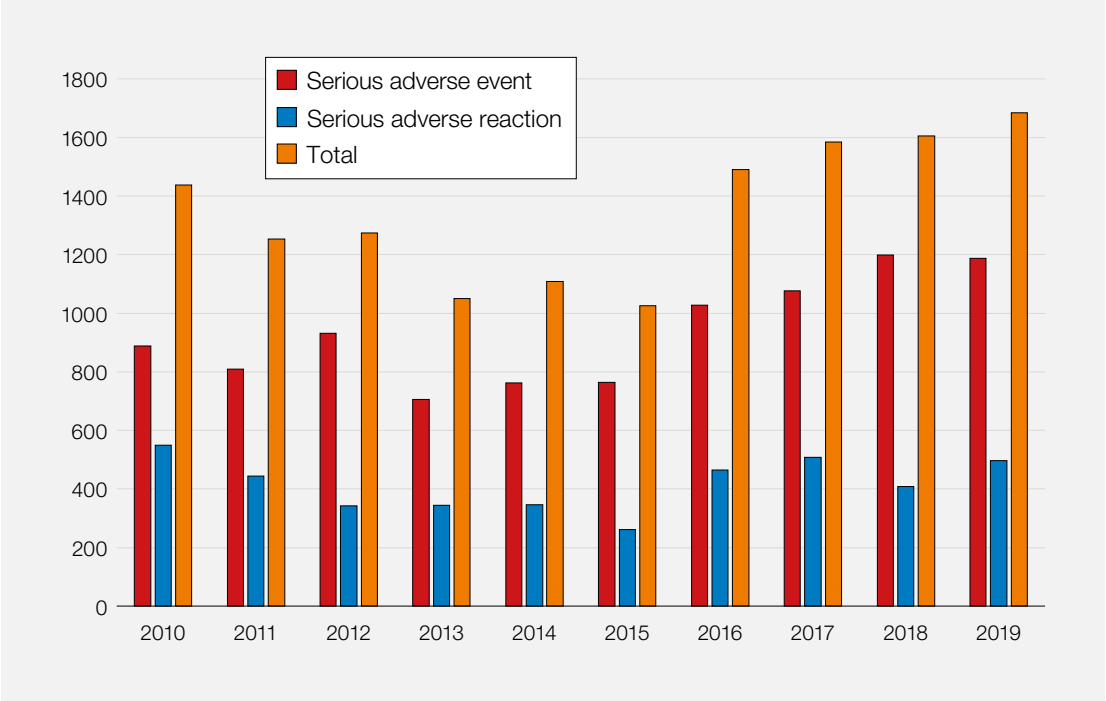
SABRE report data

Table 26.1 and Figure 26.1 display the total number of confirmation reports that were submitted and satisfy the European Commission reporting criteria for SAR and SAE since 2010. Since even old data are live, and subject to amendment, the table has been updated to reflect changes made to historic reports.

Table 26.1: Submitted confirmation reports 2010–2019

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
SAE	889	810	931	705	762	764	1027	1076	1198	1187
SAR	549	444	343	345	346	262	464	508	408	497
Total	**1438**	**1254**	**1274**	**1050**	**1108**	**1026**	**1491**	**1584**	**1606**	**1684**

Figure 26.1: Submitted confirmation reports 2010-2019



There has been a minor increase in the total number of reports received by the MHRA that qualify for onward reporting to the European Union (EU) (5%) in 2019. However, the number of SAE reports received has remained static with the increase coming from a rise in the number of SAR reports submitted. The MHRA receive SAR confirmation reports from SHOT following expert review.

Serious adverse events n=1187 (-11)

Definition: (BSQR 2005) 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.

The MHRA works closely with reporters when assessing SAE reports. If the initial investigation and report appears not to have identified or addressed the RC and contributory factors or identified appropriate and robust corrective and preventive action (CAPA), the SABRE team will discuss areas for improvement with the reporter. In many cases, working together with reporters has identified RC that had not been considered. Once the true RC have been identified, more robust CAPA can be proposed which will improve the QMS.

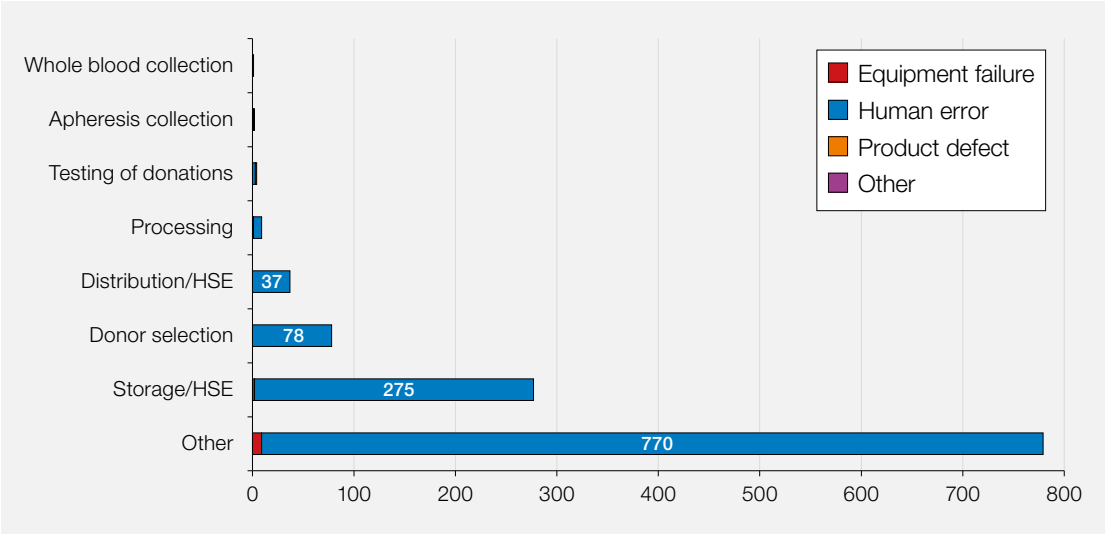


Figure 26.2: 2019 SAE confirmation reports by deviation and specification

HSE=handling and storage errors

Numbers too small to be annotated on the figure: Whole blood collection: human error=1; Apheresis collection: human error=1, other=1; Testing of donations: human error=3, product defect=1; Processing: equipment failure=1, human error=8; Storage/HSE: equipment failure=2; Other: equipment failure=9

The number of SAE reports and type of reports have remained similar. There is an increase in the number of storage SAE and a reduction in the number that fall into the 'other' categories.

Storage data n=277 (+25)

Storage remains the second largest individual error category and comprises of all BSQR reportable storage SAE in both the laboratory and clinical areas. The MHRA has broken this category down further to try and identify specific storage error subtypes, Table 26.2. For a description of the sub-categories used, see Appendix 26.1.

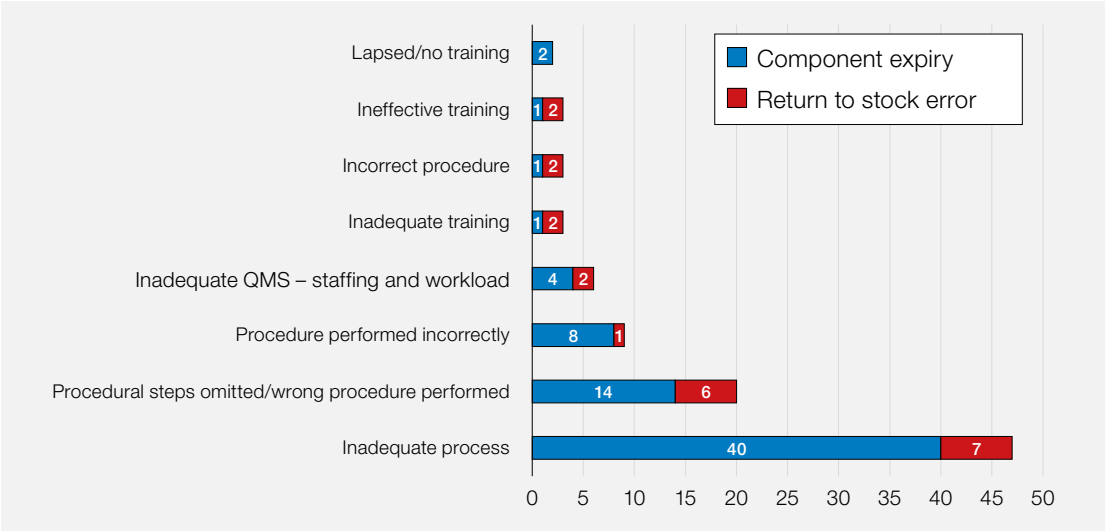
Storage sub-classification	2019 (+/- 2018)	2018 position
Incorrect storage of component	102 (+4)	1
Component expiry	71 (+14)	2
Sample expiry	39 (-2)	3
Return to stock error	22 (+14)	6
Storage temperature deviation	15 (-3)	4
Failure to action alarm	12 (+1)	5
Miscellaneous	8 (+2)	8
Security	5 (NC)	9
30minute rule	3 (-5)	6
Total	**277 (+25)**	

Table 26.2: SAE storage error sub-classifications

NC=no change

The number of reports has increased by approximately 10%. Most of these increases are in the component expiry and return to stock sub-categories. Although typically laboratory-based activities, there may be some element of error outside the laboratory, e.g. clinical areas not completing storage records correctly or not returning expired or expiring components according to agreed procedures.

