ANNUAL SHOT REPORT 2018

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Serious Hazards of Transfusion

Serious Hazards of Transfusion (SHOT)

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Foreword

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Author: Mark Bellamy

Currently, there is huge media interest in the Infected Blood Inquiry into patients harmed by historical infected transfusions. This relates primarily to the transmission of hepatitis C in the 1970s and 1980s, an era when as an entity hepatitis C was not recognised and serological testing or screening of blood and blood components had not yet become available. The hepatitis C virus was discovered in 1989, and it was soon realised that this accounted for many of the cases of 'non-A non-B hepatitis' seen up to that time. An early screening test for hepatitis C was developed and introduced within a few months after that; and a more sensitive and effective test was developed in 1992. Since then, transmission through blood and blood products has reduced dramatically. In the current Annual SHOT Report, we tabulate the risk of failure to detect potential infectivity in the window period (before sero-conversion) for hepatitis B, to be around 0.5 per million transfusions. For hepatitis C and human immunodeficiency virus (HIV), it is orders of magnitude lower. While this should be immensely reassuring for patients and the public at large, the press nevertheless conveys a sense of considerable bitterness and anger over the transfusion-related virus transmission which happened before screening measures were in place.

Undoubtedly, there are lessons to be learned, and the Inquiry will hopefully highlight ways in which we can mitigate 'unknown' risks in the future. These may include proper rigorous data collection and tracking, so that those at risk of transfusion-related complications can be identified, and offered appropriate help at the earliest juncture.

There is also a risk which arises from the Inquiry, or rather, from popular reaction to it (including reporting). A sense of public anger may fuel blame culture, which ultimately can only defeat the processes of reporting and learning. The principle of a 'just culture' is often poorly understood, and is clearly not the same as a 'no blame' culture.

A system in which both complications of transfusion, and near misses (including delays and omissions) are openly reported and shared is crucial to advancing safety, building on the advances of the last 25 years. At an individual and organisational level, it may be helpful, instead of conceptualising a 'reporting' culture, to think in terms of a 'sharing' culture. Sharing our errors has a number of advantages. First, it enables us to mitigate any further or ongoing harm which may already be in train. Second, it establishes the conditions for learning and pattern recognition, so that we better understand what has happened (or could have happened). Third, this in turn enables us to change practices and systems, reducing the chance of similar events in the future. Fourth, it establishes a culture where the individuals involved support each other, and share their concerns and the emotional elements of the experience. This fosters future openness and sharing.

In the current report, there were 20 deaths related to transfusion, and 109 cases of major morbidity. These figures seem low, and might imply relative safety. However, it is also quite clear that the blood component usage and reporting rates by centre are not linked as one might expect if all incidents were reported. There are a number of perceived barriers to sharing transfusion errors and near misses. These may include staffing levels, the perception of the value of reporting, the perception of the difficulties and inconvenience involved in reporting, and importantly, the possibility that evidence from reports is used to discipline individuals. This latter possibility, of which there are anecdotal reports, would of itself have a disproportionate effect on sharing and safety. For this reason, it is important that such practices do not enter the healthcare culture, and that unsubstantiated rumours are likewise addressed. Haemovigilance should stand out as a beacon of safety in healthcare; there should be very clear separation between the safety culture to which we all subscribe, and the popular culture of blame which we encounter on a daily basis in the outside world and the media.

2 Participation in United Kingdom (UK) Haemovigilance

Authors: Debbi Poles and Chris Robbie

Reporting in 2018

Participation in UK haemovigilance remains very high, and in the calendar year 2018 there were only three registered National Health Service (NHS) Trusts/Health Boards that did not submit any new reports to either SHOT or the Medicines and Healthcare products Regulatory Agency (MHRA). Of the three non-reporting NHS organisations, one was a medium level user of blood components (based on the 2017 SHOT participation benchmarking component user levels, see Table 2.1), one was a very low user, and one was an indirect user who may have made reports via another reporting organisation.

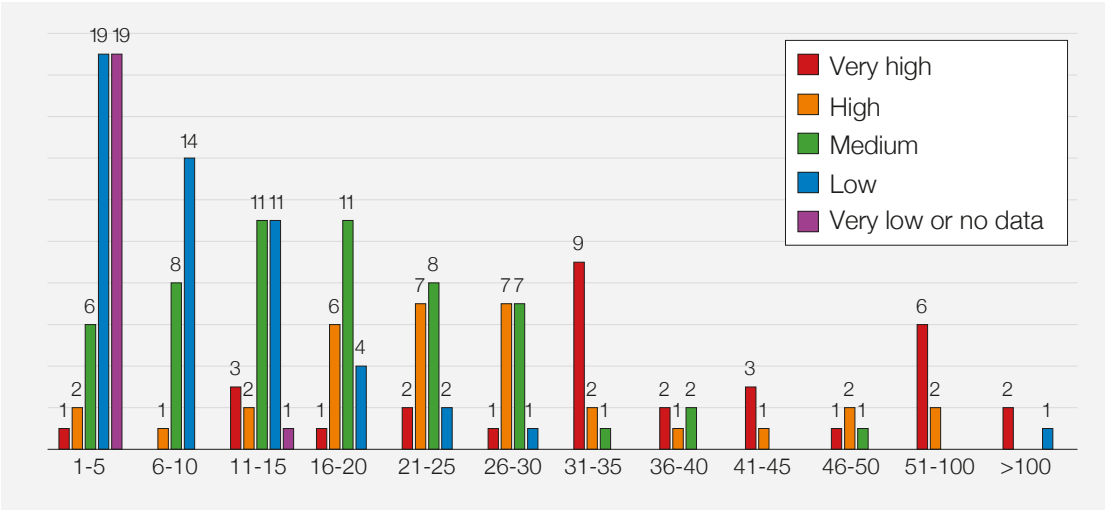
Although in general participation is high, there are widely differing levels of reporting between organisations. Analysis was carried out to look at the number of reports made by each NHS Trust or Health Board, and independent reporting organisations based on their usage levels (again, using the 2017 SHOT participation benchmarking usage criteria below).

Table 2.1: SHOT participation benchmarking usage levels

Usage level	Total components per annum
Very low	<1,000
Low	1,001–7,000
Medium	7,001–12,000
High	12,001–20,000
Very high	>20,001

This analysis shows that there is a wide spread of reporting levels across the different size organisations. Surprisingly there was one very high usage, and two high usage organisations that made five or fewer reports during 2018. Whilst there is no 'right' or 'wrong' number of reports, organisations with this level of blood use would be expected to have a higher level of reporting than this.

Figure 2.1: Number of 2018 reports by reporting organisation and component usage level



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 each year.

Variable rates of incidents reported from Trusts/Health Boards could be due to multiple factors, for example, staffing issues, variable resource allocation, organisational cultures, and robustness of transfusion practices.

Learning point

- Reporters should benchmark their participation levels against similar sized organisations and try to identify any underlying reasons for wide variations

Figure 2.2 demonstrates that the majority of serious adverse blood reactions and events (SABRE) reporters are actively engaged in UK haemovigilance reporting (by either submitting new reports, or closing off older reports), with the majority of active reporters reporting in the first month of 2019. The few that have never reported or have not reported in the last year are either facilities, care homes, private hospitals and a very small NHS organisation with fewer than 200 units issued per year.

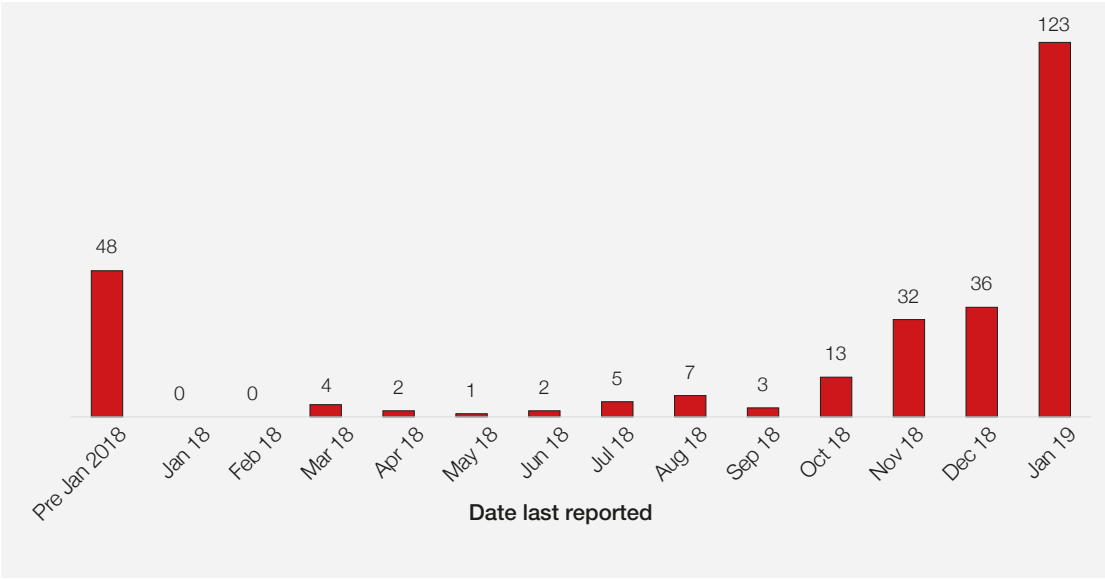
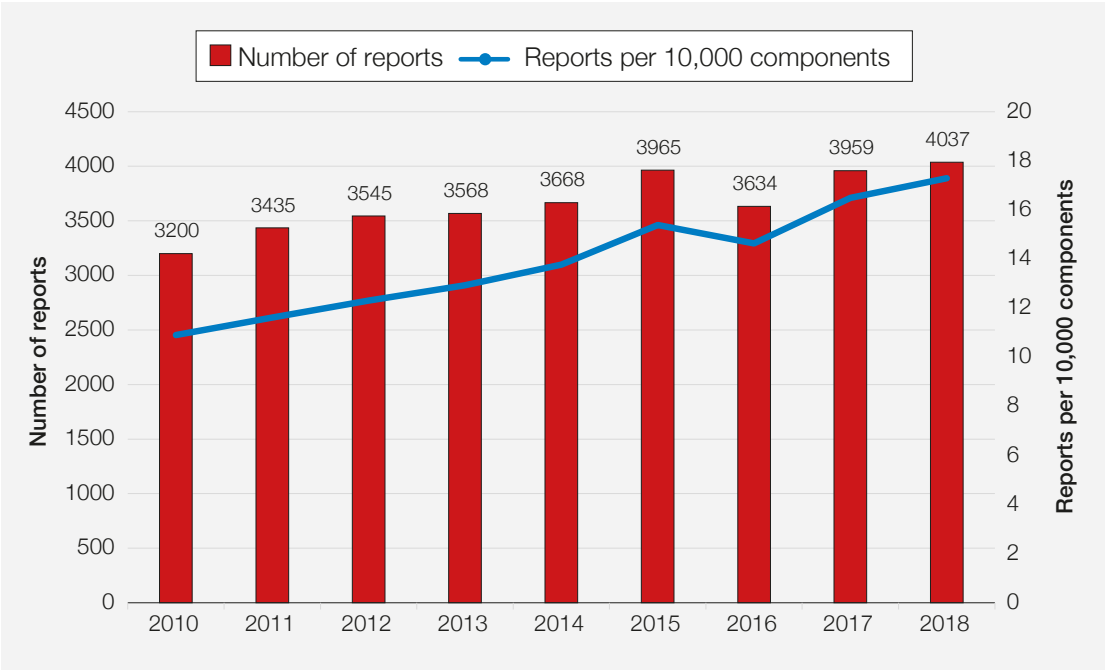


Figure 2.2: The last time a report was received on SABRE from an active SABRE account

The number of reports received on the SHOT database has increased slightly from 2017, but the increase is largely due to one particular report of a refrigerator failure that led to 106 patients being administered anti-D immunoglobulin which was out of controlled temperature storage. Without the single incident involving multiple cases, the reporting numbers this year would have decreased from last year. The analysis in Figure 2.1 that shows some large organisations with low reporting levels, could indicate that there is under-reporting of some incidents. In spite of this, reporting levels per 10,000 total components have continued to increase year-on-year, from 10.9 reports per 10,000 components issued in 2010, to 17.3 in 2018 (Figure 2.3). This is an increase of 58.7% over the nine-year period, however during this time, component issue levels have also decreased by approximately 20%.

Figure 2.3: Number of reports submitted to SHOT, and per 10,000 components issued 2010-2018



SHOT reporting by UK country

In total, 4037 reports were submitted to SHOT in 2018 and the breakdown by country, including total component issues, is shown in Figure 2.4.

Reporting organisations in England have reported a lower percentage of total cases than last year (79.9% in 2018 compared to 83.5% in 2017), while the overall percentages have increased for Scotland and Northern Ireland. Reporting from Wales remains very similar to 2017 at 4.9% of total reports (Bolton-Maggs et al. 2018). The reasons for this may need to be explored further, they could be due to increased awareness and improved reporting.

Full tables containing the breakdown of data from 2018 and previous years can be found in the supplementary information on the SHOT website www.shotuk.org.

Table 2.2: Total issues of blood components from the Blood Services of the UK in the calendar year 2018

	Red cells	Platelets	FFP	SD-FFP	MB-FFP	Cryo	Totals
NHS Blood and Transplant	1,422,742	252,951	166,462	90,500	6,336	41,386	**1,980,377**
Northern Ireland Blood Transfusion Service	41,352	8,229	3,505	1,110	299	955	**55,450**
Scottish National Blood Transfusion Service	142,670	23,881	16,203	3,580	425	3,135	**189,894**
Welsh Blood Service	85,570	10,343	8,460	4,000		421	**108,794**
Totals	**1,692,334**	**295,404**	**194,630**	**99,190**	**7,060**	**45,897**	**2,334,515**

FFP=fresh frozen plasma; SD=solvent detergent-sterilised; 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

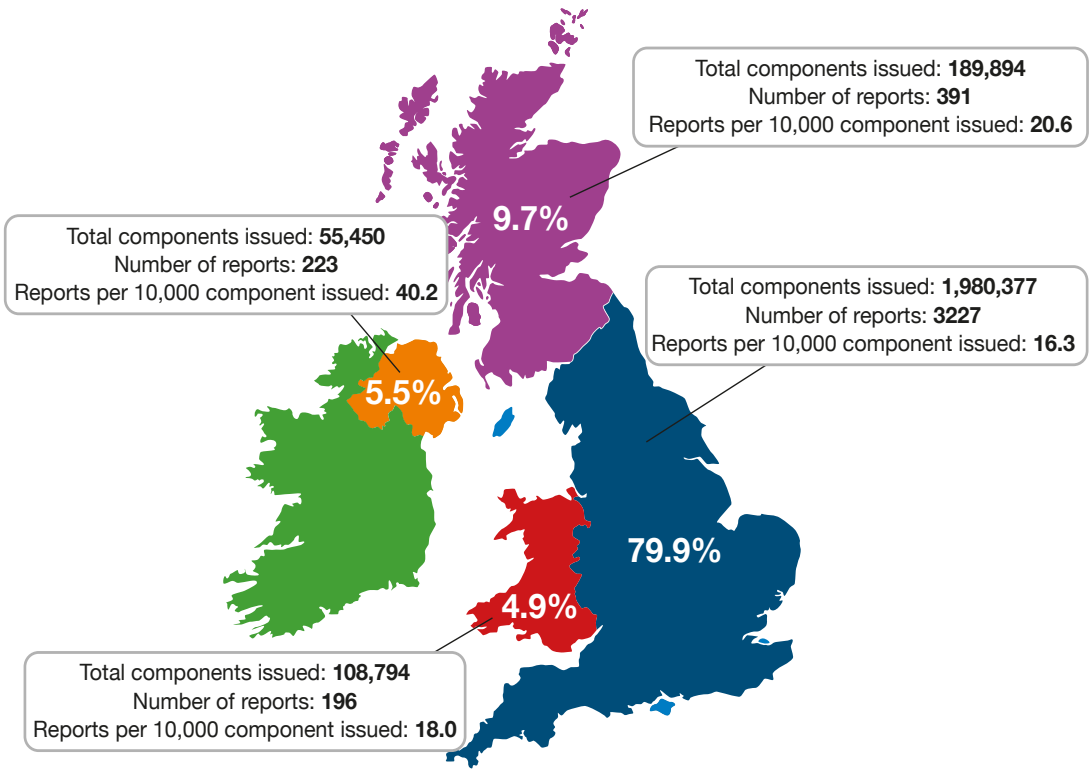


Figure 2.4: Percentage of SHOT reports submitted by UK country

Cases included in the 2018 Annual SHOT Report n=3326

The total number of reports analysed and included in the 2018 Annual SHOT Report is 3326. This is an increase of 96 from the 3230 reports analysed in the 2017 Annual SHOT Report (published 2018). This number does not include 39 reports of anti-D immunisation as these are part of a separate study.

The number of reports excluding 'near miss' and 'right blood right patient' is 1659, a small reduction from 1671 in 2017.

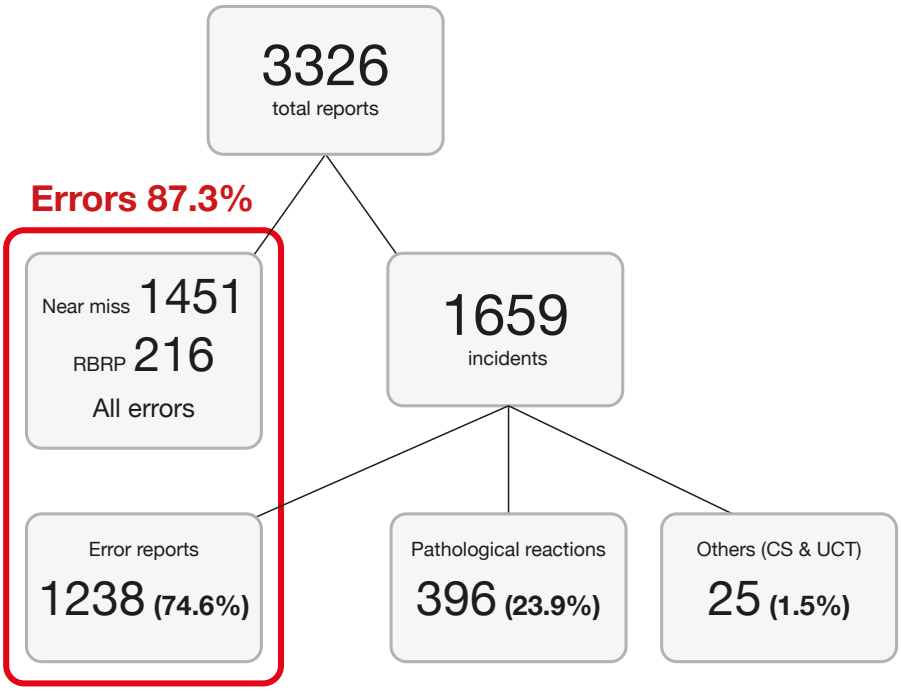


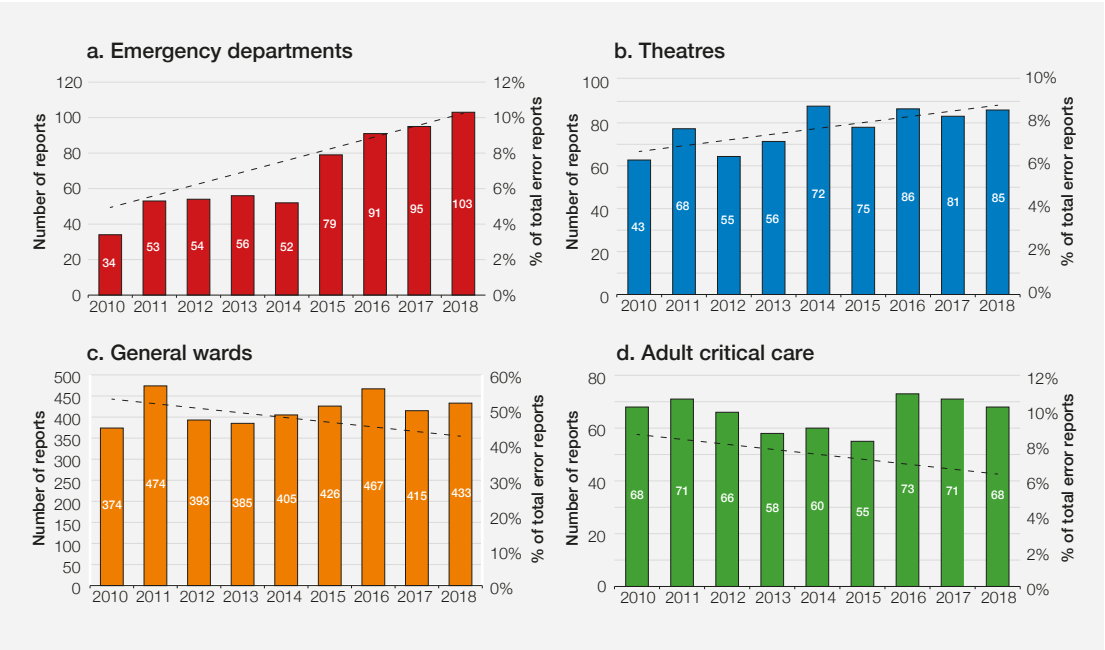
Figure 2.5: Categorisation of reports analysed in 2018

RBRP=right blood right patient; CS=cell salvage; UCT=unclassifiable complications of transfusion

Analysis of errors by location

The trends of error reports by different locations reported in the last two Annual SHOT Reports have been updated again for 2018. The trends for all four areas analysed have continued in the same direction, with emergency departments now contributing to more than 10% of all error reports to SHOT in 2018. Theatres also show a slight increase year on year as a percentage of total error reports, while the general wards and adult critical care units show a downward trend.

Figure 2.6: Trend of error reports from different departments



Reference

Bolton-Maggs PHB (Ed), Poles D et al. (2018) on behalf of the Serious Hazards of Transfusion (SHOT) Steering Group. The 2017 Annual SHOT Report. https://www.shotuk.org/shot-reports/ [accessed 30 May 2019].

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

3

Author: Shruthi Narayan

Key SHOT messages

- Errors account for 87.3% (2905/3326) of all reports (including near miss (NM) and right blood right patient (RBRP); Figure 3.1), and 74.7% of incidents excluding NM and RBRP
- Near miss events continue to account for a large proportion (1451/3326, 43.6%) of the incidents reported to SHOT and have increased again this year, n=1451 in 2018, compared to n=1359 in 2017
- Staff involved in transfusion need to be vigilant at each step in the transfusion process - they should verify each step, particularly where patient identification is involved, and should never make the assumption that errors could not have been made in the preceding steps in the process or anytime in the past. Staff should aim to get it right the first time and every time. Clinicians need to be aware of the risks of transfusion-associated complications in patients with severe anaemia and should be extra cautious when the patients have additional risk factors
- Staffing challenges are noted as contributory to many events reported to SHOT. Staffing levels must be appropriate in all areas involved in transfusion. Inadequate staffing, lack of training and poor supervision is associated with an increased risk of errors putting patient safety at risk
- Emergency transfusion saves lives. Do not delay. Do not let the patient bleed to death or die from anaemia
- A just and learning culture is vital to promote safety in organisations. Incident investigations should be thorough and identify attributable system-related and human factors so that appropriate actions can be instituted

Deaths where transfusion was implicated n=20

This number includes deaths definitely, probably and possibly related to the transfusion. Delays in transfusion and pulmonary complications were the main causes of reported transfusion-related deaths in 2018. Transfusions with pulmonary complications contributed most to both deaths and major morbidity.

Major morbidity n=109

Most major morbidity was 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

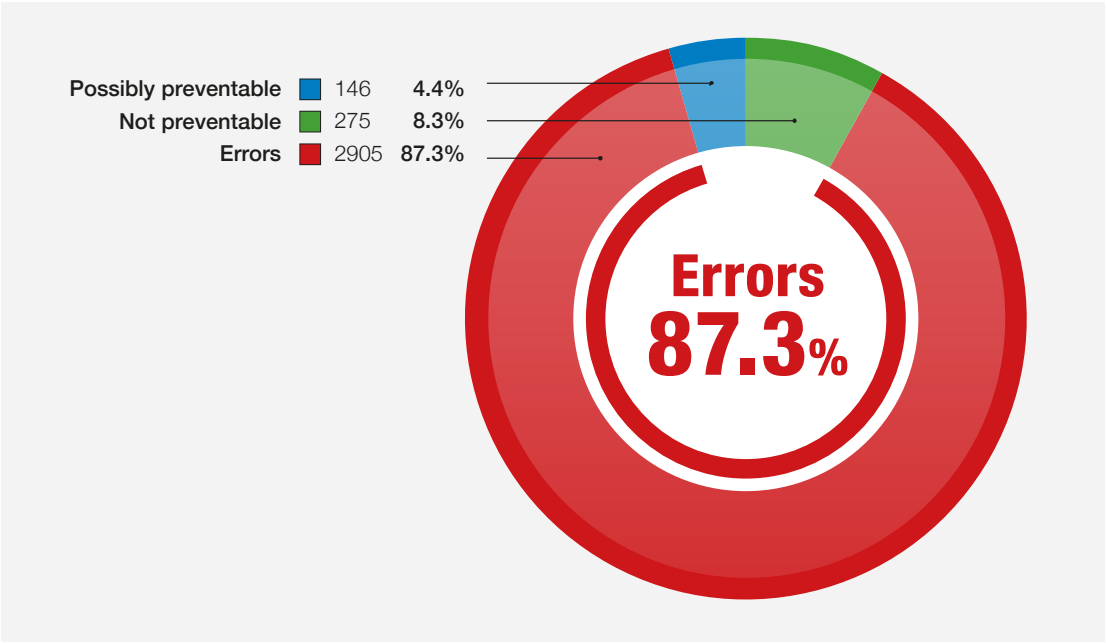
Potential for major morbidity: potential risk of D or K sensitisation in a woman of childbearing potential

Table 3.1: Mortality and major morbidity data by reporting category in 2018

	Death definitely related	Death probably related	Death possibly related	Major morbidity
Delayed transfusion		2	6	
Overtransfusion			1	
FAHR				60
HTR		2		4
IBCT-WCT (clinical)				1
IBCT-WCT (laboratory)				2
IBCT-SRNM (laboratory)				1
UCT				3
TACO		2	3	36
TAD			2	1
TRALI		1		
TTI		1		1
Total	**0**	**8**	**12**	**109**

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

Figure 3.1: Errors account for the majority of reports: 2905/3326 (87.3%)



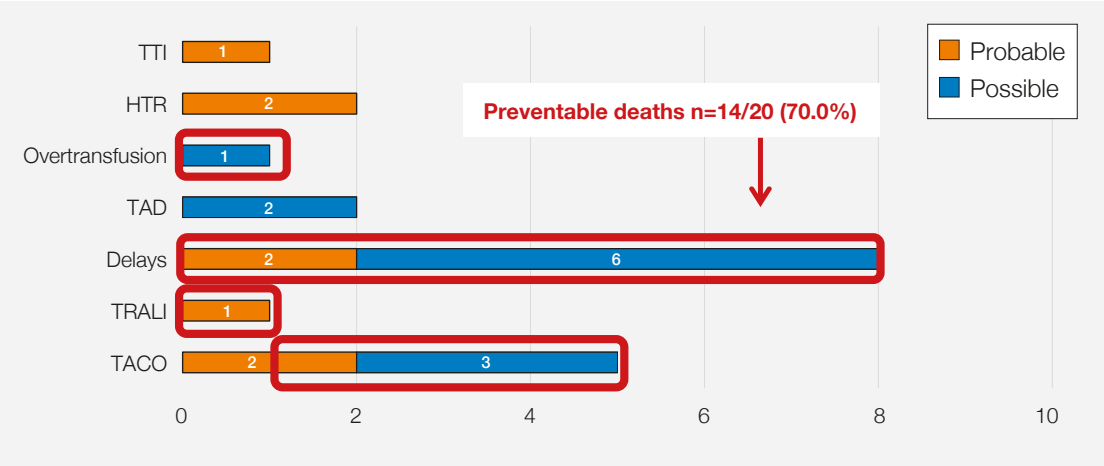


Figure 3.2: Deaths related to transfusion (with imputability) reported in 2018 n=20

HTR=haemolytic transfusion reaction; TAD=transfusion-associated dyspnoea; TRALI=transfusion-related acute lung injury; TACO=transfusion-associated circulatory overload; TTI=transfusion-transmitted infection

Most of the deaths attributable to transfusion are associated with delays and TACO. Review of cumulative data shows that pulmonary complications are the leading cause of transfusion-related death, and nearly a quarter were related to delays. In this period (2010-2018) there were 2 deaths from ABO-incompatible transfusion.

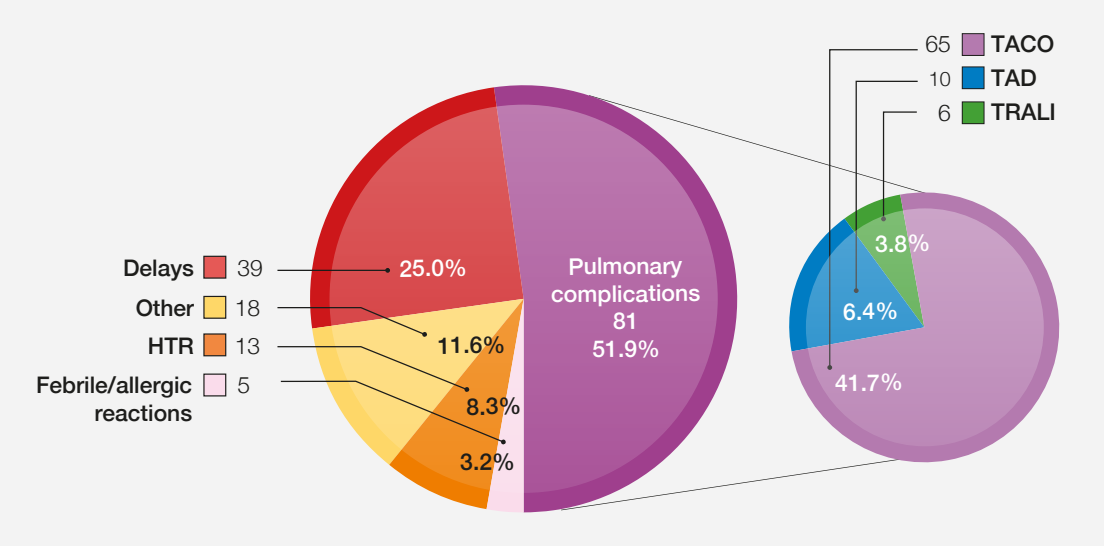


Figure 3.3: Transfusion-related deaths 2010 to 2018 n=156

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

'Other' includes 1 each for post-transfusion purpura (PTP), transfusion-associated graft-versus-host disease (TAGvHD) and anti-D immunoglobulin related; there were 6 in the avoidable, over or undertransfusion (ADU) category, 2 transfusion-transmitted infections (TTI), and 7 deaths related to other unclassified reactions

Errors without harm to patients n=1667 (near miss and right blood right patient reports).

Other errors with actual or potential harm n=1238 (handling and storage errors, avoidable and delayed transfusions, anti-D Ig errors and incorrect blood component transfused); see Figure 2.5 in Chapter 2, Participation in UK Haemovigilance Reporting.

Summary data and risks associated with transfusion

Data collected in 2018 are shown in Figure 3.4. Near miss reporting continues to teach valuable lessons and contributed to 1451 (43.6%) of the total 3326 reports.

Cumulative data for 22 years are shown in Figure 3.5.

Figure 3.4: Summary data for 2018 all categories n=3326 (ranked by number)

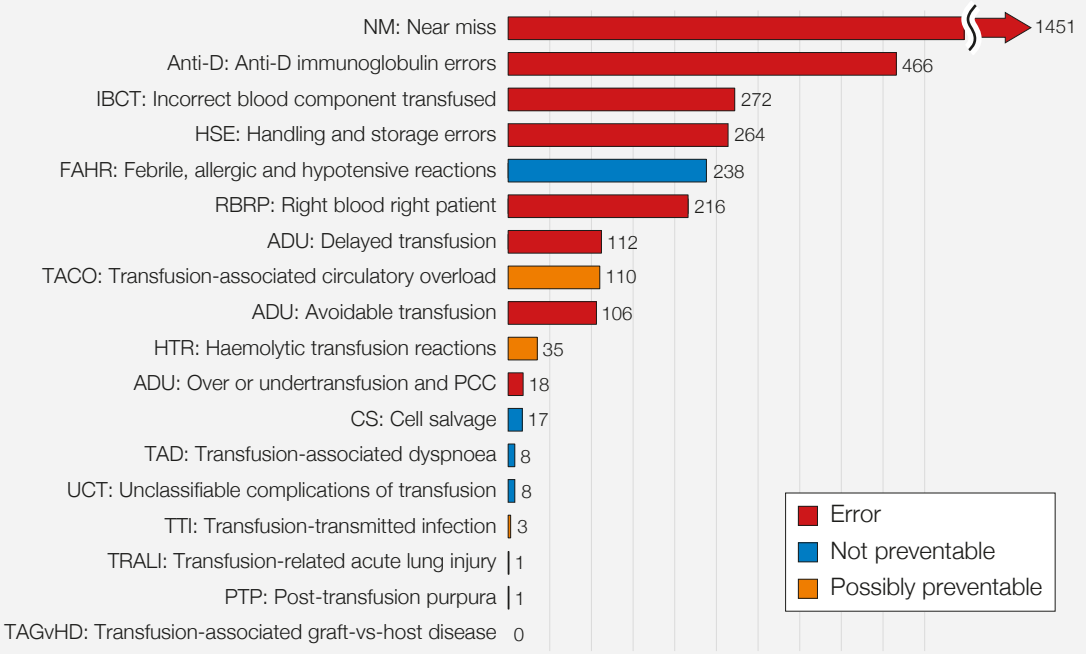
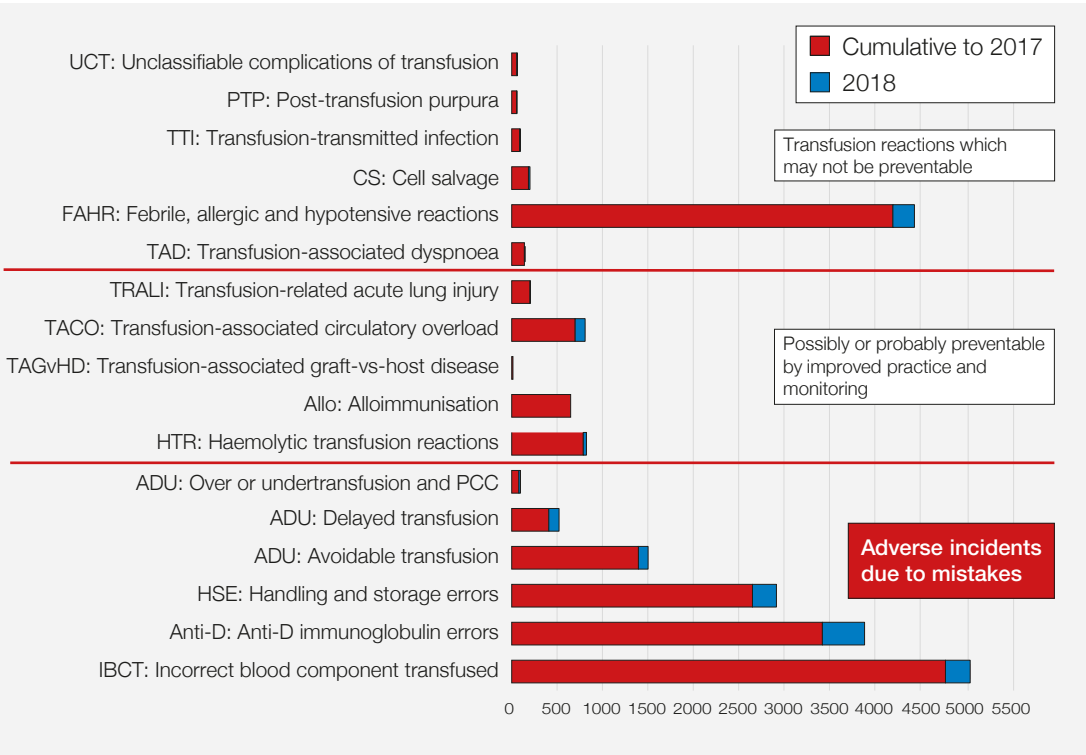


Figure 3.5: Cumulative data for SHOT categories 1996 to 2018 n=21474



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

Risks for transfusion are calculated per 10,000 components issued. This translates into a risk of death close to 1 in 117,000 and of serious harm close to 1 in 21,000 components issued in the UK. The risks of transfusion-transmitted infection are much lower than all other transfusion-related complications.

Total morbidity	0.467 per 10,000 components issued	1 in 21,418
Total mortality	0.086 per 10,000 components issued	1 in 116,726

Table 3.2: Risks of death or major morbidity from transfusion in 2018

The following figure 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.

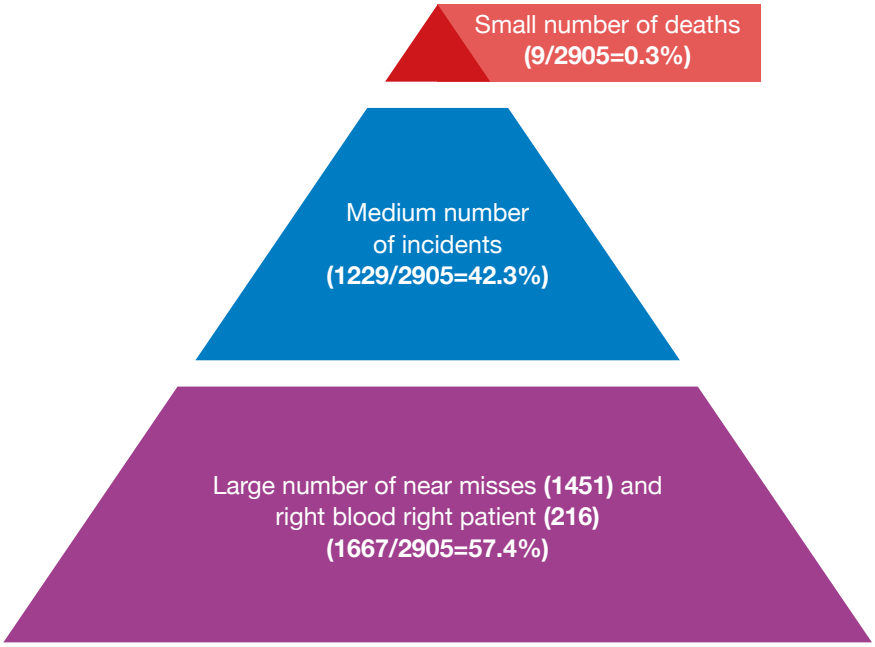
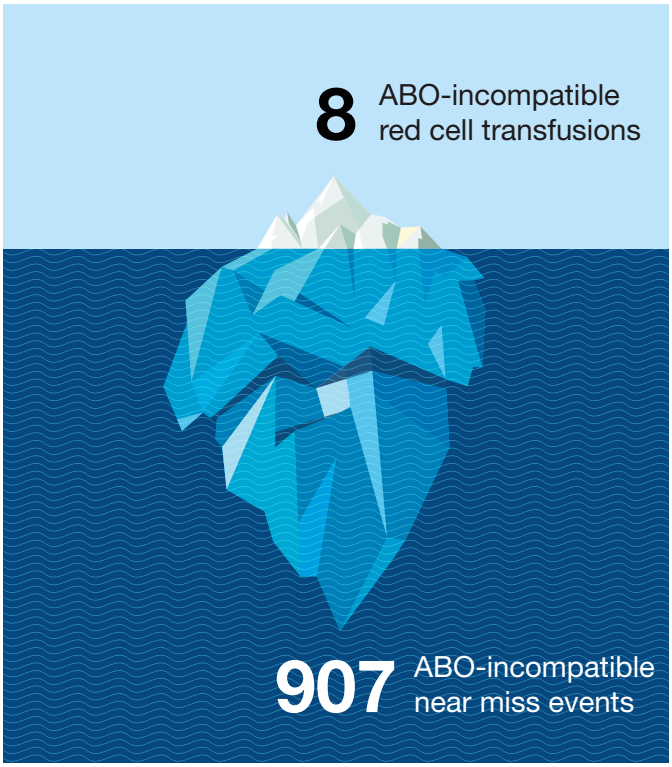


Figure 3.6: Reported errors triangle

ABO-incompatible red cell transfusions n=4

There were 4 ABO-incompatible red cell transfusions reported in 2018, of which 3 were errors that could have been identified at administration. No patient deaths were reported, however this resulted in major morbidity in 2 patients. These are further described in Chapter 8, Incorrect Blood Component Transfused (IBCT) (Cases 8.1 and 8.2). Review of near miss data shows that these are the tip of a much larger iceberg. Data from 2016-2018 shows that although there were 8 ABO-incompatible red cell transfusions there were 907 near misses where an ABO-incompatible transfusion would have resulted. In 2018, 290/792 (36.6%) of wrong blood in tube (WBIT) errors could have resulted in an ABO-incompatible transfusion (Chapter 12a, Near Miss – Wrong Blood in Tube (WBIT)). These will not be detected unless there is a previous record in the transfusion laboratory and demonstrate the importance of the group-check policy (BSH Milkins et al. 2013). These errors, which could have lethal outcomes, demonstrate the importance of correct patient identification at the time of sampling, and the correct full completion of the final bedside check (a rule not a guideline).

Figure 3.7: ABO-incompatible red cell transfusions 2016 to 2018



In addition, there were 3 inadvertent transfusions of ABO-incompatible blood components, 2 of fresh frozen plasma and 1 of cryoprecipitate; no harm resulted. As before, such incidents demonstrate that either local protocols were not in place or not being followed appropriately. All clinical staff involved in transfusion must check compatibility properly at the time of transfusion and is one of the essential steps in the bedside check (BSH Robinson et al. 2018, DH 2017).

Erroneous transfusion of ABO-incompatible blood components almost always reflects a preventable breakdown in transfusion protocols and standard operating procedures and can have disastrous consequences, with significant morbidity and mortality. These incidents need to be investigated in a systematic manner to identify system vulnerabilities to mitigate risks and improve patient safety. Investigations should not focus only on staff failings as in doing so will miss identifying system-wide changes that need to be incorporated to address prevalent issues.

A recent review of NHS England Never Events, 'Opening the door to change' (CQC 2018) revealed 'the failure to reduce the toll of never events tells us there is something fundamental about the safety culture of our health care' and the majority of investigations into never events require human factors-based solutions.

Caution when transfusing patients with very low haemoglobin

It has been well known that both chronic and acute anaemia is associated with compensatory circulatory and cardiac changes irrespective of the aetiology of anaemia (Hegde 2006; Metvier 2000; NATA online and Song 2018). This can be further compounded by the underlying cause for the anaemia for example haematinic deficiency that can independently affect myocardial function. The hyperdynamic circulation related to anaemia increases the load on the heart, causing myocardial ischaemia and hypoxia and if the anaemia is not corrected, eventually leads to heart failure. Clinicians need to be aware of the risks and be vigilant when transfusing patients with severe anaemia with or without other additional risk factors. Details of a couple of such cases can be found in Chapter 17b, Transfusion-Associated Circulatory Overload (TACO).

Delays in transfusion

Delays in transfusion contribute to death and morbidity and are often caused by poor communication between the clinical and laboratory staff. The total number of reports of delayed transfusion has increased with time: 101, 95, 112 reports in the last 3 years. Problems with the management of major haemorrhage were reported in 34 cases in 2018, 19 being delays in transfusion. In 1 case the patient's death was possibly related to the delay. The most important factor in major haemorrhage cases was poor communication, often at several points. In major haemorrhage every minute counts and delays threaten patient safety. All staff working in areas where major haemorrhage may occur must be trained with drills to understand procedures and how to rapidly access appropriate blood components. Teams must ensure debriefs after every incident. Attention needs to be paid to interprofessional team learning to help prevent delays. Every hospital should audit major haemorrhage protocol activations to ensure appropriateness and to learn from each episode. For further details, see Chapter 10a, Delayed Transfusions.

Missed irradiation of cellular components where indicated

Irradiation of cellular components was missed in 81 patients in 2018. In 64/81 (79.0%) cases the error was made in clinical areas and 17 in the laboratory. The cumulative number of reports of patients known to have missed irradiation is now 1478 since 1999. Patients were exposed to one or more components. There have been no cases of TAGvHD reported since 2001 in patients who received leucodepleted red cells. Irradiation of cellular components for susceptible patients was introduced several decades ago and guidelines were published in 1996, and revised in 2010 (BSH Treleaven et al. 2010). The case reported in 2012 was caused by an intrauterine transfusion (IUT) with maternal blood (not leucodepleted, not irradiated and human leucocyte antigen (HLA)-related). None of the 13 cases reported up to 2001 occurred in patients with conditions where irradiation was recommended in the guidelines: 6 occurred in patients with B-cell diseases; 3 after cardiac surgery; 2 had no recognised risk factors. Two others were subsequently found to have immune deficiency. At least 4/13 (30.8%) were documented to have shared HLA haplotypes with their red cell donors and 2 received red cells less than 7 days old.

There is insufficient evidence to recommend any change in practice, but it is important to continue reporting to SHOT so that the evidence can inform change in practice in the future.

Investigating incidents

Incident investigations continue to be an area of concern and are often identified to lack depth, detail and scope. Actions generally identified 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. An effective investigation requires a methodical, structured approach to information gathering, collation and analysis. In general, incidents should be investigated and analysed as soon as possible and identify the right causes through application of the right model. This should identify and implement the right solutions and monitor the impact of the solutions. It is equally important to share lessons learnt with other healthcare professionals. It is vital that investigations avoid routine assignment of blame. Analyses of incidents is a powerful method of learning about healthcare organisations and lead directly to strategies for enhancing patient safety.