Figure 26.3: Human error sub-categories of the two most increased storage errors



QMS=quality management system

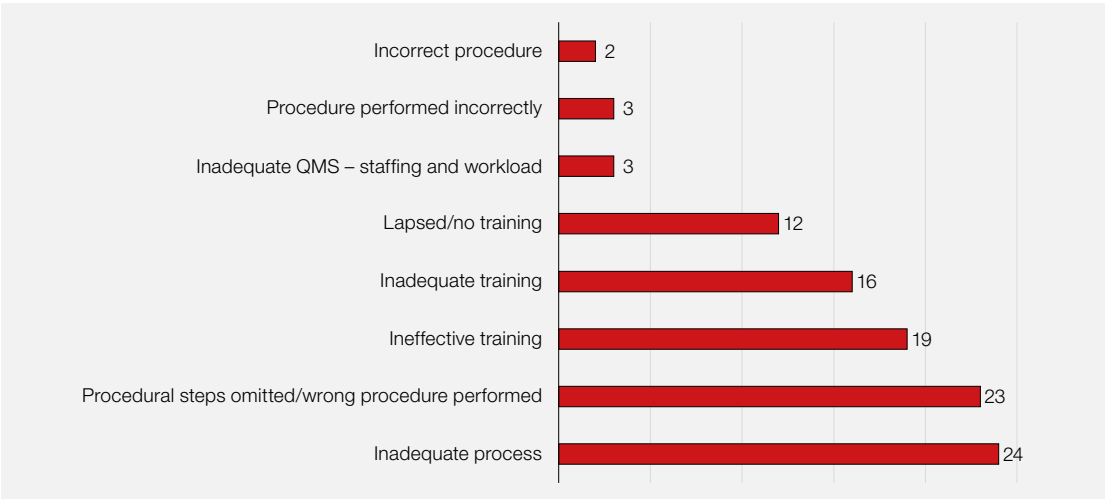
Analysis of the human error sub-category for these errors shows that over half of all the reports demonstrate inadequate process. The MHRA defined 'human error' category can be found in Appendix 26.3.

Recommendations

- Improve the design of processes used to identify and quarantine expired components, preventing them being used
- Improve the design of the processes used to capture storage data and verifying components are suitable to return to the supply chain

Action: Hospital transfusion teams

Figure 26.4: Incorrect storage of component by specification



QMS=quality management system

Although the storage of components occurs in both the laboratory and clinical areas, most of the errors in this category occurred outside the laboratory setting. Typical examples of error are;

- Components stored in unmonitored drug refrigerators
- Components stored in decommissioned blood refrigerators
- Components stored at the incorrect temperature
- Errors often involve untrained staff including bank and locum staff

Investigation of these errors has demonstrated various causes and factors.

Recommendations

- Improve the design of processes involved in storage and quarantine of components. This includes arrangements for when storage equipment is temporarily decommissioned
- All staff involved in handling and storage of components must be appropriately trained to do so
- Ensure staff are identified for training, that training material is thorough and that staff competencies are assessed and updated frequently
- Ensure new, locum and bank staff are informed of storage arrangements before they can handle blood

Action: Hospital transfusion teams

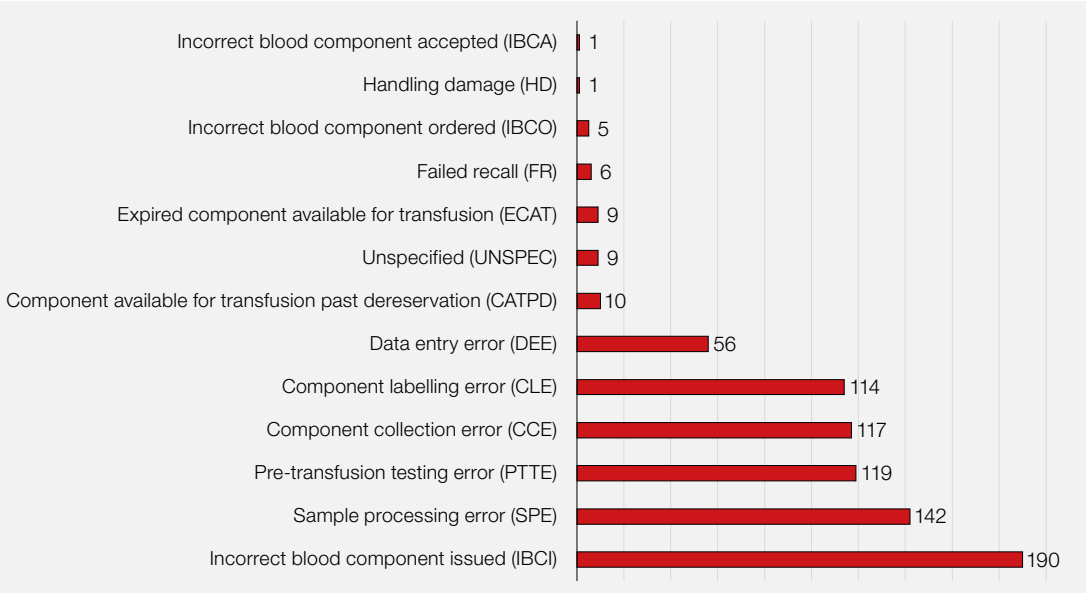
Other n=779 (-58)

Since 'other' is the largest category of SAE reports, the MHRA haemovigilance team has created sub-categories to further analyse this type of error, Table 26.3. For a description of sub-categories, see Appendix 26.2.

Table 26.3: 'Other'

Other sub-category	2019 (+/- 2018)	2018 position
Incorrect blood component issued (IBCI)	190 (-22)	1
Sample processing error (SPE)	142 (-43)	2
Pre-transfusion testing error (PTTE)	119 (+26)	5
Component collection error (CCE)	117 (+3)	4
Component labelling error (CLE)	114 (-17)	3
Data entry error (DEE)	56 (-17)	6
Component available for transfusion past de-reservation (CATPD)	10 (+4)	7
Expired component available for transfusion (ECAT)	9 (+4)	10
Unspecified (UNSPEC)	9 (+4)	9
Failed recall (FR)	6 (NC)	7
Incorrect blood component ordered (IBCO)	5 (+1)	11
Handling damage (HD)	1 (-1)	12
Incorrect blood component accepted (IBCA)	1 (NC)	13
Total	**779 (-58)**	

Figure 26.5: 'Other'



There has been a 7.5% reduction in the number of reports in the 'other' category. Except for component collection errors, the errors in the 'other' category are typically laboratory-based. The data show improvements to;

- Selection of components for issue meeting specific requirements
- Rejection of incorrect samples and forms
- Entry of data, particularly when registering new patient details
- Labelling of components

However, there has been an increase in pre-transfusion testing errors. Analysis later in this chapter will show that the most commonly occurring PTTE errors are due to inadequate process design and ineffective training, possibly relating to the education of new staff.

Although work still needs to be done to reduce SAE further in transfusion laboratories, it should be noted, with cautious optimism, the reduction is SAE associated with the regulated activities of transfusion laboratories.

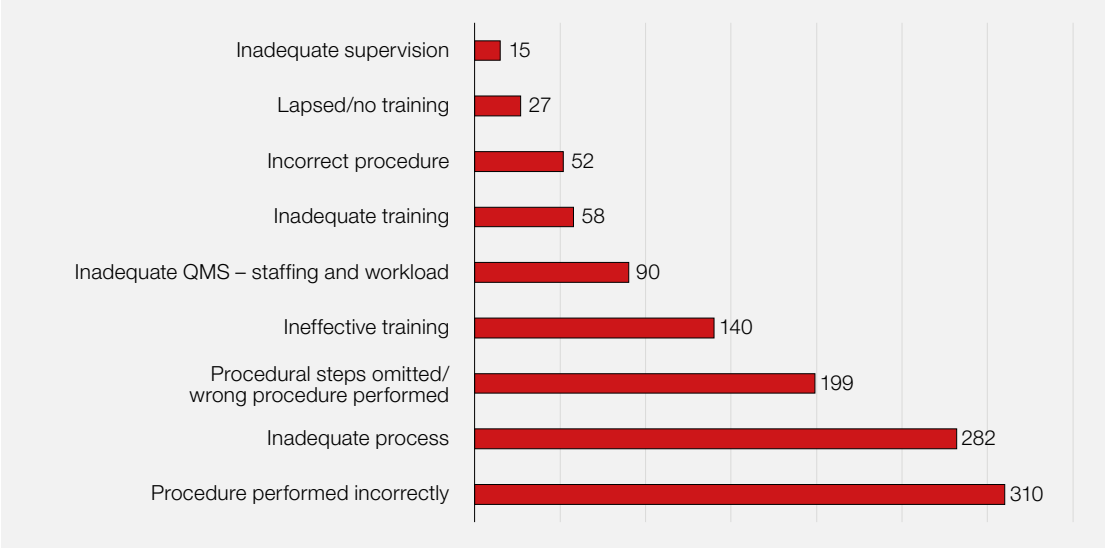
Human error category and human factors

To understand reports in the human error category, the MHRA have continued to use sub-categories which can be applied to the report narratives to help understand the human factors involved. For a description of the categories used, see Appendix 26.3. Table 26.4 shows the breakdown of reports in the human error subcategories.

Table 26.4: Human error sub-category, 2019

Human error sub-category	Total 2019 (+/- 2018)	2018 position
Procedure performed incorrectly	310 (-50)	1
Inadequate process	282 (+69)	3
Procedural steps omitted/wrong procedure performed	199 (-51)	2
Ineffective training	140 (+14)	4
Inadequate QMS – staffing and workload	90 (-8)	5
Inadequate training	58 (+1)	6
Incorrect procedure	51 (+16)	7
Lapsed/no training	27 (+5)	8
Inadequate supervision	15 (+1)	9
Total	**1173 (-3)**	

Figure 26.6: Human error sub-category



NOTE: These numbers should be used as guidance only. The quality of this data is limited by several factors.

QMS=quality management system

- The RC of incidents are usually the result of many contributory factors. The sub-category chosen reflects the most likely reason for the main SAE category. However, this year, if multiple factors are involved relating to the QMS, then 'inadequate process' has been chosen as the sub-category rather than choosing a category that best fits the main SAE reported
- The sub-category chosen is based on the information in the report. A limited investigation or a report which does not provide the MHRA with enough information may not be sub-categorised appropriately

In last year's chapter it was pointed out that many reports lacked detail and indicated that staff were solely responsible for errors. It was stated that poor quality investigations and RC analyses could have given the wrong impression about the factors behind why errors were occurring. Much work has been done in helping transfusion professionals improve the quality of their investigations during training and education days and at the 2019 SHOT Symposium. The presentation can be found here http://forums.mhra.gov.uk/showthread.php?4150-Incident-reporting-presentation.

The data show that there has been a reduction in those SABRE reports which have been interpreted as slips and errors by individual members of staff. Increases in categories that relate errors to processes, procedures and training demonstrate that improvements to QMS have taken place. It is hoped that reduction in the number of SAE in this category is a direct result from improvements to QMS identified through better investigations and the identification of the true RC and robust CAPA.

Recommendations

- Continue to improve the quality of investigations and incident reporting
- In accordance with the good practice guide (GPG), if human error is determined to be the root cause, this must be justified having ruled out improvements to other areas of the quality management system (QMS)
- Before concluding that an error is due to an individual, consider if the workload, staffing, skill-mix and working environment and conditions led to the behaviour that caused the error

Action: Hospital transfusion teams

Top 5 SAE

Slips and lapses account for 44% of the SAE reported. Assessment of the other 56% of QMS errors provides the top 5 areas where errors occur, and improvement is required.

SAE deviation sub-category	Specification sub-category
Incorrect blood component issued (IBCI)	Inadequate process
Component collection error (CCE)	Ineffective training
Pre-transfusion testing error (PTTE)	Inadequate process
Incorrect blood component issued (IBCI)	Ineffective training
Pre-transfusion testing error (PTTE)	Ineffective training

Table 26.5: Top 5 SAE with human error sub-category

The following examples have been used to illustrate what might be considered effective CAPA to address the RC. They are not meant to represent actual investigation processes and CAPA for all similarly categorised incidents, but are representative of many of the reports received, and are designed to focus on improvements to systems, practice and transfusion laboratories.

1) Incorrect blood component issued (IBCI) – inadequate process (n=59)

Case 26.1: Patient requiring irradiated blood post auto haemopoietic stem cell transplant (HSCT) transfused with non-irradiated blood

The laboratory information management system (LIMS) contained two records for the patient, only one of which had an alert flag for irradiated blood components recorded against it. Sample received and booked in against the patient record with no alert flag. Verbal request later received for red cells and non-irradiated red cells selected and transfused.

Duplication of records was not identified in the laboratory and irradiated blood requirements not identified from the clinical details of previous samples.

There was no indication that irradiated blood was required on the group and screen request form or the transfusion prescription chart. Staff performing the bedside checks were not aware that the patient required irradiated components.

Recommendations

- The laboratory must have processes in place to create records that avoid duplication and to merge records according to defined and documented processes
- Where a laboratory has access to data regarding the specific requirements of a patient, these records may be held in various formats in both hard and electronic copy. Traceability between the formats must be maintained

Action: Hospital transfusion teams

2) Component collection error (CCE) – ineffective training (n=33)

Case 26.2: Adult emergency blood that was not cytomegalovirus (CMV)-negative taken instead of paediatric emergency blood

A nurse who was new to the hospital was asked to collect the 'infant flying squad blood'. Despite having been trained, the nurse thought that 'infant flying squad blood' was for helicopter use and removed an adult unit.

Recommendations

- Whether involving new or agency staff, ensure they are thoroughly trained in any collection procedures
- Ensure that the training covers all terms and types of component in use, as new staff will be unfamiliar with local procedures and used to procedures elsewhere

Action: Hospital transfusion teams

3) Pre-transfusion testing error (PTTE) – inadequate process (n=27)

Case 26.3: LIMS allowed electronic issue (EI) when the analyser transferred a blank result

The antibody result on the blood grouping analyser could not be deciphered as positive or negative. A blank entry in the LIMS was transferred and allowed the EI of blood without a valid antibody result.

It was unclear if the LIMS set up was incorrect from its installation or following an upgrade. It was clear that initial validation and subsequent re-validations were not adequate.

Recommendations

- Introduction of new equipment, software and processes, including upgrades and amendments must be adequately managed through change control processes
- Validation and qualification of LIMS and processes must be robust to ensure that the equipment performs as intended

Action: Hospital transfusion teams

4) Incorrect blood component issued (IBCI) – ineffective training (n=22)

Case 26.4: Incorrect patient blood group issued during LIMS downtime

A patient grouped as group O D-negative, but a unit of group O D-positive was selected for indirect antiglobulin test (IAT) crossmatch in error during LIMS downtime. Investigation showed that there was unfamiliarity with the downtime process and confusion over the correct procedures and checks.