Root cause analyses (RCA), a structured facilitated team process to identify root causes of an event that resulted in an undesired outcome is routinely used when investigating adverse incidents. This helps identify breakdowns in processes and systems that contributed to the event and helps develop effective, credible and tangible corrective and preventative actions. Effective RCA should therefore reduce the risk of future harmful events by minimising or eliminating the root causes. Further details can be found in Chapter 25, Medicines and Healthcare products Regulatory Agency (MHRA) Report.

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Key Messages and Recommendations 4

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Transfusions continue to be very safe in the United Kingdom (UK): with approximately 2.3 million blood components issued in the UK in 2018, risks for transfusion as calculated per 100,000 components issued translates to a risk of death close to 1 in 117,000 and of serious harm close to 1 in 21,000 components issued. Pulmonary complications post transfusion and delays in transfusion continue to be the leading causes of death. The number of transfusion-associated circulatory overload (TACO) cases reported to SHOT have increased steadily over the last few years. Key recommendations in this area from the recent SHOT reports including the need to undertake a formal pre-transfusion risk assessment for TACO whenever possible and using weight-adjusted red cell dosing to guide the appropriate number of units required for all nonbleeding adult patients (Bolton-Maggs et al. 2018 and Grey et al. 2018) continue to be applicable.

Since SHOT (the UK confidential haemovigilance reporting scheme) began in 1996, the key messages and the recommendations have been vital in improving transfusion safety and have impacted practices right from the selection and management of donors to changes in hospital practices with improvements in education and training. However, despite these measures, most incidents continue to result from mistakes, often multiple, in the transfusion process. Similar themes emerge in the incidents reported with poor communication among staff, gaps in knowledge and training, instances of poor clinical decision making, deviations from standard procedures, staffing issues and overall prevalent culture in teams and organisations that prevent learning from experience and inhibit improving transfusion and patient safety.

It is time to have a holistic approach towards achieving safer systems in healthcare. Rather than solely focussing on safety of particular processes, there is a need to rethink strategy and consider the people involved, addressing their behaviours, attitudes, relationships and culture. It is important to decentralise safety, empower professional judgement in all staff and see people as resources to harness not problems to control. While recording, reporting and trending are important, we need to actively move from a reactive system to a proactive system. Recording and learning from ‘near misses’ is a step in this direction and such events continue to account for a large proportion of the incidents reported to SHOT (1451/3326, 43.6%) and have increased in 2018, n=1451, compared to n=1359 in 2017. Identifying and investigating near misses is a key element to finding and controlling risks before actual harm results. These can significantly improve transfusion safety and enhance the safety culture within healthcare.

The long term aims 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.

Key SHOT messages

- **Learning from near misses:** Identifying and investigating near misses is a key element to finding and controlling risks before actual harm results. These can significantly improve transfusion safety and enhance the safety culture within healthcare
- **Investigating incidents:** Investigations must be systematic and thorough, proportionate to the risk and impact and identify systems-based corrective and preventative actions. It is important to review whether the corrective actions were successful in improving patient safety. Systemic and organisational problems should be fully investigated, as staff related amendments are less likely to resolve underlying systemic issues
- **Rethinking transfusion education:** Transfusion training with technology enhanced learning for all healthcare professionals should be geared towards delivering a high quality patient care as members of a multidisciplinary team, in addition to a thorough and relevant knowledge base in transfusion, clinical and laboratory staff must be trained in patient safety principles with recognition of human factors and quality improvement approaches. Multiprofessional learning 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)
- **Staffing challenges:** These are often quoted as contributory in many events reported to SHOT. 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. This is a systemic or management issue, not an individual one. Addressing this key issue will help towards reducing and capturing human error. Under-reporting of incidents reduces learning opportunities and is a problem if understaffing means known incidents are not reported
- **Standard operating procedures (SOP):** Many incidents reported to SHOT appeared to result from failure to follow correct procedures. The types of reported deviations include: not following stipulated steps; skipping steps; accidental omissions; performing activities without authorisation; doing additional activities; inadequate processes; wrong procedure being performed. SOP need to be simple, clear, easy to follow and explain the rationale for each step. This will then ensure staff are more engaged and more likely to follow the SOP

Recommendations

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 recommendations from the previous Annual SHOT Reports remain pertinent. All healthcare organisations involved in transfusion are encouraged to continue implementing these and ensuring measures have been effective. The following system based strategies will help improving transfusion and overall patient safety.

The framework of a just and learning culture

There is an urgent need to have a culture shift, a significant change from a culture using an approach to deal with system errors punitively. It is one that has prevented learning, listening, openness, honesty, excellence in care and ultimate patient safety. NHS organisations need to continuously develop systems that recognise and deal with people in a 'just' way, acknowledging through learning to support the changes required when people make errors. Sometimes those errors can be human, or behavioural choices and some through system error. Staff should encourage each other to see errors as events and those events as opportunities to learn, which in turn will improve understanding while encouraging one another to be honest in disclosure without fear of retribution in every learning and supportive organisation. The framework of a just culture ensures balanced accountability for both individuals and the organisation responsible for designing and improving systems in the workplace. The 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 will help empower employees to proactively monitor practices at the workplace and ensure safety. Risk reduction will be achieved by focusing on human behaviours and redesigning systems.

The Institute for Healthcare Improvement's (IHI) 'Leading a Culture of Safety: A Blueprint for Success' (IHI 2017) suggests that leaders seeking to transform their organisation's culture would do well to commit focused attention on six key areas:

- Establishing a compelling vision for safety
- Building trust, respect, and inclusion
- Educating and engaging board members in patient and workforce safety issues
- Emphasising safety in the development and recruitment of clinical leaders and executives
- Adopting just culture principles to focus on systems flaws over individual blame when things go wrong
- Setting and modelling behaviours such as transparency, active communication, and civility as expectations for all

In healthcare, while each of these is an essential element for leaders to address, they are also interdependent. It is critical for health leaders to recognize that safety (transfusion safety, medication safety and overall patient safety) — or the lack of it — impacts many other elements within their organisations, from reputation to financial health to staff retention. Safety must become a core value in all organisations.

When things do go wrong, patients and their families expect three things: to be told honestly what happened, what can be done to deal with any harm caused, and to know what will be done to prevent a recurrence to someone else. All healthcare professionals have a duty of candour. The General Medical Council (GMC) and Nursing Medical Council (NMC) have provided guidance applicable to all doctors, nurses and midwives registered with GMC and NMC across the UK. These can be accessed using the following links:

https://www.gmc-uk.org/ethical-guidance/ethical-guidance-for-doctors/candour---openness-and-honesty-when-things-go-wrong and https://www.nmc.org.uk/standards/guidance/the-professional-duty-of-candour/read-the-professional-duty-of-candour/. Every healthcare professional must be open and honest with patients when something that goes wrong with their treatment or care causes, or has the potential to cause, harm or distress. They must also be open and honest with their colleagues, employers and relevant organisations, and take part in reviews and investigations when requested. In addition, they must be open and honest with their regulators, raising concerns where appropriate. Staff must support and encourage each other to be open and honest, and not stop someone from raising concerns. It is only through this approach that healthcare professionals can work together with patients to make systems safer and restore the confidence that the public places in our healthcare services.

Main recommendation 1

- All National Health Service (NHS) organisations must move away from a blame culture and towards a just and learning culture. This is vital to ensure that NHS organisations recognise and deal with people in a just way, acknowledging through learning to support the changes required when people make errors. Sometimes those errors can be human, or behavioural choices and some through system error

Action: Hospital Chief Executives and Medical Directors, National Blood Transfusion Committee, Hospital Transfusion Teams

Human factors

Human factor approaches should underpin all patient safety and quality improvement practices, offering an integrated, evidence-based and coherent approach to safety, quality and excellence of care provided. For the last few years SHOT has highlighted the importance of human factors and ergonomics (HFE) when reporting transfusion incidents. Since 2016 a human factors investigation tool (HFIT) has been linked to the SHOT online reporting database and lessons learned from those questions have been published in the last two Annual SHOT Reports (Bolton-Maggs et al. 2017 and 2018). From January 2017 a self-learning package was made available to help reporters consider all human factors aspects of adverse incidents https://www.shotuk.org/reporting/human-factors-tuition-package/ and in January 2018 a link to a simple animated video demonstrating healthcare human factors was also added https://t.co/qTeUoPiUlq. However, the uptake has been disappointing with difficulties in IT access and WiFi availability among the reported factors.

All staff in the NHS must be familiar with HFE concepts. To truly improve transfusion and overall patient safety, we need much more than just awareness of these principles. HFE concepts need to be integrated into all healthcare systems. In 2004, the National Patient Safety Agency (NPSA 2004) recommended the use of Human Factors as part of the 'Seven Steps to Patient Safety'. There has been good progress since then including a National Concordat bringing together several NHS organisations. SHOT support the NPSA/National Concordat recommendations and all hospitals should consider how these are implemented with respect to transfusion.

There is an increasing momentum to widely adopt HFE approaches in the NHS. These include a national recommendation for accredited healthcare tailored HFE education (HEE 2016, Hignett et al. 2016) and engagement with HFE expertise for the review of incidents (Department of Health 2015). The Healthcare Safety Investigation Branch (HSIB) Annual Review 2017/18 states that their investigation model is based on a deep knowledge of human factors (HSIB 2018, p.2). The Care Quality Commission (CQC) document Quality Improvement in Hospital Trusts encourages a systems approach to quality improvement in hospitals (CQC 2018a, p34) and their analysis of Never Events in 2017-18 highlights that the overwhelming majority require human factors based solutions (CQC 2018b, p4). The GMC has published plans to embed human factors into the investigations of adverse events by rolling out human factors training to all the fitness to practise decision makers, case examiners and clinical experts (GMC 2018). The NMC first included reference to human factors in their code of conduct published in 2015 and this was recently updated in October 2018 (NMC 2018, p17).

SHOT strongly encourages all staff involved in transfusion to attain as much knowledge as possible about HFE principles that can be incorporated into their day-to-day work. Understanding HFE would be particularly useful when investigating serious incidents in order to identify system and organisational problems, which could lead to more effective corrective and preventative actions. It will be of great help to encourage the contribution of professional (qualified) Ergonomists & Human Factors Specialists via consultation and employment.

HFE expert facilitated systemic incidents analysis with healthcare stakeholders can potentially enable effective and efficient patient safety incident investigation identifying remedial actions on underlying system issues beyond individual issues. HFE practitioners could assist at organisational and/or regional level.

Main recommendation 2

- All clinical and laboratory staff should be encouraged to become familiar with human factors and ergonomics (HFE) concepts. All healthcare organisations should consider employing a qualified HFE professional and encourage healthcare professionals to collaborate with HFE experts and quality improvement professionals - this approach will help develop and embed sustainable system level improvements and maximise learning opportunities from adverse incidents

Action: Hospital Chief Executives, Hospital Risk Managers and Hospital Transfusion Teams

Making better transfusion decisions

It is evident from several reported cases in the Annual SHOT Report that fundamental errors are being made in making transfusion decisions, see Chapter 10, Avoidable, Delayed or Under/Overtransfusion (ADU). There are continued reports of transfusions in patients with haematinic deficiency without any evidence of bleeding or haemodynamic compromise. There were 27 cases of avoidable O D-negative red cells, a precious and limited resource. Delays in transfusion continue to be of concern. Delays in recognition of gastrointestinal bleeds and errors in communication are common. TACO reports continue to rise, while this could be due to increased awareness and therefore higher reporting, clinicians need to be vigilant and assess patients and have a holistic approach individualised to each patient when taking transfusion decisions. As recommended previously, using a TACO checklist will help identify and potentially address risk factors in a timely manner. Basic errors such as clinicians acting on erroneous blood results (see Chapter 23, Paediatric Cases) have resulted in transfusion errors. It is of paramount importance that personnel interpreting blood results understand potential variables which will make laboratory tests unreliable.

Tools such as the one below are a simplistic approach to promote better decision making in day-to-day transfusion practice thus improving patient blood management and patient safety. ABC and its variations are initialism mnemonics for essential steps used in resuscitation when dealing with a patient. A similar ABCDE approach to facilitate decision making in transfusion is proposed which will promote evidence-based decisions and safer patient care (see Figure 4.1).

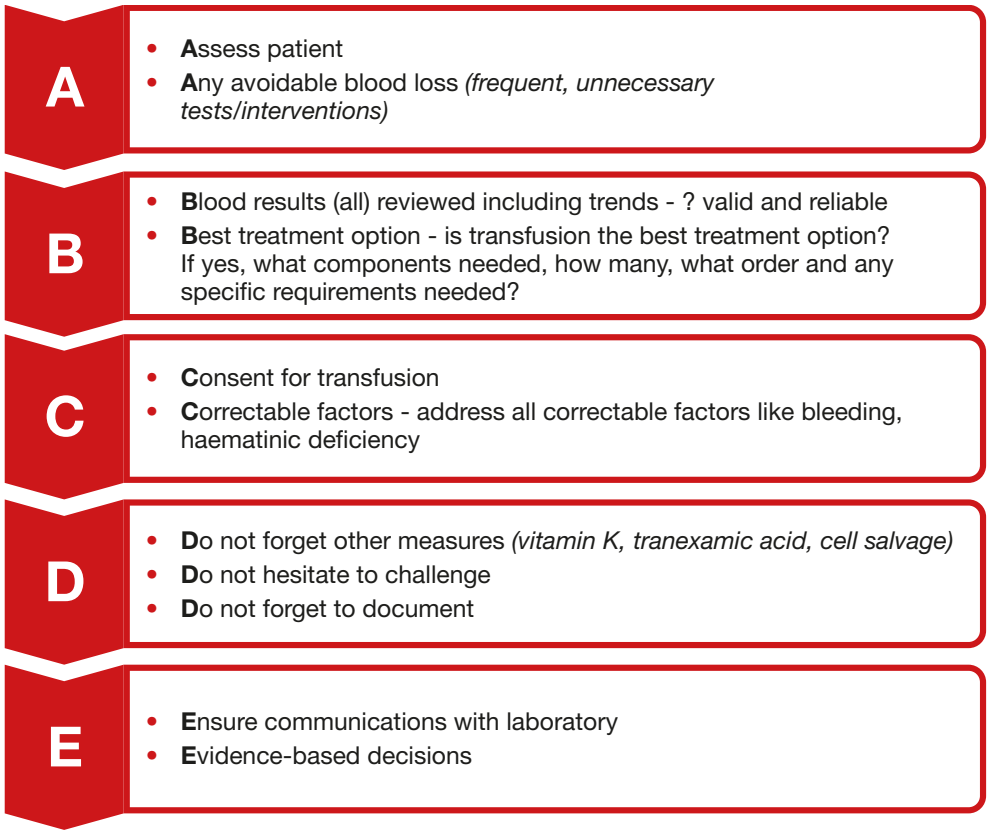


Figure 4.1: The A-E Decision Tree to facilitate decision making in transfusion

All transfusion decisions must be made after carefully assessing the risks and benefits of transfusion therapy and clinicians should base their decision whether to transfuse blood components on the patient's complete clinical picture and not quantitative criteria only. Transfusing patients when medically necessary and not delaying transfusions when clinically warranted is key to promoting patient safety. All patients should be assessed prior to transfusion so that optimal measures can be undertaken to prevent and manage potentially preventable complications such as TACO.

Main recommendation 3

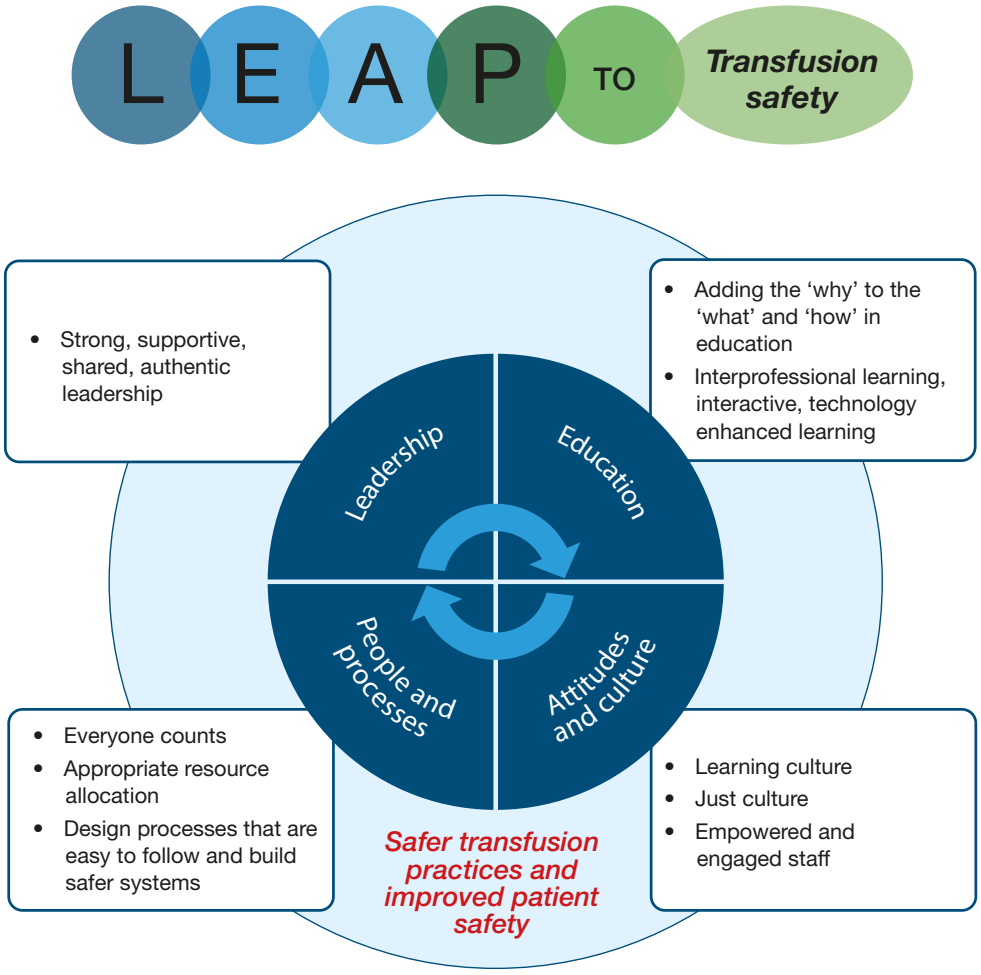
- All transfusion decisions must be made after carefully assessing the risks and benefits of transfusion therapy. Clinical and laboratory staff must work collaboratively and in a co-ordinated fashion to be able to deliver individualised, holistic, patient-centred care

Action: All staff involved in transfusion practice

Bringing these all together

Based on the above key messages and recommendations, the following matrix covers all the key aspects to improving transfusion safety and overall patient safety. Improvements need to be focussed in all these areas to be effective.

Figure 4.2: LEAP to transfusion safety



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5 Donor Haemovigilance

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Definitions:

Donor haemovigilance:

The systematic monitoring and surveillance of donor adverse events.

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

- Donor safety is of paramount importance and is assured, in as far as it can be, by donor selection guidelines, standard operating procedures, adequately trained staff and appropriate facilities. Despite these measures, various adverse events and reactions can and do occur during and after blood donation
- The rate of serious adverse events of donation (SAED) in 2018 was 0.23 per 10,000 donations in the United Kingdom (UK) or 1 SAED per 43,794 donations approximately. This rate is similar to previous Annual SHOT Reports. SAED are therefore very rare, making blood donation a generally safe process
- Donor problems related to needle insertion persisting for more than a year and vasovagal events resulting in donor hospitalisation or injury continue to be the most frequently reported SAED
- 70% of the donors who suffered a SAED were withdrawn from the active donor panel
- Blood Services have a duty to take reasonable care to ensure that donors are aware of 'material risks' of blood donation

This chapter presents data from the four UK Blood Services on SAED, with illustrative cases and recommendations for donor care. Numerator and denominator data for each Blood Service is also presented.

Background

Blood donation remains a voluntary, independent and altruistic act that is essential to patient care across several medical and surgical disciplines. Although generally safe, complications do sometimes occur. Keeping adverse consequences as low as possible is a duty of collection facilities with regards to quality of care and is vital to sustain adequate blood supply.

Good donor care not only involves the implementation of measures to minimise the risks to donors and the subsequent management of any adverse reactions, it also requires informing donors of the material risks of blood donation. The Montgomery v Lanarkshire case of March 2015 drew fresh attention to informed consent (Chan et al. 2017). Simply providing the information and getting a signature on the consent section of the health check questionnaire may not be enough to evidence proper consent. Blood Services have a responsibility to share the risks of donation with potential donors so that they are fully aware of what complications may ensue.

Complications related to blood donations are adverse reactions and events with a temporal relation to a blood donation. Complications are broadly classified into two main categories: those with predominantly local symptoms and those with predominantly generalised symptoms. The actual knowledge of adverse reactions among blood donors is limited to a few publications issued from large surveys in the United States (2008), Denmark (2008), Japan (2009) and Switzerland (2011), which reported incidence rates varying from 0.82% to 3.48% (Gavillet et al. 2013). The collection of these data rely on donors notifying the Blood Service of any adverse reactions. Newman et al. (2013) suggested that minor and delayed events are likely to be under-reported, as an overall complication rate of 36% was found after systematically interviewing blood donors three weeks after collection.

Presyncopal reactions and haematomas represent most events, while severe complications are very rare (5-74 of 100,000 donations) (Gavillet et al. 2013). Adverse events reduce the likelihood of a second donation as only a quarter of donors who have suffered a syncope will return for future donation (France et al. 2004).

The wide variability of complication rates observed in these studies may reflect the lack of standardised reporting practice. The 2008 International Society of Blood Transfusion (ISBT) standard for surveillance of complications related to blood donation introduced a classification with descriptions of types of complications. Subsequent revisions were made to this document so that the definitions were easy to apply in a standardised way and they aligned with those used in the AABB donor haemovigilance system (Goldman et al. 2016, ISBT 2014). The current classification system, which has been implemented by all four UK Blood Services, allows for benchmarking for donor adverse events both internally in the UK and internationally. It also enables monitoring of the effectiveness of any interventions to reduce event rates. SAED should all be fully investigated with a root cause analysis or similar tool to ensure that proper preventative and corrective actions are implemented. European legislation (European Blood Directives 2002/98/EC and 2005/61/EC) which has been subsequently transposed into UK law through the Blood Safety and Quality Regulations (BSQR) mandates that blood establishments notify the competent authority in their country of any serious adverse events or reactions. Each Blood Service therefore submits to the Medicines and Healthcare products Regulatory Agency (MHRA) an annual overview of SAED and adverse events related to the quality and/or safety of blood or components in donors and recipients.

Data

The following table summarises the whole blood and apheresis donations collected in the four UK Blood Services last year with a total of 1,883,153 donations (whole blood and components) collected.

Table 5.1: Cumulative data from the UK Blood Services 2018

Donations from 2018		NHSBT	SNBTS	NIBTS	WBS
Whole blood	Donations from male donors	689,467	68,316	23,392	50,662
	Donations from female donors	811,741	82,958	21,106	47,146
	Donations from new donors	168,342	14,380	5,119	11,586
	Donations from repeat donors	1,332,866	136,894	39,379	86,222
Apheresis	Donations from male donors	65,646	8,229	3,863	2,137
	Donations from female donors	7,170	567	387	366
	Donations from new donors	224	0	76	77
	Donations from repeat donors	72,592	8,796	4,174	2,426
Total number of donations in 2018		**1,574,024**	**160,070**	**48,748**	**100,311**

The following table provides information related to the total number of donations, number of whole blood donations, component donations and total number of SAED reported by each of the UK Blood Services for the calendar year 2018 (January - December).

Table 5.2: Summary of SAED from the 4 UK Blood Services for the calendar year 2018 (January - December)

	NHSBT	SNBTS	NIBTS	WBS
Whole blood donations	1,501,208	151,274	44,498	97,808
Apheresis/component donations	72,816	8,796	4,250	2,503
Total donations	1,574,024	160,070	48,748	100,311
Total number of donors SAED	**34**	**5**	**2**	**2**

Rate of SAED per 10,000 donations in the UK:

This equates to a rate of 0.23 SAED per 10,000 donations or 1 SAED per 43,794 donations approximately

In total, there were 43 SAED reported, of which 34 were reported from NHSBT, 5 from SNBTS, 2 from NIBTS and 2 from WBS. It is recognised that there is variation in the number/rate of SAED reported from each Blood Service. Factors contributing to this are being explored through a joint Joint UK Blood Transfusion and Tissue Transplantation Services Professional Advisory Committee (JPAC)/SHOT working group so that there is better harmonisation across the Blood Services. The SAED reported from the four UK Blood Services in 2018 fell into the following reporting categories:

SAED by category in 2018	
01. Death within 7 days of donation	1
02. Hospital admission within 24 hours of donation	12
03. Injury resulting in a fracture within 24 hours (including fractured teeth)	9
04. Road traffic collision (RTC) within 24 hours of donation	1
05. Problems related to needle insertion persisting for more than a year or requiring hospitalisation/intervention	16
06. Acute coronary syndrome (ACS) diagnosed within 24 hours of donation	1
07. Anaphylaxis	0
08. Haemolysis	0
09. Air embolism	1
10. Other event	2 (DVT*)
Total SAED in 2018 reported	**43**

**Deep venous thrombosis (both upper limb)*

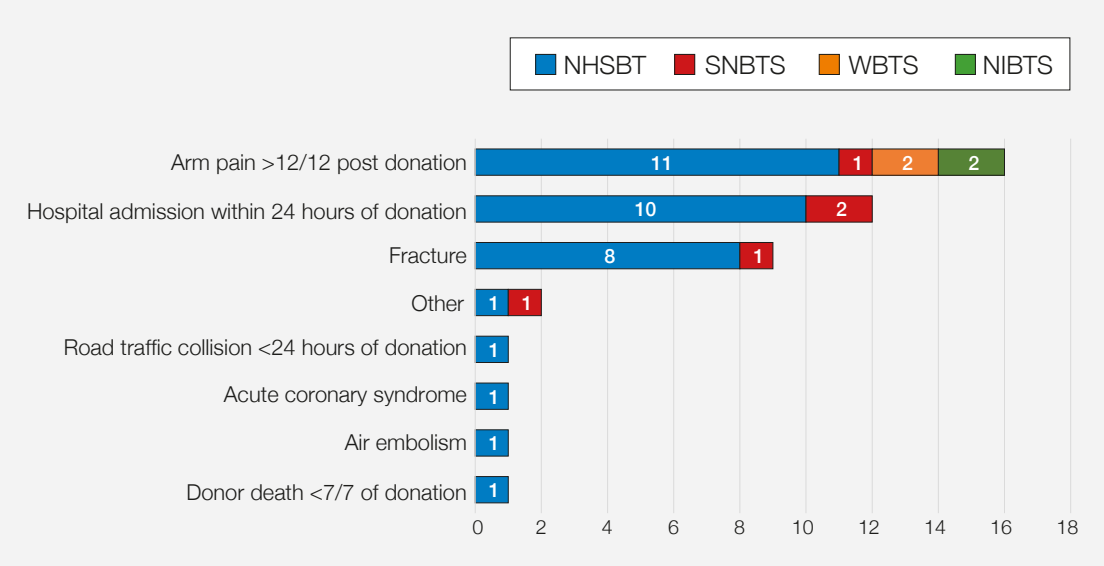


Figure 5.1: SAED by category in 2018

NHSBT=National Health Service Blood and Transplant; SNBTS=Scottish National Blood Transfusion Service; WBS=Welsh Blood Service; NIBTS=Northern Ireland Blood Transfusion Service

As illustrated above, the two most common events were donors who reported problems related to needle insertion persisting for more than a year (rate of 0.08 per 10,000 donations) and donors who required hospital admission within 24 hours of donation (rate of 0.06 per 10,000 donations). Two thirds of the hospital admissions were due to vasovagal reactions, and eight of the nine injuries resulting in fracture were due to vasovagal reactions.

There was one donation-related death. A regular platelet donor in their mid-60s died 4 days following an uneventful donation. The donor had previously donated over 200 times without any documented adverse events apart from one episode of bruising. The health check questionnaire raised no health concerns, there were no deviations from procedure, and no Blood Service fault was identified following investigation. This was supported by the post-mortem examination; cause of death was coronary artery atherosclerosis, resulting in a severe myocardial infarction.

Comparison with previous years

The four UK Blood Services have produced an annual summary report to SHOT of SAED recorded since 2015. The 2018 figures are similar to the previous three years:

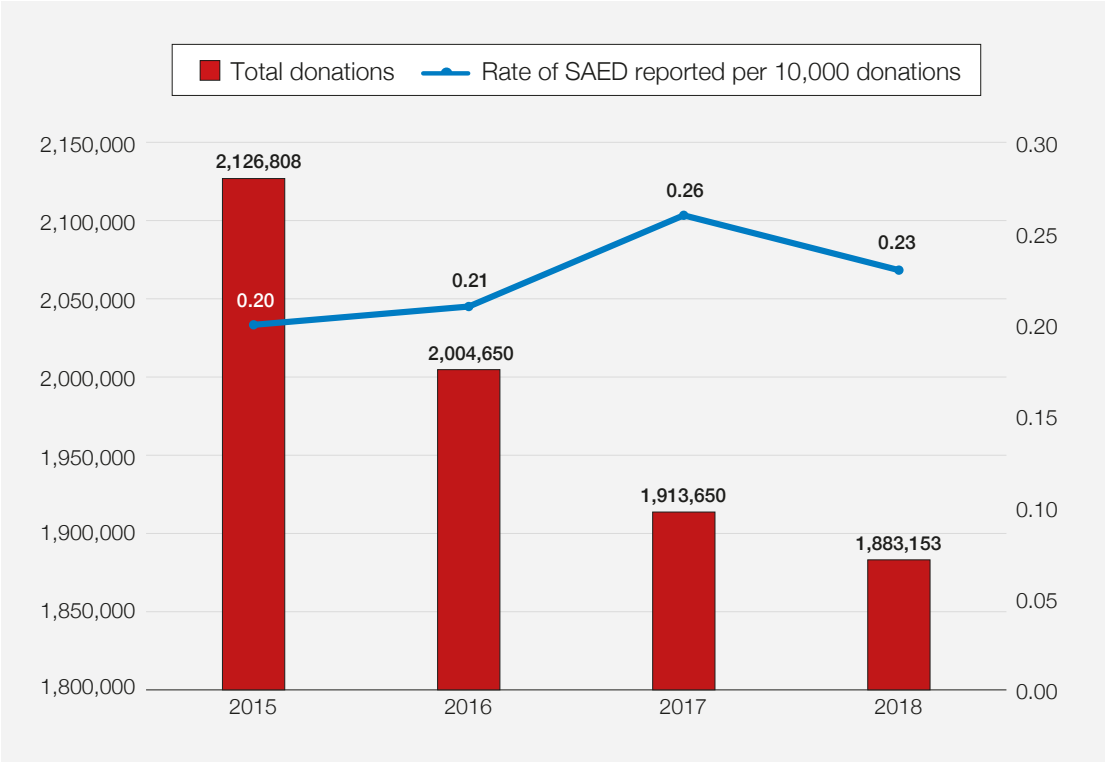
2015: 37 SAED; 0.20 SAED per 10,000 donations (1 per 50,000 donations)

2016: 42 SAED; 0.21 SAED per 10,000 donations (1 per 47,730 donations)

2017: 50 SAED; 0.26 SAED per 10,000 donations (1 per 38,273 donations)

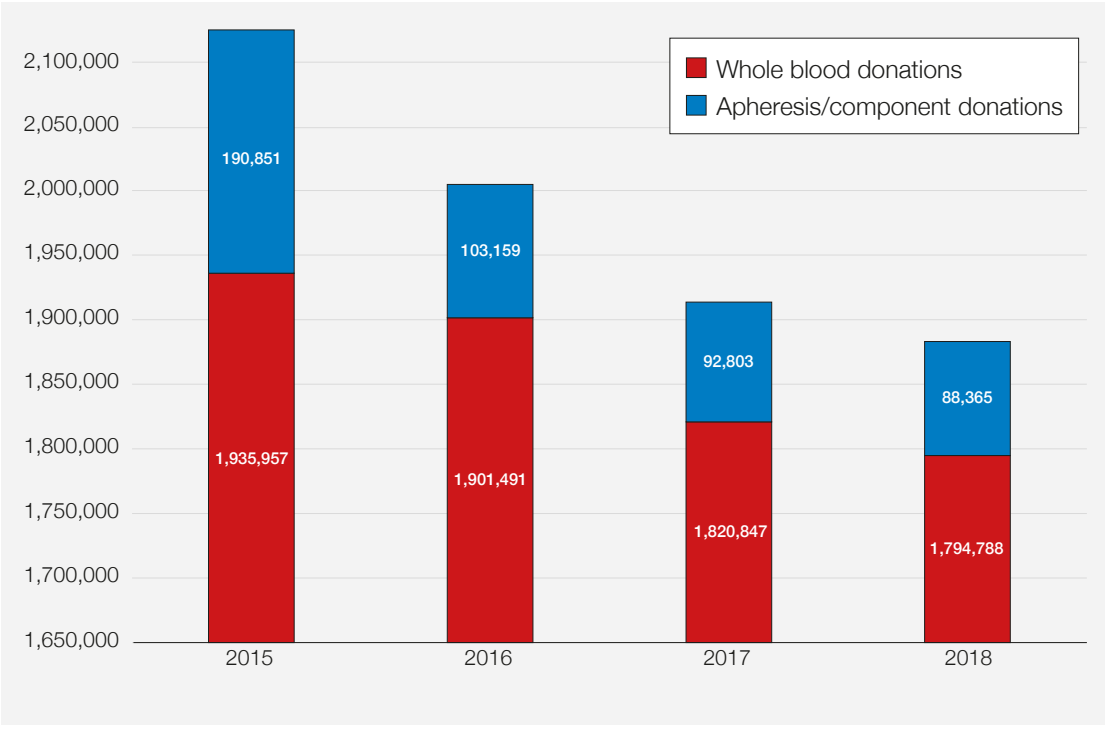
The trend in the rates of SAED reported per 10,000 donations in the last 4 years are illustrated in Figure 5.2.

Figure 5.2: Rate of SAED reported per 10,000 donations in the UK from 2015-2018



It is important to keep these events in proportion: approximately 2 million donations have been collected across the UK annually over these years and serious incidents are rare.

Figure 5.3: Trend in number of donations collected in the UK



Case examples of SAED

Case 5.1: Venepuncture-related persistent arm pain more than one-year post donation

A regular female whole blood donor who had donated 13 times previously without any adverse event, reported persistent problems with her donation arm >1-year post donation. She remembered the donation being initially slow. This prompted staff to reposition the needle, which immediately resulted in discomfort. The donor did not report this symptom at the time and a full donation was taken. The donor was left with a constant pain at the venepuncture site with an intermittent stinging sensation travelling up her arm towards her shoulder joint. Although her range of movement was preserved, she described her arm as heavy and occasionally supported it with a cushion. She had no local bruising. The donor was referred to a vascular surgeon and clinical neurophysiologist. A small neuroma was queried however this was excluded by a normal ultrasound scan. No evidence of a peripheral nerve lesion was evident on nerve conduction studies. The donor has been withdrawn from blood donation.

Venepuncture-related arm problems do occur and can have debilitating long term effects due to on-going pain and restricted function. Needle-related complications include haematoma, arterial puncture and painful arm, which may result from nerve irritation through a haematoma or from direct injury to a nerve or other structure (ISBT 2014). Phlebotomy best practice has suggested that for venepuncture the inserted needle should be placed superficially, and the medial aspect of the antecubital fossa should be avoided. Minimizing needle movement while in situ is probably also wise; however, taking the high anatomic variability into account, the risk of inadvertent nerve damage is still a possibility (Ramos et al. 2014). Peripheral nerve injuries are defined by a persistent burning, shooting, electrical-type pain or paraesthesia in a specific nerve distribution, which begins immediately while the needle is in situ, or can be delayed for several hours thereafter. Pain in the arm, without characteristics of nerve irritation, may be related to tissue injury, possibly due to a haematoma in the deeper tissues. Donation staff must be aware of these possible complications and advise donors properly during acquisition of informed consent. Some donors may be reluctant to report any venepuncture related pain or discomfort. It is therefore important that staff check with the donor if they have any of these symptoms, as the needle should be removed immediately to minimise the risks of any long-term injury.

Case 5.2: Rare complication of DVT post venepuncture

A regular female donor felt that her arm was a little tight and tender after giving blood; no bruising was noted. From 2 days post donation, her upper limb and ipsilateral chest wall became increasingly red, swollen, itchy, sore and heavy; the veins appeared prominent when compared with the left side (Urshel's sign). The donor was short of breath on minimal exertion. She contacted the Blood Service 1-week post donation and was advised to attend the emergency department urgently. An extensive upper extremity deep venous thrombosis (UEDVT) and pulmonary embolus (PE) were confirmed. She was discharged on Rivaroxaban and will likely remain on this, with follow up, for at least 6 months. The donor's only risk factor for UEDVT was use of the combined oral contraceptive pill (OCP), commencing a few weeks prior to this donation. The donor has been withdrawn from blood donation.

UEDVT as a complication of blood donation is extremely rare with only a small number of published cases reported in the literature. Donors most commonly presented with progressive arm pain, arm swelling, and a bruise (Newman et al. 2015). It is recognised and included in the international classification of adverse events of donation. UEDVT may involve the axillary, subclavian and brachial veins (Campbell et al. 2012). These account for up to 10% of all DVT (Flinterman et al. 2008), and occur with a rate of around 16 per 100,000 of the population per annum (Spencer et al. 2007). Donation in this instance, with associated decrease in blood volume, in an individual at slightly higher risk due to the combined OCP, appears to have affected Virchow's triad and triggered clot formation. Risk factors for UEDVT are like those for lower extremity DVT, with the notable exception of thrombophilic coagulation defects (Haba et al. 2017). PE is a complication in 5-8% of cases of UEDVT (of any cause) with mortality of 0.7% (Mintz et al. 2017). However, data suggests that the incidence of PE, especially subclinical PE, may in fact, be higher (up to 36%), as symptoms and signs can be minimal (Mintz et al. 2017). Post thrombotic syndrome can also complicate UEDVT in up to 13% of all cases of UEDVT (primary and secondary UEDVT) (Mintz et al. 2017).

Rare complications of blood donation, like DVT, can occur. Blood Services should encourage donors to make early contact with the Blood Service if they experience arm complications so that they can be appropriately investigated and managed.

Case 5.3: Delayed vasovagal reaction resulting in injury/fracture and hospitalisation within 24 hours post donation

A regular female whole blood donor who had donated over 30 times previously without any adverse event, reported that she had fainted on the evening following her donation. The donor gave a whole blood donation in the afternoon without any adverse event. The donor went out for a meal in the evening. During the meal the donor became warm and stood up to take her sweater off, the donor then lost consciousness falling forward onto her face. The donor sustained facial injuries including maxillae fractures. Surgery was performed the following day and the donor was discharged from hospital 2 days later. 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 physiologic 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 (Kamal 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.

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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 [2003] OJ L33/30. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32002L0098 [accessed 30 May 2019].

Commission Directive 2005/61/EC of 30 September 2005 implementing Directive 2002/98/EC of the European Parliament and of the Council as regards traceability requirements and notification of serious adverse reactions and events [2005] OJ L 256/32. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32005L0061%20&from=EN [accessed 30 May 2019].

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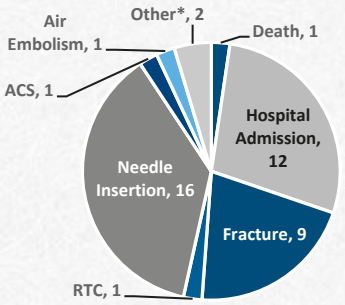
Figure 5.4: Summary of Serious Adverse Events following Blood donation reported to the UK Blood Services in 2018

Serious Adverse Events following Blood Donation reported to the UK Blood Services in 2018

In 2018 the UK Blood Services collected approximately 1.9 million donations. Forty three serious adverse events of donation (SAED) were reported (1 in 43,794 donations). Serious adverse events are very rare following blood donation but do occur and can have a significant impact on donor health and donor retention.

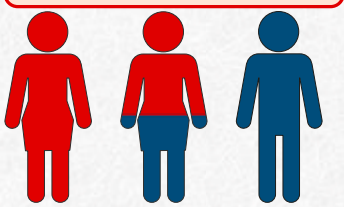
Breakdown of Serious Adverse Events in 2018

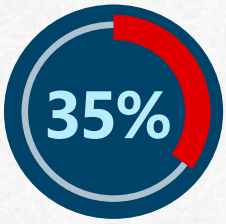
SAED Categories n=43



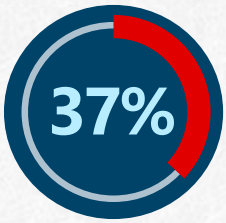
RTC=road traffic collision, ACS=acute coronary syndrome
**Other = Upper limb deep vein thrombosis*

Female donors accounted for 23/43 (53%) SAED





15/43 SAED were as a direct result of a vasovagal reaction



16/43 SAED were related to persistent arm problems 12/12 post donation

7/10 donors who suffered an SAED were withdrawn from future donations

2/43 SAED related to upper limb deep vein thrombosis following donation.

8/9 fractures were related to vasovagal reactions, 4 immediate and 4 delayed reactions.

1 report of a donor death <7 days of donation and 1 report of acute coronary syndrome <24 hours of donation.

Key Messages

Donor safety is of paramount importance and is assured, in as far as it can be, by donor selection guidelines, standard operating procedures, adequately trained staff and appropriate facilities.

Complications during or following donation can happen despite the safety measures in place

Arm problems relating to needle insertion persisting for more than a year and vasovagal events resulting in donor hospitalisation or injury continue to be the most frequently reported SAED

ERROR REPORTS

6 Human Factors in SHOT Error Incidents n=2905

Author: Alison Watt

Key SHOT messages

- Incident investigators should analyse events fully to uncover all system failures, because research has shown it is uncommon for an individual staff member to be solely responsible for an incident. If the investigation places too much emphasis on human error, the opportunity may be lost to prevent further incidents by amending underlying system issues
- Knowledge and understanding of human factors and ergonomics principles will help reporters to assess all aspects of incidents to promote further learning
- Analysis of error cases reported to SHOT continues to show that previous SHOT recommendations, learning points and key messages have not always been fully implemented. SHOT suggest a periodic review of these using the relevant Annual SHOT Report tools that are available in the resources section of the SHOT website, including both current and archived resources https://www.shotuk.org/resources/
- SHOT strongly encourage hospital staff to participate fully in the National Comparative Audit of Blood Transfusion (NCA) vein to vein continuous voluntary audit

For the last few years SHOT has highlighted the importance of human factors and ergonomics (HFE) when reporting transfusion incidents. Since 2016 a human factors investigation tool (HFIT) has been linked to the SHOT on-line reporting database (Dendrite™), which asks reporters to score four factors out of 10: Staff, environment (e.g. local workspace), organisation (e.g. Trust/Health Board issues) and government/regulatory factors. Lessons learned from those questions have been published in the last two Annual SHOT Reports (Bolton-Maggs et al. 2017 and 2018). The major conclusions in both years were that scores attributed to staff members as a cause of error were higher than scores given to other potential human factors. From January 2017 a self-learning package was made available to help reporters consider all the human factors aspects of adverse incidents https://www.shotuk.org/reporting/human-factors-tuition-package/ and in January 2018 a link to a simple animated video demonstrating healthcare human factors was also added https://t.co/qTeUoPiUlq. It is disappointing that in 102/2905 (3.5%) cases the reporter identified that they could not access a video from their organisation's information technology (IT) system, hence could not view the human factors presentation. This comment related to 36/191 (18.8%) of the different reporting organisations that submitted reports to SHOT in 2018.These were mainly National Health Service (NHS) Trusts/Health Boards, but also included some independent healthcare providers. In an era when many individuals can access media such as videos from their mobile phone, outdated or restricted institutional IT in nearly 1 in 5 healthcare organisations may be reducing opportunities to enhance learning, not only of HFE principles, but also any other video-based education and continuing professional development.

Figure 6.1 shows the comparison of percentage scores given for the four human factors categorised by the uptake of self-learning opportunities by reporters. The percentages in the labels of each column for 2017 and 2018 represent the cases pertaining to that category, i.e. approximately three-quarters of cases were reported by individuals who had availed themselves of that learning opportunity, while in about a quarter of cases the reporter had not stated they used the self-learning material. These data show that over the last three years, there has been very little change in the distribution of scores given to

the four human factors, although the trend across the three years is to assign slightly less responsibility to the staff members, especially if the self-learning package has been read.

A statistical analysis of the data from all three years since the HFIT was introduced has shown there is some limited evidence that the use of self-learning led to a reduction in the extent to which reporters attributed staff as a cause of the incident, p=0.10. There is strong evidence that the use of self-learning increased the extent to which reporters attributed environment, organisation, and regulation as contributing to the incident, p<0.0001 for all three human factors. Therefore, when the incident reporter has used some form of self-learning, the attribution of culpability to staff is reduced and for each of environment, organisation, and government/regulatory is increased. SHOT strongly encourages reporters to use human factors and ergonomics principles to help assess all causes of an incident.