Recommendations

- Consideration should be given to more frequent refresher training in processes that are less often performed, or processes performed by staff who spend less time in transfusion
- Consideration should be given to practicing emergency and downtime processes
- Procedures must be clear and unambiguous
- Staff must consult standard operating procedures (SOP) if unsure or unfamiliar with a process instead of assuming or improvising

Action: Hospital transfusion teams

5) Pre-transfusion testing error (PTTE) – ineffective training (n=19)

Case 26.5: Incomplete antibody identification leading to transfusion of incorrectly selected red cells

Two red cells were requested for a patient with known antibodies requiring a full crossmatch. Two different panels were completed out-of-hours, and two units crossmatched and issued. The next day another biomedical scientist (BMS) checked the results and noticed a reaction in another cell that had not been noticed previously. Another panel was completed, and a new antibody identified.

Although trained and competency assessed six months previously, the initial BMS had not followed the correct procedure and had omitted to annotate the antigram with a conclusion. CAPA required their re-training with the laboratory manager.

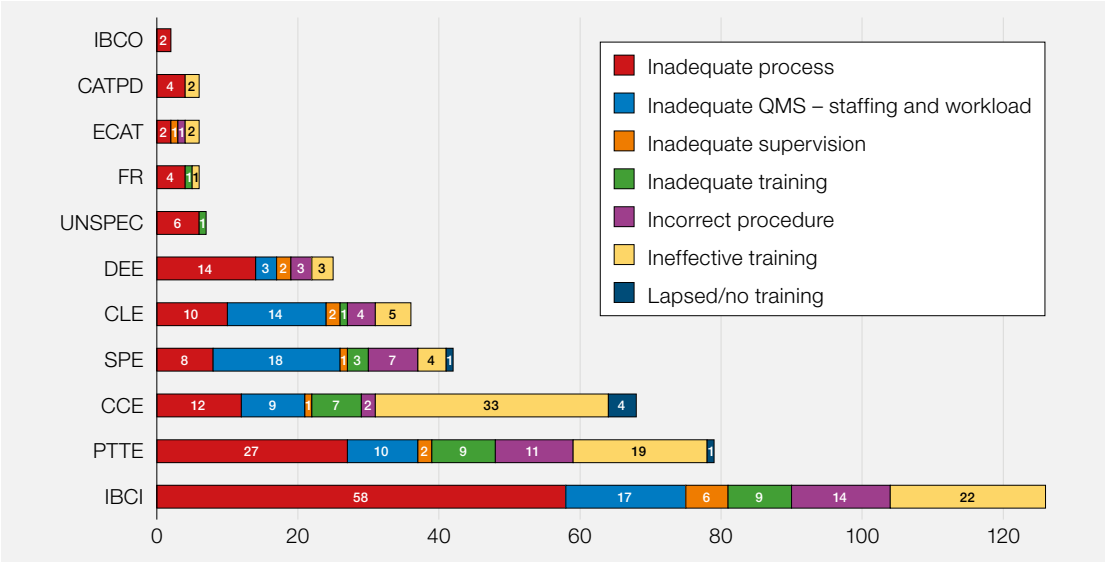
The investigation also demonstrated several other factors which may have contributed to the actions of the BMS. Long term vacancies disrupted their training where the manager had been required to cover shifts. The testing in this incident should have been conducted during the day and not out-of-hours. CAPA also identified in the report included filling staff vacancies with locums until full-time staff employed.

Recommendations

- Ensure training is planned adequately to ensure staff fully understand processes and procedures before they are assessed as competent to work alone
- If long term vacancies are impacting the laboratory's ability to function, this must be flagged to senior management and resolved as soon as practicable
- All training must include a robust competency assessment to ensure competency of individuals both during routine and out-of-hours

Action: Hospital transfusion teams

Figure 26.7: Other Sub-category and root cause for all SAE other than procedural steps omitted/wrong procedure performed and procedure performed incorrectly

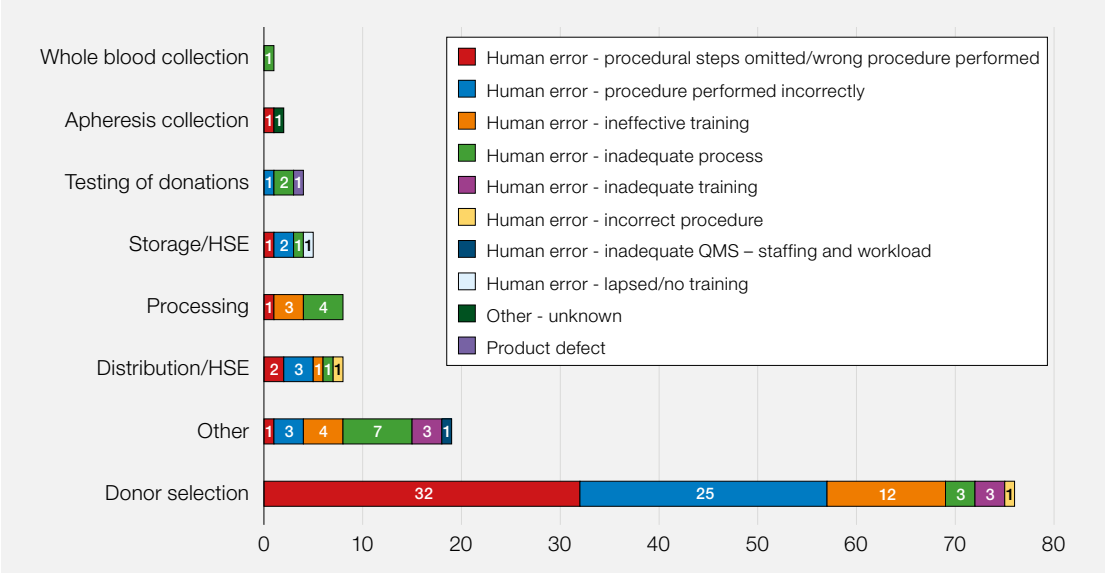


See Figure 26.5 for key to category abbreviations

Blood establishment reporting n=123 (+24)

Although reports from BE are included in the main analysis, the specific nature of the SAE reports from BE are lost in the greater numbers of reported hospital transfusion laboratory SAE. Figure 26.8 displays the reported BE SAE in 2019.

Figure 26.8: Blood establishment SAE event category by specification



HSE=handling and storage errors; QMS=quality management system

There has been an increase in the number of reports from BE, the majority being in the donor selection category. It is interesting to note that most of these reports originate from one country. These errors are usually picked up by the QMS before blood is issued which may account for the low numbers of these types of error reported by the other three UK BE. Assessment of these reports do not demonstrate significant weaknesses of the process but rather a healthy and open reporting culture. Reporting these errors has allowed that BE to demonstrate improvements to its training in donor selection.

Assessment of the 'other' category, Figure 26.9, shows that BE are also reporting errors associated with the selection of components and pre-transfusion testing, but assessment of the CAPA demonstrates improvements have been identified in process design and training.

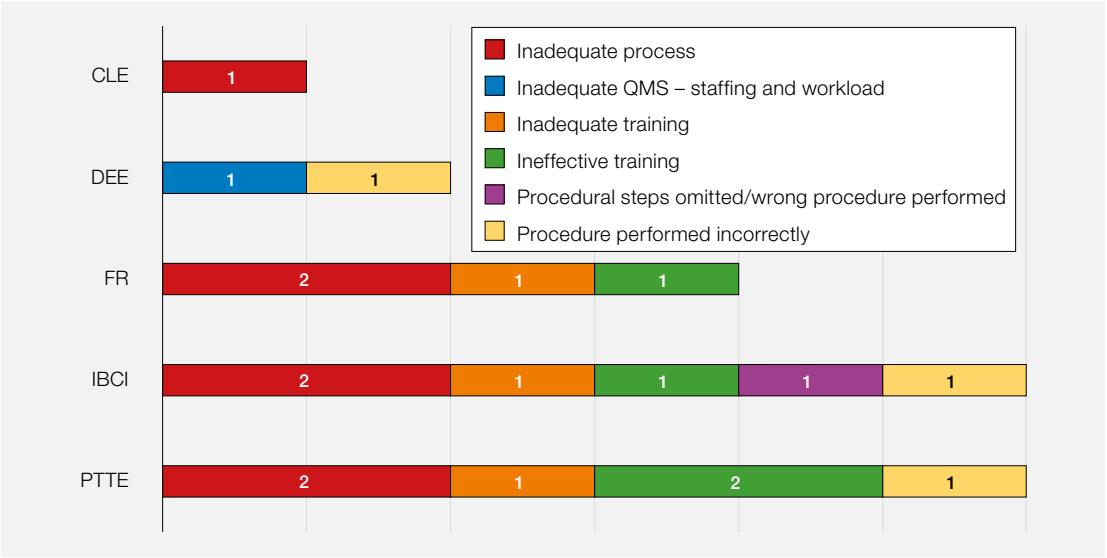


Figure 26.9: BE reports in 'other' category

See Figure 26.5 for key to category abbreviations

Comment from Julie Staves, Chair of the National Blood Transfusion Committee (NBTC) Laboratory Managers' Working Group

It is pleasing to see that once again the transfusion laboratory community continue to ensure appropriate adverse incidents are reported through the correct processes to MHRA and SHOT. This is of particular note given that laboratory staffing is an ongoing area of concern.