It is uncommon for an individual staff member to be solely responsible for an incident and research has shown that 90% of quality lapses are defined as blameless for the individual (Karl and Karl 2012 and Reason 1997). If the investigation of incidents places too much emphasis on human error, the opportunity to resolve underlying system problems may be lost. As an illustration 427/2905 (14.7%) cases were scored as 10/10 for 'attributable to unsafe practice by individual staff member(s)', with no scores given for any other system problem. Of these cases, 83/427 (19.4%) gave an answer to a new question asked for the first time in 2018 'If you could change one thing to make this incident less likely to happen again, what would it be?'. Many of these replies indicated a change in the system, which suggests the cause of incident is unlikely to have been solely attributable to a staff member. A few examples of system changes listed are:

- Vein to vein blood sampling and labelling (similar comments were made several times)
- A biomedical scientist (BMS) should issue all components day and night
- The clinic sheet did not contain the patient's D group; column now added to the document
- Implementation of the bedside checklist, which is currently in progress
- A range should be developed to reduce calculation errors for neonates and children
- Use electronic communication, not an old fashioned written book
- The correct patient's notes must be on the correct patient's bedside
- Better understanding of iron deficiency anaemia and the risks of transfusion-associated circulatory overload (TACO)

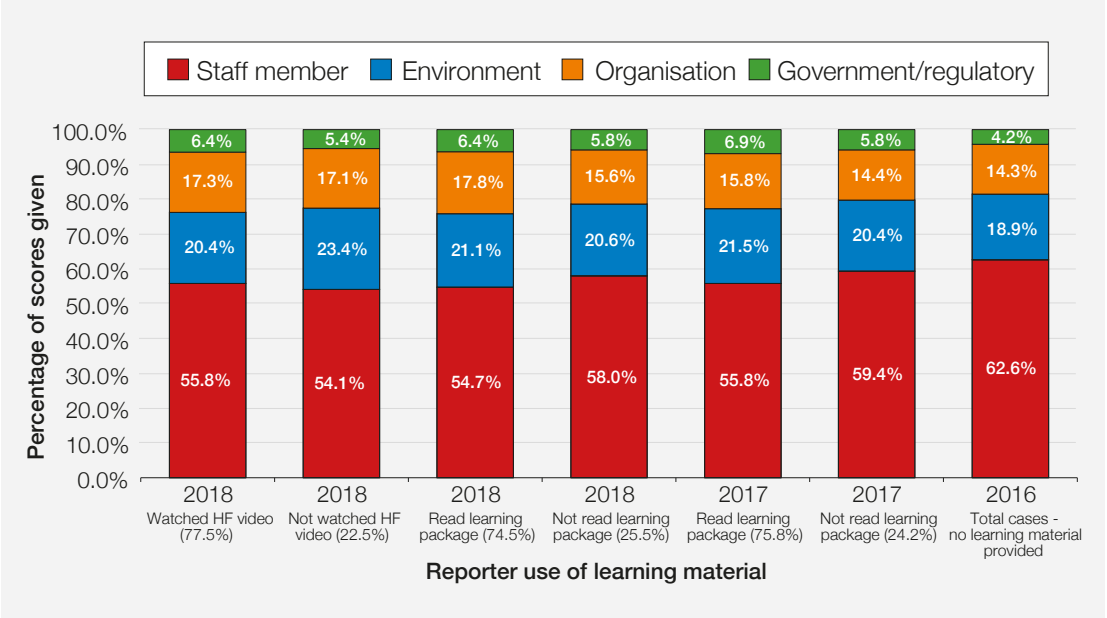


Figure 6.1: Evaluation of uptake of self-learning opportunity and comparative percentages of scores for human and organisational factors

Percentages in column labels=proportion of cases where the reporters used/did not use learning material

HF=human factors

Case 6.1: Culpability attributed solely to staff member(s), but system problems also identified

The clinical picture and observations supported acute blood loss, so fluids were started in recovery and a venous blood gas was taken (now thought to be from the drip arm). The haemoglobin (Hb) result was 50g/L compared to a preoperative Hb of 145g/L. A venous blood sample sent to the laboratory gave a Hb result of 19g/L, with abnormal clotting, and again this is thought to have been from the drip arm. Laboratory staff deleted all results except the Hb and clotting screen and added a comment to repeat these tests as they were spurious results. There was clear indication that the Hb result of 19g/L was incorrect as comments were added. It is unusual that a result of 19g/L would be reported and the laboratory manager has concluded all the results should have been removed and not validated. Two units of red cells were crossmatched for transfusion within 15 minutes of these erroneous results being received. A repeat full blood count (FBC) was not taken until after the two units had been transfused (post-transfusion Hb 105g/L). It is difficult to know if the blood gas Hb of 50g/L was correct, but the post-transfusion Hb results suggests it was from a drip arm. A review of observations, including a drop in blood pressure, shows they were consistent with acute blood loss and with a post-transfusion Hb of 105g/L it is likely that this patient would have needed transfusion regardless of the erroneous results. However, one unit may have been sufficient.

Lessons learnt: samples should not be taken from a drip arm; spurious results should be deleted, with new samples requested and, if clinically indicated, a single unit should have been transfused.

Case 6.1 was scored as 10/10 for individual culpability with no scores for other human factors. However, the incident report shows several learning points related to clinical procedures and laboratory systems. As no scores were assigned to system and organisational problems, it is possible that opportunities to improve the processes might have been missed, such as introducing electronic barriers to prevent transmission of grossly abnormal results. A recommendation and a learning point from the 2013 Annual SHOT Report (Bolton-Maggs et al. 2014) are alluded to in this case, but may not have been fully implemented yet: (1) Don't give two without review, which was inspired by a campaign devised by NHS Blood and Transplant (NHSBT)'s Patient Blood Management team advising to give only one unit of red cells, then check the results before further transfusion, (2) Inappropriate transfusions could be avoided if laboratories did not transmit results they know or suspect to be inaccurate, but instead requested a second sample.

In 309/2905 (10.6%) cases, no score was given for any of the four factors, which may reduce the chances of the incident investigators making recommendations for system-related actions. Case 6.2 is a good example of an incident investigation that has identified many system issues, but no scores were entered into the SHOT questionnaire to identify the contribution of these factors to the incident.

Case 6.2: No scores given for human factors, but many system issues were identified

A patient was prescribed fresh frozen plasma (FFP) but cryoprecipitate was issued from the transfusion laboratory. The error was not detected at collection or at the final bedside administration, so an incorrect component was transfused. The following organisational and system problems were identified in the incident investigation:

- *Busy night shift and lone working, so laboratory worker was tired*
- *There was no second check in the laboratory due to lone working*
- *The cryoprecipitate had been put in the wrong section of the freezer*
- *Due to staffing levels a routine stock check had not taken place when scheduled*
- *The laboratory information management system (LIMS) did not state the component being issued (LIMS now changed to do this and a new electronic blood-tracking system is planned)*
- *Two units were brought to the ward, but only one had been requested*
- *The ward was very busy*
- *The blood component label has small print which was being read in poor lighting*
- *Second check on the ward was done by a nurse who had just returned from a break*

- *Nursing knowledge and understanding of the different components may be an issue*
- *A safety critical checklist resource for staff to carry and access at the bedside is to be developed*
- *The transfusion record is to be updated to include a components section as part of the pre-transfusion checklist*

Themes emerging from this case show problems with technology (LIMS issues and no blood-tracking), staffing levels (lone working and workload); procedures (second checks and checklists), education (staff knowledge) equipment design (label print, lighting). These are all work environment, organisational or government level issues, i.e. not directly staff-related. Revealing these system-related issues in an incident investigation and scoring them appropriately in the SHOT questionnaire may encourage greater learning about the underlying factors that can lead to adverse events.

Vein to vein audit

SHOT has been working with the NCA of blood transfusion on a suite of audit tools to cover all the nine steps of the transfusion process, which SHOT has defined and used for analysis since 2013 (Bolton-Maggs et al. 2014). This is known as the vein to vein audit and the audit tools are currently being trialled before a launch for use by all hospitals later in 2019 (NCA 2018). This audit will be continuous voluntary audit, but SHOT strongly supports this audit and encourages hospital staff to participate as fully as possible.

Within the tools there will be two human factors questions, to be asked at each step, from which we can assess resilience in the transfusion process. These consist of an open narrative question to encourage staff to describe adaptations voluntarily and a follow up question to score the level of support received from management. These questions have already been tried throughout the complete transfusion process in a few hospitals and SHOT would like to thank the anonymous volunteers who facilitated those pilot sessions. Early data from the trials showed that staff make many adaptations to standard procedures in transfusion and these have been categorised into: 1) preferred adaptations, which are developments expected to improve the process and 2) forced adaptations, which are workarounds and coping strategies when ideal solutions are outside of their control. Adaptations are made within staff members' sphere of influence and largely without the knowledge of management (Watt et al. 2019a). Further analysis has been done of the pilot data in collaboration with the Human Factors in Complex Systems group at Loughborough University Design School. The analysis shows some interesting insights into the limitations of adaptations and how this affects resilience in the transfusion process. This work is awaiting publication (Watt et al. 2019b).

Commentary

The importance of HFE continues to be recognised by major healthcare organisations as demonstrated by several publications in 2018. The Healthcare Safety Investigation Branch (HSIB) Annual Review 2017/18 defines that their investigation model is based on a deep knowledge of human factors (HSIB 2018, p.2). The Care Quality Commission (CQC) document Quality Improvement in Hospital Trusts encourages a systems approach to quality improvement in hospitals (CQC 2018a, p34) and their analysis of Never Events in 2017-18 highlights that the overwhelming majority require human factors based solutions (CQC 2018b, p4). Also, the General Medical Council (GMC) has published plans to embed human factors into the investigations of adverse events by rolling out human factors training to all their fitness to practise decision makers, case examiners and clinical experts (GMC 2018). The Nursing and Midwifery Council (NMC) first included reference to human factors in their code of conduct published in 2015 and this was recently updated in October 2018 (NMC 2018, p17).

SHOT strongly encourages transfusion professionals to attain as much knowledge as possible about HFE principles that can be incorporated into their day-to-day work. Understanding HFE would be particularly useful when investigating serious incidents in order to identify system and organisational problems, which could lead to more effective corrective and preventative actions.

Acknowledgement

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Adverse Events Related to Anti-D Immunoglobulin (Ig) n=466

7

Author: Katy Cowan

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

- A total of 466 reports related to errors involving anti-D immunoglobulin (Ig) were reviewed by SHOT in 2018. In 272/466 (58.4%) the reports related to the omission or late administration of anti-D Ig. This is an ongoing and concerning trend that results in large numbers of women being put at risk of sensitisation to the D antigen which could have associated morbidity and mortality in affected neonates
- Cell-free fetal deoxyribonucleic acid (cffDNA) testing is being carried out more widely, but there are indications that clinicians are not acting on the results
- There is evidence of misunderstanding of routine antenatal anti-D Ig prophylaxis (RAADP) and the need for **additional** anti-D Ig for any potentially sensitising events (PSE)
- There is evidence to indicate that anti-D Ig is not being administered in response to PSE. This is particularly happening in departments whose main expertise may not be management of pregnancy
- Women seem to be unaware of the importance of reporting PSE in a timely manner which is resulting in them receiving anti-D Ig later than the recommended 72 hours post PSE
- There continues to be poor communication between hospital and community midwifery teams regarding the need for anti-D Ig, particularly in the care of those women who have early hospital discharges

Recommendations

- All staff involved in the requesting, issuing and administering of anti-D immunoglobulin (Ig) must have received appropriate training and education in relation to anti-D Ig, such as completion of the anti-D Ig module in the Learn Blood Transfusion (LBT) e-learning package (www.learnbloodtransfusion.org.uk)

Action: Hospital Transfusion Laboratories, Hospital Transfusion Committees, Trust/Health Board Chief Executive Officers (CEO), Obstetric Departments, Community Midwifery Teams, Early Pregnancy Units, Emergency Departments

- Midwives must be vigilant with correct sample taking and labelling technique when taking samples for cell-free fetal deoxyribonucleic acid (cffDNA) testing, and then check and document the results clearly

Action: Community Midwifery Teams, Obstetric Departments

- Maternity services need to have systems in place to ensure that those women who are D-negative understand the importance of anti-D Ig prophylaxis in the event of a potentially sensitising event (PSE). It is also vital that women understand what constitutes a PSE in order for them to know when to attend for care

Action: Community Midwifery Teams, Obstetric Departments, General Practitioners

Commentary

This year's Annual SHOT Report, once again emphasises persistent misunderstandings about the provision of anti-D Ig. Due to this ongoing lack of knowledge and understanding, women continue to be put at risk of sensitisation.

The persistent high numbers of reports of late administration or omission of anti-D Ig reveal insufficient understanding of the importance of anti-D Ig being administered within 72 hours following a PSE. This issue applies to both clinical staff and the D-negative women concerned. There were a number of reports this year where women did not report the PSE until after 72 hours had passed. These reports are not included in the overall numbers in this chapter, as there was no error made by the healthcare professionals involved, however, these women are still at risk of sensitisation. Guidance on the use of anti-D Ig should be followed (BSH Austin et al. 2009, BSH Qureshi et al. 2014, BSH White et al. 2016, NICE 2012 and NICE 2016).

Deaths n=0

There were no deaths reported that related to errors associated with anti-D Ig in 2018.

Major morbidity n=0

No women were reported to have developed immune anti-D following errors in clinical management in 2018. However, the follow up on cases is short and alloimmune anti-D may not be evident until the next pregnancy. It is therefore important that any new cases of alloimmune anti-D identified in pregnancy are reported to SHOT, so that a real picture can be compiled of the implications of the errors reported.

Potential for major morbidity n=272

In 2018, 272 of the reports received related to the omission or late administration of anti-D Ig. These incidents all have the potential for the women involved to develop an immune anti-D and are therefore a considerable concern for the risk of fetal morbidity in future pregnancies.

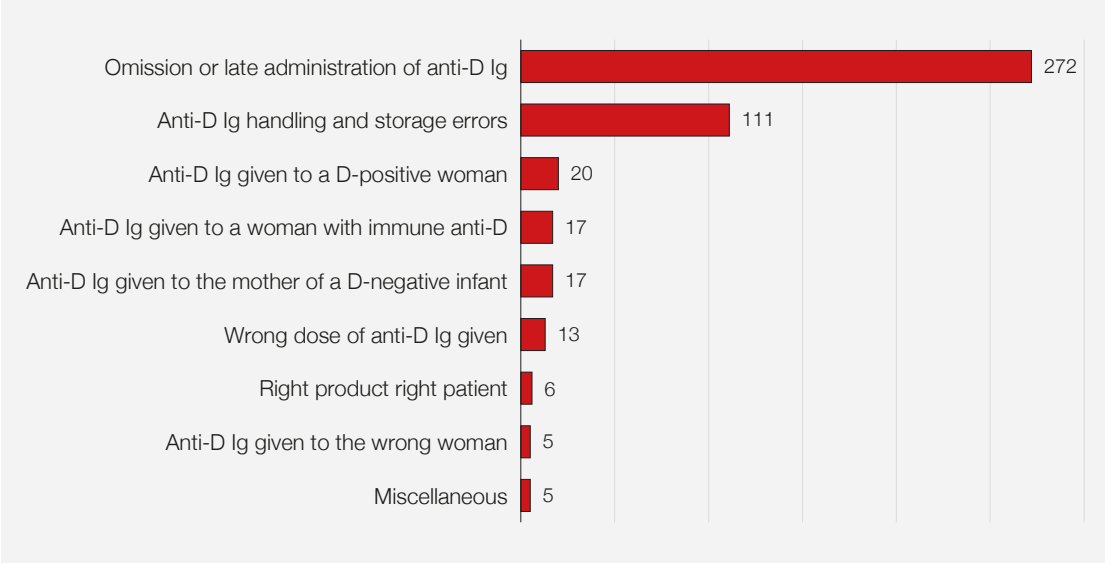


Figure 7.1: Distribution of anti-D Ig related error reports in 2018 n=466

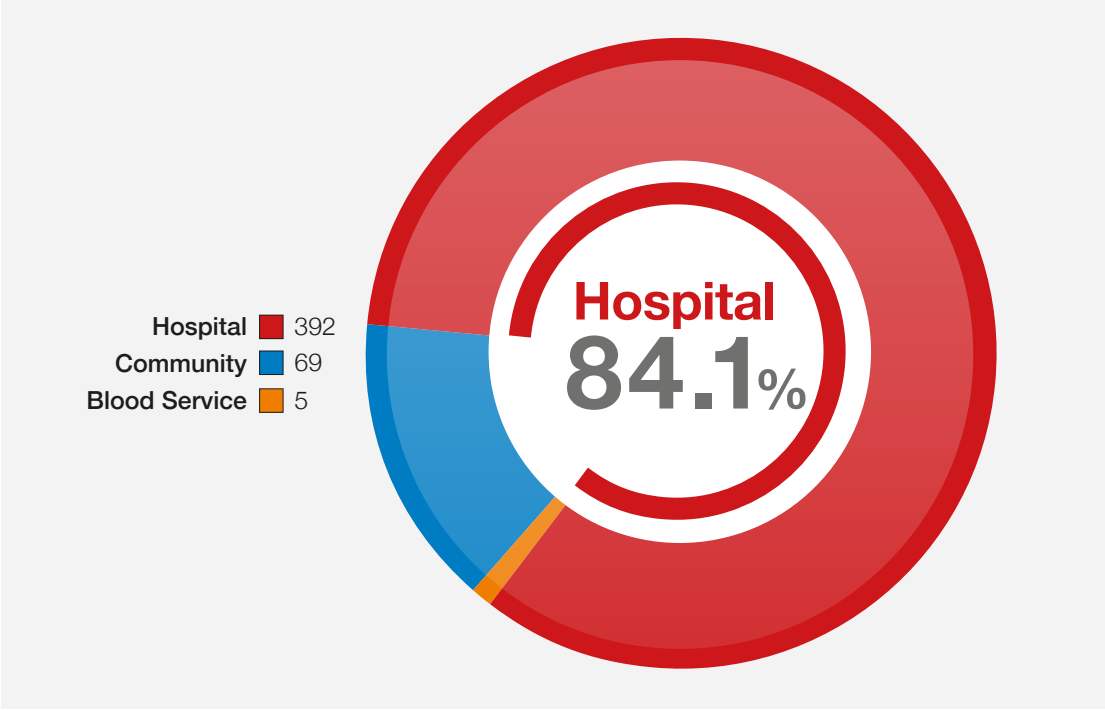
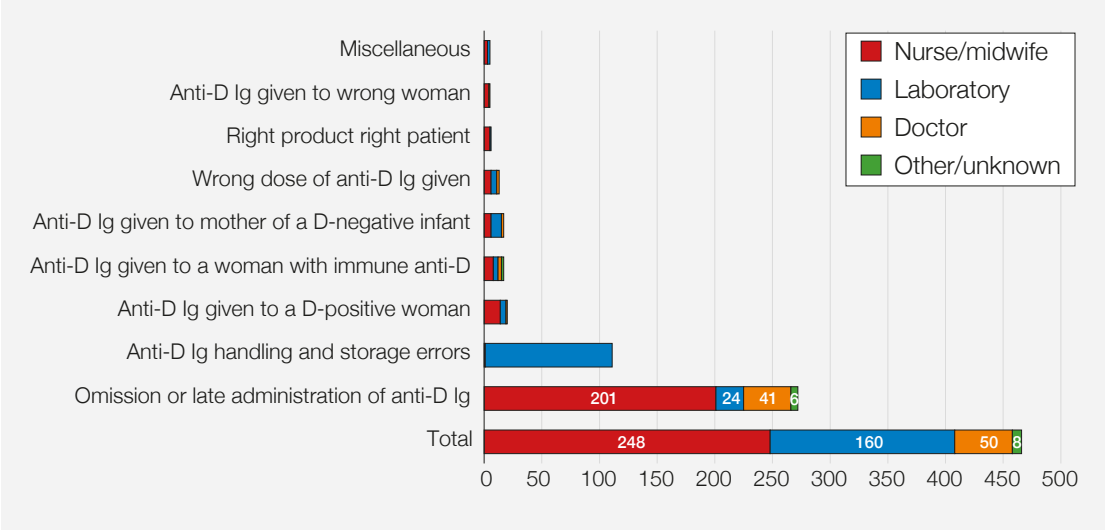


Figure 7.2: Location of errors associated with anti-D Ig

Overview of cases

Most errors, 440/466 (94.4%) occurred during normal working hours (08:00–20:00). Clinical staff were responsible for 298/466 (63.9%) of the errors reported across all of the categories. Of the clinical errors, 229/298 (76.8%) were made by midwives, 19/298 (6.4%) by nurses and 50/298 (16.8%) by doctors of all grades, including both consultants and general practitioners (GP).

Figure 7.3: Staff group responsible for the primary error associated with anti-D Ig by category



Omission or late administration of anti-D Ig n=272 (58.4%)

Errors associated with omission or late administration of anti-D Ig occurred most often in a hospital setting 213/272 (78.3%), although there were still numerous reports occurring in the community including GP practices.

Recurring themes identified were:

- Anti-D Ig not being administered within 72 hours of a PSE
- Lack of understanding amongst staff of when anti-D Ig is required
- Lack of communication between hospital and community midwifery teams – particularly in those patients discharged early after delivery
- Failure to understand and act upon the results of cffDNA testing resulting in both missed and unnecessary doses of anti-D Ig being given
- Anti-D Ig being ordered from the laboratory but not collected. Again, this particularly seems to be around the early discharge of patients

Case 7.1: Anti-D Ig not collected from the refrigerator

A known D-negative woman had an elective caesarian section following induction of labour, failure to progress and a large baby. Post delivery the baby's group was determined to be D-positive and anti-D Ig was issued day 1 postnatally. The mother did not receive anti-D Ig until day 5 postnatally.

Handling and storage errors related to anti-D Ig n=111 (23.8%)

There were 110 laboratory errors, and 1 clinical error; 110 of which occurred within a hospital environment. There was a large refrigerator failure which accounted for 106 reports.

Anti-D Ig given to D-positive women n=20 (4.3%)

These were split into 15 clinical and 5 laboratory errors. There were 13 in hospital and 7 in the community. In 2 cases the woman's blood group was confirmed as 'weak D-positive' and anti-D Ig was still issued from the laboratory. The most common error was failure to check the historical blood group results prior to the ordering or issuing of anti-D Ig.

Case 7.2: Failure to check blood results

A patient informed a newly qualified midwife that she was 'due a jab' at 28 weeks. This information was acted on rather than following policy and checking the blood group first. The patient was new to the hospital and had no obstetric notes with her. The woman was D-positive and received 1500IU anti-D Ig unnecessarily.

Anti-D Ig given to a woman with a known immune anti-D n=17 (3.6%)

There were 12 clinical errors and 5 laboratory errors, with the main error for both staff groups being the failure to check the historical blood group before requesting and administering anti-D Ig.

Case 7.3: Anti-D Ig given to a woman with known immune anti-D

A sample was received from a patient who had to come in every 4 weeks for anti-D quantification. The biomedical scientist (BMS) noted on the form that there was a tick in the box for anti-D Ig having been administered. The transfusion manager was informed who asked the transfusion practitioner to investigate. The transfusion practitioner checked the patient's notes and found evidence that anti-D Ig had been administered despite a laboratory report stating that it was not to be given.

Case 7.4: Anti-D Ig given to a woman with known immune anti-D

A patient with known immune anti-D was given 500IU prophylactic anti-D Ig when attending a day assessment unit in a maternity hospital following a PSE. The midwife did consult the doctor who suggested that the patient should be given it.

Anti-D Ig given to the mother of a D-negative infant n=17 (3.6%)

There were 8 clinical errors and 9 laboratory errors. There were two main themes in these reports:

- Anti-D Ig being issued prior to the infant blood group being checked
- Misinterpretation or misunderstanding of, or failure to check the results of cffDNA test results

In 7 reports women received anti-D Ig despite a cffDNA test confirming that they had a D-negative fetus.

Case 7.5: Misunderstanding of cffDNA test result

The International Blood Group Reference Laboratory (IBGRL) reported that the cffDNA test predicted the fetus to be D-negative. This document was scanned onto the maternity system and the electronic record completed correctly. This flagged that the fetus was D-negative. Later in pregnancy the woman presented with a per vaginal (PV) bleed. There was a request for Kleihauer and anti-D Ig. The Kleihauer was reported as not required with the comment that the fetus of this pregnancy was predicted to be D-negative. The obstetrics and gynaecology registrar prescribed anti-D Ig. Anti-D Ig was issued and administered to the woman.

Anti-D Ig being given to the wrong woman n=5 (1.1%)

These were 4 errors made by midwives and 1 by a doctor.

The dominant theme amongst these reports was a failure to perform positive patient identification (ID) prior to the administration of anti-D Ig.

Case 7.6: Positive patient ID not carried out prior to administration of anti-D Ig

A dose of anti-D Ig intended for a D-negative patient was incorrectly administered to the wrong patient (who was D-positive). The midwife performed a verbal ID on the name only (which the patient confirmed) but did not check the date of birth or patient ID wristband.

Wrong dose of anti-D Ig given n=13 (2.8%)

Doses of anti-D Ig should never be split to give a smaller dose (to maintain traceability and follow manufacturers recommendations). It is safe to give a larger dose.

There were 8 errors in the clinical area and 5 originated in the laboratory. In 2/13 cases women received less than the recommended dose and 3/13 women had not had a Kleihauer taken within the recommended timeframe to establish whether or not they required further anti-D Ig, leaving these 5 women potentially susceptible to sensitisation.

Case 7.7: 1500IU vial of anti-D Ig split

A lady who had miscarried booked in to see her GP for anti-D Ig administration. The GP gave anti-D Ig from midwives' clinic stock and only gave 0.3mL of the 1500IU in a 1mL vial.

Right product, right patient n=6 (1.3%)

In 5 of these cases the error originated with the midwife and 1 from the laboratory. Anti-D Ig was issued and administered to women who needed it, but there were subsequently errors identified related to the blood sample that had been received in the laboratory.

Case 7.8: Patient given anti-D Ig without waiting for results of blood group and save sample

A patient had a group and save taken prior to administration of anti-D Ig for a PV bleed at 15 weeks gestation. The sample was rejected and no further sample was taken prior to the injection. Therefore, it was not known if the patient had immune anti-D.

Miscellaneous n=5 (1.1%)

Of these errors, 3 were clinical and 2 from the laboratory.

Case 7.9: Kleihauer sample found to be haemolysed after anti-D Ig had been issued

A sample was received into the laboratory post delivery for neonatal grouping and Kleihauer request on a D-negative lady. The anti-D Ig was issued and the sample was centrifuged before the Kleihauer film was spread. The sample was found to be haemolysed the following day, too late to test a repeat sample as the anti-D Ig had been administered. A further repeat sample was then not requested in order for the quantification to be carried out for fetomaternal haemorrhage (FMH).

Case 7.10: Anti-D Ig issued before group and screen completed

A Kleihauer was performed for a PSE at 37 weeks gestation for a patient who was historically AB D-negative. The anti-D Ig was administered to the patient the next day. However, 4 days later, the blood transfusion laboratory realised that the group and screen had not been completed.

Near miss anti-D Ig cases n=31

Of the near miss cases, 12 originated in the clinical area and 19 from the laboratory. The majority of the near misses, 20/31 (65.5%), were due to staff failure to follow standard operating procedure (SOP) or policy.

IT-related Anti-D Ig cases n=12

Further details of the IT-related reports can be found in the supplementary information on the SHOT website www.shotuk.org.

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8 Incorrect Blood Component Transfused (IBCT) n=272

Authors: Jayne Addison, Peter Baker, Simon Carter-Graham, Heather Clark, Hema Mistry and Shruthi Narayan

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

Clinical

- A robust checking process at the administration step immediately prior to transfusion remains a critical step to support prevention of transfusion of ABO-incompatible blood components

Laboratory

- Key SHOT messages are stated in Chapter 14, Laboratory Errors

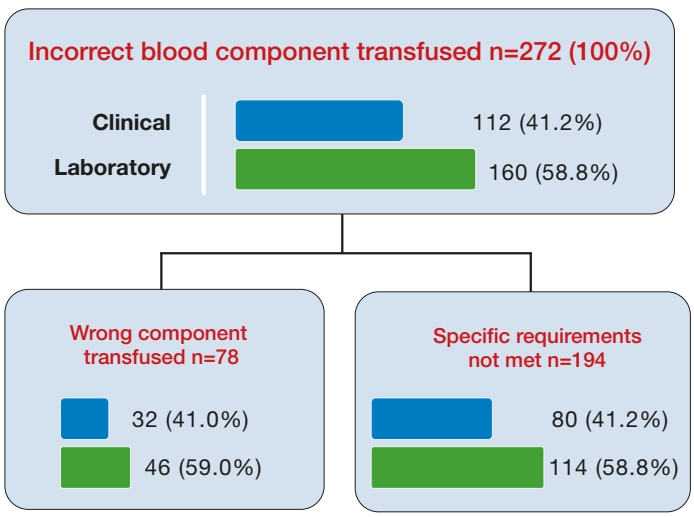


Figure 8.1: Overview of reports where an incorrect blood component was transfused in 2018 n=272

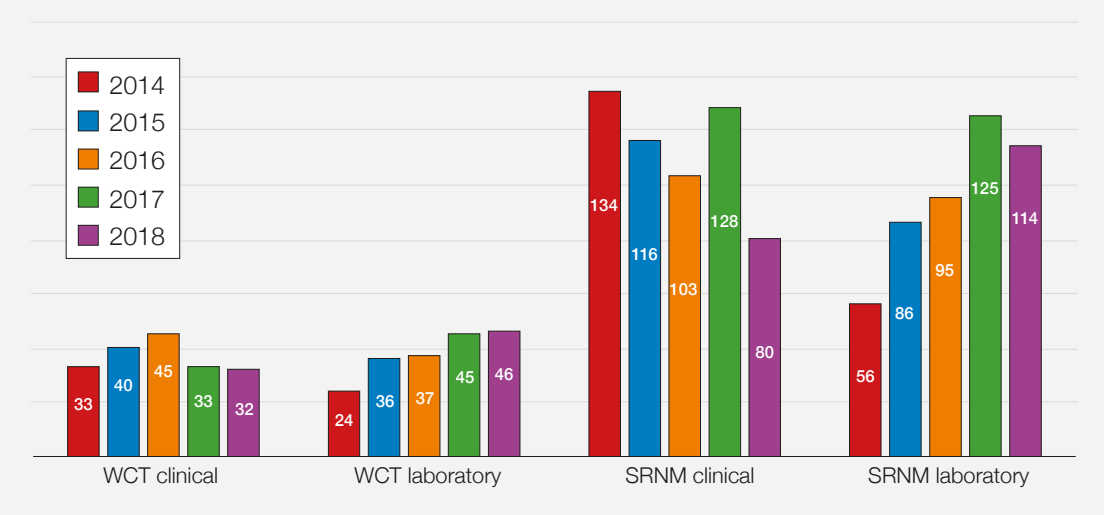


Figure 8.2: Review of IBCT reports over a 5-year period

WCT=wrong component transfused; SRNM=specific requirements not met

Deaths n=0

There were 17 deaths reported under IBCT (3 incidents due to clinical errors and 14 resulting from laboratory errors), however, none of the deaths were attributable to the transfusion (imputability 0 excluded or unlikely).

Major morbidity n=4 (clinical n=1 laboratory n=3)

Case 8.1: Failure to perform the administration checks at the bedside leads to transfusion of ABO-incompatible red cells and results in major morbidity

The nurse checked the details on the unit of red cells against the prescription with one of the ward doctors. The checks were performed, and the prescription was signed at the nurse's station, not at the bedside. The nurse failed to positively identify the patient, failed to perform any bedside checks and did not ask another trained and competent member of staff to perform the same checks at the bedside. The transfusion was commenced on the wrong patient.

The patient received approximately 50mL of incompatible red cells, (donor group A D-positive, recipient group O D-negative). Symptoms of reaction included; desaturation to SpO2 88%, the respiratory rate increased to 40 breaths per minute and the patient was 'feverish'. The patient was treated with hydrocortisone, chlorphenamine and oxygen and moved to critical care and monitored for organ damage. She remained in critical care for several days before moving back to a general ward and being discharged home.

Multiple factors were identified in the root cause analysis (RCA):

- Short staffing on the ward
- Colleagues offering to help although not competency-assessed
- Breaks not being taken
- Low level of competency-assessed staff
- Failure to escalate increased work load and stress
- Staff unfamiliar with the environment
- Multiple transfusions taking place on the same ward
- Electronic clinical transfusion systems in place but not utilised in the hospital at the administration step

Recommendations from the RCA:

- Review and consider prioritisation of business case for extending the use of the electronic systems at the administration step
- Ensure staff are made aware of who can second check blood components
- Place blood transfusion back onto training days
- Ensure blood transfusion competencies are visible on 'eRoster'

What happened to the patient who the transfusion was intended for? This was reported as a near miss avoidable transfusion. See Case 10b.5 in Chapter 10, Avoidable, Delayed or Under/Overtransfusion (ADU).

Case 8.2: Major morbidity following transfusion of ABO-incompatible (ABOi) red cells due to misinterpretation of manual ABO grouping

Group-specific red cells were requested urgently, during core hours, for a patient with an upper gastrointestinal bleed. No transfusion history was available for the patient at the time of issue. The emergency department (ED) requested group-specific red cells due to the perceived risk to the patient of a delay. Red cells were released prior to completion of the serological crossmatch due to the urgency of the situation. Serological crossmatching identified that the red cells were incompatible. The manual ABO grouping of the patient had been interpreted incorrectly as B D-positive (correct group was A D-positive). A second member of staff was available, but it was not policy to second check the result. No testing on a second sample was undertaken to confirm the group and the policy did not specify issuing group O red cells until a second group was obtained. The biomedical scientist (BMS) did not routinely work in the transfusion laboratory. The patient received approximately 90mL of incompatible red cells and was admitted to the intensive therapy unit (ITU) due to the adverse transfusion event. No further ill effects were observed.

This case highlights the problem of not having a robust policy for emergency issue when incomplete testing has been performed at the time of issuing components based on results from a single sample. It also highlights the importance of a two-person check when validating results and demonstrates the importance of competency and practice familiarity especially related to laboratory staff who do not routinely work in transfusion.

Case 8.3: Interpretation error and inappropriate electronic issue (EI) resulted in the wrong ABO group transfused to a liver transplant patient

Red cells were requested out-of-hours for a patient who underwent an ABO-mismatched liver transplant (patient B D-positive, donor liver O D-positive) in a different centre three weeks earlier. The patient had previously been grouped manually but a historical record was available on the laboratory information management system (LIMS) at the time. The analyser identified anti-B in the patient plasma, but the result required manual interpretation on the LIMS and was misinterpreted as B D-positive. The LIMS then allowed EI when serological crossmatch should have been performed and the electronic tracking system did not alert as the blood issued matched the patient's group. Following transfusion, the patient had a spike in temperature and became tachycardic, tachypnoeic, with an increased oxygen requirement. The transfusing hospital rarely dealt with transplant patients.

Learning point

- Manual interpretation of results during testing should require a second person check for confirmation of results and interpretation, and the laboratory information management system (LIMS) should be robustly validated to exclude electronic issue (EI) when appropriate. It is important that biomedical scientist (BMS) staff understand the transfusion requirements for all types of patient conditions and how to manage anomalous results

This case also highlights opportunities for clearer information to be available for patients where care is shared between different facilities.

The final case of major morbidity involved a woman of childbearing potential who was sensitised to the Kell antigen when K-negative blood was not selected.

ABO-incompatible blood component transfusions n=7

Unintentional transfusion of ABO-incompatible blood components is a National Health Service (NHS) Never Event (NHS England 2018). In Scotland these would be reported as Red Incidents through the Scottish National Blood Transfusion Service clinical governance system and/or those of the Health Board.

There were 4 cases of unintentional transfusion of ABO-incompatible red cells (3 clinical errors and 1 laboratory error) and although the risk of haemolysis and serious harm is more likely with red cells than with other components, there were 3 additional cases (all laboratory errors) of unintentional ABO-incompatible transfusions, 2 of fresh frozen plasma (FFP) and 1 of cryoprecipitate, Figures 8.3 and 8.4.

These provide important lessons for both clinical and laboratory staff. These cases are also reportable as NHS England Never Events.

The ABO-incompatible blood component transfusions are described under Cases 8.1 and 8.2 under major morbidity, Cases 8.4, 8.5, 8.7 and 8.8 below, and Case 8.12 under multiple errors.

Figure 8.3: Clinical ABO-incompatible red cell transfusions n=3

ABOi=ABO-incompatible

Case 8.4: Failure to correctly complete the checking process at the administration step leads to transfusion of ABO-incompatible red cells

A unit of red cells (group B D-positive) was correctly collected, prescribed and delivered to the clinical area. Two registered nurses using a 'dependent check' checked the unit against the laboratory paperwork and prescription but not the patient. The nurse then went to the wrong patient and commenced the transfusion (patient group A D-negative). The doctor on the ward noticed that a transfusion had been commenced on his patient for whom he had not prescribed blood, he investigated and immediately stopped the transfusion.

The investigation revealed that the patient was not wearing an identification band and would not be able to identify himself.

Recommendations from the RCA:

- Amendment made to transfusion pathway to emphasise 'no wristband, no transfusion'
- Update transfusion policy to specify the use of an 'independent' check

This case highlights that the process for checking blood components and positive patient identification immediately prior to administration must be followed and that the use of a bedside checklist could ensure the correct steps in the procedure are followed and avoid any steps being omitted.

SHOT continues to recommend local blood transfusion policies follow national guidelines and if local policy requires a two-person checking procedure, each person should complete all the checks independently (double independent checking) (BSH Robinson et al. 2017).

Case 8.5: Failure of the correct checking process at both collection and administration steps leads to transfusion of ABO-incompatible red cells

The wrong unit of red cells was collected by a healthcare assistant (HCA) from a remote issue refrigerator without any formal checks. The collection slip included the correct patient details for whom the transfusion was intended. The HCA had been trained and competency-assessed to collect blood components, but this had expired. Red cells were taken for another patient with a similar surname.

The nurse on the ward failed to notice the wrong unit of red cells had been collected and then failed to complete the administration checks at the bedside, including failure to positively identify the patient. The patient (group O D-positive) received the full unit of group A D-positive red cells. The patient was admitted overnight as a precaution, no signs of reaction noted and was discharged home the following day.

Contributory factors identified from the RCA:

No distractions or staffing issues were noted. The incident occurred during a Saturday nurse-led service for transfusions only. This was run by bank staff as extra shifts for regular staff from the ward where the patients were treated as in-patients. The investigation cited lack of leadership, a relaxed atmosphere and the repetitive nature of the task as contributory factors leading to this event.

Recommendations from the RCA:

- Explore possibility of electronic system for collection of blood components
- Review the nurse-led Saturday service

This case demonstrates that processes must be followed even when staff know their patients well and everyone is carrying out the same task for all patients. The use of a transfusion bedside checklist could ensure that all steps in the process are performed with all patients every time and positive patient identification (asking the patient to state their name and date of birth, and first line of address in Wales) is an essential step in the process to prevent wrong component transfused.

Identification of patients, samples and blood components throughout the transfusion process can be enhanced using electronic transfusion management systems using barcodes on ID bands and blood components and hand-held scanners linked to laboratory information systems.

A further case of transfusion of ABO-incompatible cryoprecipitate has been reported and is included here as a learning opportunity.

Case 8.6: Intentional transfusion of ABO-mismatched cryoprecipitate

Cryoprecipitate was requested for a patient (group A) with ongoing bleeding as per advice from a consultant haematologist. Group A was initially thawed but had to be discarded as not used within the 4-hour time limit. There were no further units of group A cryoprecipitate in stock, only group O. The BMS checked the standard operating procedure (SOP) and blood transfusion policy and could not find any definite statements that said group O could or could not be given to a group A patient. After liaising with a senior BMS and checking the Joint United Kingdom (UK) Blood Transfusion and Tissue Transplantation Services Professional Advisory Committee (JPAC) website (https://www.transfusionguidelines.org/transfusion-handbook/2-basics-of-blood-groups-and-antibodies/2-4-the-abo-system), group O high-titre negative units of cryoprecipitate were issued and transfused with no adverse impact noted.

The decision to transfuse in this case was taken after assessing the risks of delay to transfusion, and lack of availability of group-specific cryoprecipitate. This case was not included in the number of ABOi cases because the decision to transfuse was intentional, as per available guidance and had no adverse impact on the patient. However, the case is included in the total number of WCT cases and has been described here as a learning opportunity.

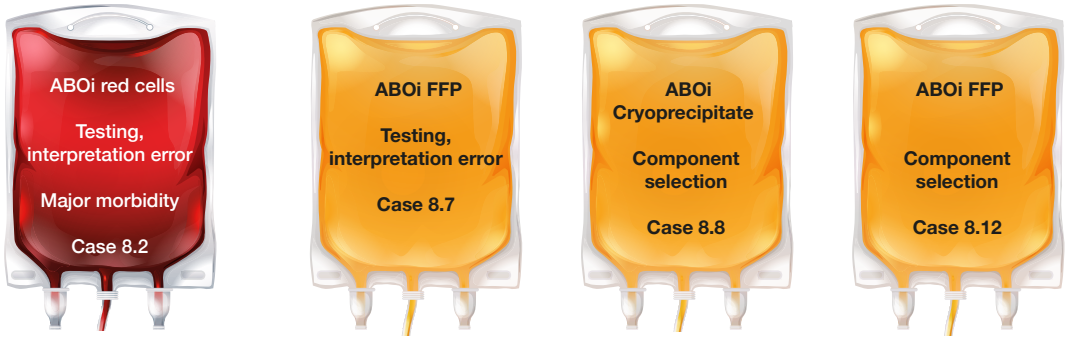
Plasma components (e.g. fresh frozen plasma, cryoprecipitate) should be compatible with the ABO group of the recipient to avoid potential haemolysis caused by donor anti-A or anti-B. FFP and cryoprecipitate contain only a small amount of red cell stroma (red cells after FFP thawing would be expected to be <0·001mL in 300mL FFP). This means that sensitisation following administration of D-positive plasma to an D-negative individual is very unlikely to occur. Hence, plasma components of any D-type can be given regardless to the D-type of the recipient. Anti-D immunoglobulin is not required in these situations.

While in general, in order to avoid the risk of ABO-associated haemolysis in recipients, plasma of donors with identical ABO blood group to the recipient should be used as the first choice; in an emergency, if the patient's blood group is unknown, ABO non-identical plasma is acceptable if it has 'low-titre' anti-A or anti-B activity. Group O plasma components should ideally only be given to group O patients.

This case is a reminder to all staff involved in transfusion about principles of compatibilities for plasma components which differs from red cells. Also, it was identified that the local SOP and blood transfusion policy did not specifically cover or clarify group compatibility for cryoprecipitate.

The use of plasma components including compatibilities is covered in detail in the BSH guidelines (BSH Green et al. 2018). It was noted that the NHS Blood and Transplant leaflet for healthcare professionals http://hospital.blood.co.uk/media/29844/blc7132.pdf states *'group O cryoprecipitate should only be given to group O recipients'* and has been taken from the BSH guidelines. As per the JPAC website, group O or B could be considered as second choice for providing cryoprecipitate to group A patient when group specific component is not available. It does however clarify that *'Group O plasma-rich blood components such as fresh frozen plasma (FFP) or platelet concentrates should not be given to patients of group A, B or AB if ABO-compatible components are readily available. Cryoprecipitate contains very little immunoglobulin and has never been reported to cause significant haemolysis'* https://www.transfusionguidelines.org/transfusion-handbook/2-basics-of-blood-groups-and-antibodies/2-4-the-abo-system. This is being updated to align with the current BSH guidelines.

Figure 8.4: Laboratory ABO-incompatible transfusions n=4



ABOi=ABO-incompatible; FFP=fresh frozen plasma

Case 8.7: ABO-incompatible FFP issued following an interpretation error during testing

FFP was requested urgently for a patient with no historical record. A rapid immediate spin of the blood group was performed on the first sample (group B) to allow defrosting to commence. The sample was then placed on the analyser as urgent to perform the group and screen. A further immediate spin was performed on a second sample (again group B) before component issue. The results of the first sample were still not available on the analyser after 40 minutes so the FFP was issued based on two immediate spin groups. When the analyser group was available it was found to be group AB with a weak A antigen. The laboratory had recently installed a new analyser that was configured for efficiency rather than speed and the group did not get processed independently of the antibody screen. At the time the senior BMS was the only competent person in the laboratory and was training and supervising two new BMS staff.

This case highlights the depth of planning required during validation procedures of new instruments. If during validation it had been identified that there was increased time needed to get grouping results, then new systems could have been put into place to allow the emergency issue of group O red cells and AB/A plasma components in the absence of complete testing.

It also highlights the inappropriate pressure placed upon transfusion staff to maintain a safe service in the absence of staffing resource.

Case 8.8: ABO-incompatible cryoprecipitate selected in error

A patient with obstetric haemorrhage required cryoprecipitate to maintain their fibrinogen above 2g/L. The patient was group B and the only cryoprecipitate available was either group A or group O high-titre (HT) negative. Although the SOP stated the patient should receive group A the BMS thought that considering it not being HT-negative they would issue group O.

Learning point

- It is important to ensure stock that may possibly be issued in ABO-mismatched scenarios is of the correct specification and the standard operating procedure (SOP) is clear about replacement group issues

Near miss - there were a further 11 potential ABO-incompatible transfusions which were detected prior to the patient being transfused (10 laboratory and 1 clinical).

Good news - The number of reported red cell ABO-incompatible transfusions is reducing over time, Figure 8.5, and remains consistently low with 8 reported cases during the past 3 years.

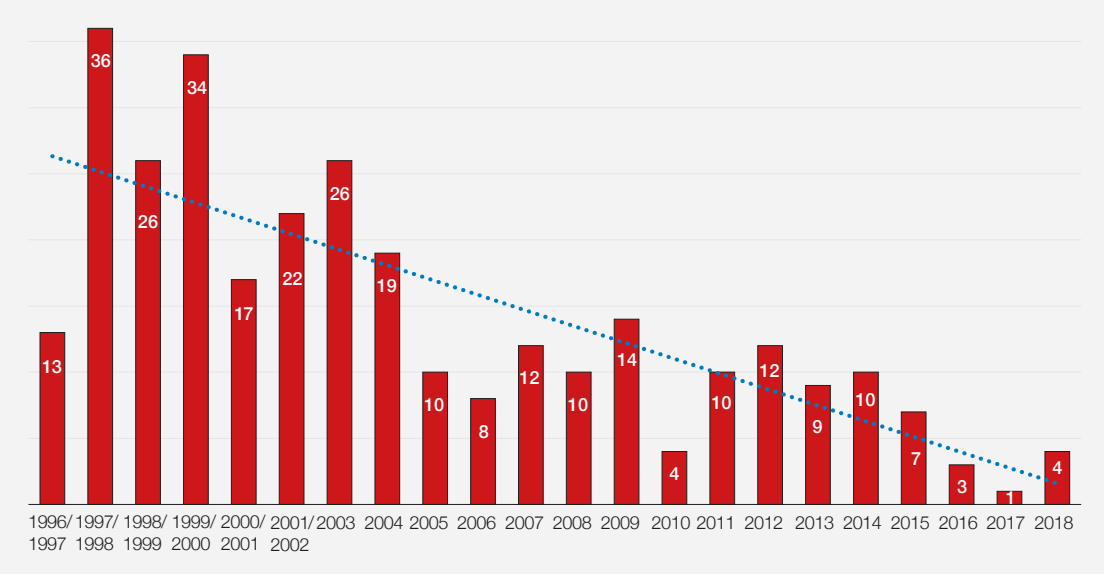


Figure 8.5: Number of ABO-incompatible red cell transfusions 1996-2018

There were opportunities to prevent 'never events' occurring during 2010-2018, despite all efforts by frontline staff and specific practical actions implemented to support prevention of transfusion of ABO-incompatible components. In 41/55 (74.5%) ABO-incompatible red cell transfusions the first error either occurred at or could have been identified at the administration step, Figure 8.6.

A recent review of NHS England 'never events', 'Opening the door to change' (CQC 2018) revealed 'the failure to reduce the toll of never events tells us there is something fundamental about the safety culture of our health care' and the majority of investigations into never events require human factors' based solutions.

The report has made recommendations to encourage a change in culture and behaviour, and in turn reduce the risk of harm to patients (CQC 2018).

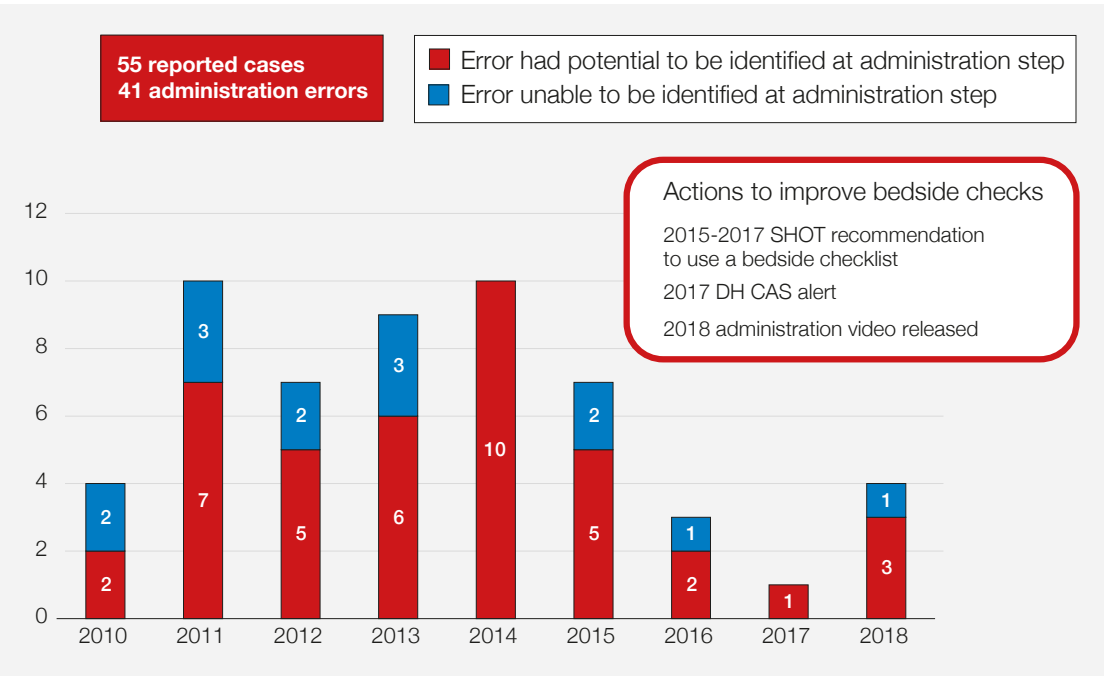


Figure 8.6: Number of ABO-incompatible red cell transfusions where the first error occurred or had the potential to be identified at the administration step 2010-2018

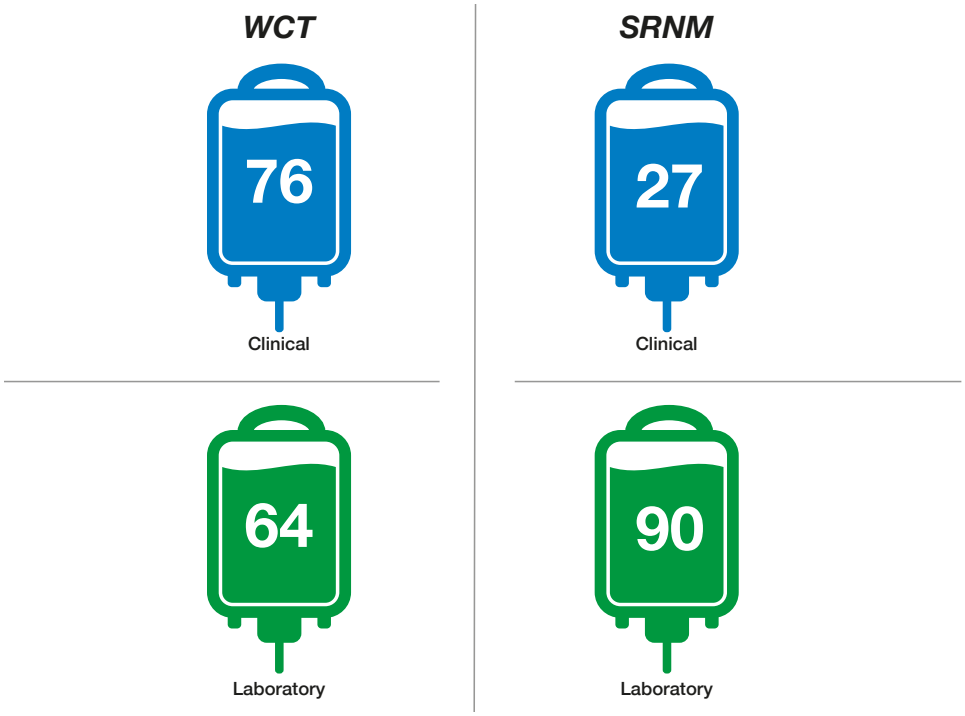
DH=Department of Health; CAS=central alerting system

Near miss IBCT n=257

Definition:

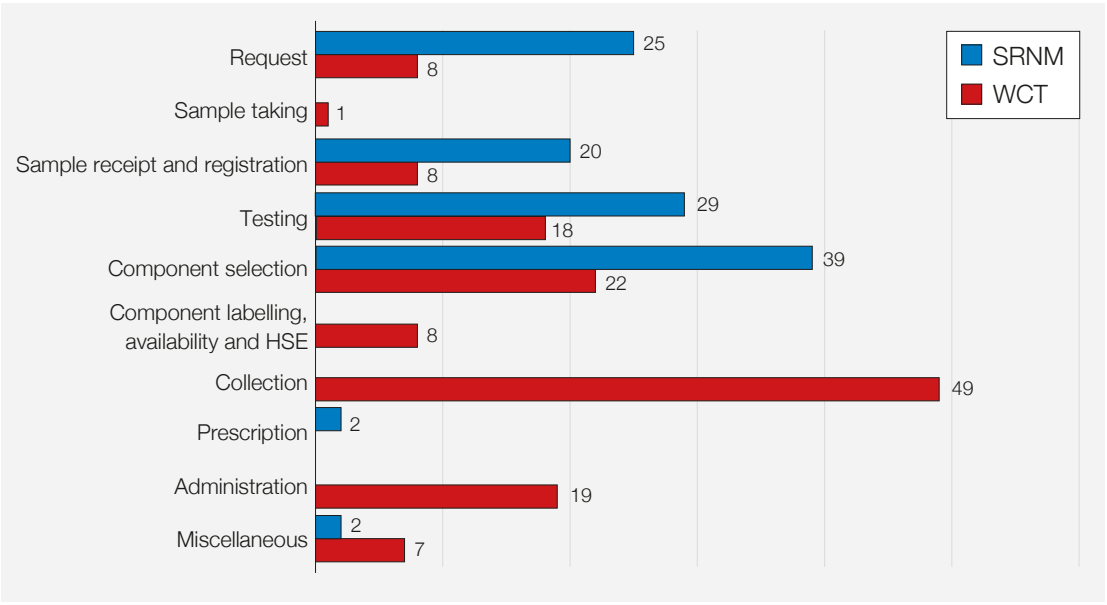
A 'near miss' event refers to any error which if undetected, could result in the determination of a wrong blood group or transfusion of an incorrect component, but was recognised before the transfusion took place.

Figure 8.7: Overview of reports of near miss IBCT n=257



WCT=wrong component transfused; SRNM=specific requirements not met

Figure 8.8: Points in the transfusion process where the first mistake occurred (clinical and laboratory) leading to near miss wrong component (WCT) or specific requirements not being met (SRNM) n=257



WCT=wrong component transfused; SRNM=specific requirements not met

Critical steps in the transfusion process

Errors occur at each of the nine steps in the transfusion process. Each step incorporates independent checks at every point that should, if carried out correctly and in full, be able to identify any errors made earlier. Figure 8.9 illustrates the nine steps including both clinical and laboratory areas and the two critical points where positive patient identification is essential.

The clinical cases in this chapter demonstrate where the incident initially occurred, the category of error and helps to understand why they happen and identify any learning points for clinical and laboratory staff.

Note: Errors associated with laboratory steps are discussed in more detail in Chapter 14, Laboratory Errors.

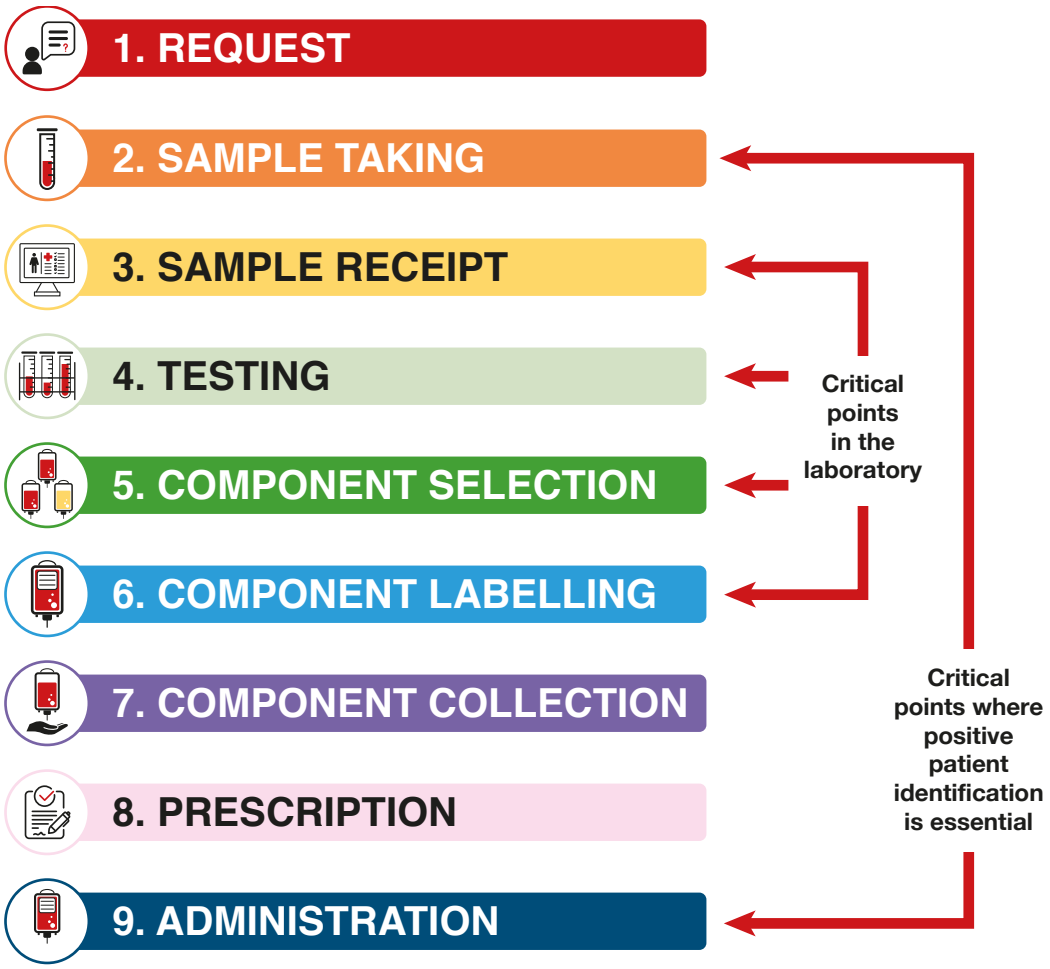
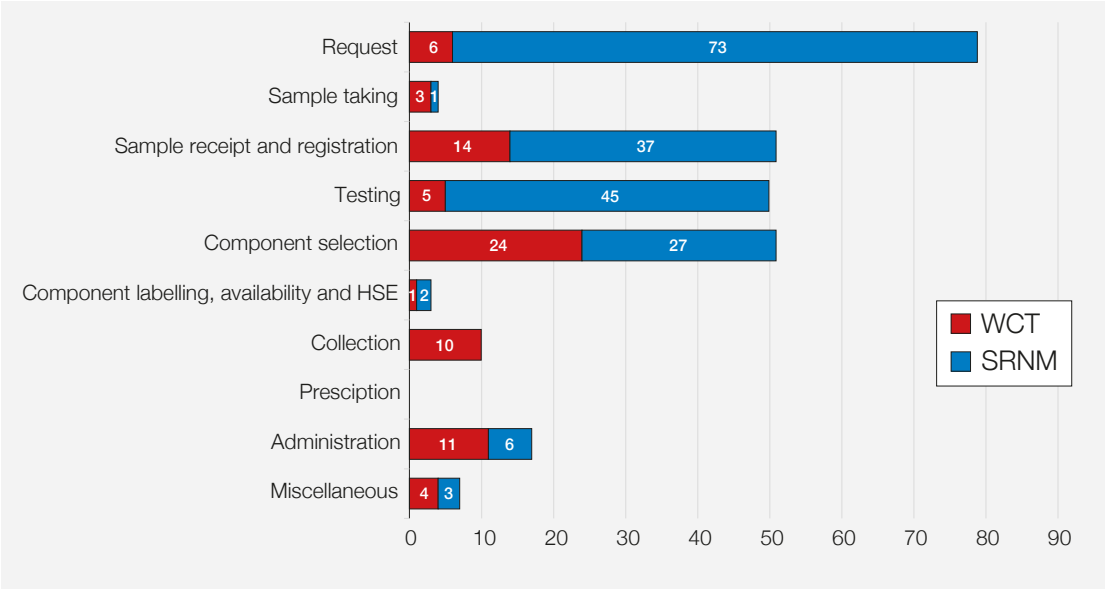


Figure 8.9: Transfusion process (nine steps)

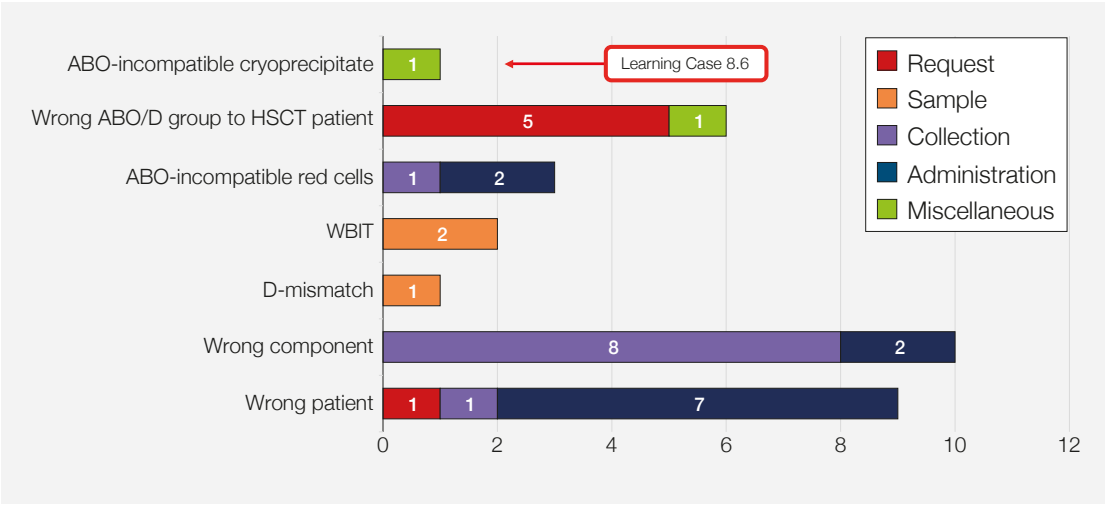
*Note: Once a decision to transfuse is made, the authorisation or prescription may be written at variable times during this sequence, but **must be checked at the final stage**.*

Figure 8.10: Points in the transfusion process where the first mistake occurred (clinical and laboratory) leading to wrong component transfused(WCT) or specific requirements not met (SRNM) n=272



HSE=handling and storage errors

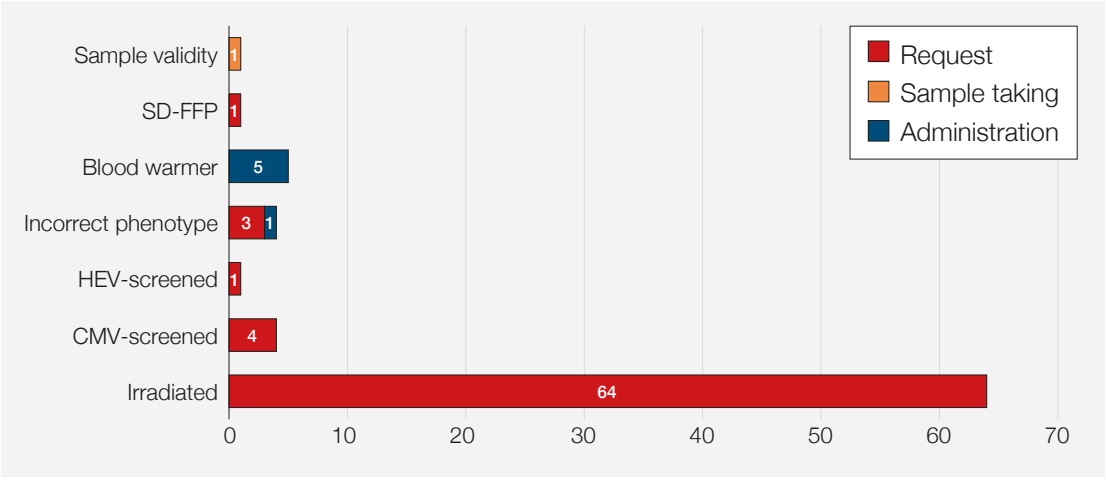
Figure 8.11: Clinical errors resulting in wrong component transfused n=32



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

There were no prescription errors reported in 2018

Figure 8.12: Clinical errors resulting in specific requirements not being met n=80



SD-FFP=solvent detergent fresh frozen plasma; HEV=hepatitis E virus; CMV=cytomegalovirus

There were no collection or prescription errors reported in 2018

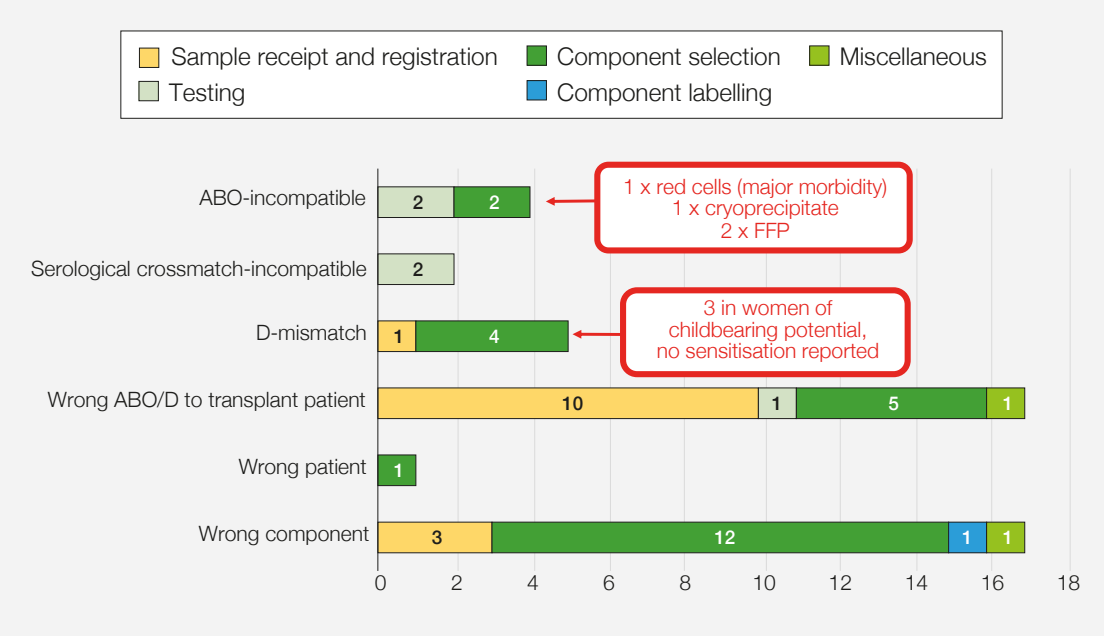


Figure 8.13: Laboratory errors resulting in wrong component transfused n=46

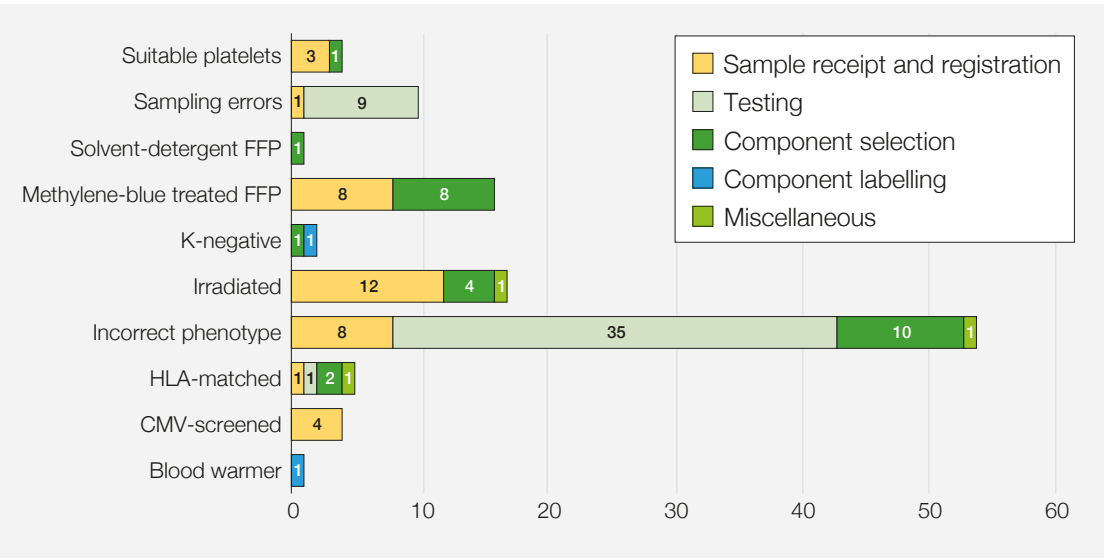


Figure 8.14: Laboratory errors resulting in specific requirements not being met n=114

FFP=fresh frozen plasma; HLA=human leucocyte antigen; CMV=cytomegalovirus

Step 1: Request errors n=79 (plus 33 NM cases)

The request is the first of the nine steps in the transfusion process following the decision to transfuse. Specific requirements not met account for 73/79 (92.4%) of all primary request errors.

Good news – the number of primary request errors has fallen compared to previous years.

Figure 8.15: Reduction in the number of SRNM primary request errors

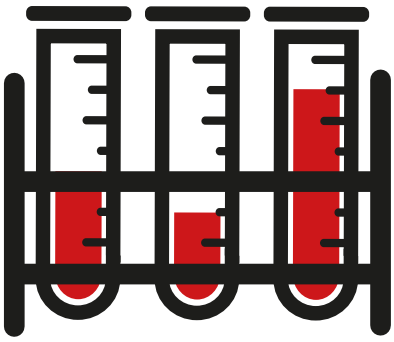
Learning point

- There are opportunities to identify the correct specific requirements at several steps in the transfusion process. Staff in both clinical and laboratory areas should remain vigilant and raise any suspected omission with requesting clinicians

Step 2: Taking the blood sample n=4 (plus 1 NM case)

Taking a blood sample for pre-transfusion compatibility testing is one of two critical points in the transfusion process where positive patient identification is essential. Figure 8.9 (transfusion process).

Figure 8.16: Summary of sampling cases



Two separate cases involved a mix up of samples (WBIT) between neonatal twins

One suspected historical case of WBIT led to a D-mismatched transfusion

One case of a sample that was not labelled correctly in the clinical area. The patient's date of birth was written in the 'date taken' box and 'date of birth' box. Not noticed by the laboratory staff and blood was issued and transfused using an invalid sample

WBIT=wrong blood in tube

Learning point

- Extra vigilance is required when taking samples from neonates of multiple births

Step 3: Sample receipt and registration n=51 (plus 28 NM cases)

Correct procedures for sample receipt and registration are essential to ensure that the right investigation is performed for the right patient on the right sample at the right time (dependent on the patient's transfusion history).

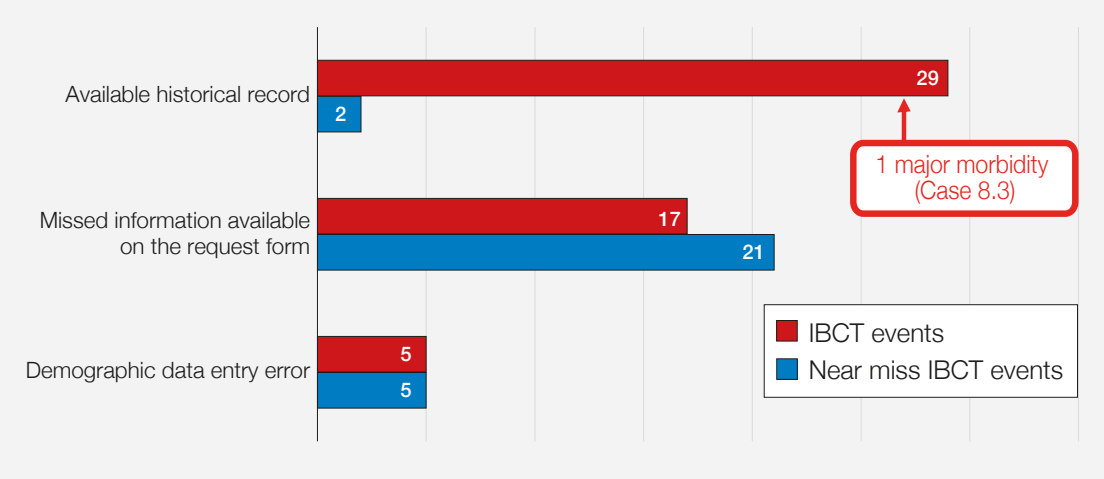


Figure 8.17: Sample receipt and registration errors with outcome n=79

IBCT=incorrect blood component transfused

All learning points and laboratory-related incidents in sample receipt and registration are detailed in Chapter 14, Laboratory Errors.

Step 4: Testing n=50 (plus 47 NM cases)

Correct analysis is required to ensure the safe provision of blood components for transfusion and should be undertaken in full compliance with local and national guidelines for pre-transfusion testing (BSH Milkins et al. 2013).

Figure 8.18: Testing errors with outcome n=97

ABOi=ABO-incompatible; FFP=fresh frozen plasma

Procedural errors continue to be the most common testing error. This year the key laboratory recommendation is the importance of following procedures. All learning points and laboratory-related incidents in testing are detailed in Chapter 14, Laboratory Errors.

Step 5: Component selection n=51 (plus 61 NM cases)

This step ensures that the correct components (together with the specific requirements) are selected to comply with the patient's requirements and the clinical request.

There were two selection errors where ABO-incompatible cryoprecipitate and FFP were transfused to patients, see Cases 8.8 and 8.12, and a further 2 near miss episodes where the patient had the potential to receive ABOi red cells, but these were detected at the bedside. All learning points and laboratory-related incidents in component selection are detailed in Chapter 14, Laboratory Errors.

Step 6: Labelling, availability and handling and storage errors n=3 (plus 8 NM cases)

The correct component needs to be labelled with the correct four (or five) key patient identifiers; first name, last name, date of birth (DOB), unique patient identifier (and first line of address in Wales) (BSH Milkins et al. 2013). Components need to be accessible and available for the time required, if this is not attainable then the clinical area need to be informed. The components need to be handled and stored in the correct way as defined in the guidelines (JPAC 2013). There was one near miss where the BMS was lone working and labelled the unit incorrectly. The clinical staff member was notified of an incompatibility from a personal digital assistant (PDA) alert where it was noticed that the unit was A D-positive and that the patient was O D-positive.

All learning points and laboratory related incidents in component labelling are detailed in Chapter 14, Laboratory Errors.

Step 7: Collection n=10 (plus 49 NM cases)

This step ensures that the correct component is collected from the storage site and delivered to the correct clinical area.

Good news – in 2018 the number of primary collection errors was 10, this has fallen compared to the 26 reported cases in 2017.

Collection as the primary error accounted for 10/32 (31.3%) of clinical WCT. Of the 10 incorrect components collected, 8 were the wrong component type, e.g. platelets instead of FFP. The transfusion priority for 5/8 (62.5%) was indicated as urgent or an emergency. The remaining 2 were the correct component type but were intended for other patients, 1 resulting in an unintentional ABO-incompatible red cell transfusion (see Case 8.5).

Figure 8.19: Summary of wrong component type cases

Three cases of wrong 'yellow' (FFP, cryoprecipitate, platelets) components **collected** and administered

Two cases of adult emergency red cell units **collected** and then administered to paediatric patients

One case of a red cell unit **collected** instead of platelets and administered

One case of emergency O D-negative red cells **collected** instead of issued O D-negative (group specific was not available)

One case of platelets **collected** instead of red cells and administered

FFP=fresh frozen plasma

Learning point

- Errors remain evident in high pressure/urgent situations. The procedure should be clear at the point of collection to allow ease of selection of the correct component type, especially those that are of the same colour

There were a further 49 errors made at the point of collection that could have led to a WCT if not detected immediately prior to transfusion at the administration step, Figure 8.8.

Step 8: Prescription (written authorisation) n=0 (plus 2 NM cases)

This step is identified in Figure 8.9 as step 8, but although the prescription may be written at different points in the transfusion process it should be completed and checked prior to the final administration step.

Step 9: Administration n=17 (plus 19 NM cases)

Administration as a primary error accounted for 11/32 (34.4%) of clinical WCT. Of the 17 administration errors, 9 involved transfusion of components to the wrong patient, 2 resulting in ABO-incompatible red cell transfusion. The remaining 2 WCT involved the wrong component type transfused during massive haemorrhage.

The failure to use a blood warmer continues to be the main reason for administration errors in the SRNM category accounting for 5/6. In the remaining SRNM case the laboratory failed to supply the correct phenotype for a patient with sickle cell anaemia.

Where it was indicated that a two-person check was being used for all reported cases of primary collection and administration errors, 8/27 stated the use of an 'independent' check, 7/27 used a 'dependent' check, 6 used a one-person check and 6 were unknown.

There remains variance in practice when performing the checks prior to administration and the 2 cases below illustrate how the use of a 'dependent' check can lead to the wrong patient being transfused. A 'dependent' check is not the recommended process for checking components prior to administration, (BSH Robinson et al. 2017) as over reliance on the other person can happen and then neither check correctly.

Near miss WCT clinical cases show that 24/58 of wrong patient incidents were detected by electronic ID systems at the point of administration.

Case 8.9: Use of a 'dependent check' at the administration step leads to transfusion to the wrong patient

A ward sister confirmed the date of birth with the patient against the identification band and prescription. A healthcare assistant (HCA) as the 2nd checker failed to check these details against the compatibility label.

A bedside checklist was not in use in this hospital.

Recommendations – Trust/Health Board to explore if the use of HCA as 2nd checkers for blood administration is appropriate and consider the use of electronic clinical systems

Case 8.10: Use of a 'dependent check' and failure to identify the patient at the administration step leads to transfusion of the wrong patient

Two registered nurses performed a dependent check (one nurse checked the identification band and the other nurse checked the blood component and the prescription). They did not positively identify the patient.

Both were competency-assessed and knew they should perform the check using an independent check. The event took place in the emergency department (ED), and was extremely busy and a shortage of staff was noted

Case 8.11: Transfusion to the wrong patient despite the use of an electronic system to alert staff of an error

The wrong identification band was placed on a child which was intended for another child that was also due a transfusion that day.

The nurse took a unit of red cells to the child wearing the wrong identification band. Although there was an electronic prompt to carry out a verbal positive identification check, this did not take place. The electronic system was unable to alert the nurse this was the wrong patient because the unit matched the wristband

Figure 8.20: Three cases demonstrating transfusion to the wrong patient

Learning point

- The use of a 'dependent' check at the administration step can contribute to transfusion of the wrong patient. Staff need to ensure they understand the difference between a two-person 'dependent' and a 'double independent' check

An instructional video regarding the pre-administration blood component transfusion bedside checklist was produced in 2018 collaboratively by SHOT and the NHSBT Patient Blood Management team, and can be found on the SHOT website (www.shotuk.org).

Miscellaneous n=7 (plus 9 NM cases)

There were 7 cases where the primary error was not associated with the nine steps in the transfusion process.

Clinical n=2 (2 WCT)

- Cryoprecipitate was wasted in the clinical area due to time-expiry see learning Case 8.6
- The wrong D group was provided to a HSCT patient due to shared care between two hospitals

Laboratory n=5 (2 WCT and 3 SRNM)

- Two of these were due to errors originating in the Blood Service:
  - One wrong component selected and one patient that received an incorrectly phenotyped unit
- Three where laboratory staff did not update the patient records when instructed leading to:
  - Two patients where their specific requirements were not met, irradiated and HLA-matched components respectively
  - Wrong ABO group to a HSCT patient

Multiple errors

Many reported cases include more than one error and demonstrate there are missed opportunities to detect errors and prevent transfusion of an incorrect blood component.

Case 8.12: ABO-incompatible FFP selected incorrectly for a neonate

A neonate required plasma exchange in the early evening out-of-hours during a shift handover. Due to resource pressure on the laboratory and the fact that the laboratory was not familiar with neonatal transfusion, group O plasma was selected for a group A patient. Soon after starting the shift the BMS on duty was under pressure when clinical staff came to collect the FFP. Assuming the previous BMS staff had selected the correct component and under pressure the BMS ignored the warning flag and overrode it. The clinical staff were unaware that, unlike red cells, group O is not the universal plasma group. The laboratory had logged a request with the LIMS supplier to block issue of group O plasma components to non-group O recipients, but this work had not been completed.

Primary error - component selection: The laboratory management had previously identified a weakness in the LIMS and requested a block, however, at the time there was sufficient knowledge within the staff, but they failed to respond to an alert flag (assumed the BMS on shift beforehand had selected the correct component) from the LIMS to alert them they had selected group O plasma for a group A patient.

Multiple missed opportunities to detect the primary error in the following steps of the transfusion process are as follows:

Component labelling: During the labelling step the BMS did not check the group of the plasma component.

Collection: Failure to notice that the wrong component had been collected from storage site/hospital transfusion laboratory.

Administration: Clinical staff thought group O FFP would be compatible. They were unaware that, unlike red cells, group O is not the universal plasma group.

This case highlights the importance of all staff involved in transfusion knowing and understanding ABO groups and component compatibilities as recommended in the 2017 Annual SHOT Report (Bolton-Maggs et al. 2018).

IT-related IBCT cases n=125

Further details of the IT-related reports can be found in the supplementary information on the SHOT website www.shotuk.org.

Commentary

It is encouraging to see a reduction of reports at two steps in the transfusion process this year; the number of errors made at the point of requesting specific requirements and the number of errors that occur at the collection step.

Important lessons can be learnt from errors made at all steps in the transfusion process, (clinical and laboratory) and most striking is the number of errors that have the potential to be stopped at the administration step. If these are identified immediately prior to administration, they will prevent the most serious transfusion incident – unintentional transfusion of an ABO-incompatible blood component. This can lead to patient harm or death.

There continues to be strong evidence for implementation of a bedside checklist and/or electronic identification systems to strengthen identification of errors at the final step of the transfusion process.

References

BSH Green L, Bolton-Maggs P, Beattie C, et al. (2018) BSH Guidelines on the spectrum of fresh frozen plasma and cryoprecipitate products: their handling and use in various patient groups in the absence of major bleeding. *Br J Haematol* 2018;**181(1)**:54-67. https://onlinelibrary.wiley.com/doi/epdf/10.1111/bjh.15167 [accessed 30 May 2019].

BSH Milkins C, Berryman J, Cantwell C, et al. (2013) Guidelines for pre-transfusion compatibility procedures in blood transfusion laboratories: *Transfus Med* 2013;**23(1)**:3-35. http://onlinelibrary.wiley.com/doi/10.1111/j.1365-3148.2012.01199.x/full [accessed 30 May 2019].

BSH Robinson S, Harris A, Atkinson S, et al. (2017) The administration of blood components: a British Society for Haematology Guideline. *Transfus Med* 2018;**28(1)**:3-21. http://onlinelibrary.wiley.com/doi/10.1111/tme.12481/full [accessed 30 May 2019].

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JPAC (2013) Guidelines for the Blood Transfusion Services in the UK: 8th Edition Red Book. https://www.transfusionguidelines.org/red-book [accessed 31 May 2019].

NHS England (2018) Never Events list. https://improvement.nhs.uk/documents/2899/Never_Events_list_2018_FINAL_v7.pdf [accessed 30 May 2019].

9 Handling and Storage Errors (HSE) n=264

Authors: Diane Sydney and Hema Mistry

Definition:

All reported episodes in which a patient was transfused with a blood component 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 message

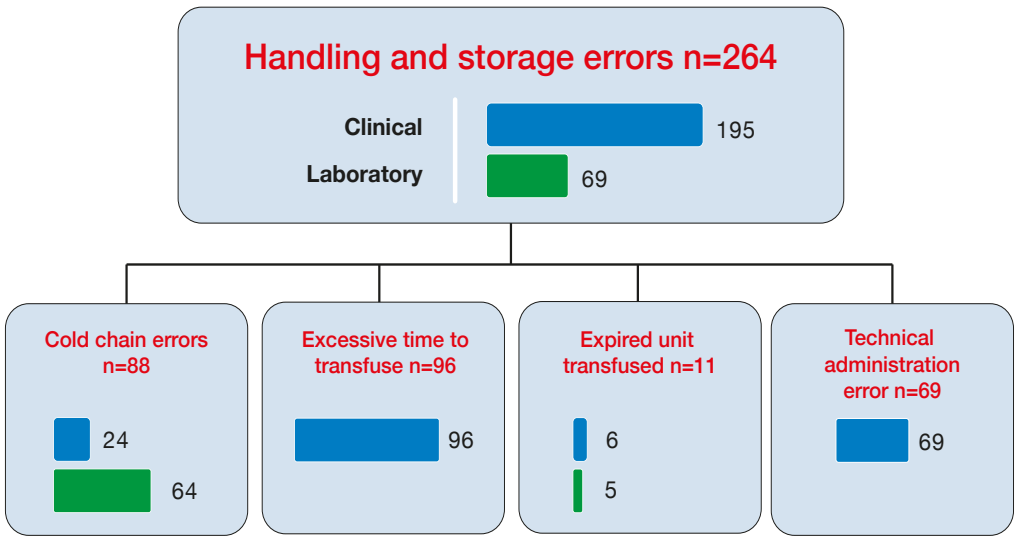
- All clinical staff need to be aware of recommended transfusion times. The British Society for Haematology (BSH) administration guidelines state 'red blood cells should be transfused in 4 hours from the time the component was removed from the refrigerator' (Robinson et al. 2017). SHOT only accept cases that have been transfused in excess of 5 hours (Foley et al. 2016)

Key SHOT messages from 2017 still remain pertinent - communication and do not assume, verify (Bolton-Maggs et al. 2018).

In 2018 264 HSE cases were reported (243 in 2017) (Bolton-Maggs et al. 2018). Clinical errors accounted for 195/264 (73.9%) and laboratory errors 69/264 (26.1%). In addition, there were 157 near miss HSE, 96/157 (61.1%) clinical, 61/157 (38.9%) laboratory.

Figure 9.1 illustrates the breakdown of HSE incidents. In most HSE categories the numbers remain similar to 2017, however reports of excessive time to transfuse (>5 hours) increased by 29.7% in 2018 from 74 (2017) to 96. Fortuitously of the 96 cases of excessive time to transfuse there were no cases of patient harm reported, nevertheless there is the potential for patient harm due to possible bacterial proliferation as a result of the time interval from removal from controlled temperature storage (CTS).

Figure 9.1: Breakdown of 2018 HSE reports n=264



The three cases below demonstrate how patient safety, verification and effective communication is critical especially when transferring patients/shared care of patients or shift handovers as they can result in excessive time to transfuse.

Case 9.1: Poor handover between two nurses overseeing the same patient leads to excessive time to transfuse

Nurse 2 received a handover from nurse 1 at 15:30 to look after a patient receiving a transfusion. When nurse 2 went to the patient, it was identified from the blood transfusion tag that the transfusion sample for the patient had expired at 14:00. Nurse 2 stopped and discontinued the transfusion at that time. On further investigation the unit had been collected from CTS at 10:15, the transfusion had been running for 5 hours 15 minutes. As the sample for the patient had expired at 14:00 and this was clearly marked on the transfusion tag, the transfusion should have been discontinued at that time or nurse 1 should have ensured that there was adequate time to infuse the unit according to local policy. On investigation nurse 1 had recognised that the transfusion should have been running at an appropriate rate and had requested assistance with this task. Furthermore, although nurse 2 stopped the transfusion, neither nurse 1 or 2 had undertaken the appropriate safe transfusion practice training. The patient did not experience any clinical reaction.

The points below indicate where in the process this error could have been prevented

- Nurse 1 raised concerns and asked for support, however did not stop the transfusion
  - There was inadequate support from other clinical staff
  - Both nurses did not have valid safe transfusion practice training appropriate to their role, leading to the nurses undertaking duties that they were not trained to perform
- Depending on local policy the transfusion could have continued, following a risk assessment as it was started before the time of sample expiry (BSH Milkins et al. 2013)

Case 9.2: Multiple staff missed opportunities to perform patient observations following transfusion

The laboratory issued four units of red cells to an acute clinical ward. The patient received two units. When the transfusion laboratory was undertaking traceability checks, it was identified that the first unit transfused had exceeded the recommended time to transfuse from removal of the component from controlled temperature storage. On further scrutiny of the transfusion form it was identified that the patient had baseline observations undertaken at 15 minutes, however no further observations were taken until the start of the second unit 6 hours and 35 minutes later. The patient was being transferred with transfusion in situ, and there was inadequate communication as to whose overall responsibility it was. Multiple staff missed carrying out checks and the unit was taken down shortly after arriving on the new ward.

Case 9.3: Poor communication during transfer of a patient between hospitals

A unit of O D-negative was removed from the emergency blood refrigerator without informing the laboratory staff. Almost two months later no documentation had been returned to the referring laboratory in relation to this unit. On investigation the unit was transfused to the patient while the patient was being transferred to another hospital. The referring hospital requested the documentation to be forwarded, however this did not happen, and a complaint was raised. The nurse who escorted the patient during the transfer recalled that the blood had been given prior to transfer but could not recall the patient details. The emergency department (ED) record stated the patient required blood but the transfusion record/ chart was transferred with the patient. It is still not known if the unit had been transfused.

There were multiple breakdowns in communication between the ED and the laboratory before the patient was transferred. The ED should have contacted the laboratory in advance of the transfer. Communications were equally challenging between the two hospitals when trying to establish the correct events and requesting transfusion documentation. This was further compounded with the delay in follow-up, making it difficult for staff to recall the exact events which led to conflicting accounts.

Of note, the National Blood Transfusion Committee (NBTC) Emergency Planning Working Group (EPWG) has recently produced a very useful document to provide revised guidance for hospital transfusion teams to prepare for, and respond to, conventional major incidents and mass casualty events. The guidance considers the transfusion emergency preparedness, resilience and response for both major incidents and large-scale disruption due to other causes and can be accessed using this link: https://www.transfusionguidelines.org/uk-transfusion-committees/national-blood-transfusion-committee/working-groups.

Learning points

- Staff should not participate in any part of the transfusion process if they are not trained and deemed competent to do so
- Staff should always remain observant during the transfusion process, including monitoring the transfusion rate to ensure that the correct rate is maintained, be vigilant with the administration checks and ensure that the correct giving set is selected for use
- Staff should stop the transfusion if the unit has exceeded the maximum transfusion time of 4 hours
- During transfers between hospitals clinical staff should contact their laboratory for advice and to ensure that the blood or components are transported and delivered correctly
- Hospitals where patients have received blood or components during transfer should ensure the return of any documentation to the patients referring hospital

Laboratory-related HSE including key messages and learning points are discussed in further detail in Chapter 14, Laboratory Errors.

Near miss HSE cases n=157

The 157 near miss HSE cases primarily involved cold chain errors 127/157 (80.9%) followed by 28/157 (17.8%) where expired units were almost transfused to patients and 2/157 (1.3%) where a technical administration error was spotted prior to transfusion.

IT-related HSE cases n=23

Further details of the IT-related reports can be found in the supplementary information on the SHOT website www.shotuk.org.

Commentary

The overall findings remain comparable with previous years. SHOT reiterates that all staff who participate in the handling and storage of blood and blood components throughout the transfusion process related to collection, testing, processing, storage, distribution and administration of components should adhere to the correct procedures that are outlined in guidelines and their local transfusion policy. Transfusion policies should be based on the most recent published guidance available (Robinson et al. 2017).