The reduction in SAE resulting from the laboratory is a positive result. It is also of note that there has been an increase in the identification of improvements to the QMS which resulted from investigations which is indicative of better knowledge of investigation processes which was highlighted as a concern in the previous Annual SHOT Report.

The ongoing problems seen in the errors occurring in returning units to stock and in components being available to the clinical area after they have expired is worrying, and reviewing the processes involved should be a priority.

Serious adverse reactions (SAR)

Definition: (BSQR 2005) 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 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 blood bank

Blood products

Adverse reactions involving blood products (i.e. licensed medicines such as anti-D Ig, Octaplas® (solvent-detergent fresh frozen plasma), or coagulation factor concentrates should be reported to the MHRA via the Yellow Card scheme (http://yellowcard.mhra.gov.uk).

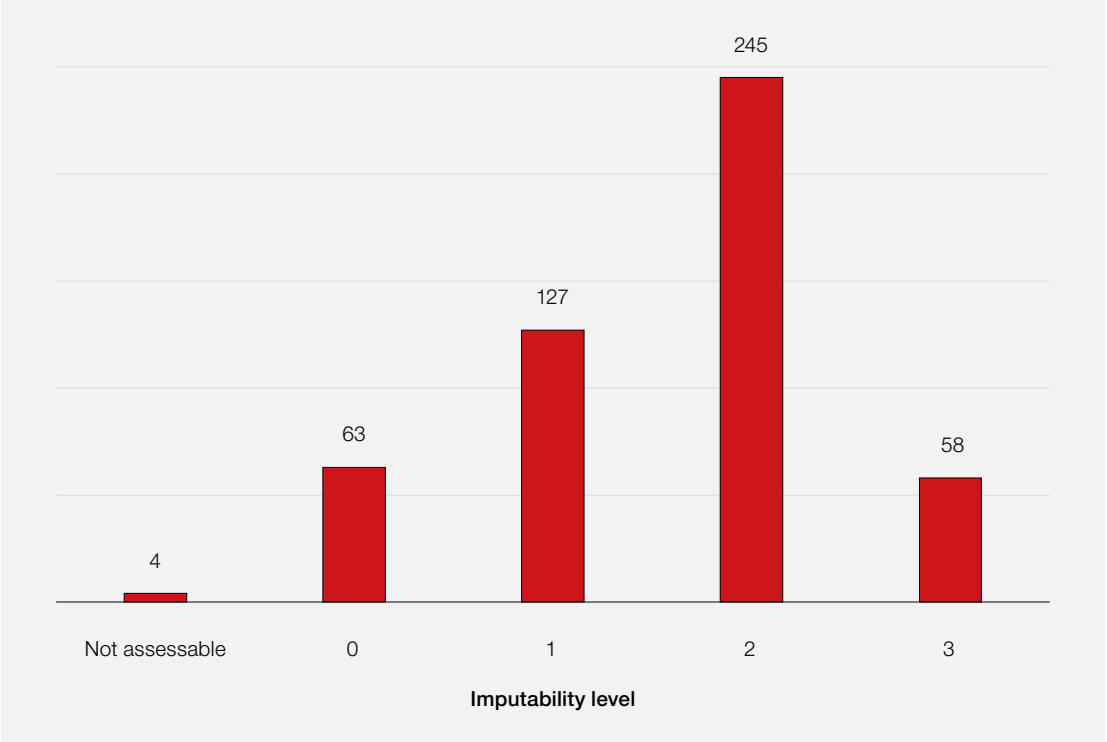
Summary of SAR report data

To avoid any confusion, the MHRA will only supply, in this Annual SHOT Report, total SAR figures reported to Europe, see Table 26.6

Table 26.6: SAR reports, by imputability, 2019 (n=497)

	Imputability score				
	0	1	2	3	N/A
SAR reports by imputability score	63	127	245	58	4

Figure 26.10: SAR reports, by imputability, reported to SABRE in 2019



Haemovigilance team managers update 2019/20

Author: Mike Dawe

The responsibilities of the post are designed to support the transfusion community in all aspects of the regulatory process that the competent authority is responsible for at all levels, of the transfusion management chain whilst ensuring the MHRA remain impartial.

2018-2019 activity

Activity	Number
HBB, BE, RTC/laboratory managers/TP meetings	20
Manufacturers	6
Education days	7 (4 further days arranged for early 2020)
Total	**33 (37)**

RTC=regional transfusion committee; TP=transfusion practitioner

Findings and recommendations

The following observations have been noted:

Lack of available capacity and knowledge to balance operational need with MHRA compliance

Sections 1.2.2, 1.2.5 and 2.2 of the GPG underpins the fact that personnel are a central cog in the management of every QMS, and as such the management has the ultimate responsibility for providing resource that is fit for task to ensure business continuity by developing an adequate capacity plan.

A capacity plan must be in place to demonstrate that staffing levels are sufficient to cover the workload, that not only includes out-of-hours shifts, but also the effective implementation, development and management of an effective QMS. Where a shortfall is identified, senior management should take action to ensure sufficient resource is made available. To achieve this, sites must map their processes so the component parts can be identified, and the relevant internal and external pressures and relationships can be established.

Manufacturers not meeting a site's needs

The Haemovigilance Team Manager has engaged with manufacturers to help them understand their role in sites meeting their regulatory requirements highlighting that a collaborative approach, between the manufacturer and the site, is key to maintaining and developing an effective QMS.

The following issues have been identified but are not limited to:

1. LIMS systems upgrades and patches being installed without an appropriate explanation and assessment of their impact – failing to adequately assess the full impact has shown a detrimental effect on a sites compliance. Examples of this include but not limited to:
   - An increased burden on available resource and business continuity by sites being forced into deviating from normal procedures via the introduction of additional and extra steps
   - Users being unaware of the duplication of patient records allowing for special requirement flags not being met and altering the EI algorithm allowing for the inappropriate EI of units to patients
2. Analysers not meeting the users expectations and as a result secondary processes and systems being introduced within the operation process flow – introducing secondary systems, although not necessarily inappropriate, can raise other issues. For example breaking the electronic chain for patients to qualify for EI, causing a deviation from routine procedures putting pressure on available resource as these deviations must be documented, carefully investigated for causative factors of any defect and, where necessary, followed up by the implementation of CAPA to prevent recurrence

If an error/deviation is the fault of the analyser/LIMS then the laboratory will be expected to show a detailed examination, root cause analysis (RCA), risk assessment and CAPA has been made and implemented. To achieve this, it may require close collaboration with the manufacturer to resolve any issues that are found as software and/or technical changes may need to be made. In most circumstances these changes can only be made by the manufacturer but must stay in line with the sites business processes.

Sites are reminded that LIMS/software manufacturers must provide clear and unambiguous release notes for every version of any upgrade so the site can assess its impact in line with good practice principles. These release notes must be made readily available so the appropriate assessment of their impact can be made, and the associated risks mitigated. This includes all version upgrades i.e. if a site has version 1 and upgrades to version 3 then the manufacturer must provide the release notes to both 2 and 3 before version 3 is installed so an appropriate change control and validation process can be achieved.