References

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Avoidable, Delayed or Under/ Overtransfusion (ADU), and Incidents Related to Prothrombin Complex Concentrate (PCC) n=236

10

Authors: Paula Bolton-Maggs and Simon Carter-Graham

Key SHOT messages

- Every minute counts:
  - 81 factors contributing to delayed transfusion were identified in 34 major haemorrhage protocol (MHP) activations
  - Delayed transfusion was compounded by delay at multiple steps
  - Poor and delayed recognition of major gastrointestinal bleeding in elderly people particularly when admitted for another cause contributes to morbidity and mortality
- Transfusion at night may be necessary and should not be delayed where there is a clear and urgent indication
- Trade names and abbreviations may cause confusion, delay and inappropriate treatment – avoid them
- Second victims: support for staff involved in a serious incident is essential
- Do not waste O D-negative units: policies for use of group O red cells should be updated to permit O D-positive units to be used in emergencies in female patients >50 years of age and in males >18 years of age
- Anticoagulants are dangerous: staff need training about indications for and use of prothrombin complex concentrate

Overview of ADU cases

- **Delayed transfusions n=112** (of these, 3 also involved avoidable O D-negative transfusions)
- **Avoidable transfusions n=106** (of these, 1 was also a delayed transfusion). Of note, there were 15 cases of transfusion-associated circulatory overload (TACO) who received avoidable transfusions which contributed to their overload, see Table 10b.2 (numbers counted in TACO)
- **Under or overtransfusion n=15**
- **Cases related to PCC n=9** (of these, 6 were delayed transfusions, and are included in the numbers of the relevant section)

Near miss (NM) cases n=12 (not included in the total 236 above)

Six unnecessary transfusions were avoided. Notable cases are shown below.

- One report noted failure of the label printer in the laboratory so that for 18 hours all forms and labels were hand written with potential for delay in transfusion
- A cardiac operation was nearly delayed due to miscommunication as staff waited for confirmation for blood availability when it was available

- A major haemorrhage call was made giving the wrong patient details but detected before components were released
- Excessive amounts of blood components were requested for two separate infants but the errors in prescription were detected prior to transfusion

Reclassification of cases

Several cases were reclassified after expert review, details of which can be found in the supplementary information on the SHOT website (www.shotuk.org).

Deaths n=9

Altogether 21 deaths were recorded, 12 reported as unrelated to transfusion, and 9 where the transfusion event played a part.

There were 6 deaths that were 'possibly related' and 2 'probably related' to delayed transfusion.

One death was recorded as 'unrelated' to the transfusion incident (delay and potentially unsafe use of group O) but this death was identified elsewhere in the report as due to bleeding so this one is included, as the delay may have contributed.

One death was 'possibly related' to overtransfusion.

Major morbidity n=0

There were no ADU cases reported in 2018 that resulted in major morbidity.

IT cases for ADU chapter n=18

Further details of the IT-related reports can be found in the supplementary information on the SHOT website www.shotuk.org.

Delayed Transfusions n=112

10a

Definition:

Where a transfusion of blood/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).

There were 112 reports of delayed transfusions in 2018 versus 95 in 2017. This total includes 6 cases where prothrombin complex concentrate (PCC) infusions were delayed.

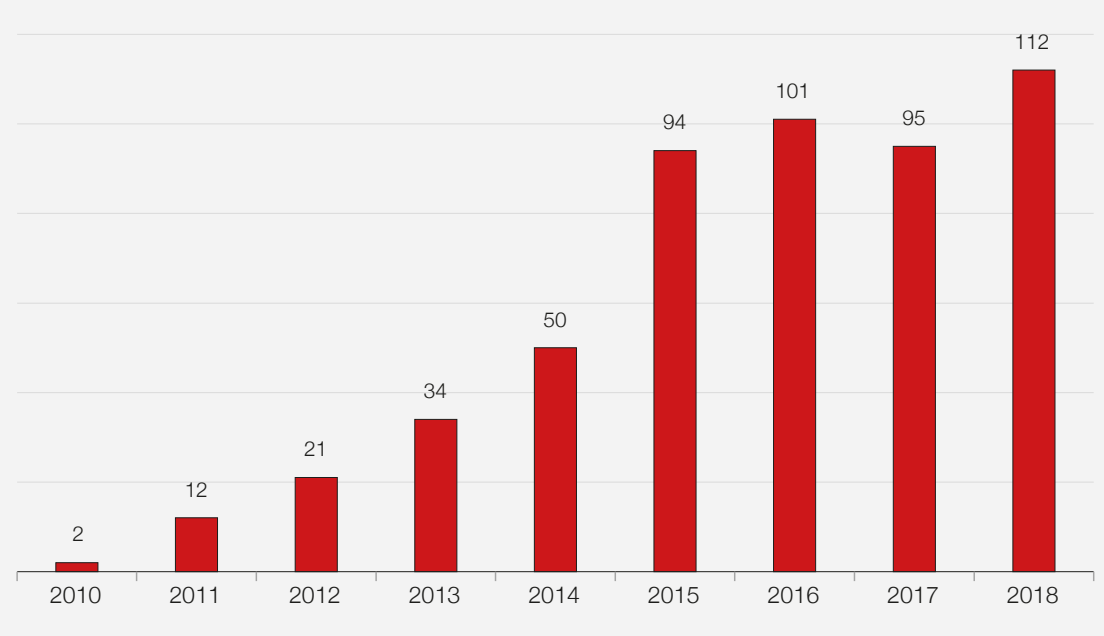


Figure 10a.1: Delayed transfusion reports by year 2010-2018

In 13 cases delays were experienced during MHP activation and in a further 6 cases with major haemorrhage but without MHP activation.

Deaths n=8

Of the 12 deaths reported in this category, 8 were related to the delay in transfusion. Two were 'probably related' and 6 'possibly related' to the delay. In one case, although the reporter noted that the death was 'unrelated' to transfusion delay, the cause of death was 'multiple organ failure secondary to uncontrolled bleeding'. These are described below.

Deaths 'probably related' to delay n=2

Case 10a.1: Delayed transfusion with contribution from multiple assumptions

A man in his 80s was in the high dependency unit (HDU) following elective aortic aneurysm repair and had a haemoglobin (Hb) of 77g/L due to haematuria. He had ischaemic heart disease (IHD). A transfusion was prescribed in the evening but he did not receive the transfusion and suffered cardiac arrest the following morning.

Many assumptions were made and there was poor handover: the prescribing doctor requested that the transfusion take place as soon as possible, but the nurses assumed it was non-urgent; staff assumed there was already blood available, but the units prepared for surgery had been returned to stock. The patient was shortly to be transferred to a ward and there was a policy not to transfuse at night unless essential.

Case 10a.2: Delay treating gastrointestinal (GI) haemorrhage

A man in his 80s was admitted (at 08:55) with a GI bleed (history of blood in stools) and Hb 76g/L. He was unwell, hypotensive (blood pressure 93/42mmHg) dizzy and unable to stand, with a raised early warning score. Two units were requested at 10:16, available at 12:07, but were not prescribed and never transfused. He was on warfarin for atrial fibrillation (AF) and his international normalised ratio (INR) was 7 for which he received timely treatment with PCC and intravenous (IV) vitamin K. He deteriorated and had a cardiac arrest within 5.5 hours (at 14:26) and died due to prolonged untreated hypovolaemic shock. The primary cause of death was recorded as massive upper GI haemorrhage due to gastric ulcers.

The case review noted that the emergency department (ED) staff did not recognise how unwell the patient was at transfer, particularly as there was no overt bleeding, and also that there was no clear plan and a lack of communication about the proposed transfusion on transfer to the ward at 12:50. There was clear evidence of deterioration in the vital signs (increased respiratory rate, tachycardia and continued fall in blood pressure) which was not escalated to the medical team.

Deaths 'possibly related' to delay n=6

Case 10a.3: Death from GI haemorrhage due to failure to recognise and treat this in a timely manner

A man in his 70s was admitted with back pain and shortness of breath and died while receiving a red cell transfusion 2 days later. Multiple co-morbidities included IHD with previous stroke, chronic kidney disease and AF for which he was on warfarin. He had known previous anaemia and received iron injections at home. On admission his Hb was 83g/L so he was prescribed a unit of red cells in the evening of Day 1. His INR was >7 for which he received a suboptimal dose of 1mg vitamin K; during the admission he had several episodes of melaena. He was transferred from the ED to the medical admissions unit (MAU) and then to a ward but the transfusion did not start until the morning of Day 3 when he then had a cardiac arrest.

Several issues were identified in the investigation:

- Failure to look for evidence of GI bleeding. A digital rectal examination was not carried out by the doctor in the ED, the foundation year doctor (who clerked the patient), nor the reviewing consultant. Had the GI bleeding been identified on Day 1 the patient could have had a gastroscopy on Day 2 and this may have prevented his death
- Failure to rapidly reverse his anticoagulation. Vitamin K was administered at 18:20 on Day 1 but only 1mg, which is inadequate for acute bleeding with a prothrombin time (PT) of 101 seconds (s) (normal range usually about 12s). Further PT results on Day 2 confirmed that only partial correction had occurred. Consideration of prothrombin complex concentrate treatment should have taken place when bleeding was overt, at 02:00 on Day 3
- Transfusion was delayed. It was planned on Day 1, and again by the reviewing consultant at 13:45 on Day 2. Transfusion was indicated after 17:00 on Day 2 when a falling Hb of 71g/L was reported
- Poor and confusing medical and nursing documentation

Case 10a.4: Delay in recognising serious GI bleeding

A man in his 70s was admitted with community-acquired pneumonia reporting a 10-day history of productive cough on a background of chronic obstructive pulmonary disease (COPD). During admission his Hb level fell from 151g/L on admission to 128g/L on Day 2. Repeat blood tests and

rectal examination were not done on Day 3, despite the patient complaining of black stools and being on medication which could cause bleeding (aspirin). On Day 5 (a Saturday) he had episodes of melaena - 'a large amount' - and was noted to be hypotensive with a tachycardia; Hb was 89g/L. He was stable so oesophago-gastroduodenoscopy (OGD) was planned for Day 7 (Monday), The patient had a two-unit red cell transfusion due to a further fall in Hb to 61g/L on Day 6 (Sunday) associated with tachycardia and repeated episodes of melaena. In the early hours of Day 7 (Monday) he became agitated and complained of abdominal pain. His Hb was 60g/L and four units of red cells were given. He deteriorated further and suffered cardiorespiratory arrest. Cardiopulmonary resuscitation (CPR) was commenced but was unsuccessful.

The National Institute for Health and Care Excellence (NICE) guidelines recommend that patients with an upper gastrointestinal bleed should have an OGD within 24 hours (of admission) (NICE 2012). Patients with upper GI bleeding should have a Blatchford score recorded to assess the bleeding risk (Banister et al. 2018; Chatten et al. 2018). There was a delay in obtaining senior review on Day 7. There was a further delay in starting the transfusion due to difficulty with venous access.

The case review noted that patients who deteriorate likely due to upper GI bleeding should have urgent senior review and blood transfusion started without delay.

Case 10a.5: Multiple causes for delay with death from hypovolaemic shock due to GI bleeding

A woman in her 80s was seen at home for a chest infection (Day 1) and refused to come to hospital. The following day (Day 2) she was seen again by the general practitioner (GP) and again declined admission although she was noted to be very pale and hypotensive (94/54mmHg, pulse rate 96 beats per minute (bpm)). On Day 3 the ambulance crew were called to her home where she was found collapsed, very short of breath and cyanosed. The working diagnosis was an acute exacerbation of COPD. She was admitted at 11:05 and waited in a chair for 3 hours. Blood results available at 17:20, 6 hours after admission, showed Hb 65g/L. She was then noted to have melaena at 19:00 so a diagnosis of GI bleeding was made, and red cell transfusion authorised. At 8 hours after admission (19:00), a blood sample was taken for crossmatch (which arrived in the laboratory 1.5 hours later). Blood was issued within an hour, however the transfusion was delayed and did not take place at all.

At 01:46 she had a cardiac arrest and died. The cause of death was recorded as cardiac arrest due to hypovolaemic shock and GI bleeding. The report notes communication failures and staff distractions due to the unit being very busy.

Learning point

- Prompt recognition and timely management of gastrointestinal (GI) bleeding, especially in complex elderly patients, is imperative. Delays can contribute to patient death. Every second counts

Patients with evidence of GI haemorrhage require close monitoring, timely investigation and appropriate transfusion; this may be incremental to keep up with bleeding, keeping a close watch on the Hb and clinical signs of bleeding. These patients do not often have sudden massive haemorrhage, and many are at increased risk of TACO (age and comorbidity). (Case 17b.1 in Chapter 17b, Transfusion-Associated Circulatory Overload (TACO), 'Rapid correction of anaemia can precipitate TACO in the absence of other comorbidities and risk factors').

Case 10a.6: Delay related to poor communication

A frail woman in her 80s died from hypovolaemic shock with bleeding from a leg haematoma. When blood was requested the laboratory requested a second sample as clinicians had not communicated the urgency. There was a delay of more than 2 hours.

In an emergency the need for a group-check sample from a previously untransfused patient may be overridden if this would delay urgent transfusion.

Case 10a.7: Intraoperative death from haemorrhage

An elderly patient was admitted with trauma. During planned surgery on Day 7 of admission there was unpredictable and catastrophic bleeding (estimated more than 2.5L within minutes), and the patient arrested and died in theatre.

A serious incident external review was undertaken. There was a changeover of anaesthetist during the procedure. The patient received two units of fresh frozen plasma (FFP) but no red cells. The external reviewer noted that the major haemorrhage protocol was not activated and considered that this degree of bleeding should have resulted in more aggressive action. In severe haemorrhage minutes may matter; there was also concern over internal delays in blood gas analysis. This unfortunate event could not have been foreseen and probably was not preventable. The external reviewer noted the considerable impact of this event on the medical staff involved.

Extract from the external review of this case notes the importance of supporting the staff involved in any serious incident

The reviewer noted the openness of discussion and the open learning culture in the department.

'This has been a great shock to a 4th year consultant anaesthetist; their confidence has been shattered, their self-belief shredded….this colleague has learnt a hard and bitter lesson. It is now time to heal and support them.

The two juniors directly involved show complete and heartfelt discomfort .. I detect, and it is unfair, self-blame and doubt. One junior has doubted their career path and considered a change.

The role of the primary consultant: I was moved by the obvious torture he is still going through…in hindsight he admits his actions were not optimal. Given time again it would all be dealt with differently. I think this shows a very brave and commendable degree of insight .. the role of a consultant can be a lonely and high stress environment. Decisions are often based on incomplete evidence under sub-optimal circumstances. It is all too easy in the comfort of an office to review notes and find glaring inadequacies in others.'

The external reviewer felt that all reasonable actions were taken to maximise this patient's chances of survival for the majority. However, he noted that only a litre of crystalloid was given, the changeover of anaesthetic staff occurred at a critical moment, no group-specific blood was given. The junior doctor requested crossmatched blood, then left. The surgical team thought that 'blood was ordered' so were unaware that this could take up to one hour to provide. Consequently, the MHP was not followed.

Case 10a.8: Potentially unsafe use of O D-negative blood in an emergency in a patient with red cell alloantibodies at a hospital with no overnight transfusion laboratory support

A woman in her 70s on peritoneal dialysis presented to her local hospital with acute bleeding overnight when the laboratory was closed. Anticoagulation with full dose low molecular weight heparin had been started on this day, and she developed a very large subcutaneous haematoma. This was treated as major haemorrhage and she received two units of emergency O D-negative blood while awaiting crossmatched blood from another site. However, neither the laboratory staff (who could have come in) nor haematologist was contacted. The clinical staff did not note that she had atypical antibodies (anti-N and auto anti-e) and therefore that the O D-negative units might be incompatible. She was transferred to the dialysis unit at another hospital where she later died as a result of complications of this bleed. There was no adverse reaction to the O D-negative units and the crossmatch of further units was completed at a distant site. Six compatible units were issued 12 hours after admission and one transfused.

The death from bleeding was initially classified as 'unrelated to transfusion' but due to the presence of many relevant factors, it has been included as possibly related (imputability 1) here.

It is important that patients who are bleeding do not die from haemorrhage so it may be necessary and appropriate to use emergency group O D-negative red cells. However, in the presence of irregular antibodies these may not be compatible and have the potential to result in haemolysis. Group O D-negative red cells will be e-positive. Advice should be sought from the haematologist and transfusion laboratory staff in this situation for both transfusion (how to monitor for and manage potential immune haemolysis) and anticoagulant management.

A case of haemolysis following transfusion of incompatible O D-negative red cells in an emergency (postpartum haemorrhage) is reported in Chapter 18, Haemolytic Transfusion Reactions (HTR). In this instance the patient had known anti-Jk^{a}. The patient was admitted to intensive care with renal impairment and required ventilation. Retrospective typing of the emergency units showed one or more was Jk^{a}-positive.

Additional educational cases

Case 10a.9: Delay caused by misunderstanding of abbreviations

Red cells were requested with the clinical details 'IUT 27+6/40 PROM'. The biomedical scientist (BMS) interpreted IUT as 'intrauterine transfusion' and ordered red cells suitable for this. However, in this instance, IUT meant 'in utero transfer'; the blood was required for the mother, not the baby. There was additional miscommunication during a telephone call resulting in delay to provision of red cells for the mother, and wastage of three units that had been provided as 'suitable for intrauterine transfusion'. On review of this case the haematologist suggested that all requests for intrauterine or exchange transfusion should go through a senior member of the transfusion laboratory staff.

Several medical abbreviations have multiple meanings so should be avoided, particularly in communication across different departments. For example, PID can mean pelvic inflammatory disease or prolapsed intervertebral disc, and there are 75 other meanings. AAA (abdominal aortic aneurysm) has 198 alternatives (source: acronyms.thefreedictionary.com). This may occur even within a specialty (e.g. MI can mean both mitral incompetence and myocardial infarction).

Learning point

- Abbreviations may be misunderstood, so do not assume that others understand without spelling it out. One abbreviation can have more than one meaning

Case 10a.10: Transfusion inappropriately delayed overnight with misinterpretation of guidelines (see also Case 10a.1 above)

An elderly woman (with diabetes) was admitted with a low Hb of 46g/L due to severe iron deficiency. The medical team refused to authorise transfusion overnight despite adequate ward staffing with three very experienced nurses more than capable of managing a transfusion reaction. She was prescribed two units of red cells. The on-call medical team were not happy for the patient to be transfused overnight in view of minimal medical cover to provide support for possible transfusion reaction. Although clinically stable at the time, the patient was at high risk due to her very low Hb. The hospital transfusion policy, while stating that consideration must be given to the safety of the transfusion, notes that the patient's clinical condition must be taken into account. The policy does not prohibit transfusion at night.

In this case there was clearly a difference of opinion between the nursing and medical staff. The nursing numbers and experience in this case were adequate to proceed. SHOT guidance is clear that transfusion must not be delayed where the need is urgent. This elderly woman also had diabetes and likely cardiovascular disease, increasing her risk of ischaemic damage from hypoxia with this degree of anaemia. Transfusion of one unit followed by reassessment would be appropriate to see at what point she could continue with iron rather than red cell transfusion.

Case 10a.11: Delayed transfusion: failure to recognise and respond appropriately to a haematological emergency in an elderly man

The elderly man with chronic lymphatic leukaemia (CLL) and significant co-morbidity complicated by known autoimmune haemolytic anaemia (AIHA) was admitted as an emergency with Hb 44g/L but did not receive transfusion until 15 hours later. Referral to the haematology team (to whom he was known) was not made for nearly 12 hours when treatment was rapidly escalated but there were additional delays; the second unit of blood was delayed as the patient transferred between wards.

The investigation identified lack of a clear transfusion plan, no referral to haematology on admission, no direct communication between the admitting doctor and the laboratory, and despite documented deterioration of the patient, the nurses and doctors failed to recognise or respond to this.

Case 10a.12: Urgent blood release delayed after postpartum haemorrhage (PPH) because of a verbal error in the order

The laboratory issued group-specific A red cells for Patient 1 following a 2L PPH but the blood was required for a different patient, Patient 2, whose group was O. There were two patients with the same first name who delivered at the same time. The midwife ordering the blood heard the wrong name and ordered blood for another woman. The group A red cell unit could not be collected from the electronic kiosk because the identification (ID) on the pick-up slip did not match the ID on the electronic system.

The reporter noted that they were very short of midwives and could not recruit and retain staff. As a result of this incident staff were reminded to always repeat back all verbal requests to ensure the details are correct. This illustrates the importance of correct patient identification and wrong transfusion was prevented by the information technology (IT) system.

Problems related to management of major haemorrhage n=34

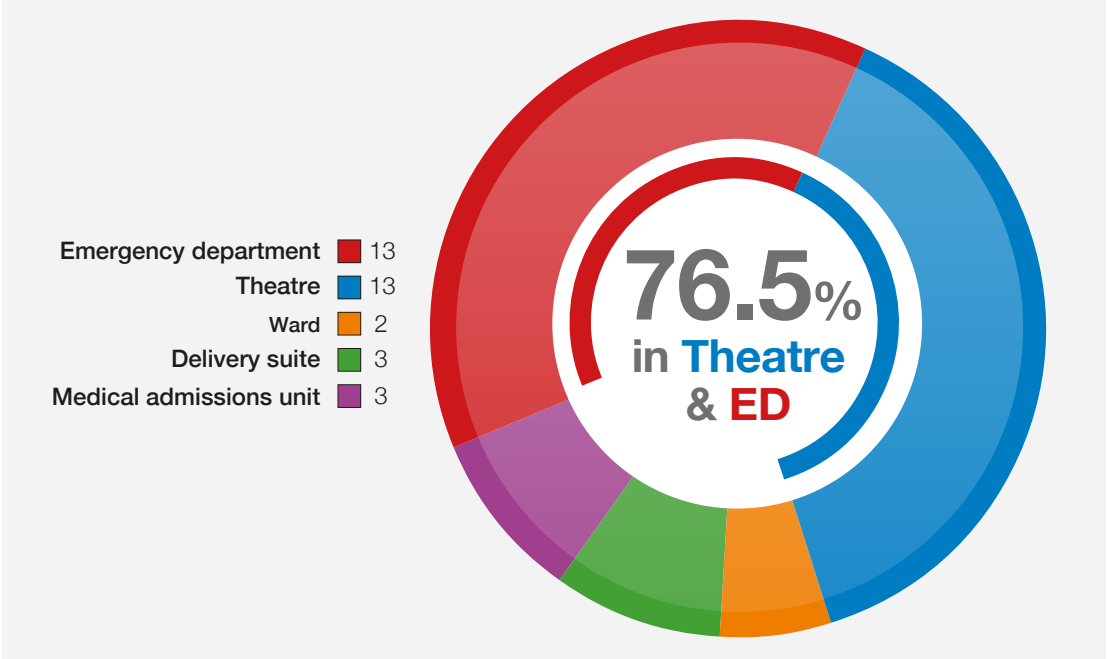
This subsection describes all incidents related to major haemorrhage, and includes 19 delayed transfusions, 12 instances of avoidable transfusion and 3 overtransfusions.

In this group of patients, there were 6 deaths, 5 unrelated to the delay and 1 (Case 10a.7) was 'possibly related' to the delay.

The transfusion priority in 32/34 was 'emergency', 1 was 'urgent', and 1 was not specified. The MHP was activated in 27/34 cases.

The majority, 26/34 (76.5%) of reported incidents in this category occurred in the ED or theatre.

Figure 10a.2: Location of major haemorrhages



There were 12 cases of avoidable transfusion related to major haemorrhage with (11) or without (1) protocol activations; in 9 of these, emergency O D-negative units were transfused unnecessarily.

There were 19 cases of delayed transfusion (in addition one avoidable case where O D-negative blood was transfused unnecessarily was also delayed). In 6 of these there was major haemorrhage without MHP activations.

There were 3 cases of overtransfusion in the context of major haemorrhage, all are detailed below.

Case 10a.13: A young person with significant multisystem injuries

A very seriously injured young person was transferred with multiple trauma: head injury with raised intracranial pressure, major chest injuries, significant intra-abdominal uncontrolled haemorrhage from a high-grade liver laceration and very high-grade splenic injury. Peripheral injuries included stable pelvic fracture, femoral shaft fracture and the patient was haemodynamically unstable. The patient received red cells and plasma in transit. Following admission during complex surgery and resuscitation they received 19 units of red cells, 14 units of FFP, three units of platelets and four of cryoprecipitate. Post-transfusion Hb was 199g/L requiring venesection.

The emergency care resulted in survival from these extensive injuries. However, case review was undertaken to investigate why the patient was overtransfused. Persistent hypotension and poor perfusion had been attributed to blood loss when it was caused by misplacement of the chest drain resulting in a tension pneumothorax. Repeated blood gas and laboratory analyses were available throughout surgery and stabilisation showing adequate Hb levels of about 140g/L but these had not been taken into account.

Case 10a.14: Unexpected bleeding during surgery

An elective nephrectomy for a tumour was converted from a laparoscopic to an open procedure with estimated 2L blood loss from the renal vein. The patient received 15 units of red cells, five of FFP, two of platelets and two of cryoprecipitate. The pre-transfusion Hb was 123g/L and 4 hours later was 156g/L. The patient suffered cardiac arrest and was transferred to ITU postoperatively, but this was not attributed to the transfusion.

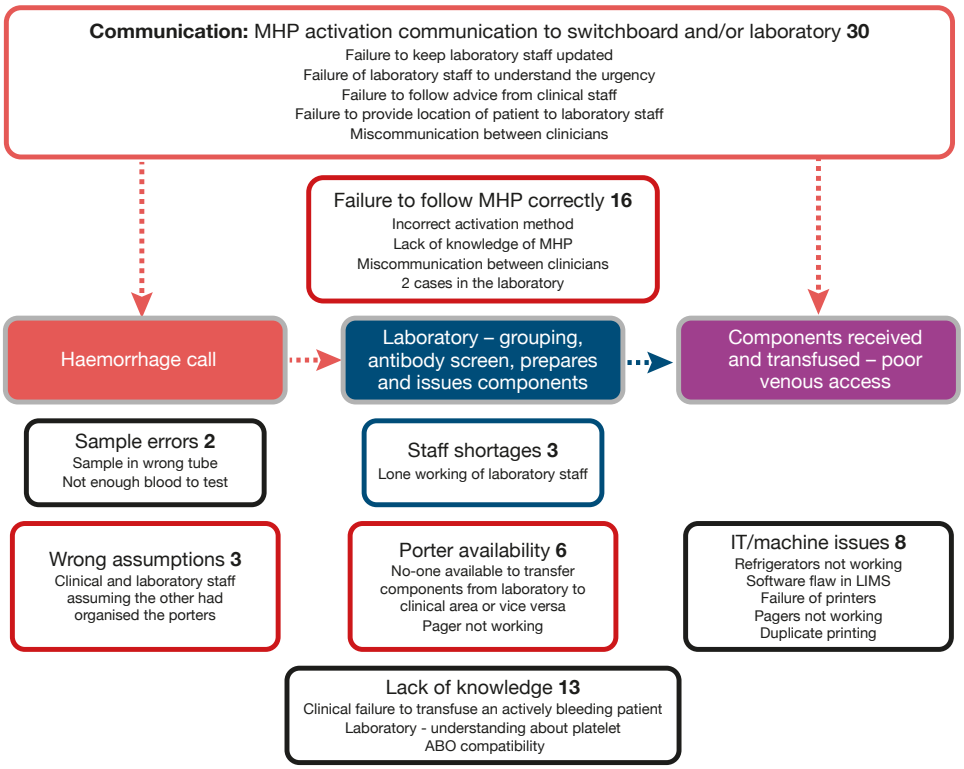
Case 10a.15: Inaccurate estimate of bleeding

Unexpected blood loss into a drain (300mL) following mastectomy resulted in activation of the MHP. This was considered to be an inappropriate activation with an overestimation of the blood loss. The patient received two units of blood and the FFP was wasted. The post-transfusion Hb the next day was 123g/L.

These three cases demonstrate difficulties in assessment of blood loss in an emergency. The first case was particularly difficult for the attending staff owing to the very severe injuries; the case review was important as it noted that in the stressful environment the useful evidence from blood tests was overlooked.

Factors identified in 34 major haemorrhage cases (27 MHP calls) n=81 (often more than one per case)

Figure 10a.3: Holdup points identified in the major haemorrhage transfusion pathway



MHP=major haemorrhage protocol; IT=information technology; LIMS=laboratory information management system

30/34 (88.2%) communication factors

- Miscommunication between clinicians
- Failure of biomedical scientist or porter's pagers
- Misunderstanding of verbal information between clinician and laboratory staff
- Failure to follow advice from haematology staff
- Failure of laboratory staff to understand clinical urgency
- One hospital had different packs depending on whether the MH was associated with trauma (Pack 1 includes FFP) or not associated with trauma (Pack 1 does not include FFP)
- Failure to update laboratory staff following MHP activation. Recurring failure of clinical area to update laboratory staff and confirm stand down
- Failure to check transfusion history in a patient with known alloantibodies followed by transfusion of O D-negative units
- Failure to provide location of the patient to the laboratory staff

16/34 (47.1%) MHP procedure not followed correctly

- Incorrect activation method
- Misunderstanding of correct procedure including failure to use emergency group O D-negative units
- Provision of platelets with MHP Pack 1 in error (should only be in Pack 2)
- Failure to complete patient identification, and prescription in the wrong place
- Failure to ensure the laboratory staff and porters were contacted

- Failure of laboratory staff to start thawing FFP following use of Pack 1 in order that it would be ready for Pack 2
- Laboratory staff lack of knowledge and failure to follow procedures

13/34 (38.2%) lack of knowledge contributing to the two issues above

- Failure to transfuse actively bleeding patients or activate the MHP when advised to

6/34 (17.6%) porter availability e.g. nobody to transport blood units from laboratory to clinical area

5/34 (14.7%) equipment failures

- Blood refrigerator in theatres out of action, porters had been informed but the clinical staff were not aware
- Failure of plasma thawer

3/34 (8.8%) wrong assumptions made

- Laboratory staff received no calls from the ED following admission of a patient with haemorrhage and first provision of emergency units so they assumed the MHP was stood down (there was a special telephone number not used by the clinical area)
- Continued transfusion on the assumption that the patient was bleeding without consulting available results which showed normal Hb results
- Clinical area and laboratory staff each assumed the other was responsible for organising the porters

3/34 (8.8%) staff shortages – lone working of laboratory staff

3/34 (8.8%) IT issues included failure of printers, duplicate printing and inability to release paediatric emergency units due to a software flaw

2/34 (5.9%) sample errors – one sent initially in heparinised tube, second sample too small to test; another sample sent in wrong tube so needed to be repeated

Logistics

These included situations where there had been no one available to transport the relevant components to the clinical area from the laboratory. These were related to staff shortages. There were some cases where incorrect assumptions had been made causing delays.

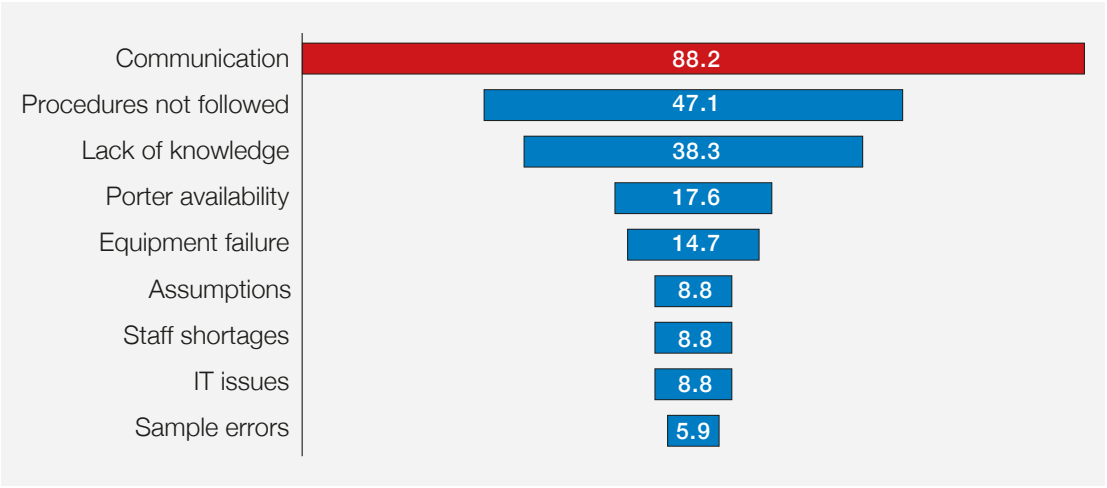


Figure 10a.4: Poor communication is the most common factor contributing to errors in MHP-related reports (results as %)

IT=information technology

Major bleeding without activation of the MHP was reported in 7/34 (20.6%) cases.

There were 6 cases that occurred in theatre and 1 case in the delivery suite.

There were overall 9/34 cases of major haemorrhage that occurred in trauma patients, all associated with delay.

Commentary

It is disappointing that there were so many problems reported in the management of major haemorrhage, most resulting in delayed transfusion. In major bleeding every minute counts. A published review of 680 trauma patients noted that every minute of delay from activation of the MHP to delivery of components increased the odds of death by 5% (Meyer et al. 2017). It is now more than 8 years since the National Patient Safety Agency published their Rapid Response (NPSA 2010). This alert was issued in relation to 11 deaths and 83 incidents of harm due to delays reported over a 4-year period. Here we report 34 incidents related to major haemorrhage in a single year, 19 resulting in delay. There were 16 reports to SHOT of delay in 2016, and 19 in 2017, in total 54 over the past 3 years. The most important factor contributing to delay is poor communication, as shown above and similarly in previous years.

Guidelines published in 2015 recommend that all staff 'involved in frontline care must be trained to recognise major blood loss early, know when to activate/trigger the local major haemorrhage protocol and take prompt and appropriate action' (BSH Hunt et al. 2015) and good communication is essential. One centre has devised a transfusion prescription template which improved balanced transfusion (FFP:RBC ratio) in trauma cases monitored 2012-2016 (Swieton et al. 2018). This template includes reminders about what blood samples to take and which patients might be eligible for group O D-positive rather than D-negative emergency units. A recent review addresses the many advances in management of major haemorrhage in trauma but not these basic issues of communication and logistics (Curry and Davenport 2019). The key components of a MHP are listed in another recent review (Booth and Allard 2018) and include scope, activation method, choice of components, communication, stand-down and regular review including training and drills. The evidence from SHOT reporting suggests that there is room for improvement.

Additional cases related to errors in major haemorrhage protocol activation are found in Chapter 14, Laboratory Errors, Case 14.7, and Chapter 13, Right Blood Right Patient (RBRP), Case 13.1.

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Avoidable Transfusions n=106

10b

Definition:

Where the intended transfusion is carried out, and the blood/blood component itself is suitable for transfusion and compatible with the patient, but where the decision leading to the transfusion is flawed. This includes transfusion based on poor knowledge, communication failures, incorrect decisions or poor prescribing.

Avoidable use of emergency O D-negative blood where group-specific or crossmatched blood was readily available for the patient.

The total of 106 excludes 3 cases classified under delay which were also associated with avoidable transfusion of O D-negative units. This compares with 101 in 2017.

Avoidable transfusions contributed to circulatory overload in 15 cases. These are counted in Chapter 17b, Transfusion-Associated Circulatory Overload TACO).

MHP factors n=12

These cases are discussed in more detail in the section under delayed transfusions.

Cases involving major haemorrhage factors included 9 with MHP activation, resulting in avoidable use of O D-negative units.

In one case, misreading the gas machine result as 'Hb 50' when this was 'HHb', resulted in MHP activation and the patient was transfused.

Most blood gas machines include CO-oximetry as a bolt-on option. It is a separate unit to the main Clarke electrode blood gas analyser. The CO-oximeter unit tends to use specific wavelengths of light to look at oxygenation state of haemoglobin by specific wavelength absorption. Commonly, it reports total haemoglobin (tHb, A in Figure 10b.1), although this is not especially accurate. It also reports carboxyhaemoglobin and methaemoglobin. The final value reported on some (but not all) machines is reduced haemoglobin, i.e. structurally normal haemoglobin in a deoxygenated state. This is often annotated HHb, the first H relating to hydrogen, hence the 'reduced' state (B in Figure 10b.1) and is not the true Hb result.

	Results				Crit. Low	Reference Low	Reference High	Crit. High
	Measured (37.0°C)							
	pH		7.37		[7.20	7.35	7.45	7.60]
	pCO_2	↑	6.8	kPa	[2.6	4.3	6.4	9.3]
	pO_2	↓	9.0	kPa	[6.0	11.0	14.4	--]
	Na^+	↓	135	mmol/L	[120	136	145	160]
	K^+		4.2	mmol/L	[2.8	3.5	5.1	6.5]
	Cl^-		99	mmol/L	[80	98	107	120]
	Ca^{++}		1.19	mmol/L	[0.75	1.15	1.33	1.60]
	Hct	↓	35	%	[18	37	50	60]
	Glu	↑	14.4	mmol/L	[2.5	3.6	5.3	25.0]
	Lac	↑	2.3	mmol/L	[--	0.3	2.0	4.0]
	CO-Oximetry							
A	tHb	↓	110	g/L	[70	117	174	200]
	O_2Hb		92.5	%	[--	90.0	95.0	--]
	COHb		1.3	%	[--	0.0	3.0	10.0]
	MetHb		0.8	%	[--	0.0	1.5	--]
B	HHb	↑	5.4	%	[--	1.0	5.0	--]
	sO_2		94.5	%	[--	94.0	98.0	--]
	Derived							
	BE(B)	↑	3.1	mmol/L	[--	-2.0	3.0	--]
	HCO_3^-std		27.3	mmol/L	[10.0	21.0	28.0	40.0]

↑↓ Outside Reference Range

Figure 10b.1: Blood gas result illustrating the difference between total Hb (A) and HHb (B)

Avoidable use of O D-negative units n=27

There were 27 cases of avoidable O D-negative red cell use, of which 9 (see above) were associated with MHP calls and one other with major haemorrhage without MHP activation. In the 10 cases with major haemorrhage, 5 were less than 50 years of age (3 male and 2 female), but 5 were over 60 years of age (3 male and 2 female).

In those without major haemorrhage, n=17, a total of 12 patients 6/8 women and 6/8 men (together 75.0%), were over 50 years of age (in 1 case age and gender was not provided).

A national audit of the use of O D-negative red cells (May 2018) including data from 193 sites with fate known for 5343 units, found that 321 (6%) O D-negative red cell units were transfused to male and female patients >50 years of age as an emergency. This audit reported that 32% of sites do not have a policy to provide O D-positive red cells in an emergency to unknown male patients and females >50 years old.

Learning point

- Group O D-positive units are suitable in an emergency for females over 50 years, and for males >18 years of age

The stability of supply chain for O D-negative red cells is a challenge for all Blood Services. Measures should be in place to ensure supply is adequate for those who need this group the most:

- O D-negative patients with detectable or historical anti-D
- O D-negative women of childbearing potential
- Patients of childbearing potential and paediatric patients of unknown blood group
- O D-negative males <18 years of age

Regularly transfused O D-negative patients and patients whose blood specifications cannot be met within their own blood group might require O D-negative red cells. Unnecessary use outside these indications can destabilise the supply chain and expose the most vulnerable patients to additional risk.

Recommendation

- Hospitals should regularly review their transfusion policies in relation to use of O D-negative red cells and consider including use of O D-positive red cells for males >18 years of age and female patients of non-childbearing potential when an emergency transfusion is required

Action: Hospital/Health Board Transfusion Committees

In 30 patients (including 3 delays) the use of group O D-negative red cells was avoidable;

- In 10 cases group-specific units were available
- In 9 cases delayed provision of crossmatched units was due to an earlier error (includes the 3 delays)
- In 7 cases crossmatched units were available
- In 1 case two samples were taken from the wrong patient
- In 1 case O D-negative was given to a patient with antibodies who could only be crossmatched at a distant centre. This is also potentially unsafe but the emergency need may override this
- In 1 case bleeding post tonsillectomy, the MHP was activated but the patient was transfused with Hb 143g/L
- In 1 case with folate deficiency the MHP was activated inappropriately, Case 10b.4 below

Learning points

- Use of crossmatched or group specific red cells is preferable to use of O D-negative units. Group O D-negative red cells are not safe for all patients. They may be incompatible and result in haemolysis in patients who have irregular red cell antibodies
- Patients should not die from lack of red cells. In major haemorrhage where the patient has a positive antibody screen or known antibodies for which compatible blood is not readily available aim to give ABO, full Rh and K-matched units and discuss with a haematologist

For further information see SHOT Bite No 8. Massive Haemorrhage - Delays (under current resources on the SHOT website www.shotuk.org).

Three cases of delay where emergency O D-negative units were used:

Case 10b.1: Wrong details provided by ambulance staff

A patient was transferred from another hospital with ruptured abdominal aortic aneurysm. Patient details were wrong on the ambulance transfer form (the hospital-based ID band and addressograph labels were not used) and then these wrong details were used for the hospital's information system. Several samples with different spelling of the first name were sent to transfusion; group O D-negative red cells were used in the interim.

Case 10b.2: Wrong bleep number

Emergency O D-negative red cells were used as the ED could not get through to the laboratory staff because they were using the wrong bleep number.

Case 10b.3: Potentially unsafe use of O D-negative units in a patient with AIHA

A patient with AIHA secondary to non-Hodgkin lymphoma and Hb 25g/L had refused blood on religious grounds but on the 3rd day consented to transfusion. Three blood samples were rejected by the laboratory; when satisfactorily repeated, the patient was found to have irregular red cell antibodies, but the clinical team decided to use uncrossmatched O D-negative units.

These are not necessarily safe (see above), but the severity of the anaemia and delay justified this decision.

Why were the samples rejected? The phlebotomist had decided her way of labelling the tubes was neater and so did not follow correct procedure; in addition, the electronic labelling equipment was not working properly.

There was an additional case of delay in a patient with AIHA (Case 10a.11).

Avoidable red cell transfusions in patients with haematinic deficiency n=8

Case 10b.4: Panic at low Hb result led to MHP activation and inappropriate transfusion of three different components for folate deficiency

A woman in her 30s was admitted as an emergency and found to have Hb 30g/L with mean cell volume (MCV) 118fL. The laboratory staff requested a repeat sample, but this advice was ignored. She had no evidence of bleeding or decompensation, was normotensive and had no symptoms of anaemia to warrant transfusion. The haematology registrar had noted the high MCV and advised that haematinics should be checked and not to transfuse the patient. However, a trainee activated the MHP. The BMS, not aware of the clinical situation, did not challenge this and the woman received an inappropriate transfusion of four units of O D-negative red cells together with two of FFP and one of platelets (count 45x10^9/L). The folate result (<1.6 microg/L indicating severe deficiency) was available 11 hours after the MHP activation.

The patient had severe anaemia and a low platelet count due to the folate deficiency and did not need platelets. Transfusion of one unit of red cells might have been reasonable, but activation of the MHP and transfusion of the other components despite advice to the contrary shows a startling lack of knowledge and lack of respect for the advice given by a specialist.

Learning points

- When a low haemoglobin (Hb) occurs unexpectedly it is advisable to repeat the sample to ensure it is not due to poor sampling
- The mean cell volume (MCV) provided as part of full blood count results can help categorise anaemia and determine which additional investigations are appropriate

There were 7 additional cases of avoidable transfusion in people with iron deficiency anaemia (IDA). Five were prescribed by registrars or foundation year doctors, and one by a consultant. Four were in the ED and two in gynaecology settings. One was caused by analyser error. There were also two cases of delayed transfusion where the primary diagnosis was iron deficiency. In many of these it might have been reasonable to transfuse a single unit if the patient was symptomatic, but all were transfused excessively (Table 10b.1). A further avoidable transfusion for iron deficiency was associated with a febrile reaction and is reported in Chapter 16, Febrile, Allergic and Hypotensive Reactions (FAHR), Case 16.3.

Learning points

- In patients presenting with very low haemoglobin (Hb) before arranging transfusion first diagnose the cause
- Look at the mean cell volume (MCV); this is very elevated in B12 and folate deficiency (treat with the appropriate vitamin and transfusion can usually be avoided even at very low Hb levels)
- The MCV is reduced in iron deficiency proportionate to the degree of anaemia. Treat iron deficiency with iron therapy
- Before transfusion consider underlying risk factors (age, comorbidity particularly ischaemic heart disease)
- Transfuse the minimum amount; if really necessary, give one unit and review
- Note that transfusion-associated circulatory overload (TACO) can be precipitated with rapid correction of anaemia (Case 17b.1, Chapter 17b, Transfusion-Associated Circulatory Overload (TACO))

Table 10b.1: Excessive or delayed transfusions in iron deficiency

Patient age	Sex	Hb g/L	Number of units transfused	Comments
50s	M	45	3	Known iron deficiency anaemia lost to follow up
50s	F	85	4	Post-transfusion Hb 166g/L. Consultant prescription pre-hysterectomy
80s	F	39	2	Four units were prescribed
Teen	F	NS	2	Menorrhagia
40s	F	49	3	Menorrhagia
70s	F	46	2	Delayed overnight inappropriately*
40s	F	54	NS	Symptomatic anaemia; Three samples rejected due to labelling errors. 5-hour delay

*NS=not specified *discussed under delays*

Recommendation

- Cases of inappropriate management of haematinic deficiency are reported every year. Education about the haematological effect of iron, B12 and folate deficiency should be taught at undergraduate level

Action: Undergraduate medical and nursing schools

Cases of avoidable transfusions complicated by TACO n=15

These cases are included in the numbers in Chapter 17b, Transfusion-Associated Circulatory Overload (TACO). The causes were mixed but reports usually noted an inappropriate number of units and/or rate of transfusion.

Table 10b.2: Avoidable transfusions precipitating TACO n=15

Age of patient	Hb and background	Number of red cell units	Notes
90s	Transfusion based on wrong Hb 67g/L, actual 114g/L	4	Pneumonia and CV* disease
70s	Hb 64g/L, MCV 108	2	Underlying CV disease, 2nd unit not needed
60s	Hb 66g/L; transfused overnight, sepsis and relapsed lymphoma	3	TACO on 3rd unit. Should check Hb after each unit
60s	Known low B12 and folate recorded in 2017, confirmed on repeat, and not treated. Hb after one unit 56g/L	1 plus 6 more issued. TACO after 3 of these	Miscommunication resulted in overtransfusion and cardiac arrest
60s	Hb 58g/L chronic iron deficiency (MCV 68fL) due to angiodysplasia	1	TACO with first unit, on aspirin and steroids, no iron
60s	Post operation with background vascular disease	2	Second unit given in error
60s	Intermittent rectal bleeding, not severe	2, then 2 more units despite symptoms of TACO	TACO on 2nd unit but still more given. Iron advised
50s	Case 17b.1** Hb 34g/L	3 units transfused very rapidly	Cardiac ischaemia and raised troponin
70s	Hb 96g/L, breathlessness attributed to this mild anaemia but may have been heart failure	2, admitted later in day to another hospital	Cardiac disease with heart failure
90s	Hb 64g/L, macrocytic	2, TACO with 2nd unit	Cardiac disease
70s	Malignancy, respiratory compromise before transfusion, Hb 76g/L	2, TACO 6 hours after 2nd	On home oxygen
70s	Relapsed lymphoma, Hb 80g/L	2, TACO after 2nd	One unit sufficient
80s	Hb 78g/L	2, 2nd was not necessary	Positive fluid balance >1.3L before transfusion
80s	MDS Hb 84g/L	NS*, readmitted with pulmonary oedema	Aortic valve disease
60s	Pancytopenia, Hb 34g/L, platelets 27, neutrophils 0.85 due to leukaemia. Case 17b.3 **	4 units of red cells, 1 of platelets 3 of FFP	Overtransfused and admitted to ITU

**NS=not specified; CV=cardiovascular; MDS=myelodysplastic syndrome*

***Chapter 17b, Transfusion-Associated Circulatory Overload (TACO)*

Other examples of avoidable red cell transfusion:

Case 10b.5: Near miss – avoidable transfusion for one patient is associated with ABO-incompatible transfusion in another due to failure of bedside identification

An elderly patient was admitted after a fall with two fractures. Her Hb was 82g/L and she was transfused with one unit of red cells. A second unit was collected but not given, as it was decided not necessary. This decision should have been made before the unit was collected. However, after checking the unit with the doctor at the nurses' station, transfusion of this unit was started in error on another patient who was also being transfused. This wrong patient received ABO-incompatible red cells as a result and suffered major morbidity (Case 8.1 in Chapter 8, Incorrect Blood Components Transfused (IBCT)).

As a result of this case transfusion training was put back on the organisation-wide programme, competencies will be logged electronically, and the roll out of electronic tracking will include bedside modules.

Three patients transfused who had religious objections to blood components

Case 10b.6: Patient transfused despite religious objection

A woman in her 70s with religious objection received a red cell transfusion (despite having specified that she did not want transfusion) due to failure of handover when she was transferred to ITU.

Case 10b.7: An elderly man with repeated transfusions against his religion was detected incidentally

An elderly man with renal disease was transfused red cells on six occasions over a 3-year period but with no evidence of consent. His religion was not consistently recorded in the notes nor is there evidence that alternatives to red cells were discussed, nor whether or not he consented to red cell transfusion on the last two occasions. This was picked up incidentally at a morbidity and mortality review following trauma management. In 2014 there was evidence of consent for transfusion for serious bleeding when the Hb was 51g/L. On three other occasions he was transfused with no record of consent. The renal physician commented regarding past refusals of transfusion, there is no evidence that this was followed up.

Case 10b.8: Missed advance directive

A patient with religious objection and an advance directive in place was transfused following GI bleeding at a time when lacking capacity. This was discovered later and was due to communication factors and failures to follow hospital policy.

A further case is described under the prothrombin complex concentrate section.

Avoidable transfusion of platelets n=17

Case 10b.9: An inappropriate platelet transfusion due to confusion over names and failure of correct patient identification

A haematology patient informed his consultant that he had been called in for a platelet transfusion 3 months earlier. Despite repeated questioning at the time by the patient, and a normal platelet count of 230x10^9/L a month before, he received this transfusion without a check of his count on the day.

The doctor had made a verbal instruction to the booking clerk. Two patients had the same surname and the wrong one was called in for transfusion. The other one, who needed platelets and who had been informed verbally by the doctor, was admitted as an emergency the day before.

There were several failures of procedure. The review resulted in the following corrective actions:

- The patient scheduler will email back to the referring person following a verbal request to confirm identification and instructions

- The prescriber/authoriser will check the platelet count prior to prescribing and will document the result
- The person administering the component will check the count prior to administration
- The transfusion laboratory staff will save and store telephone logs for up to a year

The other 16 cases of inappropriate platelet transfusions included:

- 3 cases where the platelet count was above the threshold for transfusion
- 3 cases where the low platelet count was caused by clumping in the sample
- 2 had dilute samples from drip arms; clinicians ignored the request for repeat
- 1 wrong blood in tube sample
- 1 patient transfused four adult treatment doses of platelets without appropriate indication
- 1 patient was transfused platelets that were intended for weekend cover
- 1 patient was on aspirin and anticoagulants; platelets not correct treatment
- 1 patient with chronic aplastic anaemia without bleeding
- 1 inappropriate transfusion at another hospital
- 1 misreading of the result, '8.6' read when the result was $86x10^9$/L
- 1 transfusion of platelets in major haemorrhage when major haemorrhage Pack 1 erroneously contained platelets (these are included in Pack 2).

Avoidable transfusion of FFP n=4

Case 10b.10: Inappropriate FFP transfusion based on coagulation results from heparinised syringe

Three units of FFP were transfused for abnormal coagulation results prior to surgery. These results were caused by the blood being taken into a heparinised syringe and were therefore invalid.

The patient had possible ascending cholangitis and an endoscopic retrograde cholangiopancreatogram (ERCP) was planned. The white cell count was raised at 23.8x10^9/L (normal range 4-10x10^9/L), with normal coagulation and platelet count.

The next day the white cell count was still raised, and the platelet count had fallen (335 on admission down to 177x10^9/L). The coagulation screen was abnormal, and repeat was also abnormal with prothrombin time (PT) 23 seconds (s) (normal range (NR) usually 11 to 13.5s), activated partial thromboplastin time (APTT) 40s (NR usually 30-40s but varies with method and range was not given in this case report), and thrombin time (TT) 18s, (NR 12-14s). Two days later the platelet count had fallen to 54x10^9/L.

The patient was very difficult to bleed; several attempts had been made by different members of staff. It was decided to take an arterial blood sample (and the laboratory had agreed to this). The doctor knew the arterial blood gas kit contained heparin, but he knew the laboratory staff were aware. Blood was taken and then transferred into the coagulation sample tube and into tubes for a full blood count and electrolytes.

The platelet count was 27x10^9/L consistent with continued fall. The coagulation screen results were more abnormal with PT 24s, TT 46s and no APTT result could be given. The laboratory comment was 'results abnormal, repeat'. The consultant haematologist reviewed these and previous results, being aware that the patient was difficult to bleed. He decided not to repeat the bloods and advised 10mg IV vitamin K and one unit of platelets followed by a full blood count 1-hour post transfusion to confirm that the platelets incremented by 30-40. He advised that the patient should receive 1 to 2 litres of FFP and be monitored for overload.

The following morning a full blood count and coagulation screen showed that the platelet count was 20x10⁹/L and the coagulation was normal. Another request was made for a unit of platelets pre-procedure. The junior doctor who had come back on duty noted the grossly abnormal results from the previous evening. He asked his colleague if there had been any difficulties taking the sample. At this point the junior doctor realised what had happened regarding the results due to the heparin contamination.

Lessons learnt

- Samples for coagulation studies must not be taken in any sample bottles containing heparin
- If staff are struggling to take coagulation screen samples the coagulation department should be contacted directly to discuss the options available to them with one of the BMS staff. The department can provide smaller bottles (1.2mL) compared to the normal 3.2mL fill volume
- If in the future abnormal coagulation screen results of a similar nature are obtained the laboratory should perform a fibrinogen (if there is enough sample and it is not too old to analyse)

It is surprising that the consultant haematologist did not recognise the characteristic abnormalities associated with heparin in the sample – a relatively unchanged PT, prolonged TT and unrecordable APTT. These results were very different to the previous ones and not characteristic of hepatic dysfunction.

Commentary

- Many avoidable transfusions demonstrate a surprising lack of knowledge of basic haematology which should be taught at undergraduate level, particularly the characteristic features in the blood count in iron, B12 and folate deficiency
- Group O D-negative blood is a precious resource and it is clear that hospital policies could permit greater use of O D-positive units for older women and men in an emergency
- Avoidable transfusions contributed to several cases of TACO reinforcing the messages and recommendation for appropriate pre-transfusion assessment

Under or Overtransfusion n=15 10c

All cases of under or overtransfusion were clinical errors. One undertransfusion was also delayed (and included in those numbers) due to a laboratory misunderstanding.

There were 3 patients that were undertransfused and 12 over transfused, 3 of these in relation to major haemorrhage. There were 6 paediatric cases: 1 undertransfused and 5 overtransfused.

Deaths n=1

There was 1 death related to overtransfusion. This is described in Case 10c.4.

Undertransfusion n=3

Case 10c.1: Confusion about dose of red cells in a young child

A young child was given a smaller volume of red cells than required due to confusion over the calculations and involving two units of red cells.

Case 10c.2: Transfusion not monitored properly after patient transfer

An elderly woman admitted with gastrointestinal bleeding received O D-negative blood in the emergency department but about 6 hours later checking established that only a small volume had been given. The transfusion had not been properly monitored and repeat Hb results suggested this might also have been an avoidable transfusion.

Case 10c.3: A second case of inadequate monitoring of transfusion

An elderly woman with fractured neck of femur was undertransfused. Six hours after a unit of red cells was set up it was noted that the pump had been switched off and the patient had not received the full unit. The patient died but this was unrelated to the transfusion.

Overtransfusion n=12

The 3 cases that relate to major haemorrhage are described earlier (see Cases 10a.13 to 10a.15).

Case 10c.4: Death related to overtransfusion

A patient in her 70s, weight 38kg, presenting with a rectal bleed was overtransfused, receiving three units. The pre-transfusion Hb was 158g/L and post transfusion was 195g/L. The patient was venesected but 2 days later had a cerebral event. She died 5 days after the transfusion and a further cerebral event. The transfusion was thought to be contributory to her death.

Further overtransfusion cases can be found in the supplementary information on the SHOT website www.shotuk.org.

Commentary

It is notable that the death occurred in an elderly woman of low weight, whose Hb was normal prior to transfusion. Such cases have been reported in previous years. GI bleeding can be difficult to assess and this is a reminder that such vulnerable patients need continued re-assessment for the evidence of bleeding and Hb monitoring.

As in previous years 5 cases were errors in volumes given in children, particularly 4 overtransfusions in infants. An additional case classified as a handling and storage error is noted in Chapter 23, Paediatric Cases (Case 23.7); a child received an excessive volume because of incorrect pump setting.

These cases reinforce the recommendation from last year, that clinical staff authorising or prescribing for children should receive training in weight-based prescribing (Bolton-Maggs et al. 2018, p170).

Reference

Bolton-Maggs PHB (Ed), Poles D et al. (2018) on behalf of the Serious Hazards of Transfusion (SHOT) Steering Group. The 2017 Annual SHOT Report. https://www.shotuk.org/shot-reports/ [accessed 30 May 2019].

Incidents Related to Prothrombin Complex Concentrate (PCC) n=9

10d

These occurred in an elderly population, age range 62 to 90 years, median 83 years.

Six (66.7%) of these were reported because of delayed treatment. All were classified as emergency or urgent transfusions. Minutes count.

Case 10d.1: PCC given at an inappropriate rate due to lack of knowledge

Treatment was indicated for insertion of a chest drain in a patient with a haemothorax. PCC was started at the wrong rate of 8mL/hour instead of 8mL/minute. The prescribing doctor did not state a rate and was not competent to administer it. This was a fraught situation including cardiac arrest during the transfusion. As a result, further training was provided in the ED and there was discussion with all staff involved.

Case 10d.2: Inadequate dose required urgently for intracranial haemorrhage

Urgent treatment was required for an elderly patient on warfarin, INR 3.5, with intracranial haemorrhage. This site only had 500IU in stock and there was a delay in obtaining the rest of the 1500IU from another site resulting in delay of 1.5 hours. Although stock checks had taken place the staff had not ensured further supplies were ordered. The procedures have been tightened up.

Case 10d.3: Treatment delay due to lack of knowledge

Emergency surgery for a perforated ulcer was delayed because the ward staff were unclear how to obtain and administer PCC. Training needs were identified and have been resolved.

Case 10d.4: Confusion over similar trade names results in wrong product transfusion

An elderly man was admitted with gastrointestinal bleeding. There was confusion over similar blood component/product names. The patient was admitted with bleeding needing warfarin reversal. The patient also received emergency group O D-negative red cells (three), and platelets. Octaplas® (solvent-detergent fresh frozen plasma (SD-FFP)) was requested verbally without informing the laboratory staff about the need for warfarin reversal, and five units of Octaplas® were issued after 2 hours waiting for the correct documentation. Three units were transfused before the written request clarified what was required, and Octaplex® (PCC) issued with a delay of 3.5 hours for treatment. The laboratory BMS agreed they should not have released the product without written confirmation.

Learning points

- Transfusion laboratories and hospital transfusion protocols should not use trade names, which are particularly confusing, but rather describe these clearly as ‘solvent detergent fresh frozen plasma (SD-FFP)’ and ‘prothrombin complex concentrate’ in order to avoid confusion
- There are slight differences between the two commercially available prothrombin complex concentrate (PCC). Hospital/Health Board protocols should reflect dosage as indicated for the specific product
- PCC should be administered immediately (NICE 2015) and certainly within an hour particularly for serious bleeding and intracranial haemorrhage (ICH)

Further cases can be found in the supplementary information on the SHOT website www.shotuk.org.

These cases demonstrate lack of knowledge in many areas. It is surprising that clinical staff do not know that 'Octaplas®' and PCC are blood products.

Reference

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See also several useful references in the 2016 Annual SHOT Report (published 2017) page 106-107.

Bolton-Maggs PHB (Ed), Poles D et al. (2017) on behalf of the Serious Hazards of Transfusion (SHOT) Steering Group. The 2016 Annual SHOT Report. https://www.shotuk.org/shot-reports/ [accessed 30 May 2019].

Immune Anti-D in Pregnancy: Cases reported up to end of 2018

11

Authors: Jane Keidan and Sue Robinson

Definition:

Cases of D-negative 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

- All cases of alloimmune anti-D found for the first time in pregnancy should be reported to SHOT
- Clinical staff involved in the management of D-negative women in pregnancy should have clear policies for acting appropriately upon 28-week serology results
- Robust procedures should be in place in the clinical area and the laboratory to ensure that, where indicated, women are followed up to ensure clearance of fetal cells after larger fetomaternal haemorrhages (FMH)
- D-typing results should be interpreted with care to avoid classifying D-variant as D-positive, a result of 2+ or less should be further investigated and the woman treated as D-negative until the D-type has been confirmed
- Data on cell-free fetal deoxyribonucleic acid (cffDNA) testing will be collected to provide evidence and learning from errors particularly interpretation of results

Introduction

Since 2012 SHOT has been conducting a prospective study of women who produced immune anti-D detected for the first time in the current (index) pregnancy to improve understanding of the causes of continuing anti-D immunisations. 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, in both the index pregnancy and the pregnancy immediately before the index pregnancy (if applicable).

Results

In 2018 a total of 42 cases were reported, 9 cases occurred in women with no previous pregnancies (NPP), 1 case was excluded as the information provided was insufficient. In 33 women with previous pregnancies (PP), 2 cases were excluded as the information provided was insufficient.

The reason for the fall in reported cases is not clear and could be due to under-reporting or a true fall in the rate of new immunisations.

Anti-D immunisation in pregnancy remains under-reported if the following assumptions are made:

- National Institute for Health and Care Excellence (NICE 2008) evidence for routine antenatal anti-D Ig prophylaxis (RAADP) quoted a reduction in sensitisation rate from 0.95% without RAADP to 0.35% when RAADP was used

- Systematic review in 2004 (Jones et al. 2004) showed that the percentage of sensitised women fell from 1.9-2.2% to 0-0.2% with antenatal prophylaxis
- There were 636,401 births recorded in England on Hospital Episode Statistics up to March 2017, of which 17% will be D-negative mothers (108,188), of which 59% will carry D-positive babies - that is 63,831 pregnancies at risk
- If we use failure rate of 0.2%, then we would expect 128 immunisations per year from RAADP failures

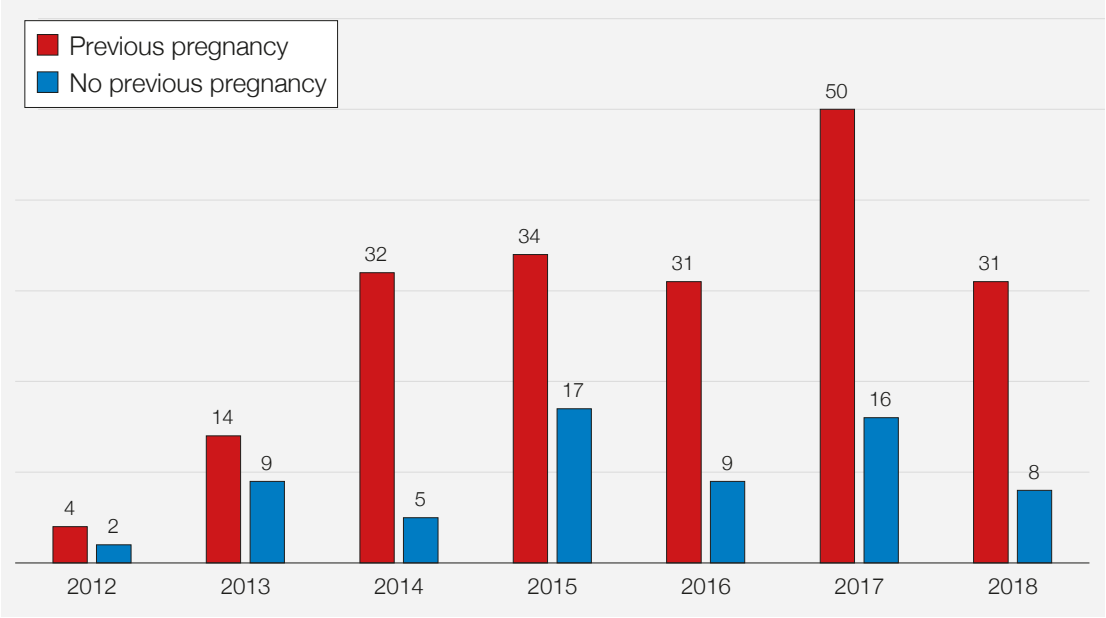
Plus

- There were 272 reports to SHOT of omission or late administration of anti-D Ig in 2018, some of which may result in immunisation

For the first time, questions on the use of cffDNA were asked but as the test has not been implemented in many centres yet, the data are too sparse to draw meaningful conclusions this year. However, going forward this data should provide important information on areas where errors can occur for example due to wrong blood in tube, laboratory testing and resulting, transcription of results and interpretation of results.

Cumulatively SHOT now has useful data on 66 women with NPP and 196 women with PP.

Figure 11.1: Number of reports of anti-D immunisation in pregnancy by year, 2012-2018



No previous pregnancy (NPP) n=8

There were 8 new cases in 2018 (one case excluded), cumulative to date 66 cases.

Further information, and tables containing similar details to those published in previous Annual SHOT Reports, can be found in the supplementary information on the SHOT website www.shotuk.org.

Summary of 2018 NPP data

Half of the women were found to be immunised at delivery, and all of these cases were delivered beyond 40 weeks. One case had been grouped as D-positive and so received no RAADP. She was subsequently shown to be D-variant. The other 3 cases received apparently 'ideal' care, with timely RAADP and no identifiable sensitising episodes. However, in these, as in other cases where no potentially sensitising event (PSE) is reported, there can never be certainty that the woman has not experienced an unreported early termination or miscarriage. It is of note that 3 cases where immune anti-D was only detected at delivery were obese and delivered beyond term.

Pregnancy outcomes in NPP case

In 2018 outcome was reported in 7/8 cases (one case provided no outcome information). All 7 pregnancies resulted in live births of which 4 pregnancies where alloimmune anti-D was detected only at delivery had a gestation of >40 weeks (41^{+4}, 42, 42, 42^{+6}).

There were 4 babies that had no complications, 2 cases required phototherapy, 1 case required phototherapy and exchange transfusion. In 1 case no information on interventions was submitted apart from an ultrasound for anaemia performed during pregnancy.

Cumulatively, all 66 pregnancies resulted in 67 live births, of which 41 had no complications, 15 babies required phototherapy and 7 cases required exchange transfusion. No details were provided in 3 cases.

Case studies

Case 11.1: D-variant

A primiparous woman in her 30s, with a booking weight of 95kg (BMI 35), typed as D-positive. She had a live birth at 42 weeks gestation. Alloimmune anti-D was detected on the delivery sample. Samples were referred to the Blood Service for investigation, and the woman typed as partial D category DIV. The baby required no interventions for haemolytic disease of the fetus and newborn (HDFN).

The problem of D-variants is discussed in the conclusions at the end of this chapter.

Case 11.2: Delivery at 42+6 weeks

A primiparous woman in her 30s, with a booking weight of 61kg (gestation at booking 8 weeks), received a single dose of RAADP (1500IU) at 28 weeks. She delivered at 42^{+6} weeks. Alloimmune anti-D was detected at delivery (titre 1 in 256), and there were no reported PSE. The baby required no interventions for HDFN.

Case 11.3: A small antepartum haemorrhage (APH) at 8-9 weeks, thought to be clinically insignificant

A primiparous woman in her 20s, with a booking weight of 58.3kg, had a cffDNA test at 17^{+5} weeks which was inconclusive. She received a single dose of RAADP (1500IU) at 28 weeks. A sample taken at this time was subsequently shown to contain alloimmune anti-D 12.8IU/mL, rising to a level of 66IU/mL at 34^{+2} weeks gestation. The baby was delivered at 35 weeks gestation and required exchange transfusion and phototherapy.

RAADP was given before the result from her 28-week sample, which showed the presence of alloimmune anti-D, was available. The only identifiable PSE was a very small APH at 8-9 weeks gestation for which the woman visited her general practitioner (GP) and no action was taken.

Previous pregnancies (PP) n=31

The index pregnancy in these cases refers to the current pregnancy – the pregnancy in which alloimmune anti-D was first detected.

There were 31 new cases in 2018, cumulative to date 196 cases.

Further information, and tables containing similar details to those published in previous Annual SHOT Reports, can be found in the supplementary information on the SHOT website www.shotuk.org.

When was alloimmune anti-D detected in the index (current) pregnancy?

Where alloimmune anti-D was 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 healthy fertile women). Where anti-D is detected later in the index pregnancy, the relative contribution of events in the previous and index pregnancy is less certain.

There were 6 women who had alloimmune anti-D detected for the first time at delivery of the index pregnancy, 1 had a gestation of >40 weeks (40^{+2}).

The cumulative data show that of 30 pregnancies where alloimmune anti-D was first detected at delivery in the index pregnancy, 10 cases (33.3%) were delivered after 40 weeks gestation.

Summary of 2018 PP data

There were 12 women found to be immunised at first trimester booking indicating that sensitisation had probably occurred in the preceding pregnancy. In 19 cases, alloimmune anti-D was detected later in the index pregnancy so that the relative contribution of previous pregnancies is less clear. In 1 case alloimmune anti-D was detected in a sample taken from a non-pregnant woman.

Although the data has gaps, cases continue to be reported where despite apparently 'ideal' care in the preceding or index pregnancy, sensitisation to anti-D occurs and alloimmune anti-D develops. It is a possibility that in some of these cases there may have been a preceding 'undeclared' PSE e.g. termination of pregnancy (TOP) (medical or surgical), or cases where although anti-D Ig has been issued it was not given or not given effectively.

Nine out of 27 of the previous pregnancies (that went to term) lasted longer than 40 weeks. Cumulatively (data collected from 2015 onwards) 30 out of 128 previous pregnancies (23.4%) lasted longer than 40 weeks. NHS maternity statistics 2014-2015 indicate 17.5% pregnancies extended beyond 40 weeks. (NHS Digital 2015).

Body weight has been used in place of body mass index (BMI) as a marker for obesity as weight is more regularly reported than BMI. Using parameters for an average female in the UK, 80kg would equate to obesity in most women. We do however acknowledge the limitations in this interpretation. Of the 12 PP cases where booking weight in the previous pregnancy was known, 2 were obese. Cumulatively, of the 98 women where booking weight in the previous pregnancy was provided, 28/98 (28.6%) were obese, significantly higher than the 19% incidence of obesity in pregnant women reported by Public Health England in 2018.

Case studies

Case 11.4: Lack of follow up for clearance of fetal cells

A woman in her 30s received a single dose of RAADP (1500IU) at 28 weeks in the preceding pregnancy. She had an elective caesarian section at 38 weeks gestation. The Kleihauer test showed a FMH of >4mL and flow cytometry confirmed a 16mL FMH. The woman was given a total of 2500IU anti-D Ig but there was no evidence that she was followed up to confirm clearance of the fetal cells. Alloimmune anti-D was detected at 28 weeks gestation in the next pregnancy. In this case a further error in management occurred as the anti-D detected at 28 weeks in the index pregnancy was interpreted as passive, due to RAADP, which was given after the blood sample had been taken. The pregnancy was not followed up serologically and the baby was delivered as an emergency at 34 weeks and required an exchange transfusion.

This case emphasises the importance of following up cases where anti-D is detected to establish whether it is passive or immune (BSH White et al. 2016) so that the pregnancy can be managed appropriately and also following up large (>4mL) FMH to ensure clearance of fetal cells.

Case 11.5: Management followed current guidelines

A woman in her 30s received a single dose of RAADP (1500IU) at 28 weeks in the preceding pregnancy. She had no PSE, and had an emergency caesarian section at 41 weeks gestation. The Kleihauer test showed a FMH of 2.7mL. The woman received 500IU anti-D Ig postpartum. Alloimmune anti-D was detected at 10 weeks (booking appointment) in the next pregnancy. The baby required no interventions for HDFN.

British Society for Haematology (BSH) guidance (BSH Austin et al. 2009) recommends that where a Kleihauer shows a FMH >2mL, the sample is sent for flow cytometry to confirm the size of the bleed.

Case 11.6: Apparently ideal care in the preceding pregnancy but possible risk in the way FMH is reported

A woman in her 40s (alloimmune anti-D at booking in the index pregnancy) had apparently ideal care in the preceding pregnancy (in vitro fertilisation pregnancy). She was not obese, received RAADP (1500IU anti-D Ig into the deltoid at 28 weeks gestation), and had no PSE. The baby was delivered by emergency caesarian section at 31 weeks. FMH was measured by flow cytometry and reported as <12mL. She received the 'standard' dose of anti-D Ig used at this hospital (1500IU) but was not followed up for clearance of fetal cells.

The reporter stated that the postpartum sample analysed by flow cytometry was reported to show a FMH <12mL, which would be covered by their standard anti-D Ig dose of 1500IU. However, if FMH is >4mL guidelines advise that follow up samples are required to check for clearance of fetal cells. It was important to clarify if follow up for clearance of fetal cells was performed as there appeared no other cause of immunisation. The laboratory replied that <12mL is the standard report for flow cytometry as their standard dose of anti-D Ig will be sufficient. They stated that they never rely on a clinician to send repeat samples in case of a bleed between 4-12mL and never leave it to a report. If the bleed is >4mL the laboratory staff ring and chase samples for follow up. In this case the bleed size was 0.3mL. SHOT has concerns that clinical staff may become deskilled if all management decisions in such cases are made by the laboratory, and this may cause errors if the clinical staff then transfer to another hospital where the laboratory do not 'actively manage' such cases, as the clinical staff would be unaware that bleeds >4 mL require follow up to check that fetal cells are cleared.

Case 11.7: Misinterpretation of antibody screen at 28 weeks

A woman in her 40s attended the early pregnancy unit at 10 weeks gestation with vaginal bleeding. A transvaginal ultrasound scan confirmed a viable intrauterine pregnancy. Anti-D Ig was not given. At the 28-week appointment the antibody screen was weakly positive but was incorrectly assumed to be due to RAADP. The woman attended triage following trauma to her abdomen at 31 weeks gestation, 1500IU anti-D Ig was given and the Kleihauer showed <4mL fetal cells. At delivery, anti-D quantitation showed an increased level of 9.7IU/mL and the baby required phototherapy.

Further case studies can be found in the supplementary information on the SHOT website www.shotuk.org.

Conclusions

Clear procedures should be in place for interpretation of 28-week serology results in relation to timing of routine antenatal anti-D Ig prophylaxis. Detection of anti-D in the 28-week sample was interpreted as due to RAADP in some cases, even though the blood sample had been taken before RAADP was given. These pregnancies were, therefore, not monitored appropriately and the fetus was at risk of HDFN.

Conversely, women whose 28-week sample contained alloimmune anti-D but were given RAADP (as the serology result was received after RAADP was given) are being reported as anti-D Ig administration errors. In practice, it is recognised that most clinics do not wait for serology results before giving women RAADP, but it is important that robust procedures are in place to recall such women and ensure they are monitored correctly.

It is of note that of 14 cases (4 NPP, 10 PP) where immune anti-D was first detected at or beyond 28 weeks, 7 babies required treatment for HDFN, as some centres have questioned the need to repeat antibody screening at 28 weeks if the booking antibody screen is negative. From SHOT data, had the 28-week antibody screen been omitted, 14 women would only have had anti-D detected at an antibody screen performed at delivery and the fetus/neonate would not have been monitored in utero or following delivery: half of them required phototherapy.

It is always a balancing act when detecting D-variants. From the perspective of a maternal sample ideally the anti-D reagent would either produce a negative result or a sufficiently weak result that it is investigated as a possible D-variant; thus the individual is treated as a D-negative in terms of management of pregnancy and is in receipt of anti-D Ig until the D-type is confirmed. If testing a cord sample, however, you would want to detect any D-variants as positive, particularly if the variant is known to stimulate anti-D production. The strength of reactivity of partial D antigens with those anti-D reagents that react with them may be weaker than that of normal D-positive cells (e.g. DVI), similar to normal D-positive cells (e.g. DIII), or may even appear to have elevated D expression (e.g. DIVa). It is difficult to make recommendations regarding all D-variants since some D-variants react with all anti-D except those produced by an individual with the same D-variant (e.g. DIII).

The current guidelines only cover testing for DVI, this is because it is known that this has the lowest number of D epitopes, and is therefore the most likely to form anti-D if transfused with D-positive blood. With other D-variants it is difficult, if not impossible, to make recommendations regarding detectability with routine anti-D reagents. In general, a straightforward 3+ or 4+ reaction can be reported as D-positive, but a 2+ or less should be investigated further. (R. Haggas, UK NEQAS, personal communication).

Clinical and laboratory staff need to be aware of the importance of following up women who have a FMH of >4 mL to ensure clearance of fetal cells, as although anti-D Ig may be issued the laboratory cannot be sure that it has been administered effectively (or at all!) and the potential for immunisation is high.

Now that the majority of women receive RAADP in the form of one injection of anti-D Ig 1500IU between 28 and 30 weeks gestation, there remains the outstanding question of whether, if the pregnancy extends beyond 40 weeks, an additional dose of prophylactic anti-D Ig required and if so, when should this be given. ‘There is insufficient evidence at this time to make a recommendation for or against administering another dose of anti-D Ig to an unsensitised D-negative woman who remains undelivered at 40 weeks’ (Fung and Eason 2018).

There are several other remaining questions on ideal management to prevent immunisation in D-negative pregnancies, including the increased risk in obesity, 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.

The database now has sufficient cases to enable more detailed analyses. Initially, SHOT experts are planning to interrogate the data for ideal cases (those women who experienced no PSE and who received RAADP and postpartum prophylaxis) and see how many of these women were obese and/or whose gestation extended beyond 40 weeks in the index and/or preceding pregnancy. SHOT also plan to look in more detail at women who experienced PSE which was managed appropriately according to current guidance but who became immunised, with particular emphasis on early pregnancy events.

From 2018, SHOT has been collecting data on cffDNA testing to provide evidence and learning from errors, particularly interpretation of results.

References

BSH Austin E, Bates S, de Silva M, et al. (2009) Guidelines for the estimation of fetomaternal haemorrhage. http://www.b-s-h.org.uk/media/15705/transfusion-austin-the-estimation-of-fetomaternal-haemorrhage.pdf [accessed 31 May 2019].

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Jones ML, Wray J, Wright J, et al. (2004) A review of the clinical effectiveness of routine antenatal anti-D prophylaxis for rhesus-negative women who are pregnant. *BJOG* 2004;**111(9)**:892-902.

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12 Near Miss Reporting (NM) n=1451

Authors: Pamela Diamond, Shruthi Narayan and Debbi Poles

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.

Near miss events continue to account for a large proportion of the incidents reported to SHOT 1451/3326, (43.6%) and have increased again this year, n=1451 in 2018, compared to n=1359 in 2017.

Essentially a near miss is an event which hasn't caused any adverse impact but had the potential to do so. Identifying and investigating near misses is a key element to finding and controlling risks before actual harm results. The information gathered through near-miss reporting must be evaluated to determine root causes and plan hazard mitigation strategies. The 'lessons learnt' must be shared so that everyone can benefit from the findings. Near miss reporting is vitally important in preventing serious incidents that are less frequent but could otherwise result in patient harm. Many safety activities are reactive, that is, they occur after an injury incident. By reporting near-miss incidents we can promote proactive safety i.e. raising awareness of potential hazards and mitigation strategies BEFORE an injury occurs. Recognising and reporting near miss incidents can improve transfusion safety and enhance the safety culture in healthcare.

Continued reporting is important to support learning from near miss cases. 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.

Analysis of near miss errors in other categories

Near miss cases have been reviewed and discussed in each relevant chapter of this Annual SHOT Report, and Table 12.1 shows the chapters that include near miss events according to SHOT reporting categories.

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

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 8	932	64.2%
	Specific requirements not met (SRNM)	Chapter 8	117	8.1%
Handling and storage errors (HSE)		Chapter 9	157	10.8%
Right blood right patient (RBRP)		Chapter 13	202	13.9%
Adverse events related to anti-D immunoglobulin (Anti-D Ig)		Chapter 7	31	2.2%
Avoidable delayed or under or overtransfusion (ADU)		Chapter 10	12	0.8%
Total			**1451**	**100%**

Wrong blood in tube (WBIT) incidents make up 792/932 (85.0%) of all WCT near miss events and have been analysed and reported separately in this chapter.

Near Miss – Wrong Blood in Tube (WBIT) n=792

12a

Author: Pamela Diamond

As in previous years, WBIT continues to be the most common type of 'near miss' error reported 792/1451 (54.6%), and 792/2905 (27.3%) of total errors reported.

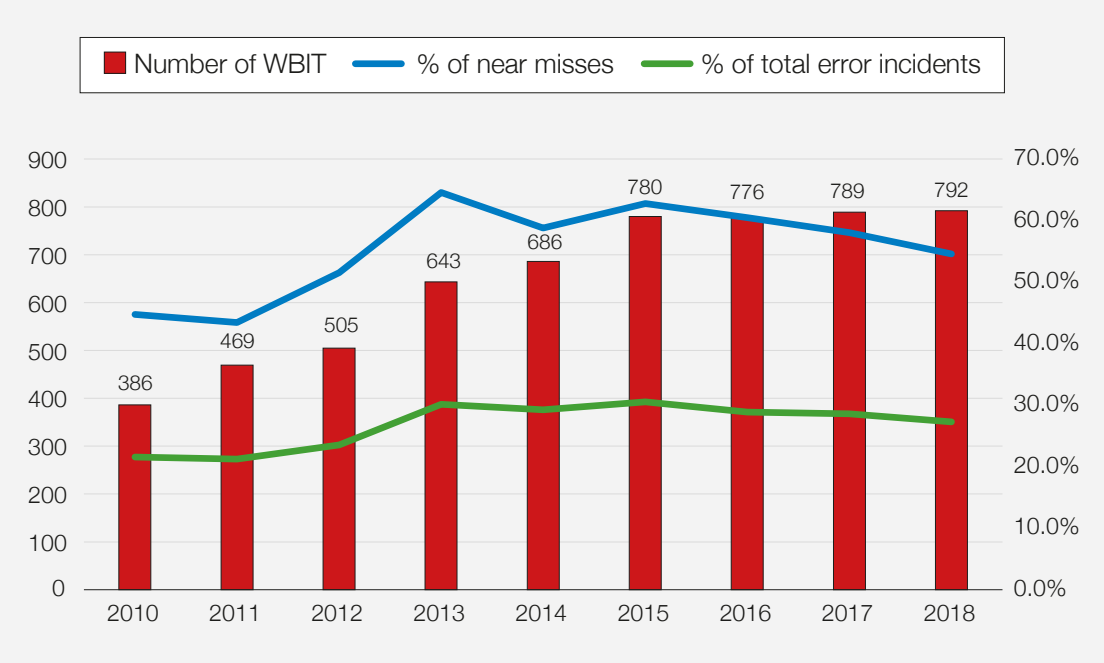

Figure 12a.1: Reports of WBIT 2010 to 2018

WBIT are most commonly identified by laboratory staff, 645/792 (81.4%) compared with 82/792 (10.4%) by clinical staff. The remaining cases were discovered by phlebotomists (1) or transfusion practitioners (2) and in 62 cases the information was not given.

Discrepant or spurious laboratory results provide tangible evidence that something has gone awry.

For other categories of incidents, such as over or undertransfusion, the decision as to whether an error has occurred may be more subjective or may differ depending on clinical opinion.

There is a strong laboratory culture of externally reporting incidents as they are governed by the Medicines and Healthcare products Regulatory Agency (MHRA). It is a legal requirement to report serious adverse events (SAE) and serious adverse reactions (SAR) via the MHRA's online reporting system, serious adverse blood reactions and events (SABRE). Hospital transfusion laboratories (HTL) are therefore very much aware of SHOT and SABRE, but despite education by transfusion practitioners, other SHOT categories are not as clear cut as WBIT and may not be brought to the hospital transfusion team's attention by the clinical area.

Learning points

- Positive patient identification (PPID) using a pre-prepared transfusion request form, checked against the patient's wristband (worn) would identify discrepancies in patient demographics prior to venepuncture. All clinical details would match information provided to the hospital transfusion laboratory thus preventing error and delay at administration of blood components
- If cord and maternal groups are the same, further testing such as the alkali denaturation test should be carried out to ensure that the samples have not been misidentified - ideally before further samples are requested from the infant to prevent unnecessary phlebotomy that may contribute to iatrogenic anaemia
- Standardised labelling of infant's samples should be agreed and adhered to in particular to reduce confusion between cord and maternal samples
- The use of bedside sampling technology has the potential to reduce errors but only if the correct procedures are followed. The use of technology can lead to a false sense of security. Contingency plans should be in place in the event of technology failure
- Staff involved in patient registration should be aware of the potential consequences of patient mis-identification

Location of WBIT errors

The majority of WBIT errors occurred on general wards, 300/792 (37.9%), with the next largest location being obstetrics, 139/792 (17.6%) and the emergency department (ED), 108/792 (13.6%).

Staff members involved in WBIT

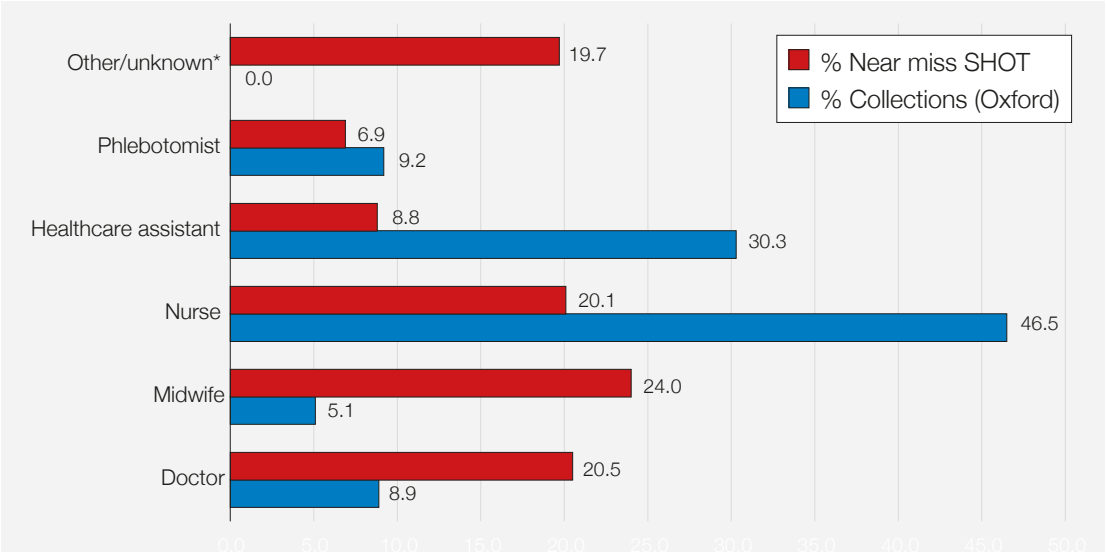

Figure 12a.2 Staff groups responsible for taking the WBIT samples reported to SHOT (n=792) compared with staff groups who take transfusion samples in Oxford Hospitals January to March 2019 (n=15619)

Denominator data have been supplied by the Oxford University Hospitals NHS Foundation Trust.

Midwives and doctors and healthcare assistants are over-represented whereas phlebotomists, nurses and healthcare assistants are under-represented following comparison against the percentage of transfusion samples taken by the equivalent staff group in Oxford hospitals.

This year midwives were the largest staff group responsible for WBIT 190/792 (24.0%), compared to doctors 162/792 (20.5%) who were previously the largest staff group responsible for WBIT. In the remaining WBIT cases, nurses 159/792 (20.1%), phlebotomists 55/792 (6.9%) and healthcare assistants 70/792 (8.8%) were responsible. In 156/792 (19.7%) the sample takers were either not stated or unknown.

Staffing shortages (RCM 2018) often result in midwives dealing with two (or more) patients in emergency situations where one or both patients may be urgently transferred to another area leading to samples being labelled retrospectively away from the patient. This coupled with mis-sampling of cord vessels, the unavailability of infant record numbers and non-standardised infant labelling increase the possibility of identification and sampling errors.

ABO-incompatibility

There were 542/792 (68.4%) reports that included the known group of the patient and the discrepant group because of a WBIT. The breakdown of these groups are shown in Table 12a.1.

	Group attributed to patient if not detected as a WBIT					
Patient group	**Group A**	**Group B**	**Group AB**	**Group O**	**Compatible**	**Incompatible**
Group A	43	44	9	113	156	53
Group B	36	3	8	29	32	44
Group AB	4	3	0	14	21	0
Group O	132	49	12	43	43	193
Totals	**215**	**99**	**29**	**199**	**252**	**290**

Table 12a.1: Blood groups and red cell compatibility of WBIT reports

If blood had been required and the error gone undetected, in 252/542 (46.5%) cases, the red cell transfusions would have been compatible, however, 290/542 (53.5%) could have resulted in an ABO-incompatible red cell transfusion with potentially life threatening complications.

Other WBIT with potential to cause patient harm

Inadequate or inappropriate anti-D immunoglobulin (Ig) prophylaxis

It is fortunate that several grouping samples are usually taken from a prospective mother during the course of her pregnancy, aiding detection of WBIT errors, but these errors may occur in early pregnancy where group-check samples may not be considered necessary as blood components are not requested. British Society for Haematology (BSH) guidelines state that a second sample should be requested for confirmation of the ABO group of a first time patient prior to transfusion (BSH Milkins et al. 2013).

There is a risk that WBIT may result in anti-D Ig being given unnecessarily (a D-positive woman misgrouped as D-negative) or, that an unidentified D-negative patient may not receive prophylactic anti-D Ig and be at risk of immunisation, affecting future pregnancies.

Of the WBIT reports, 265/792 (33.5%) were samples taken from pregnant women. Of these, 195/265 (73.6%) were WBIT where groups were identified, 114/265 (43.0%) there was no difference in D status. However, 39/265 (14.7%) would have resulted in the patient incorrectly identified as D-negative, and 42/265 (15.8%) would have been wrongly grouped as D-positive.

Iatrogenic anaemia in infants

There were 46/265 (17.4%) WBIT errors reported involving maternal and cord samples. Use of cord blood samples for initial blood tests, particularly infants of low birth weight, has been advised to reduce the risk of iatrogenic anaemia (Baer et al. 2013) but errors in sampling of the cord vessels can result in WBIT errors.

Repeat samples obtained from infants to ascertain their correct blood group may contribute to iatrogenic anaemia (Lin et al. 2000).

Case 12a.1: Historic WBIT may have led to anti-D immunisation

A patient had booking bloods taken at antenatal clinic and was grouped as O D-positive. This did not match the result of a sample taken in 2015 following a termination of pregnancy (TOP) which grouped as A D-negative. A repeat sample confirmed the group as O D-positive. The sample taken in 2015 was incorrect. It is not known if the patient was given anti-D Ig prophylaxis in 2015. The patient whose blood was in the sample tube may not have been identified and would have been at risk of anti-D immunisation.

Case 12a.2: Detection of WBIT prevents potentially inappropriate anti-D Ig prophylaxis

A Kleihauer request was received in the hospital transfusion laboratory. The patient had a historical group on file of O D-positive and would not require a Kleihauer test. The sample, however, grouped as A D-negative with a positive antibody screen consistent with prophylactic anti-D Ig. The midwife who saw this patient stated that they had not presented with per vaginal (PV) bleeding and did not require a Kleihauer test. The patient who was bled but incorrectly identified was contacted to attend the clinic the next day when a Kleihauer test was taken and prophylactic anti-D Ig given within 72 hours.

Case 12a.3: Mislabelled cord requires repeat baby sample for group confirmation

Mother and baby samples received in transfusion and both grouped as AB D-negative which was the previous group recorded for the mother. The cell-free fetal deoxyribonucleic acid (cffDNA) test had predicted D-positive. An initial test failed to identify the baby's blood group. The baby was re-bled and grouped as B D-positive. Anti-D Ig was issued for the mother and given within 72 hours.