Sites are reminded that to avoid these issues, they should:

1. Process map their systems, so they know the component parts and their relationships within the whole QMS
2. Create a detailed user requirement specification (URS) that captures everything within the business process and reflects a site's operational outputs i.e. levels of false or unexpected results

3. Agree contracts that cover

- Expected and unexpected downtime periods
- Expectation on a manufacturer regarding level of detail within release notes for upgrades and software changes
- Regular review of the contract to assess if allowances have been made for QMS changes as a result of any lifecycle change of a sites business and operational processes

This list is not exhaustive but further relevant information can be found in the GPG sections 4.7. Control of equipment and materials and 8 Outsourced activity management.

- A lack and loss of experienced staff in good practice principles

As a response for more widespread support to the transfusion community the haemovigilance team offers education days for the transfusion community to provide advice and help within the regulatory framework. Please contact mike.dawe@mhra.gov.uk or chris.robbie@mhra.gov.uk for further details.

- Delays to SABRE investigations

There is an increasing concern where SABRE confirmation reports have been delayed because of the Trust taking over the investigation process, some reports have been delayed by over 6 months. In cases like these reporters are reminded to provide an update via a footnote, in the SABRE report, that includes:

- What the immediate mitigation/action that has been put in place to ensure, at least in the short term, a repeat error does not occur
- That an interim report be submitted within 30 days to inform the MHRA of progress
- An explanation as to why the investigation final report has been extended and delayed based on good practice principles
- An appropriate assessment of the risk and the mitigation that has been put into place due to the extension of the investigation

Sites are reminded that the following section of the BSQR is relevant in this situation and as such sites must comply.

(3) A person responsible for management of a reporting establishment shall ensure that the reporting establishment notifies the Secretary of State as soon as is known, using the notification formats set out in Section A of Part 8 of the Schedule, of all relevant information about serious adverse events which may put in danger donors or recipients other than those directly involved in the event concerned.

(4) A person responsible for management of a reporting establishment shall ensure that the reporting establishment—

(a) as soon as is reasonably practicable after each serious adverse event, evaluates that serious adverse event to identify preventable causes within the process;

(b) upon completion of the investigation, completes the serious adverse event notification, using the format set out in Section B of Part 8 of the Schedule;

Section A and B of part 8 of the schedule relating to the Notification and Confirmation reports on SABRE respectively.

BSQR and medical device regulations

BSQR 2005 as amended does not specifically cover medical devices, however there may be overlap if a medical device impacts BSQR compliance. To achieve an appropriate and compliant solution sites must have a proper understanding of how medical device regulation and BSQR's work together within the regulatory framework.

It is also important to remember that sites must report the failure of any medical device to the MHRA via the Yellow Card Scheme through the following link https://yellowcard.mhra.gov.uk/.

In addition, sites and manufacturers must be aware that the new In Vitro Diagnostic Regulations (IVDR) are being introduced in 2022 and this means that some software will now be regulated under these new regulations and therefore include some elements of LIMS and analyser software.

It's not the full LIMS system that will be included but rather those algorithms (modules) used to determine a result used for direct patient treatment decision points such as AKI, Warfarin dosing and EI to name just a few. These algorithms will therefore need a CE Mark.

The link to the new regulations is: https://www.gov.uk/guidance/medical-devices-eu-regulations-for-mdr-and-ivdr.

To help you identify if certain algorithms/modules fall under the IVDR then the following link to a flowchart (https://www.gov.uk/government/publications/medical-devices-software-applications-apps) can be used, and if that doesn't give an answer, then MHRA might be able to advise if they can review specific details of the algorithm/module function in the context of its use.

If the manufacturer/provider of the LIMS has CE marked the algorithms then sites will have to validate it in accordance with good practice principles (GPG), but if sites have the algorithm changed to suit their own needs then they may need to CE mark it themselves, if it falls under the IVDR, unless they can make a case for an in house exemption. The specific details for these exemptions is still under review but the consultation information can be found at https://www.gov.uk/government/consultations/health-institution-exemption-for-ivdrmdr.

Summary

The feedback of the haemovigilance team's assistance continues to be well received and continues to help sites with their regulatory responsibilities, manufacturers with their understanding of how their products can impact within the regulatory framework where they are placed.

Sites and manufacturers have found that post visits/communicates direct from the haemovigilance team manager has achieved the following outcomes:

- Advice centred on moving a transfusion laboratory led to the Trust reversing this decision and postponing the movement until a more suitable area is found
- Obtaining the appropriate and clear and unambiguous release notes for software upgrades when they were not immediately forthcoming
- Stopping an inappropriate LIMS system being introduced when the regulations were applied to the sites proposed plan
- Advice on UKAS and MHRA inconsistencies leading to MHRA setting up a review with UKAS once BREXIT is completed
- Resolving issues between manufactures and sites regarding data integrity and false positive results to achieve both the manufacturer and the site resolving an ongoing issue with a positive outcome
- Engagement with manufacturers to assist with the products that they are introducing does not impact on a sites QMS

This list is not exhaustive.

It is also advised that sites create a communication flow where everybody can share success and failure between different sites, regarding the development and maintenance of an effective QMS. The MHRA forum is an ideal tool and as such please use the forum as much as you can via the following link: http://forums.mhra.gov.uk/forumdisplay.php?60-Blood-Forum.

MHRA Inspection activity on hospital blood banks 2018-2019

Author: Shirley Stagg

A total of 303 blood compliance reports (BCR) were submitted for review for the reporting period 01 April 2018 to 31 March 2019. Twenty-seven hospital blood banks (HBB), including two control sites, were selected for inspection; this included sites under the oversight of the Inspection Action Group (IAG) and Compliance Management Team (CMT) following previous inspections.

All deficiencies identified at these inspections were referenced against the GPG for blood establishments and hospital blood banks.

Inspection outcomes

Inspections for the reporting period 01 April 2018 to 31 March 2019 are performed in the following year, i.e. from 01 April 2019 to 31 March 2020. At the time of writing, a total of 23 inspections had been performed at 23 sites, and four planned inspections were affected by actions taken in response to COVID19. The numbers of deficiencies from the completed inspections are as follows:

Table 26.7: MHRA inspection deficiencies

Critical	Major	Other
0	28	70

Two HBB were referred to IAG following inspection and three were referred to CMT.

An overview of the compliance management escalation processes used by the GMP inspectorate, including information on the IAG and CMT referral processes, is available from the MHRA inspectorate blog: https://mhrainspectorate.blog.gov.uk/2017/02/06/overview-of-compliance-management-escalation-processes-used-by-the-gmp-inspectorate/.

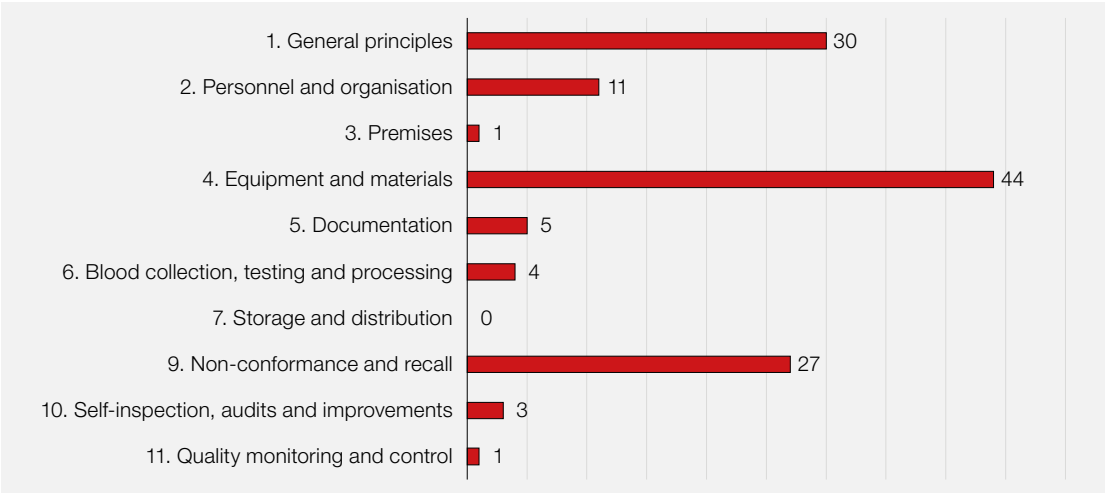
Summary of significant issues identified at inspected sites

The following data is shown in terms of references to the Good Practice Guideline for Standards and Specifications for Implementing the Quality System in Blood Establishments (GPG) for each inspection deficiency. Each deficiency cited may have multiple sub-points each with a specific GPG reference; there are therefore a higher number of GPG references than deficiencies.