Misunderstanding of the group-check policy may lead to an increase in incorrect blood component transfused (IBCT) due to WBIT

Although the introduction of group-check samples as outlined in the BSH guidelines for pre-transfusion compatibility procedures (BSH Milkins et al. 2013) has undoubtedly reduced WBIT errors and the potential for IBCT, it is disappointing and worrying that 25/792 (3.2%) reports of two samples being taken at the same time but labelled with different times have been reported. There are also examples of two samples taken despite the fact that there are several historical groups on record showing that there is a lack of understanding of the rationale behind the group-check policy.

Case 12a.4: Near miss ABO-incompatible transfusion due to circumventing the group-check policy

Two group and save samples were received from the ED on a patient with a suspected hip fracture. The samples were timed as being taken ten minutes apart. On grouping, both samples were found to be B D-positive. The historical group on file was A D-negative. A further sample was obtained and confirmed this historical group. The samples had been taken by an ED consultant and passed to a foundation year one (FY1) doctor to label as being taken at different times. The FY1 had not felt confident to question the consultant on practice they knew to be unsafe. ED policy requires two group and save samples to be taken on admission. The samples met the criteria of the group-check policy. If there had been no historical group, the patient could have received incompatible blood.

DO NOT take two samples at the same time and send one of the samples to the laboratory a few minutes later as it will result in the same error. If the wrong patient has been bled, or the sample labelled from the correct patient with someone else's details, both samples will group identically but WRONG. The patient could receive an ABO-incompatible transfusion, which may be lethal. The two sampling episodes must be separated and ideally each taken by a different person, with two completely separate requests to the laboratory (https://www.shotuk.org/resources/current-resources/ SHOT Bite No 10. Why 2 Samples?)

Bedside sampling technology

In 51/792 (6.4%) cases, reporters believed that the introduction of bedside sampling technology for phlebotomy could have prevented recurrence of the incident. However, this can be costly to implement, may give users a false sense of security and, if not used as intended, can lead to errors. This is illustrated by Case 12a.5.

Case 12a.5: WBIT due to electronic scanning of an unworn wristband for label generation

Two group and save samples were received for a patient. The first sample taken at 12:54 grouped as A D-negative and matched the patient's historical record. The second sample taken at 14:57 grouped as AB D-positive. Both samples were labelled using BloodTrack® personal digital assistant (PDA). Trauma patients at this hospital are given consecutive hospital numbers and are issued blood components on a single group sample. The nurse had labelled a sample taken by somebody else. The sample label had been generated by scanning a wristband that was not attached to the patient. The sample had actually been taken from the patient in the next bay.

WBIT due to incorrect patient registration

Registration of a patient resulting in the production of patient addressographs/demographic labels and wristbands is not considered part of the transfusion process in the way that sampling, collection or administration are. Staff members undertaking this task may not fully understand the potential consequences that an error at this stage may have. WBIT errors attributed to sample receipt and registration errors occurred in 19/792 (2.4%) cases. These included 1 case where the incorrect merging of two similarly named patient records led to the incorrect group being held on the patient's record in the laboratory information management system (LIMS) for one of the patients (see Case 12a.6), and 18 cases where a patient was registered under the incorrect patient record due to similarities in name.

Failure to update patient details or creating a new record when the patient already exists in the system may lead to missed transfusion history and/or special interest flags and possibly result in an incompatible or specific requirements not met (SRNM) error or anti-D immunisation.

With increased use of bedside sampling technology with barcode identification from the wristband, correct patient identification at this step is crucial (Callum et al. 2011).

Case 12a.6: WBIT due to incorrect merging of patient records

A group and save sample was received for a patient and the resulting group of B D-negative was found to be discrepant from the many historical groups of O D-positive. The member of staff taking blood for grouping, correctly positively identified the patient checking all the required identifiers with the patient - first name, last name, date of birth and first line of address, which were all confirmed as correct. The hospital number however belonged to the other patient which generally patients do not know and are not asked at phlebotomy. A member of clerical staff had merged two patients on the organisation-wide patient administration system (PAS) based on the same first name, last name and date of birth even though the National Health Service (NHS) number and address were different.

Case 12a.7: Patient incorrectly registered leads to many incorrect results in patient's record

A phlebotomist went to take bloods from a patient and asked them to confirm their details. These did not match the request form or the patient's wristband. When this was investigated it was found that the patient had been wrongly identified and registered as a different patient with the same name. This had gone undetected over a 2-day period. All bloods sent during this time were labelled with the incorrect patient's details.

Commentary

Analysis of the data identifies that midwives as a staff group are most likely to take a WBIT sample. This is due to a combination of factors which makes the environment in which samples are taken more prone to error: dealing with more than one patient in a short space of time (mother and infant/s); having to correctly label and sample cord blood and the possible sudden transfer of patients to other areas

in emergency situations. The potential for harm from inadequate or inappropriate anti-D Ig prophylaxis is high. Non-cord repeat samples required for confirmation of infant's blood groups may contribute to iatrogenic anaemia in infants especially those with low birth weights.

Misunderstanding of the group-check policy leading to WBIT errors of initial and confirmatory groups may lead to an increase in IBCT errors (https://www.shotuk.org/resources/current-resources/ SHOT Bite No 10. Why 2 Samples?).

Improved technology and bedside sampling systems offer a solution to increasing WBIT errors but only if used as intended. Contingency plans should always be in place to counteract the potential for error due to technological failure and in order to optimise the safety of such systems it is vital that patients are identified correctly at admission, registration through to administration, see Chapter 13, Right Blood Right Patient (RBRP) for more errors related to patient identification.

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Right Blood Right Patient (RBRP) n=216

13

Authors: Diane Sydney and Hema Mistry

Definition:

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

Key SHOT message

- The key SHOT messages from 2017 remain pertinent: importance of patient identification (PID) and bedside checklist (Bolton-Maggs et al. 2018)

There were 216 cases reported in 2018 (200 in 2017) (Bolton-Maggs et al. 2018). The variation between clinical and laboratory errors are illustrated in Figure 13.1.

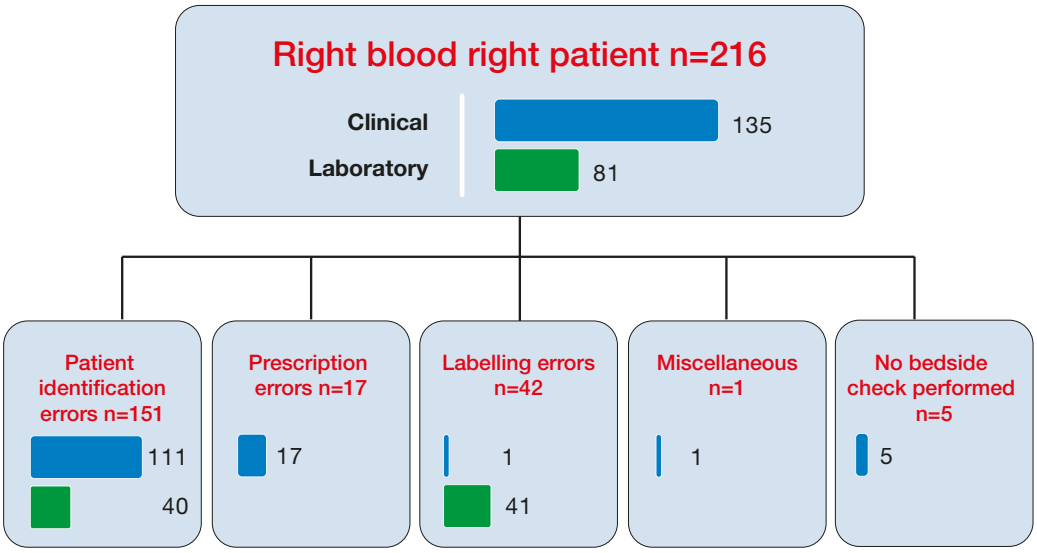

Figure 13.1: Breakdown of 2018 RBRP reports n=216

Of the 216 RBRP incidents, the single miscellaneous case was a student nurse who was asked by the consultant to collect a third shock pack during a major haemorrhage (as no one else was available) but had not been competency-assessed therefore could not gain access to the transfusion laboratory as they were not authorised for entry. They rang the bell, fortunately one of the laboratory staff came and helped on this occasion due to the urgency of the situation. The student nurse felt that they had to help and did not think about the fact that this was a task they were not able/trained to perform. The student nurse admitted they did not understand what a shock pack was. Fortunately, units were given to the patient in a timely manner, but this could have led to a delay in transfusion.

Learning point

- Staff/students can only participate in the transfusion process if they have appropriate training and are deemed competent

Patient identification (PID) n=151

PID errors are listed in Table 13.1. PID errors occurred in both the clinical, 111/151 (73.5%) and laboratory, 40/151 (26.5%) area and accounted for 151/216 (69.9%) of the RBRP reports, an increase of 31.3% from 2017 (n=115), (Bolton-Maggs et al. 2018). The laboratory PID errors have increased by 37.9% in 2018 (n=29 in 2017). There were 114/202 (56.4%) near miss PID errors where 78/114 (68.4%) occurred in the clinical area and 36/114 (31.6%) in the laboratory.

Table 13.1: Patient ID errors in 2018 n=151

Area/location	PID error	Number of reports
Clinical	Incorrect ID in relation to the four key identification datasets*	101
	No wristband/ID band	7
	Incorrect donation number	1
	Incorrect date on sample	1
	No signature on sample	1
Laboratory	Demographic data entry errors in relation to the four key identification datasets*	39
	Incorrect donation number	1
Total		**151**

**First name, last name, date of birth (DOB), unique identifier (Robinson et al. 2017)*

The two cases outlined below include multiple identification errors in the transfusion process which led to RBRP errors.

Case 13.1: Important to check PID against the label attached to the blood component and the wristband

A major haemorrhage protocol (MHP) was activated in the emergency department (ED) for a patient who had no previous historical records. Emergency O D-negative units were requested. The biomedical scientist (BMS) proceeded to issue O D-negative blood however when entering information on the laboratory information management system (LIMS) they linked the patient to a unique identifier belonging to another patient.

The porter collecting the emergency O D-negative blood arrived at the transfusion laboratory without a collection slip. The BMS gave the blood to the porter, who in turn delivered it to the ED. There were no staffing issues or other emergencies identified in the laboratory area at that time, although this patient was declared as a major haemorrhage. The nurse was confused as to why the emergency blood had another patient's details on the tag. However, as it was an emergency the nurse and another member within the team checked the prescription and confirmed the patients name and DOB with the PID band. The patient's unique ID was checked against the prescription but not checked against the label attached to the bag.

There were four subsequent points in the transfusion process where the primary error could have been identified:

- **Primary error - component selection:** When issuing emergency O D-negative units the BMS entering information onto the LIMS linked the patient's unique ID to another patient
- **Component labelling:** The BMS should have performed a check when labelling which could have identified that the unique ID did not belong to the patient the component was intended for. This could have led to a delay

- **Collection:** The porter did not have a collection slip therefore could not check which component needed collecting or be able to cross check the details on the label
- **Prescription and administration:** The nurses failed to undertake a comprehensive bedside check independently as per national requirement (Robinson et al. 2017). It is important to check PID on the wristband and the label attached to the blood component

Case 13.2: Error missed during a two-person bedside check

A foundation year one doctor spelt the surname incorrectly on the transfusion prescription or authorisation record. This form was used as part of the collection process. The healthcare support worker failed to notice the spelling error at collection. Subsequently two nurses undertaking the bedside check, failed to recognise the error.

Increasingly a transfusion record document is being used as part of the prescription or authorisation process, with medical staff predominately undertaking this task. Subsequently this document is being used for collection purposes, administration checks and also traceability. If there is an error on the prescription or transfusion record with core PID, staff undertaking the next step in the transfusion process are not detecting these errors.

These errors can be picked up by bedside verification information technology (IT) systems.

Learning points

- Staff must be vigilant if using the transfusion prescription or authorisation record as part of the collection process to ensure that core patient identification (PID) datasets are correct
- All staff working in transfusion should follow their correct local procedure/policy especially during emergencies and demanding periods as this is when errors are more likely to occur

For further laboratory-related errors and key messages and learning points for laboratory staff please see Chapter 14, Laboratory Errors.

Near miss RBRP cases n=202

There were 202 near miss RBRP incidents, 117/202 (57.9%) where the error originated in the laboratory and 85/202 (42.1%) in clinical area. Near miss errors associated with PID were the biggest group with 114/202 (56.4%), followed by labeling errors 85/202 (42.1%), the remaining 3 were prescription errors.

IT-related RBRP cases n=35

Further details of the IT-related reports can be found in the supplementary information on the SHOT website www.shotuk.org.

Commentary

As with previous years Annual SHOT Reports there has been very little alteration in the overall findings. SHOT continues to highlight that **ALL** staff participating in the transfusion process must adhere to correct PID procedures with attention to detail in all steps in the transfusion process. The administration process is a critical step in the transfusion process and the bedside check should be performed correctly and in full prior to administering the blood component to the patient.

References

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Laboratory Errors n=885 (530 errors and 355 near misses)

14

Authors: Peter Baker, Hema Mistry, Heather Clarke, Chris Robbie, Rashmi Rook and Claire Whitham

Key SHOT messages

- Many of the incidents reported appeared to result from failure to follow correct procedures, inadequate processes, omitting steps or wrong procedure being performed
- Robust root cause analysis using ergonomics/human factors approach should be undertaken to identify quality management systems (QMS) improvements to mitigate these errors
- All laboratory staff must complete annual good manufacturing practice (GMP) training (European Commission 2015)

Key SHOT messages from the 2017 Annual SHOT Report for laboratory staff on knowledge and skills, shared responsibility and information technology (IT) remain pertinent (Bolton-Maggs et al. 2018).

Summary

Laboratory errors in transfusion practice continue to put patients at risk. There were 24 deaths but none directly attributable to component transfusion. However, there were 3 instances of serious harm, 4 ABO-incompatible (ABOi) transfusions (1 red cells (serious harm to patient) and 3 plasma components) and 2 serological crossmatch-incompatible transfusions.

Major morbidity n=3

The 3 cases complicated by major morbidity were all female. One where ABO-incompatible red cells were transfused in the emergency department (as the biomedical scientist (BMS) manually interpreted the group incorrectly, group B when patient was group A), because they were released prior to completion of the serological crossmatch due to the urgency of the situation. A second sample was not tested, the patient remained in resuscitation for observations and fortuitously experienced no further adverse outcome.

The second was in a paediatric patient three weeks post liver transplant who received the wrong ABO group (patient group B, donor group O). The BMS failed to heed patient historical records where the necessary information was available. The patient experienced an acute febrile transfusion reaction and signs of haemolysis and was admitted to the intensive therapy unit (ITU). The hospital does not perform solid organ transplants and rarely admits patients less than 3 months post-transplant; therefore, no robust procedure was in place.

The third case of major morbidity involved a woman of childbearing potential who was sensitised to the Kell antigen when a warning flag on the LIMS was not heeded, and K-negative blood was not selected.

ABO-incompatible transfusions n=4

There were 4 ABOi transfusions (1 red cells (serious harm, described earlier), 2 fresh frozen plasma (FFP) and 1 cryoprecipitate). These were due to component selection errors (2) and testing (interpretation) errors (2).

The cases of serious harm and ABOi transfusions are discussed in further detail in Chapter 8, Incorrect Blood Component Transfused (IBCT).

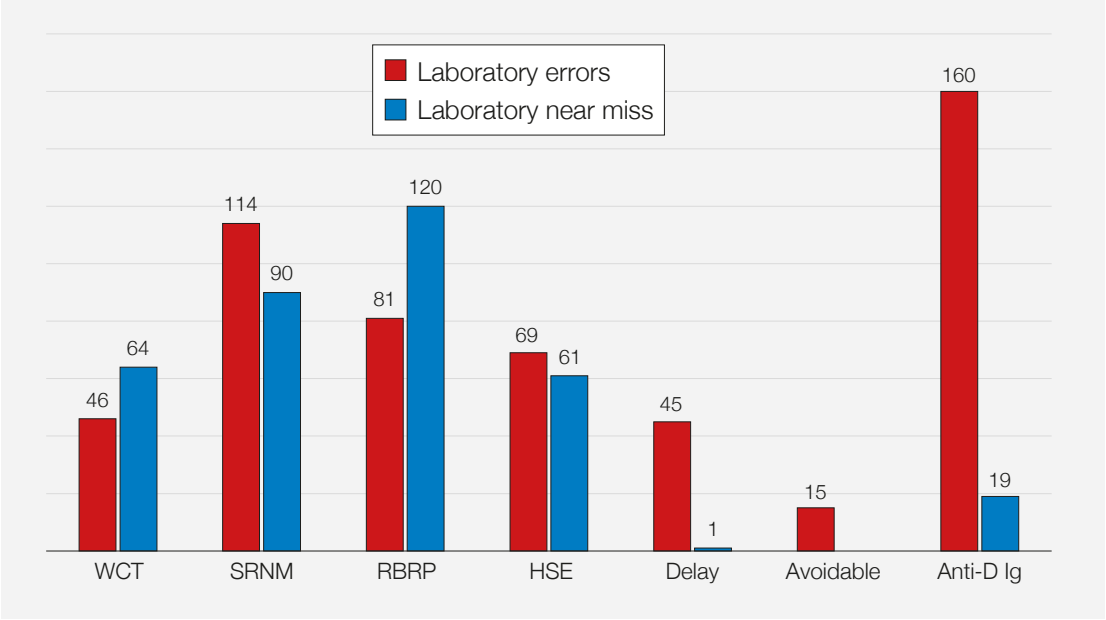
Serological crossmatch-incompatible n=2

There were 2 cases where patients received crossmatch-incompatible components due to failure to follow the correct procedure.

Processes in place need to be detailed and precise to achieve consistent and accurate results for every task undertaken and need to consider any limitations to that procedure. Procedures should be as simple as possible to follow but as complex as they need to be to ensure that staff have all the information necessary to perform and complete tasks accurately. Poor practice should be identified and corrected before it results in errors.

This year there has been an increase in the number of reports to SHOT where the primary error originated in the laboratory. There were 530 cases where a patient was transfused, and a further 355 near miss laboratory incidents. This is compared with 409 transfused cases in 2017 and 331 near miss laboratory incidents. A more thorough breakdown into laboratory errors is given in the remainder of the chapter.

Figure 14.1: Laboratory incidents and near misses by category of outcome n=885



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

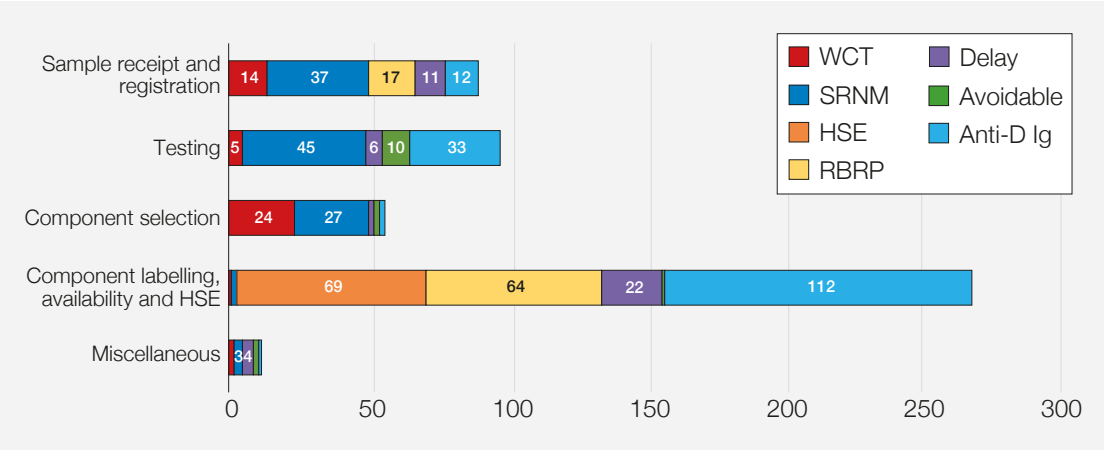


Figure 14.2: SHOT laboratory data (n=530) showing at which stage in the transfusion process the primary error occurred

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

Numbers <3 are too small to be annotated on the figure: Component selection: delay=2; avoidable=2, anti-D Ig=2; Component labelling, availability and HSE: WCT=1; SRNM=2; avoidable=1; Miscellaneous: WCT=2, avoidable=2, anti-D Ig=1

Errors with component labelling and availability for anti-D Ig errors are disproportionate as there was 1 case reported where anti-D Ig was stored inappropriately and given to 106 patients which cannot be reported to SHOT as a single incident.

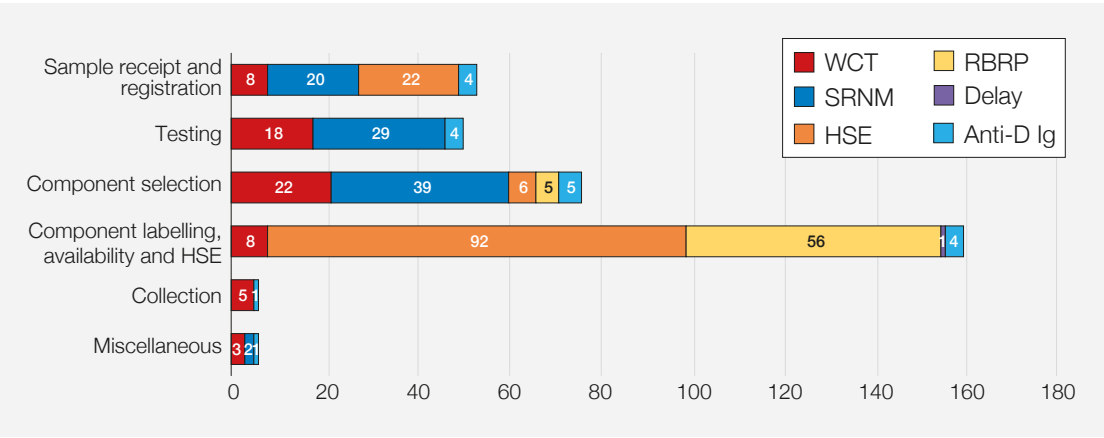


Figure 14.3: SHOT near miss laboratory errors (n=355) showing at which stage in the transfusion process the primary error occurred with outcome

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

Sample receipt and registration (SRR) n=145 (including 54 near miss)

Correct sample receipt and registration are essential to ensure that the right investigation is performed for the right patient on the right sample at the right time (dependent on the patient's transfusion history).

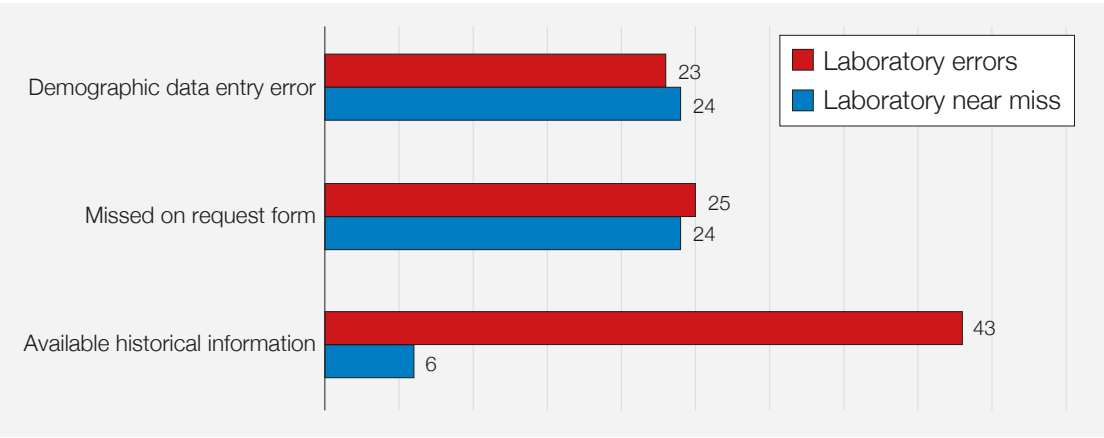


Figure 14.4: Sample receipt and registration errors with outcome n=145

Learning points from sample receipt and registration errors

- **Treatment plans:** A detailed treatment plan for transplant patients, including specific component requirements at different time points, should be shared with the transfusion laboratory prior to transplantation so relevant information is available on the laboratory information management system (LIMS) prior to receiving a request. This treatment plan also needs to be shared with the transfusion laboratory at the hospital the patient is transferred to post transplant
- **Upgrading LIMS:** Laboratory staff need to validate software appropriately and test it against a broad range of scenarios to demonstrate compliance and mitigate errors. It is essential that as much data as possible are captured from the old system into the new. If this is not possible and a legacy system is used for historical data, laboratory staff must check the legacy system for any patient-specific requirements and update and link to the new record in the LIMS before selecting and issuing components. It is also essential that laboratory staff receive in depth, comprehensive training on all aspects of the use of the LIMS and have access to a detailed LIMS standard operating procedure (SOP) to refer to if needed (BSH Jones et al. 2014)
- **Specialist Services electronic reporting using Sunquest's Integrated Clinical Environment (Sp-ICE) access (England only):** Sp-ICE should be accessible to all laboratory staff 24/7 and should be considered as part of the routine practice at sample receipt. All hospitals should have a local policy as to which patients should be looked up on Sp-ICE and that any information found must be documented on the patients record on the LIMS

The learning points for SRR from the 2017 Annual SHOT Report are still valid for heeding patient history and sample acceptance (Bolton-Maggs et al. 2018).

Case 14.1: BMS issued anti-D Ig because the midwife was persistent and did not seek further guidance

A request was received out-of-hours for 500IU anti-D Ig for a patient with a per vaginal (PV) bleed. The BMS informed the clinical area that the patient had an immune anti-D and that prophylaxis was inappropriate, but the midwife was insistent that the patient required anti-D Ig. The BMS issued it without seeking further clinical guidance although the hospital policy clearly stated that anti-D Ig was not to be issued in cases where an immune anti-D was present. Both the BMS and the midwife were aware of this policy stipulation.

There should be clear BMS training and understanding of all component/product types and their specific requirements for release/issue. If there is any uncertainty or question raised that goes against what is thought to be correct, further advice should be sought to confirm the legitimacy of the issue.

Testing n=150 (including 51 near miss)

Correct and accurate analysis of samples is required to ensure the safe provision of blood components for transfusion and should be undertaken with full compliance of local and national guidelines for pre-transfusion testing (BSH Milkins et al. 2013).

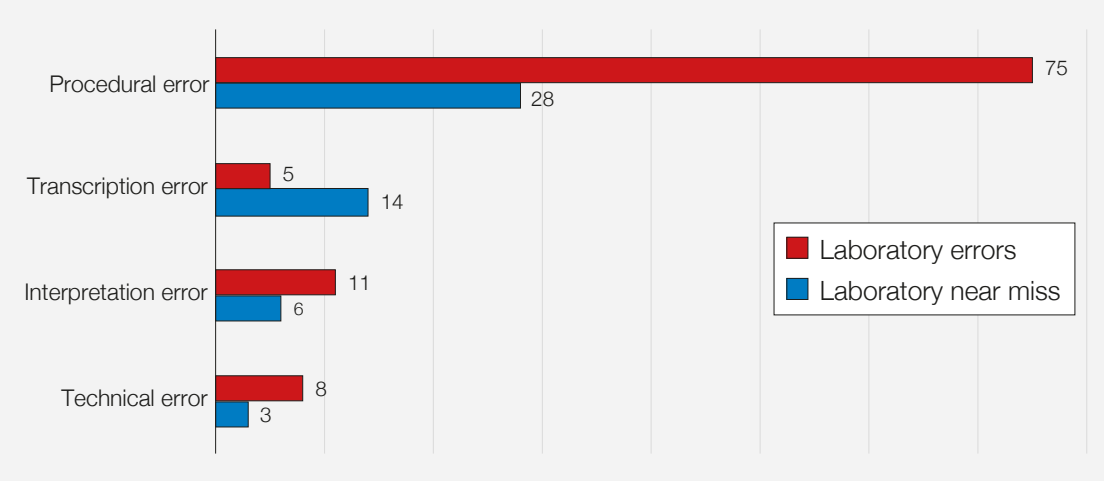


Figure 14.5: Testing errors with outcome n=150

The learning points for testing errors from the 2017 Annual SHOT Report are still valid for lessons surrounding anti-D Ig and failure to follow procedures (Bolton-Maggs et al. 2018). A more detailed and thorough investigation and root cause analysis in these errors could uncover system failures and identify any system improvements.

Case 14.2: Failure to look at Sp-ICE results in a patient receiving incorrectly phenotyped units

Eight units of red cells for a patient with newly diagnosed sickle cell disease (SCD) were requested. The request form identified that the patient had received previous transfusions. The BMS contacted the clinical area to gain a further understanding of these transfusions, but was incorrectly informed the patient had not been previously transfused. Two samples were grouped, and ABO/D/K compatible red cell units were electronically issued. Two months later the laboratory received a sample and the antibody screen was positive, but the identification panel was inconclusive. The BMS then checked with the National Health Service Blood and Transplant (NHSBT) Sp-ICE database which held a record stating that this patient had known antibodies detected 6 years earlier in another hospital. Had this been identified in the first instance the electronic issue (EI) would have been negated and the correct phenotype blood requested.

The NHSBT Sp-ICE database (England only) should be used for new patients with SCD to identify a red cell phenotype and any known antibodies.

Case 14.3: Omission or late administration of anti-D Ig as BMS fails to follow SOP accurately as they had not been trained to issue anti-D Ig

A BMS was checking outstanding work on the LIMS and found the 'anti-D Ig' field was still pending on a patient record. The system was further checked and identified that the anti-D Ig had not been issued. On checking the request form and baby's blood group to see if anti-D Ig had been omitted it was found that >72 hours had elapsed. No follow up call was received from the maternity ward. On investigation it was found that the BMS had not followed the SOP accurately, as they were not fully trained and competent to issue anti-D Ig. The request should have been placed in the appropriate file, to allow anti-D Ig to be issued by another BMS who was trained and competent.

It is inappropriate and potentially dangerous to have any staff working in the transfusion laboratory undertaking tasks they do not understand and are not fully trained and competent to perform. All staff who are not trained/undergoing training require direct supervision and/or all work checked by an experienced and competent member of staff trained in that process.

Component selection (CS) n=134 (including 77 near miss)

The process must ensure that the correct components (together with any specific requirements) are selected to comply with the patient's requirements and the clinical request.

Learning points in component selection

- **Component identification:** Components can sometimes appear to be very similar e.g. fresh frozen plasma (FFP) and cryoprecipitate. Training must include recognising the different component types and their specific storage requirements. Laboratory staff must take care in reading the label to ensure that the correct component is selected (https://www.shotuk.org/resources/current-resources/ SHOT Bite No 9. Component Compatibility)
- **Group-check sample:** A group-check sample policy should be in place and if blood is required on the first sample then group O red cells or group AB/A plasma components should be issued until a second sample is analysed to confirm the patients' blood group (https://www.shotuk.org/resources/current-resources/ SHOT Bite No 9. Component Compatibility and SHOT Bite No 10. Why 2 Samples?)
- **Unrequested specific requirements:** There is an increasing number of incidents for patients born after 01/01/1996 who require pathogen-inactivated plasma components, and this group of patients is getting larger and currently includes people up to the age of 22-23 years. These adults may present to the emergency department (ED) with bleeding from for example, trauma or obstetric causes. The laboratory needs a robust system in place to identify these patients as soon as a sample is booked in so that a flag can be added to the patient's record to ensure the correct blood components are issued, however any delay to transfusion must be avoided in an emergency situation and use of standard plasma components may be necessary

The learning points for CS from the 2017 Annual SHOT Report are still valid for unrecorded specific requirements, multiple specific requirements and compatibility of components (Bolton-Maggs et al. 2018).

Case 14.4: BMS fails to notice a wrong component was selected and continues to not notice even when the alert on the LIMS highlights the error

A haemato-oncology day case patient (group AB D-negative) required transfusion of irradiated red cells. The BMS took two units from the irradiated drawer but failed to notice one was A D-negative and the other A D-positive. The BMS then failed to respond to the alert on the LIMS highlighting the group difference and issued both units. The process failed again during the component labelling as the blood group difference between unit and patient was not noticed. The clinical area did not have any competent staff on duty available to collect the red cells, so the same BMS checked out the components and again failed to notice the group difference. The clinical area did not complete adequate bedside checks before transfusion and also missed the error. This component selection error was discovered on a later sample from this patient, when it was identified that they had developed an anti-D antibody. At the time of this incident the BMS involved had a history of stress and anxiety and the laboratory had an increased workload.

This case report highlights a systemic failure that allows a staff member with a history of stress and anxiety to work in a high pressure situation without adequate support and second checks in place. This also highlights the need for a comprehensive pre-administration bedside checklist to be in place, to include basic group ABO/D compatibilities, to assist clinical staff in spotting this type of error before a unit is transfused (Bolton-Maggs et al. 2018, DH 2017).

Case 14.5: BMS selects wrong component without following SOP or seeking further advice

A request for red cells was received out-of-hours for a leukaemia patient transferred from another centre. Two samples were received and analysed, and both showed a weak mixed field reaction with anti-B in the forward group. No historic group was available on the LIMS. The BMS contacted the clinical area and was informed there had been no previous transfusions or haemopoietic stem cell transplant (HSCT). The BMS believed the sample 'looked' like group B, therefore they crossmatched and issued group B red cells, without checking the SOP (that stated 'to give group O red cells if a clear group cannot be determined') or seeking advice from a senior member of staff working in haematology. The patient was subsequently grouped some time later and did group as B without any mixed field result. This event occurred in the early hours of the morning during a busy time in the laboratory.

This case report demonstrates that staff should never presume in the event of anomalous results. Although here the patient did turn out to be group B it was inappropriate at the time to issue group B red cells. The guidelines state that if a group is unknown then group O red cells or group AB/A plasma should be issued (BSH Milkins et al. 2013).

Component labelling, availability, handling and storage (CL) n=432 (including 161 near miss)

The right component needs to be labelled with the correct four (or five) key patient identifiers; first name, last name, date of birth (DOB), unique patient identifier (and first line of address in Wales) of the intended recipient (BSH Milkins et al. 2013). Components need to be accessible and available for the time required, if this is not attainable then the clinical area need to be informed. The components need to be handled and stored in the correct way as defined in the guidelines (JPAC 2013).

Learning points in component labelling, availability and handling and storage

- **Component storage:** Refrigerators must have their temperature monitored 24/7, with the use of a validated temperature monitoring system that will alert the laboratory if there is a power failure or temperature excursion. If an in-house system is in use, for example, if refrigerators are connected to the building management system, this must alert the transfusion laboratory or the switchboard/ estates team if there is a power failure or temperature excursion. Alerts must be dealt with or escalated immediately, and steps that need to be taken must be included in a robust protocol/ procedure

The learning points for component handling, storage, labelling and availability from the 2017 Annual SHOT Report are still valid for transposed labels, major haemorrhage protocols, storage of components and recovery of components beyond reservation (Bolton-Maggs et al. 2018).

Case 14.6: BMS incorrectly interprets a warning flag as an error on the IT system resulting in expired units being transfused

A unit of red cells was removed from a refrigerator controlled by an electronic blood management system (EBMS) at 00:43 hours. The unit had expired at midnight and the EBMS alerted the nurse collecting the unit with a message that the unit had expired and to contact the laboratory. The out-of-hours BMS incorrectly assumed the EBMS alert was related to an earlier network failure and allowed the clinical staff to take the unit back to the ward. When an attempt was made to receipt the unit in the clinical area, a second alert occurred via the personal digital assistant (PDA) again, explaining that the unit had expired and not to continue. The transfusion was started despite the alerts and pre-transfusion checks at the bedside failed to pick up the error. Within a few minutes the BMS looked into the alerts further and realised their error. The ward was contacted immediately and told to stop the transfusion however, the transfusion had already commenced.

The principle failure in this case report in the laboratory is the assumption that the alert was for another event without checking the alert for the detail. This was compounded when the clinical area got a second alert and, on this occasion, instructed them not to continue which they failed to follow. Consideration needs to be given to working with the EBMS suppliers, to develop software that does not allow the blood issue refrigerator to be accessed in the first instance if components are beyond expiry or reservation.

Case 14.7: Previous patient's compatibility labels still attached on units and transfused to another patient

A major haemorrhage protocol (MHP) was activated for a patient and the appropriate blood components were issued and transfused. The patient was to be transferred to a local specialist unit along with further blood components. The BMS contacted the ward to discuss the transfer of blood components and during this phone call the BMS was informed that the MHP had been activated again and blood was needed urgently. The MHP bleep went off and when the BMS was putting down the phone to switchboard the porter was already in the laboratory looking shaken and visibly panicked. The porter stated they wanted blood urgently and the BMS, knowing the patient was A D-positive, selected two O D-positive units from the refrigerator and boxed up these units even though these two units still had another patient's compatibility labels on them, and they were subsequently transfused. The BMS made a conscious decision due to the clinical urgency of the situation, the ward staff were aware of different patient details but knew units were compatible for the patient in the clinical emergency.

Protocols explaining the issue of components, especially those in urgent situations where uncrossmatched components are issued should be clear, prescriptive and simple to follow. Wrongly selecting components already labelled for a different patient, could have led to the emergency transfusion being delayed causing further harm and then this in turn could have resulted in a delay in the transfusion for the patient that the component was originally issued for.

Collection n=6 (all near misses)

This step ensures that the correct component is collected from the storage site and delivered to the correct clinical area.

All 6 cases were near miss incidents, in 5 of them the wrong component was given to clinical staff (3 for the wrong patient and 2 the wrong component) and 1 involved anti-D Ig given to the clinical area for a woman who had given birth to a D-negative baby. All incidents were detected prior to administration.

Miscellaneous n=18 (including 6 near miss)

This section includes instances where the error has occurred in areas other than the key laboratory steps in the transfusion process detailed above.

The outcome of the 12 miscellaneous cases where patients were transfused are; 2 WCT, 3 SRNM, 1 Anti-D Ig and 6 ADU (4 delayed, 2 avoidable).

- In 4 cases the errors originated in the blood establishment:
  - Information was not passed on correctly and the patient did not receive anti-D Ig in the correct timeframe
  - A wrong component was selected for a patient
  - A patient received a unit of the incorrect specification
  - The final patient endured a delay
- In 3 cases laboratory staff did not update the patient records when instructed leading to:
  - Specific requirements not met (1 irradiated and 1 human leucocyte antigen (HLA)-matched components)
  - Incorrect ABO group to a HSCT patient

- In 2 cases patients received an avoidable and delayed transfusion respectively due to LIMS downtime
- In 2 cases the bleep was not working resulting in a delay in providing emergency components during a major haemorrhage
- In 1 case the BMS gave incorrect information that a sample was available for testing in the laboratory when it was not, resulting in emergency uncrossmatched components being used

The 6 near miss miscellaneous cases could potentially have led to 5 patients having a wrong component transfused and 1 case related to anti-D Ig.

For further cases of avoidable or delayed transfusions see Chapter 10, Avoidable, Delayed or Under/Overtransfusion (ADU).

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

Author: Chris Robbie

The different remits and approaches to incident reporting by the MHRA and SHOT should not be seen as differing, but complementary. Regardless of the type of incidents reviewed; the root causes and analysis of the reports is largely the same in that errors are almost always the result of individuals not performing the task they should have done, or in a way that it should have been done. However, this should not mean the individual was at fault.

It should be noted that the Guide to Good Practice (Council of Europe 2016) is clear that where human error is suspected or identified as the cause of a deviation or non-conformance, this should be justified in the investigation report having taken care to ensure that process, procedural or system-based errors or problems have not been overlooked, if present (section 1.2.13).

Discussions with colleagues from SHOT, UK Transfusion Laboratory Collaborative (UKTLC), National Blood Transfusion Committee (NBTC), Royal College of Pathologists (RCPath), MHRA inspections, visits and discussion with reporters frequently cite that lack of resource, staffing, education of newly qualified staff and loss of experience all have an effect on a laboratory's performance. Improvement in QMS by effective investigation of deviations and non-conformances and implementation of effective corrective and preventive action (CAPA) should improve patient safety.

UK Transfusion Laboratory Collaborative (UKTLC)

Author: Rashmi Rook, Chair UKTLC

Importance of collective knowledge to the transfusion community

Over the last year it has become apparent and of significant concern to the UKTLC that even fewer transfusion laboratory managers (TLM) and senior BMS are attending professional meetings. Reduced participation at this level will adversely affect the *collective knowledge* that resides within this group as many laboratory technical and serological experts have retired, or are due to leave in the next few years. Improvements to patient safety and care relies on the availability of clinical and laboratory experts, so there is an urgent need to build new teams of subject matter experts (SME) to provide support and guidance at local, national and international levels. This will only be achieved by the presence and active participation of TLM and seniors at all meetings including the local transfusion technical user groups - this is shared learning at its best and has contributed to decades of progress and development made in this field.

Collective knowledge: *Knowledge that is possessed by a group or organisation and allows access to SME. For blood, this 'body of knowledge' influences decisions on public health.*

Our laboratory teams must be given adequate resources to develop. This includes time to gain expertise and knowledge of their technical systems, the understanding of serological testing regimes, and quality systems management including human factors. This can only come about once staffing levels in the laboratories are correctly set to enable these activities. When writing staff capacity plans, laboratory workload figures must not be solely based on the number of samples tested and components issued.

The following list identifies concerns raised with UKTLC and can possibly be attributed to the lack of stabilising the workforce to allow the acquisition of the right skill set, depth of knowledge and experience that is impacting on overall profound knowledge at the laboratory level. This can only be to the disadvantage to the transfusion community as a whole but particularly to our patients:

- Sub-optimal equipment and techniques being developed and implemented
- Errors with LIMS implementation, management and incorrect rules applied
- Remote issue and traceability systems being set up incorrectly
- Incorrect testing reagents being used
- Delays to updating or writing new guidelines and standards
- Lack of understanding of complex regulations and guidelines

Over the last year there has been considerable information in the media about the *Infected Blood Inquiry* dating back to the 1980s and 90s. Since these events having occurred the collaboration of laboratory and clinical specialists has helped to create a world-leading National Blood Service and haemovigilance systems that we, as part of this community should be proud of. The focus on blood safety and technology improvements to further enhance patient treatment and care, and the development of new innovative practices relies on all staff being given the right opportunities to fulfil their job roles and actively participate in this incredible community. The importance of having adequate resources to improve this knowledge base, to develop robust laboratory processes and to share information openly and transparently with colleagues across organisations and professions should not be overlooked. We cannot risk another tragedy related to blood events caused by the failure to support our staff and give them the right work conditions and opportunities to succeed at being our new generation of technical experts.

Finally, there is a need for all colleagues regardless of grade or job role to continue with their own learning, and much of this is gained by being actively involved with questioning and discussing at meetings, and respectfully challenging information or to stand up and say when things are unclear. This is the normal process of acquiring knowledge and understanding. As a respected colleague once said, *'The only silly question is the one that's never asked!'*

Updates:

- During 2018 the focus of UKTLC has been to encourage laboratories to ensure that staffing capacity plans are written, with some guidance being developed. UKTLC are also working with NHS Improvement (NHSI) on a more formal way to implement this guidance (Bolton-Maggs et al. 2019)
- UKTLC are looking at ways to incorporate the key requirements of the standards (2014) into the relevant British Society for Haematology (BSH) guidelines as these are updated rather than a full re-write of the standards. This should help to streamline information, but will be reviewed in due course (Chaffe et al. 2014)
- Continuing to promote the sharing of ideas and information on the MHRA Blood Forum http://forums.mhra.gov.uk/forumdisplay.php?60-Blood-Forum

UK National External Quality Assessment Scheme (UK-NEQAS)

Author: Claire Whitham

SHOT errors are shown to be attributable to many factors, including those related to knowledge, training, competency, and to human factors. Results of external quality assessment (EQA) show that these factors also contribute to EQA errors. An error in EQA can be seen as a 'free lesson', as CAPA undertaken in response can allow the underlying causes to be addressed before a similar error occurs in clinical practice.

This report takes into account trends in errors made during EQA exercises between June 2017 and January 2019.

It is widely understood amongst the transfusion community that the current climate in hospital blood transfusion laboratories is one of immense pressure, where increasing workloads coupled with the loss of experienced staff create additional training burdens. This has again been a contributory factor in many EQA errors made during 2017-2018. During three exercises (17E6, 17R8 and 18R8) four laboratories cited these pressures as a direct cause for EQA errors. One laboratory, working under resource and time constraints, made an error in antibody identification, correctly identifying anti-D in a sample, but misidentifying the second specificity, as a result of not following their own protocol for inclusion and exclusion of antibody specificities. Two further laboratories missed incompatible crossmatches, one caused by a failure to add plasma as a result of distraction, and the other, recording their results in a testing grid, rotated these results through 90 degrees during data entry. Another laboratory made an error in phenotyping, recording all three donors as S-negative, suggesting that the antisera being used was either not performing as expected or had not been added to the tests. There are many potential sources of distraction in the busy transfusion laboratory (see Chapter 6, Human Factors in SHOT Error Incidents); it is important to understand the potential effects of distraction and workload pressures, especially when performing critical manual testing.

There is evidence from EQA that some of the errors made are attributable to a lack of knowledge.

A number of laboratories made errors in identifying antibody mixtures in EQA exercises. The risks of misidentifying antibodies can lead to incompatible blood being issued in an urgent clinical situation. In a sample containing anti-c+K, one laboratory obtained a positive reaction with a c- K+ cell, but did not take this into consideration during interpretation, and another recorded anti-Jk^{a} as the second specificity, based on a positive reaction with a single c- Jk(a+) cell without noting that this cell was also K-positive and that anti-K could not be excluded. A further three laboratories recorded anti-S as the second specificity on the basis of a negative reaction in an enzyme technique with a c-negative, S-positive and K-positive cell that had given a positive reaction by indirect antiglobulin test (IAT). For a sample containing anti-c+M, six laboratories correctly identified anti-c but misidentified the second specificity, five recording anti-K and one recording anti-S.

To avoid misidentification, every antibody investigation should include a systematic process for exclusion and positive identification of antibody specificities, and all reactions should be accounted for before a conclusion is reached.