Deficiencies

The most frequently cited GPG references in major and other deficiencies were associated with Section 1: General principles, Section 4: Equipment and materials, Section 5: Documentation and Section 9: Non-conformance and recall. The following paragraphs will give some detail on the types of deficiencies that were raised during inspections.

Figure 26.11: Good practice section referenced in major deficiencies 2019



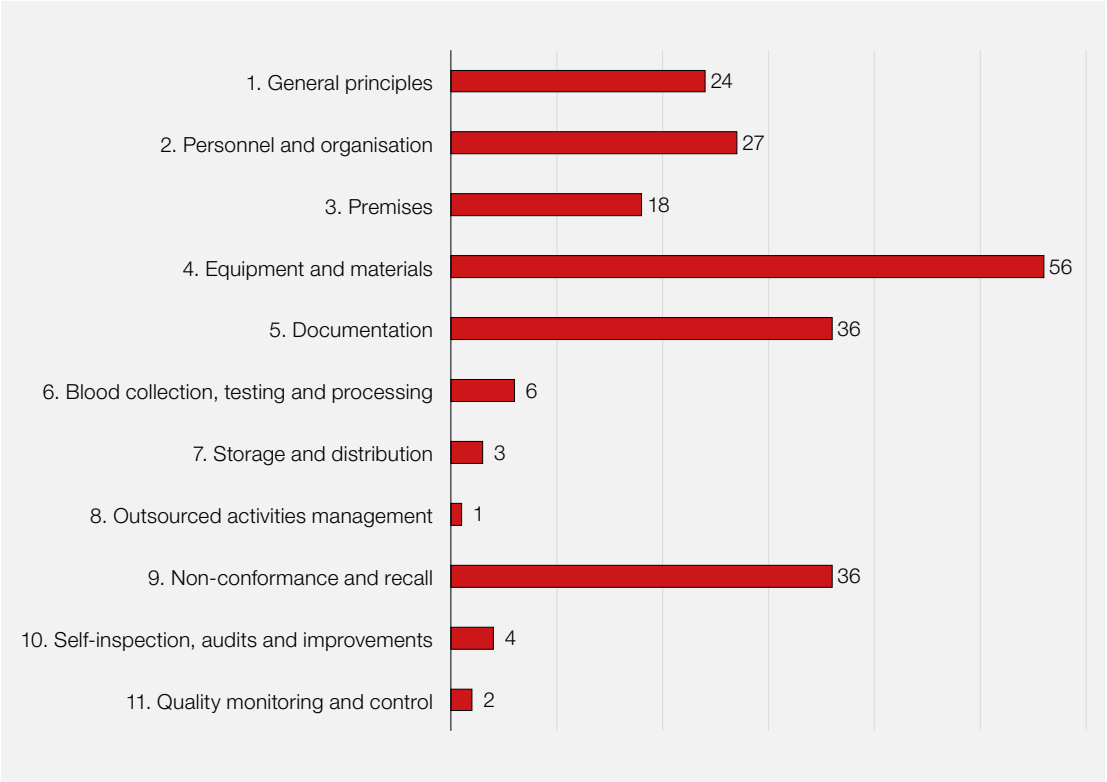


Figure 26.12: Good practice section referenced in other deficiencies 2019

Equipment and material

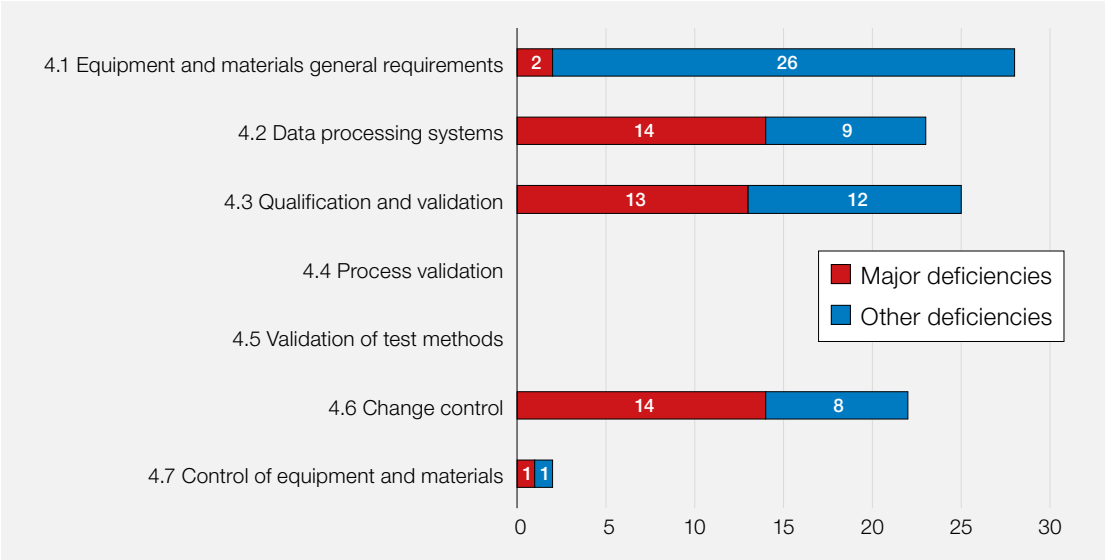
The main issues found in relation to equipment and materials were associated with qualification and validation of equipment. The following were areas of concern:

- Validation master plans did not contain the key elements of the site qualification and validation programme
- Qualification and validation documents were not appropriately reviewed and authorised
- Qualification and validation did not cover the full scope of laboratory activities
- No deviations were raised for non-compliant test results during validation activities
- There was no validation summary, or similar document, to record formal release before the next stage or completion of validation

There were issues with the calibration of equipment used for measurement. Calibration reports were not reviewed and signed to show acceptance of the document and there was no assessment of the impact of any failed calibrations. Computerised system access was not appropriately controlled, with evidence of unlocked and unattended systems and unnecessary use of administrator access for routine use of equipment.

There were examples of change controls not being raised or being raised late in the change process. Change controls should be raised at the initial concept of a proposed change. The potential impact of changes was not robustly assessed to avoid unintended consequences or plan validation. There were several instances where laboratories did not consider effectiveness checks after implementing changes.

Figure 26.13: Good practice section 4: equipment and materials



Non-conformance and recall

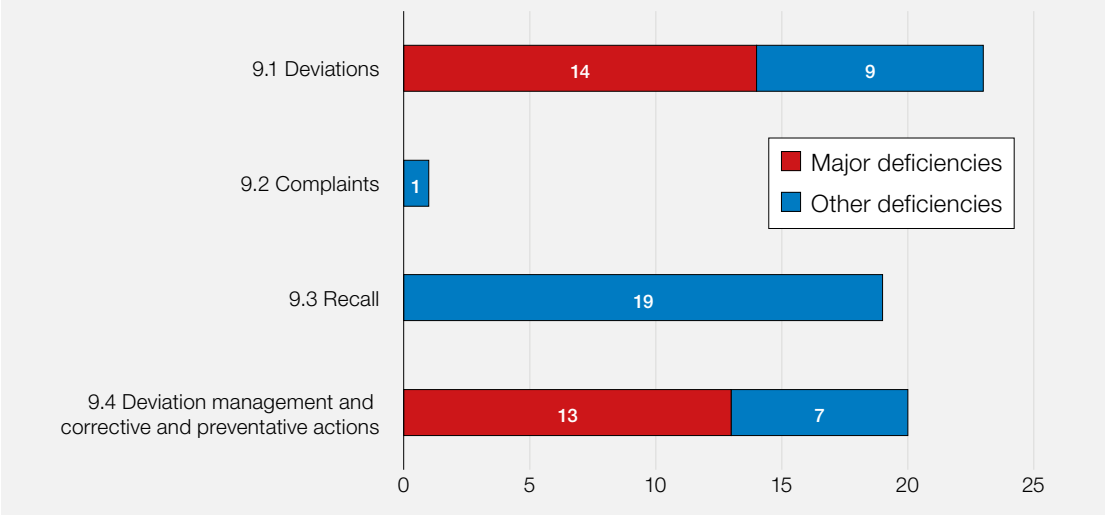
The main issues in relation to non-conformance/deviation management were associated with the level of detail contained within incident reports, the level of root cause analysis work applied and the effectiveness of CAPA.

There were several examples where the classification of non-conformances was inappropriate and this commonly related to the fact that the potential for causing patient harm was not considered. Root causes were attributed to human error without a comprehensive investigation to check for process, procedural and system-based errors. Procedures must be checked to ensure that they contain an appropriate level of detail to maintain compliance. Root cause analysis procedures within laboratories often mandated the use of tools such as 'five-whys' or 'cause and effect diagrams', however, there was little evidence of the use of such tools.

CAPA should ensure that non-conformity or quality problems are corrected, and that recurrence of the problem is prevented. There were examples seen during inspection of CAPA not addressing the identified root cause(s). Where multiple factors were involved in a non-conformance then each one must be considered in the CAPA. Evidence of actions only being partially carried out and CAPA not tracked or reviewed were seen during the review of deviation management during inspections.

The main issue identified around recall was the lack of regular evaluation of recall arrangements. Blood banks often did not consider the full scope of situations that may lead to an internal recall such as a reagent failure.

Figure 26.14: Good practice section 9: non-conformance and recall



Documentation

The generation and control of documentation was the most cited subsection of the documentation section of the GPG. Common issues included:

- Procedures that lacked detail
- Records not being completed as required. These included analyser internal quality control failure forms and return to service forms for equipment
- Requested changes to documents not being carried out in a timely fashion
- A failure to ensure that staff acknowledged new or revised SOP promptly
- Overdue document reviews
- Overwriting

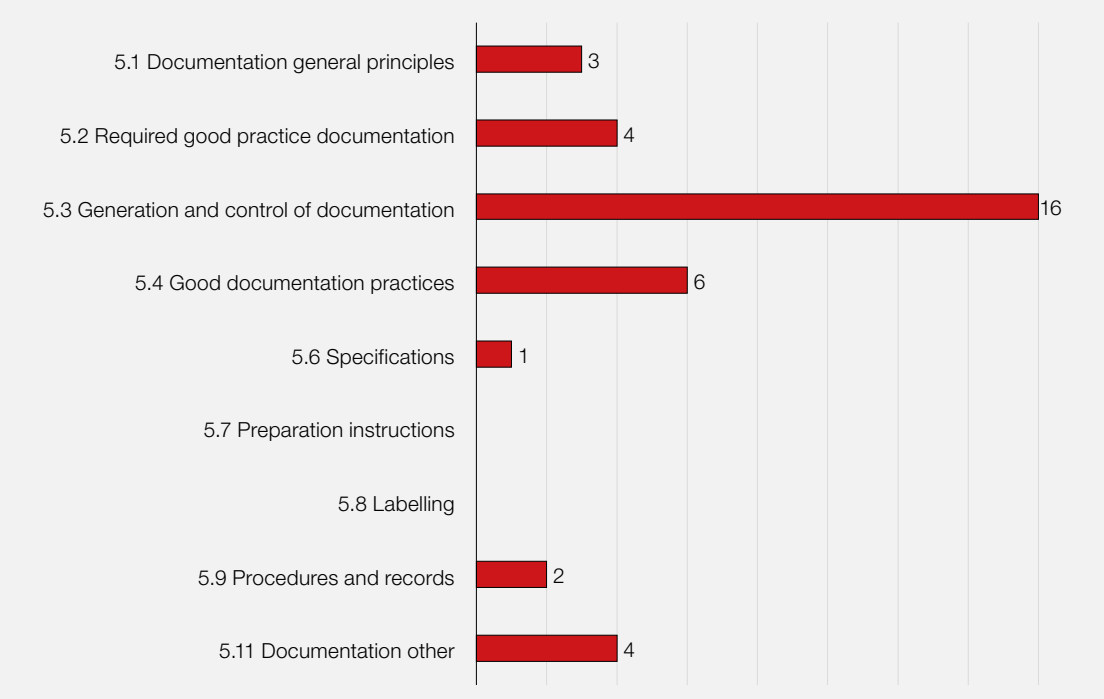


Figure 26.15: Good practice section 5: documentation

Information and guidance

For further information on MHRA and the Regulation of Blood please refer to the MHRA website: https://www.gov.uk/topic/medicines-medical-devices-blood/blood-regulation-safety.

The MHRA blood forum was launched in June 2016 as a tool to help those involved in blood component collection, processing, testing and distribution to comply with the EU Blood Directives, UK Statutory Instruments and good practice requirements. It provides the ideal opportunity for extended communication between peers and allows users to put forward their comments and get 'real-life' examples of ways in which they can manage robust quality procedures that ensure compliance and which dovetail with their own business needs and resources.

Appendices

Appendix 1: Storage subcategories

Component expiry	A component has time-expired and not been removed from the storage location according to laboratory procedures
Incorrect storage of component	A component has not been stored in the correct location
Sample expiry	A sample has expired and the component has not been removed from the supply chain for the original patient
Return to stock error	A component has been returned to the supply chain in error instead of being quarantined or discarded
Failure to action alarm	A storage location alarm has been activated but not actioned according to the procedure
Storage temperature deviation	The storage temperature has gone out of specification without an alarm being activated
Security	A storage location is accessible to staff or public who are not authorised to do so
30 minute rule	Red cells are returned to a refrigerator after 30 minutes have elapsed contrary to local procedures for return of unused red cells
Miscellaneous	Any other storage event affecting the quality and safety of blood or blood components

Appendix 2: Other subcategories

Incorrect blood component issued (IBCI)	Blood issued which does not meet the patient's specific requirements
Sample processing error (SPE)	Sample incorrectly receipted into the laboratory that should have been rejected
Component labelling error (CLE)	Typically transposition of labels
Pre-transfusion testing error (PTTE)	Any error in the process of testing patient samples and the interpretation of results
Component collection error (CCE)	Any error in the collection of components from storage locations, or the handover of components on collection from the laboratory
Data entry error (DEE)	Transcription errors of data, including both electronic and hand-written data
Failed recall (FR)	Failure to recall components in a timely manner
Unspecified (UNSPEC)	Any error affecting the quality and safety of components not specified elsewhere
Component available for transfusion past de-reservation (CATPD)	Expired components which were incorrectly collected, prior to their scheduled re-stock by the laboratory
Expired component available for transfusion (ECAT)	Any component issued for a patient, where the component expires prior to the planned transfusion
Incorrect blood component ordered (IBCO)	Components ordered from a blood establishment that do not meet the patient's specific requirements
Handling damage (HD)	Damage to a component affecting its quality and safety
Incorrect blood component accepted (IBCA)	Blood accepted into a laboratory for a specific patient where the special requirements have not been matched

Appendix 3: Human error subcategories

Procedure performed incorrectly	Failure to carry out a step(s) correctly
Procedural steps omitted/wrong procedure performed	Missing a key step or following the wrong procedure
Inadequate process	Inadequate design of a process. Also includes multiple causative factors
Incorrect procedure	Process not properly described in the SOP
Ineffective training	Training not understood by operator
Inadequate training	Training process not fit for purpose
Lapsed or no training	Carrying out a procedure without any formal training
Inadequate QMS – staffing and workload	Staffing levels below the minimum level, or unacceptably high workload has resulted in staff making errors. It is also important to consider an appropriate skill-mix when deciding on minimum staffing levels
Inadequate supervision	Errors have been made by trainees or inexperienced members of staff and should have been noticed by adequate supervision

References

Council of Europe (2018) Good Practice Guidelines for Blood Establishment Required to Comply with Directive 2005/62/EC, 15/02/2018 https://www.edqm.eu/en/good-practice-guidelines-blood-establishments [accessed 09 June 2020].

BSQR (2005) The Blood Safety and Quality Regulations ISBN 0110990412; http://www.legislation.gov.uk/uksi/2005/50/contents/made [accessed 09 June 2020].

If you would like more information on SHOT please contact:

The SHOT Office,
Manchester Blood Centre,
Plymouth Grove,
Manchester
M13 9LL

Telephone: 0161 423 4208
Email: shot@nhsbt.nhs.uk
Website: www.shotuk.org

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