The interpretation of phenotyping results has also revealed knowledge gaps. During 18R2 (Kidd typing), four laboratories recorded the rare phenotype Jk(a-b-) for one or more of the three donors. An apparent 'null' phenotype of this nature should prompt repeat testing to confirm the result.

Errors made due to the transposition of either samples or results during testing, and those made during result transcription continue to be recurring errors made in all elements of testing across the majority of EQA exercises. Although the format of an EQA exercise cannot exactly replicate clinical testing scenarios, performing checks such as sample labelling prior to the commencement of and during any serology testing, and checking results prior to any manual reporting step, could be considered to be routine practice across all laboratories. In seven exercises (17E6, 17R8, 17R10, 18R2, 18E3, 18R5 and

18R8) a number of laboratories made procedural errors which have the potential to occur during routine clinical testing or reporting of patient results, where samples were transposed during testing or recording results of ABO typing, antibody screening and identification, crossmatching and phenotyping. Causes reported include antibody identification panel reactions incorrectly transcribed from an analyser to a paper panel sheet, switching results of phenotyping at data entry, inadvertently testing samples from a previous UK NEQAS exercise, and testing Patient 1 or 3 twice in place of Patient 2.

To reduce the potential for procedural errors, checks are required at critical points in the pre-transfusion process, e.g. sample labelling, performing and interpreting manual tests and transcribing information. Care should be taken to confirm the identity of all samples before testing. For clinical samples, this requires a full check of the patient details to ensure that results are assigned to the correct patient. EQA samples should be subject to the same process with a check of the patient number and exercise code on each sample.

The exercise that produced the highest number of 'unexpected' errors in 2018 was 18R2 where laboratories were asked to perform Kidd phenotyping on the three donor samples supplied. At the end of the exercise, forty-nine laboratories had recorded 54 incorrect phenotypes, 47 of which were false negative Jk^b types for Donor W (Jk(a+b+)). Extensive investigation including testing at the International Blood Group Reference Laboratory (IBGRL) with three different anti-Jk^b reagents and a titration, confirmed that the Donor W cells had normal Jk^b expression. The majority of participants that were contacted regarding phenotyping errors had used the same anti-Jk^b reagent that required use of a 'non-standard' serological tube technique, involving an additional incubation step to '-enhance the reaction strength in typing cells of rare phenotype', if a negative reaction is obtained after the first recommended incubation.

As a part of the investigation, participants were asked to clarify the technique used to test Donor W, and a high proportion of laboratories using the implicated reagent (49%) used methodology that deviated in some way from the manufacturer's instructions. Column agglutination technology (CAT) rather than tube testing was used by 25%, and sixteen laboratories did not include the second incubation, with four of these reporting Donor W as Jk(b-). There were several comments received from participants that suggested some had experienced difficulty in obtaining the product insert, which was not provided with the reagent, and there had been confusion with another reagent for use by CAT previously provided by the same supplier, that may have been contributory factors. Whilst ultimately it is the laboratory's responsibility to use the reagent according to the instructions, the manufacturer also has a responsibility to make the instructions as clear as possible.

Some laboratories obtained negative or weak reactions with Donor W, using the implicated anti-Jk^b reagent in this and in a subsequent EQA exercise (18R8), and the scheme reported this to the MHRA. It was noted in the EQA report for 18R2 that 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. Some of those making Jk^b typing errors in exercises 18R2 and 18R8 indicated that cells with apparent homozygous expression, i.e. Jk(a-b+), had been used as a positive control rather than Jk(a+b+). When performing red cell phenotyping, it is good practice to select a 'positive' control cell with heterozygous expression of the relevant antigen to demonstrate that the weakest normal antigen expression can be detected on the test cells.

Learning point

- It is important that reagents are validated for use, manufacturer's instructions are followed and appropriate cells are selected as controls each time they are used

In most laboratories, reservation of ABO-incompatible red cells is prevented by the LIMS. However, during LIMS downtime or failure, it is important for laboratories to have robust systems and processes for ensuring that ABO-incompatibility is detected. In exercise 18R8, three laboratories, all recording a negative reaction in the IAT crossmatch, missed the incompatibility between Patient 1 (B D-positive) and Donor Y (A D-negative). The IAT crossmatch is not the technique of choice for detection of ABO-

incompatibility and in the rare situation where a serological crossmatch is used without IT support to prevent ABO-incompatibility, it is advisable to also include a crossmatch by direct agglutination at room temperature. One manufacturer of CAT states in the instructions for use for the 'Coombs' card used for compatibility testing, that 'to ensure the ABO compatibility between recipient's and donor's blood, a serological (saline at room temperature with immediate centrifugation)… is recommended'.

During 2018, UK NEQAS blood transfusion laboratory practice (BTLP) distributed a pre-transfusion practice questionnaire to laboratories in the UK and Republic of Ireland. There was little variation in practice since a similar questionnaire was reported in 2016, with the most notable change related to the policy of transfusion laboratories to be sent a 'group-check' sample prior to transfusion. In 2018, 84% of laboratories required a group-check sample (*cf.* 67% of laboratories in 2016) and 12% stated that they supply the tube for the group-check sample direct from the transfusion laboratory. There continues to be an increase in the number of laboratories using the automation for tests other than the 'group and screen', with 73% using automation for antibody identification (*cf.* 64.9% in 2016), 39.4% for crossmatch (*cf.* 34.6%), 51.7% for phenotyping (*cf.* 41.7%) and 63.9% for the direct antiglobulin test (DAT) (*cf.* 56.1%).

Conclusion related to laboratory errors

This year's Annual SHOT Report still demonstrates that staff are working beyond their capability or knowledge and giving out information they are not qualified to give or altering laboratory practice to try and achieve a safe conclusion. Robust SOP must be in place that clearly instruct staff what they should do when events fall outside their understanding or the detail of the processes and procedures being followed. It must be made clear that such events need to be referred to either a more senior/experienced BMS or a clinician with knowledge of transfusion, who can then advise on the appropriate course of action to be taken. The updated BSH administration guidelines (BSH Robinson et al. 2017) state that part of the critical pre-transfusion bedside checks should include knowledge of component compatibility for your patient prior to administering the component. However, the laboratory must also ensure that the component issued is correct for the patient it is issued to by performing essential checks before the components leave the laboratory. The SHOT nine step transfusion process requires all staff working within this process to work as a team, to ensure that the right patient receives the right blood at the right time. This requires communication and accurate handovers between staff, shifts and departments/wards. All of the laboratory key messages and learning points in this report need to be considered 24/7 not just during core hours. As reported last year, laboratory staff must be responsible for keeping their competencies up to date (HCPC 2018). Pathology services all over the UK are constantly under intense pressure and the demands on the workforce are increasing for a workforce that is already stretched and under resourced, making it even more vital that vigilance and duty of care is upheld to ensure transfusion and patient safety. Although errors in laboratory working are highlighted in this chapter, often these errors result from initial errors in clinical area or by portering staff, or laboratory errors are further compounded by additional errors by clinical or portering staff further in the time line. All hospital staff are under pressure from resource and workload issues, but all hospital staff must work together to eliminate errors, not only to improve safety for patients, but to not waste precious resource by making and then having to correct errors.

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Errors Related to Information Technology (IT) n=213

15

Author: Megan Rowley

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 by hospitals in response to errors included IT solutions, these have been included.

Summary

The number of reports related to IT is stable. In 2018 there were 213 (201 excluding anti-D immunoglobulin (Ig) errors) cases included in this chapter drawn from the primary reporting categories as shown in Table 15.1 and these are categorised in Table 15.2 (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 of the report.

Primary reporting category	Number of cases
Incorrect blood component transfused-wrong component transfused (IBCT-WCT)	24
IBCT-specific requirements not met (IBCT-SRNM)	101
Right blood right patient (RBRP)	35
Avoidable, delayed and under or overtransfusion (ADU)	18
Handling and storage errors (HSE)	23
Total	201
Anti-D Ig	12
Total including anti-D Ig	**213**

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

Deaths n=0

There were no transfusion-related deaths that involved IT errors.

Major morbidity n=1

A woman of childbearing potential was sensitised to the Kell antigen because K-negative blood was not selected probably because a warning flag was not heeded.

In addition a female sickle cell disease (SCD) patient in her 20s was given antigen-positive blood with the potential for sensitisation because the historical record on Specialist Services electronic reporting using Sunquest's Integrated Clinical Environment (SP-ICE) was not consulted.

The majority of cases were associated with no harm with only five cases resulting in minor morbidity.

Errors related to flags alerts and warnings and electronic issue are summarised below because the cases are drawn from a variety of chapters.

Further details of the IT-related reports can be found in the supplementary information on the SHOT website www.shotuk.org.

IT flags, alerts and warnings n=98

This was the largest category of IT-related errors, as has been noted in previous years. In 29 cases the LIMS or electronic blood management system (EBMS) had a flag set but it was not heeded. In 38 cases the flag had not been updated or removed in error and in a further 31 cases no flag had been set or the LIMS was not able to flag the specific requirement. The cases are included in the relevant chapters.

Learning points

- With increasing use of electronic patient records and electronic prescription of both blood components and chemotherapy, the possibility of synchronising specific requirements related to treatment should be considered. This would mean that flags, alerts and warnings present on one system could be transferred electronically to another system without the need for completion of additional specific requirements documentation
- Several reporters suggested that a national register of specific requirements (like Specialist Services electronic reporting using Sunquest's Integrated Clinical Environment (SP-ICE)) could be considered to support shared-care patients

Recommendation

- The laboratory information management system (LIMS) should be used to its full functionality including the use of flags and alerts and warnings to ensure that specific requirements are met and blood issued is compatible

Action: Transfusion Laboratory Managers

Electronic issue (EI) n=18

There were 18 cases where blood was issued electronically but the patient was not eligible because they did not meet the criteria, and 2 of these were in the RBRP category. In 1 of these cases a remote issue refrigerator allowed release of the unit despite the wrong date of birth on the LIMS.

In 16 cases that should have had serological crossmatches, 4 were in patients following recent solid organ transplant and should have been flagged as ineligible for EI.

Case 15.1: Electronic issue of granulocytes to a patient with red cell antibodies

Buffy coats were required for a patient with acute myeloid leukaemia (AML) with a red cell antibody, but the red-cell rich component was issued electronically rather than serologically crossmatched. Granulocytes are infrequently used and therefore unfamiliar to many laboratory staff. LIMS control of EI eligibility may not cover non-red cell components and therefore it is important to include this in the standard operating procedure for buffy coat and granulocyte issue.

REACTIONS IN PATIENTS

Serious adverse reactions (SAR) are defined for European Union (EU) reporting as follows:

Definition: 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

These must be reported to the Medicines and Healthcare products Regulatory Agency (MHRA). This is a legal requirement.

These are described under the following headings:

16 Febrile, Allergic and Hypotensive Reactions (FAHR) n=238

Authors: Janet Birchall, Jayne Peters and Fiona Regan

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.

Introduction

These 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).

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 will be informed if SHOT experts change the reaction classification submitted. Such a process will allow 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 give an antihistamine as first line; give adrenaline if anaphylaxis is suspected. The effect of steroids is delayed by several hours, will have no immediate effect, and should only be used to prevent a late recurrence. The use of steroids may further immunosuppress already immunocompromised patients and increase the risk of side effects such as infection

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. This should include paediatric patients where apheresis platelets are usually the platelet component of choice. If reactions continue, despite antihistamine cover, then platelets re-suspended in 100% PAS can be supplied
- Give appropriate targeted treatment and if needed, preventative cover for future transfusion (BSH Tinegate et al. 2012), as indicated in Table 16.1:

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 treated plasma

- Outpatient departments and day care units, including those in the community, should ensure patients have information about what to do if they experience a reaction after leaving the unit
- The treatment of reactions and management of subsequent transfusions should be directed by recognised guidelines e.g. BSH guidelines on the investigation and management of acute transfusion reactions (BSH Tinegate et al. 2012)

Action: Hospital Transfusion Teams (HTT)

- Reporters should report cases fully, including clinical data such as temperature and blood pressure prior to, and during, a reaction, especially if fever or hypotension are featured. The International Society for Blood Transfusion/International Haemovigilance Network (ISBT/IHN) classification should be used to grade severity (Table 16.2)
- SHOT has a role in identifying trends in reactions and events, including the monitoring of new components. It is therefore important to identify the implicated component e.g. standard/washed red cells; pooled/apheresis and or washed or human leucocyte antigen (HLA)-matched platelets; standard/virally inactivated (including type) plasma

Action: SHOT reporters

- Patients who have experienced transfusion reactions should only be tested for platelet or granulocyte antibodies within guidelines such as those set out in England by the National Health Service Blood and Transplant (NHSBT) in their Histocompatibility and Immunogenetics user guide (NHSBT 2015/16). The main indication, other than platelet refractoriness, is persistence of severe reactions despite the use of platelets where the plasma has been removed and replaced by suspension medium

Action: HTT, Histocompatibility and Immunogenetics laboratories

- Transfusions should only be performed where there are facilities to recognise and treat anaphylaxis, according to United Kingdom Resuscitation Council (UKRC) guidelines (Resuscitation Council 2008). This recommendation is also relevant for other transfusion-related emergencies such as respiratory distress caused by transfusion-associated circulatory overload (TACO) or transfusion-related acute lung injury (TRALI). When supplying to community hospitals or for home transfusions, providers must ensure that staff caring for patients have the competency and facilities to deal with reactions. This is particularly relevant in the light of proposals to increase patient treatment outside of secondary care

Action: HTT, Royal College of General Practitioners

Table 16.2: Classification of reactions

	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

Number of reactions and reaction rates n=238

In addition to the 235 reactions that comply with the definition of febrile, allergic and isolated hypotensive reactions, this section also includes 3 cases associated with IgA deficiency because of the previous association of this condition with allergy.

Total number of FAHR reactions n=235

Reactions have been classified as in Table 16.3. Severe reactions, as described in Table 16.2, are used to define major morbidity.

Table 16.3: Classification of FAHR in 2018

	Moderate	Severe	Total
Febrile	85	18	103
Allergic	62	35	97
Mixed allergic/febrile	27	7	34
Hypotensive	1	0	1
Total	**175**	**60**	**235**

NB: in 22 of the 60 reactions classified as severe this was primarily because the patient was admitted overnight

The percentage of severe reactions remains similar to previous years at 25.5%. 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, distinguishing true transfusion reactions from symptoms and signs associated with the patient's underlying condition.

Table 16.4 identifies the total number of cases submitted for review into the category of FAHR over the last five years. In total, fewer cases were reported compared to previous years. The number of cases withdrawn, as not consistent with the ISBT/IHN definition of moderate or severe febrile, allergic or hypotensive reactions, was larger. Of these, 25/125 cases were referred for consideration of inclusion into alternative categories of reaction.

Cases reported	2014	2015	2016	2017	2018
Total reported	434	407	357	390	360
Included	312	296	253	284	235
Excluded (withdrawn or unclassifiable)	122	111	104	106	125
% Excluded	**28.1%**	**27.3%**	**29.1%**	**27.2%**	**34.7%**

Table 16.4: Total FAHR cases reviewed over a five-year period

Hyperacute reactions n=3

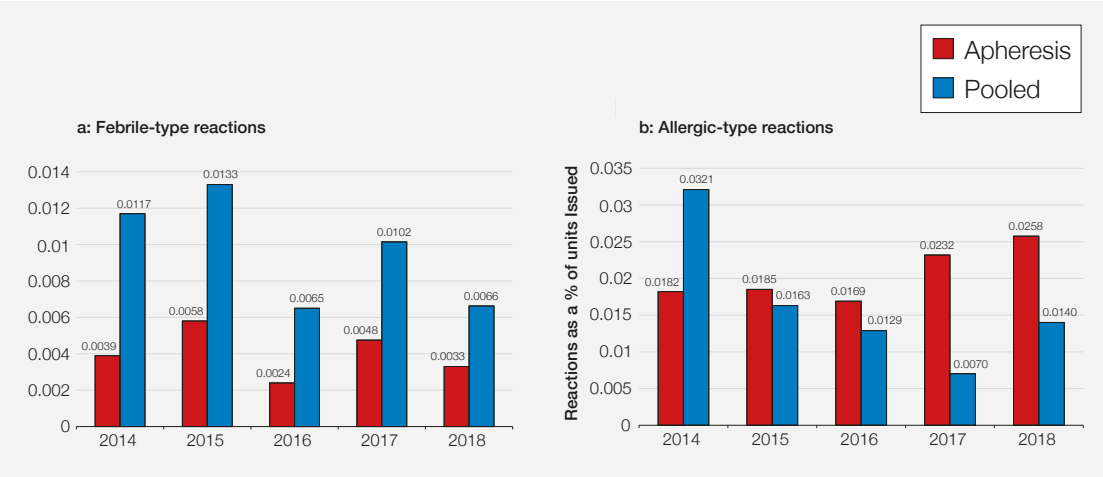
There were 3 reported cases of hyperacute transfusion reactions associated with IgA deficiency; two of which were observed in the same patient. One patient had confirmed IgA antibodies; the remaining patient had not yet been tested. For all 3 cases, the reaction occurred after transfusion of a small volume of packed red cells (between 17 and 40mL).

The transfusion reactions observed were characterised by the hyperacute onset of symptoms including tachycardia, shortness of breath without wheeze, severe anxiety, rigors and pain. Chest, loin, back and abdominal pain were all reported.

As the characteristics of these acute transfusion reactions related to IgA deficiency did not conform to those of allergy/anaphylaxis, work is underway to determine the most appropriate SHOT reporting category for such cases.

Type of reactions by component

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. The incidence of febrile reactions continues to be higher with pooled platelets compared to apheresis. Overall, there were fewer reactions reported with pooled platelets than apheresis platelets (0.02% and 0.03% respectively) as the incidence of febrile reactions to platelets is lower than allergic reactions. 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 16.1a and b).

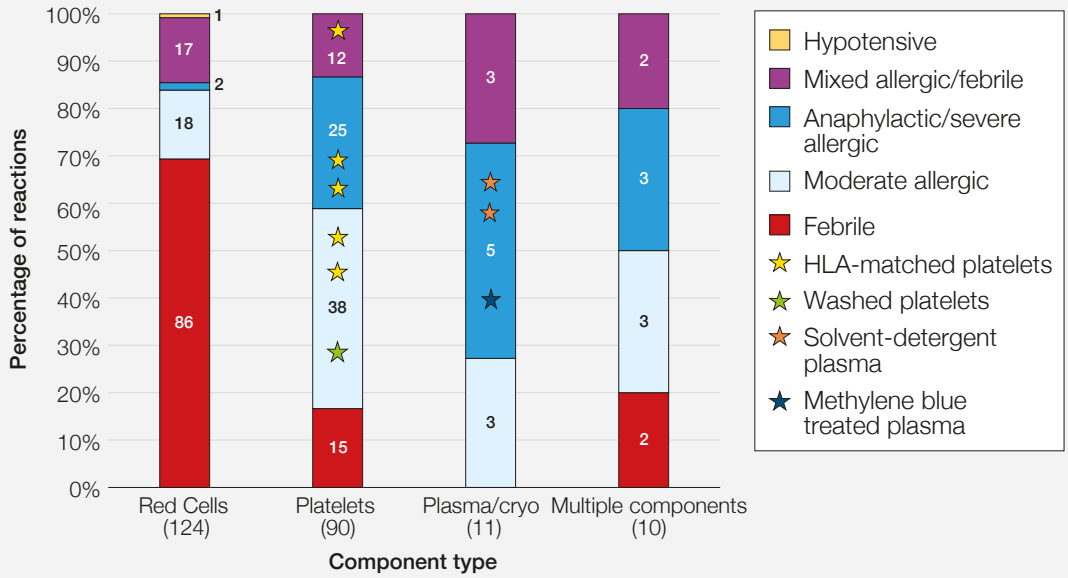


Figures 16.1: Percentage of reactions to apheresis and pooled platelets 2014 to 2018

Reactions by all component types remain similar to previous Annual SHOT Reports; see Figure 16.2. Red cells are usually associated with febrile-type reactions (~70%) whereas plasma and platelets more commonly cause allergic reactions (~70%). There were 2 reactions associated with solvent-detergent (SD)-FFP and 1 reaction was associated with methylene blue-treatment. It is notable that despite an almost certain increase in the use of virally inactivated components the number of reactions remains very low.

This year reporters were asked to state the number of days shelf life remaining at the time of the reaction if only one component was implicated. There were more pure allergic and pure febrile reactions associated with red cells but no obvious link with the age of the unit. Apheresis and pooled platelets were more likely to be associated with these reactions if there was only 2 days shelf life remaining or less, compared to fresher units, 29/38 (76.3%) and 9/14 (64.3%) respectively. However, as the number of platelet units transfused during these time periods is unknown this could simply reflect that the majority of units are used towards the end of their shelf life.

Figure 16.2: Reactions by component type



HLA=human leucocyte antigen; cryo=cryoprecipitate

NB: There were no reported febrile, allergic or hypotensive reactions associated with granulocyte transfusion

Analysis of reactions remains comparable to previous years in the following characteristics.

Table 16.5: Characteristics of FAHR

Characteristic	Occurrence
Age distribution	86% of patients were aged 18 years or over
Gender	54% male and 46% female cases
Urgency of transfusion	73% were given routinely
Timing of transfusion	43% occurred within standard hours
Location	66% were on wards and 16% in outpatient/day case units

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; an antihistamine with or without steroids to treat a subsequent pure febrile reaction remains a problem (Table 16.7). On a more positive note in 6 cases pooled platelets continued to be recommended instead of apheresis, in 3 cases discussion with a consultant haematologist/ paediatrician was advised prior to further transfusion of plasma/platelets, in 2 cases alternative treatment to blood components was suggested and in one case a single unit transfusion was advised.

	Number	Medication stated	Antihistamine +/- steroid
Febrile			
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 16.6: Treatment of reported reaction

	Number where treatment stated	Antihistamine +/- steroid stated
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%)

Table 16.7: Planned treatment of subsequent febrile reactions

Illustrative cases

Case 16.1: Febrile reaction inappropriately treated with an antihistamine and steroid

A day case patient in their 60s with myelodysplasia, haemolysis and neutropenia developed a temperature rise to 39.7°C, rigors and nausea during a red cell transfusion. They were treated with hydrocortisone, chlorphenamine, paracetamol, antibiotics and admitted on to a ward. Future transfusion management was stated to be pre-medication with an antihistamine and steroid. Although it is not clear if steroid treatment may be beneficial for the management of their haemolysis it is unlikely to prevent a further febrile-type reaction and may make infection more likely in a vulnerable, neutropenic patient.

Case 16.2: Reducing the number of units given at each transfusion episode as a reaction prevention strategy

A patient in their 60s with chronic transfusion dependent anaemia received a red cell transfusion as an inpatient. During the transfusion, they developed a temperature of 38°C associated with chills and rigors. The rate of the transfusion was reduced and they were given paracetamol, however their symptoms reoccurred therefore the transfusion was discontinued. Future management was to limit transfusion episodes to a single unit of red cells and was reported to be effective.

Case 16.3: Use of iron to avoid the need for red cell transfusion

A patient in their 80s was admitted to the ambulatory care unit for a two-unit red cell transfusion for symptomatic iron deficient anaemia. Chlorphenamine and ondansetron were given pre transfusion. On completion of the first unit the patient developed a temperature rise of more than 2°C, rigors, nausea and was treated with paracetamol. They were discharged later the same day and intravenous iron agreed as future management. It is unclear what the expected benefit was of pre-transfusion chlorphenamine, however treatment with paracetamol and future management with intravenous iron are rational. If intravenous iron is given prior to the development of symptoms this is likely to prevent the need for further urgent admission and red cell transfusion.

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BSH Estcourt L J, Birchall J, Allard S, et al. (2017) Guidelines for the use of platelet transfusions. *Br J Haematol* 2017;**176(3)**:365-394.

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Pulmonary Complications of Transfusion n=119

17

Author: Paula Bolton-Maggs

Reports of pulmonary complications continue to make the greatest contribution to death and major morbidity after transfusion. Transfusion-related acute lung injury (TRALI) is defined by SHOT as those patients with lung infiltrates during or within 6 hours of transfusion in the absence of other causes or in the presence of human leucocyte antigen (HLA) or leucocyte antibodies cognate with the recipient. This remains an uncommon complication of transfusion. The cases that do not meet these criteria, nor satisfy the updated criteria for transfusion-associated circulatory overload (TACO) are included in the transfusion-associated dyspnoea (TAD) category. As can be seen from the section on TAD, it is possible that some of these cases were TRALI or TACO, but the details and/or investigations were insufficient to include them in those categories.

Patients with respiratory complications are often elderly with multiple co-morbidities which makes it more difficult to classify them into one or another of these three groups. Surveillance criteria for TACO have now been significantly updated and the evolution of this process has been in evidence in the Annual SHOT Reports over the past three years. The criteria used for analysis of reports in 2018 are now published and it is hoped that this will result in improved case definition and reporting of this important complication. As shown in Figure 17.1 the number of TACO case reports has increased in 2018, perhaps linked to publicity associated with the National Comparative Audit of TACO (NCA 2017).

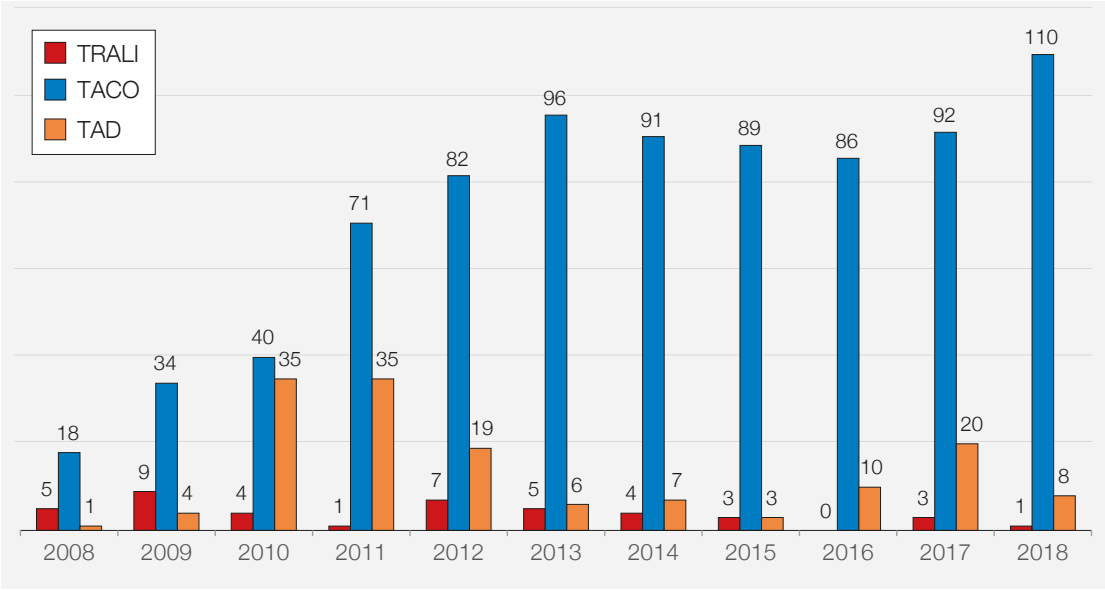

Figure 17.1: Reports of pulmonary complications by year 2008-2018

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

Over the past two years a great deal of discussion has taken place about TACO and TRALI, with the recognition that the pathophysiology of both these conditions is poorly understood, that both may occur together, and that further research is warranted. TACO may have an inflammatory component (a proportion of cases demonstrate fever). For both conditions 2-hit theories are suggested, the first being patient-related factors and the second some property of the infused blood component. TACO is a clinical diagnosis with no clear biomarker although B-type natriuretic peptide (BNP) (or N-terminal-pro brain natriuretic peptide (NT-pro-BNP), a more stable molecule) levels may be useful (Klanderman et al. 2019) and these are now incorporated into the surveillance definition. Following updated definitions for

acute lung injury (the Berlin definition, Ferguson et al. 2012) a reassessment of the diagnostic criteria for TRALI suggests that confirmatory leucocyte antigen-antibody data should be sought but are not essential for diagnosis (Vlaar et al. 2019) since there are other factors which provoke TRALI (Toy et al. 2012). This is a major change from the principles of TRALI case definition for SHOT. It is likely that many cases classified in the past as TAD may be TRALI under these revised criteria. SHOT needs to consider the impact of these recent updates on the reporting strategy, and whether in the first instance all the pulmonary complications are gathered under a single heading. In 2019 SHOT has recruited two pulmonary experts to assist in the analysis and classification of the pulmonary complications.

Some significant research findings include:

- TRALI patients have reduced levels of interleukin (IL)-10 (Kapur et al. 2017a)
- TRALI is associated with raised levels of C-reactive protein (CRP) in mice (Kapur et al. 2015)
- T-regulatory and dendritic cells may protect from TRALI through IL-10 (murine model) (Kapur et al. 2017b)
- Gastrointestinal microbial flora may affect susceptibility to TRALI (murine model) (Kapur et al. 2018)

These findings may suggest options for treatment such as IL-10 or down-modulation of CRP (Semple et al. 2018).

At least some of these pulmonary complications are potentially preventable and early recognition with prompt treatment is vital. Patient education and awareness are also important, especially if transfused as day cases or in the community.

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Transfusion-Related Acute Lung Injury (TRALI) n=1

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.

There was 1 confirmed case of TRALI this year, with a further 11 cases reported as suspected TRALI. Of these, 3 cases were transferred to transfusion-associated dyspnoea (TAD), 2 cases to transfusion-associated circulatory overload (TACO) and 4 cases were withdrawn. The final 2 cases have been deferred to the next Annual SHOT Report as serology results are in progress. The 1 confirmed case was transferred to TRALI from TAD.

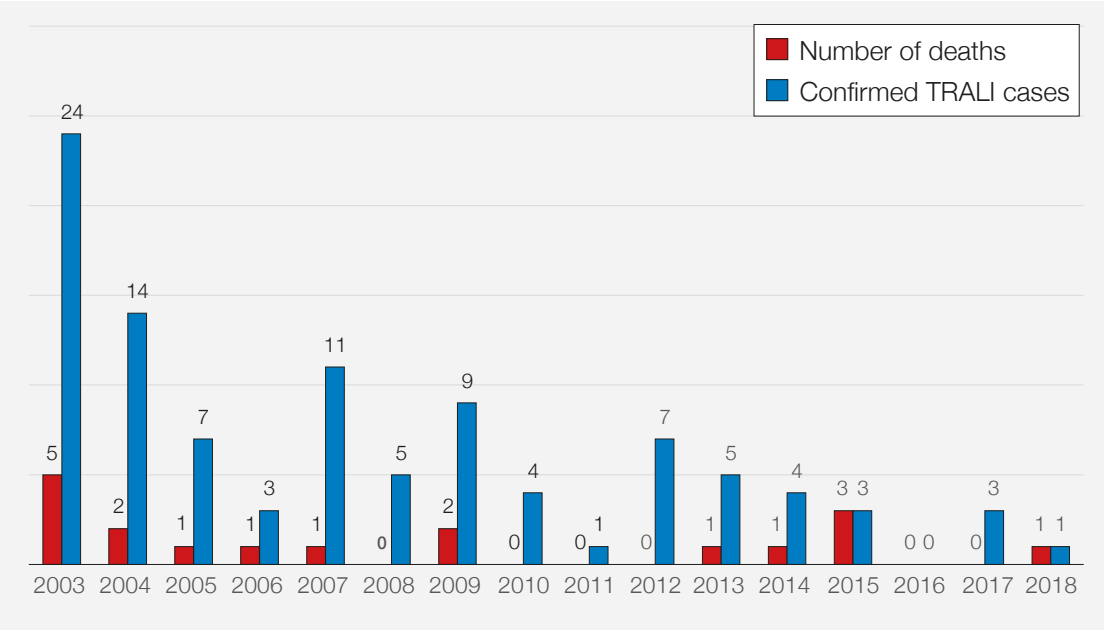


Figure 17a.1: Number of confirmed TRALI cases and deaths at least possibly related to TRALI by year of report

TRALI=transfusion-related acute lung injury

Figure 17a.1 shows TRALI cases from 2003-2018, classified using the criteria introduced in the 2016 Annual SHOT Report. The use of male donors only for fresh frozen plasma (FFP) was implemented in 2003. Cases are recorded as deaths if the death was at least 'possibly' related to the transfusion (imputability 1 or greater).

Assessment of TRALI

The classification criteria are outlined in Table 17a.1 below. A mapping of how the revised criteria compare to the widely used Canadian Consensus definitions for TRALI is given in Table 17a.3, in order to help international comparison.

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

Classification	Definition	Mapping to Canadian Consensus definition
Highly likely	Cases with a convincing clinical picture and positive serology	TRALI +positive serology
Probable	Cases with positive serology but other coexisting morbidity which could independently cause acute lung injury or fluid overload	Possible TRALI (pTRALI) +positive serology
Equivocal	Cases with positive serology in the clear presence of lung injury due to other causes or fluid overload	Not TRALI [excluded because of other morbidity but meets positive criteria]+positive serology
Antibody-negative TRALI	Cases with a convincing clinical picture where serology is not available or negative	TRALI + absent or negative serology
Unlikely - reclassify as TAD	Cases where the picture and serology was not supportive of the diagnosis. These cases are transferred to TAD	pTRALI or not TRALI + negative or absent serology

Table 17a.2: TRALI case probability (SHOT criteria) - 2018 cases

Probability	Number of cases
Highly likely	0
Probable	0
Equivocal	0
Antibody-negative	1
Unlikely-transferred to TAD/TACO	5

Table 17a.2 includes notified cases which have been transferred to other categories but not cases which have been withdrawn or deferred.

Table 17a.3: Classification using Canadian Consensus definitions

Canadian Consensus classification	Number of cases
TRALI	0
Possible TRALI	1
Not TRALI	0

Table 17a.3 includes only cases classified as TRALI, withdrawn or transferred cases would by definition be classified as 'Not TRALI'.

Deaths n=1

Case 17a.1: Antibody-negative TRALI - post mortem diagnosis without serology

A male patient in his late 60s, with recent diagnoses of advanced myelodysplasia and prostate cancer presented to the emergency department (ED) with abdominal pain, hypotension and a platelet count of 6. He had a raised C-reactive protein, metabolic acidosis with raised lactate, low albumin and renal impairment prior to transfusion and received two units of red cells and a unit of platelets on the day of admission uneventfully. Over 24 hours later, 10 minutes after starting a platelet transfusion, he became acutely breathless and hypoxic with a further fall in blood pressure and deterioration in renal function. In view of his underlying diagnoses, a decision was made not to escalate care further and he suffered a cardiac arrest shortly afterwards.

Post-mortem findings showed pleural effusions and gross pulmonary oedema, with no evidence of infection, infarction or injury, and the coroner gave 'transfusion lung injury' as the primary cause of death. Serological investigations were not performed as the National Health Service Blood and Transplant (NHSBT) expert panel felt that the picture was one of terminal decline rather than a transfusion reaction.

The case was initially reported to SHOT as TAD, however we have included the case as 'antibody-negative TRALI' in view of the coronial diagnosis. We considered imputability as 'death probably due to transfusion' as the transfusion does appear to have been a major contributor even though the patient was clearly very unwell before the transfusion.

Cumulative serological data

Since 1996, 207 of 328 reported cases have had full laboratory investigation for TRALI. Concordant antibodies were identified in 118/207 (57.0%) of these. The most frequently identified antibody specificities (either alone or in combination with other concordant antibodies) have been HLA-DR4 (22/118 cases, 18.6%), HLA-DR52 (17/118, 14.4%) and HLA-A2 (19/118, 16.1%). All other HLA antibody specificities have been identified in less than 10% of cases. Concordant HNA specific antibodies, alone or in combination, have been found as follows: HNA-1a (10/118 cases, 8.5%); HNA-2 (2/118, 1.7%); HNA-3a (2/118, 1.7%).

Analysis of reports of 187 complete TRALI investigations between 2001 and 2018 inclusive has shown that the specificities of concordant antibodies were as follows:

HLA class I alone	HLA class II alone	Both HLA class I and HLA class II	Granulocyte specific antibody (+/- HLA antibodies)	None identified
21/187 (11.2%)	36/187(19.3%)	27/187 (14.4%)	19/187(10.2%)	84/187 (44.9%)

Table 17a.4: Concordant donor antibodies 2001 to 2018 inclusive

Commentary

Numbers of confirmed and reported TRALI cases are similar to previous years. The confirmed case this year was difficult to classify. It would not strictly meet SHOT TRALI definitions as there are other plausible explanations for the reaction (as was considered by the NHSBT expert panel), and there is no serological evidence; nevertheless the case was included as TRALI as the death certificate has recorded this as the cause of death. The case highlights the difficulty in making decisions on whether to investigate serologically, especially as recalling donors for investigation does have an associated harm in terms of donor anxiety and temporary deferral. Cases in England are reviewed by an expert panel of intensivists independent of NHSBT and cases are investigated if they meet criteria of timing, hypoxia and lack of alternative diagnoses; however, the basis for the decision is not available to SHOT when reviewing. It is probably prudent to have a lower threshold for investigating donors where there is a patient death or long term harm which appears attributable to transfusion, even though other pulmonary complications may be more likely.

An updated international consensus definition of TRALI has recently been accepted for publication (Vlaar et al. 2019). This is intended to update the earlier Canadian Consensus definition and was produced using a Delphi consultation methodology between international experts, including a representative from SHOT. The new classification remains based on clinical features and takes account of updated criteria for acute respiratory distress syndrome (ARDS). It will become clearer how the new definition changes the understanding of pulmonary complications of transfusion and also how it interacts with updated definitions for TACO as the new classification becomes more widely used internationally. As a haemovigilance organisation, we consider that it remains important to distinguish antibody mediated cases in order to monitor preventative strategies. It is therefore proposed that from 2019 we will continue to classify cases according to the SHOT definition but provide a parallel classification using the new scheme for international comparison.

Reference

Vlaar APJ, Toy T, Fung M et al. (2019) A consensus redefinition of transfusion-related acute lung injury. *Transfusion* 2019 doi.org/10.1111/trf.15311.

17b Transfusion-Associated Circulatory Overload (TACO) n=110

Authors: Sharran Grey and Paula Bolton-Maggs

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

Update

The surveillance definition for TACO has been revised by a joint working group from the International Society of Blood Transfusion (ISBT) haemovigilance working party, the International Haemovigilance Network (IHN) and AABB with wide international consultation. SHOT has been a key contributor and collaborator in this work. Validation of the revised definition took place throughout 2017 and a workshop for the revision group with other leading interested parties and experts in the field was held in October 2018 as part of the AABB annual meeting.

The consensus of the workshop was agreement that the validated TACO definition criteria should now be published and with the objective of improving and standardising TACO surveillance. The transfusion-related acute lung injury (TRALI) definition has also been revised (Vlaar et al. 2019). There was recognition of the problematic nature of delineating the pulmonary complications of transfusion due to probable overlap and compounded by gaps in knowledge of the pathogenesis of these conditions. It is important this does not act as a barrier in reporting to SHOT and the transfusion-associated dyspnoea (TAD) category remains essential to ensure capture of all relevant pulmonary cases. There was considerable interest in the role of the inflammatory response in pulmonary complications of transfusion and new research is emerging in this area which will no doubt inform future revision of the definitions.

2017 saw the publication of the National Comparative Audit (NCA) of TACO and for the first time provided large-scale data on related clinical practice (Morton et al. 2017, NCA 2017). It was encouraging and useful confirmation to observe the high degree of concordance between the recommendations of the audit report and the recommendations and key messages from SHOT. This year's recommendation has been aligned to the TACO NCA recommendations with respect to patient age and body weight.

Recommendation

- A formal pre-transfusion risk assessment for transfusion-associated circulatory overload (TACO) should be undertaken whenever possible (especially if older than 50 years or weighing less than 50kg), as TACO is the most commonly reported cause of transfusion-related mortality and major morbidity

Action: All staff authorising transfusion

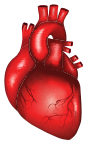
TACO Checklist	Red cell transfusion for non-bleeding patients	If 'yes' to any of these questions
	Does the patient have a diagnosis of 'heart failure' congestive cardiac failure (CCF), severe aortic stenosis, or moderate to severe left ventricular dysfunction? Is the patient on a regular diuretic? Does 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

Figure 17b.1: Updated TACO pre-transfusion checklist

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

TACO developing with transfusion for severe anaemia is an emerging signal from the data, and is an under-recognised independent risk-factor. This was highlighted in last year's Annual SHOT Report (Bolton-Maggs et al. 2018, Case 18b.3) and continues to feature in this year's data. TACO can develop in patients with severe anaemia even in the absence of other risk factors for TACO (see Cases 17b.1 and 17b.3). For this reason, 'severe anaemia' has been added to the pre-transfusion risk assessment infographic (Figure 17b.1).

The data continues to show TACO in non-bleeding patients where the volume of red cells was in excess of that calculated for their body weight and target haemoglobin (see Case 17b.2). Weight-adjusted red cell dosing for non-bleeding patients remains a recommendation.

Recommendation

- 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, National Comparative Audit, 2017)

Action: All staff authorising transfusion

Deaths n=5

TACO resulted in death of the patient in 5 reported cases.

Major morbidity n=36

TACO remains the leading cause of transfusion-related mortality and major morbidity.

Demographic overview of cases

Table 17b.1: Demographics of TACO cases

Demographic	Number of reports
Deaths (imputability 3)	0
Deaths (imputability 2)	2
Deaths (imputability 1)	3
Major morbidity outcome (serious sequelae)	4
Major morbidity outcome (minor sequelae)	6
Major morbidity (signs and symptoms with risk to life with full resolution/unknown outcome)	26
Age	Range: 1 day - 97 years Median: 76 years
Top 3 medical specialties	Acute medicine (19/110) Haematology (18/110) Anaesthesia (10/110)
Bleeding patients (indication code R1 or 'massive bleeding' indicated)	21
Non-bleeding patients (other indication codes or not stated)	89

As seen in previous years, the demographics show that TACO is more commonly reported in the older population and where transfusion is given for anaemia rather than bleeding. Haematology and adult medical specialties are again the most common specialties where TACO is reported, and this should be considered when delivering TACO mitigation and education plans.

Analysis by definition criteria

This year's data have been analysed using the reporting criteria developed by the joint working group described in the introduction (Wiersum-Osselton et al. 2019). The 2018 TACO case surveillance definition criteria are summarised below:

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

These criteria establish a surveillance definition based on a complete description of an event, including information that becomes available well after onset. This is for reporting and surveillance purposes and the criteria do not constitute clinical diagnosis for the purpose of real-time clinical interventions.

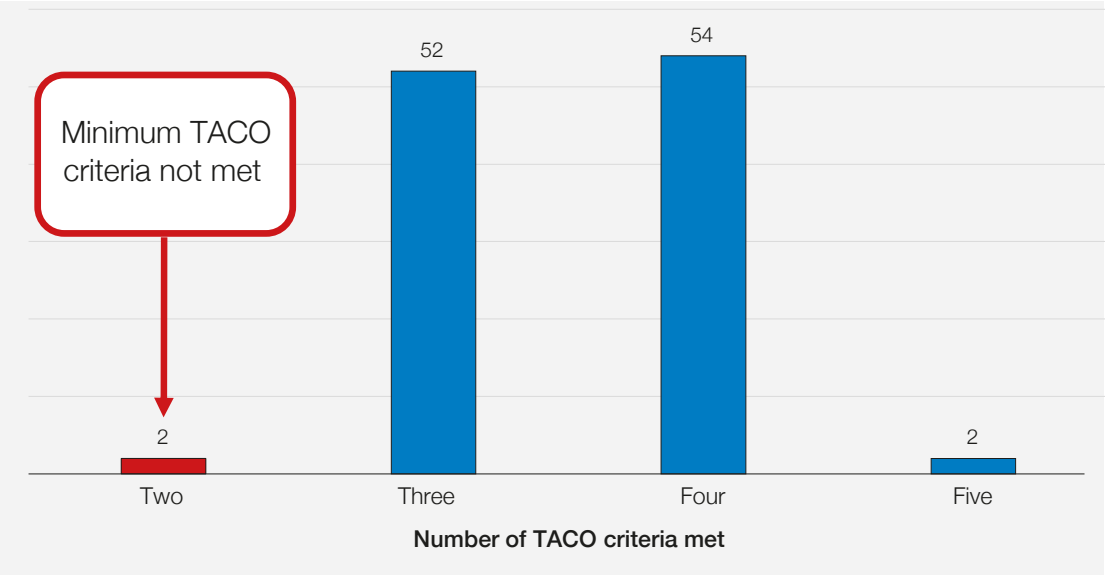


Figure 17b.2: Analysis of reports by the revised surveillance diagnosis criteria (number of criteria versus number of accepted cases)

TACO=transfusion-associated circulatory overload

There were 2 cases that scored only two criteria but were nevertheless accepted into the TACO category. This first case demonstrated respiratory distress during transfusion and radiological evidence of pulmonary oedema. The patient's condition worsened following diuretics but the patient had severe renal failure. No vital sign observations or fluid balance were available for assessment. The patient had additional comorbidities and risk factors predisposing to circulatory overload (aortic stenosis and hypoalbuminaemia). The second case had a similar respiratory and radiological picture with no response to diuretics. The fluid balance and vital sign observations were also unavailable. There was also a primary cardiac cause for pulmonary oedema (acute coronary syndrome) which complicated the assessment, and the patient had received a large volume of non-blood fluid. Taking the cases in their overall context, the evidence for TACO was clinically compelling and failure to meet the requisite number of criteria was due to lack of available data.

Demonstrating left atrial hypertension (LAH): an important aspect for categorisation of pulmonary complications of transfusion

Left atrial hypertension is an important discriminator when categorising the pulmonary complications of transfusion as radiological features in TACO and TRALI can be difficult to distinguish, and other clinical signs can be similar. This year 10/110 (9.1%) cases had echocardiography performed which was useful in demonstrating LAH. However, it is accepted that while useful for haemovigilance categorisation purposes the clinician assessing the patient may not require this investigation in order to clinically manage the patient. The 2018 TACO case surveillance definition criteria includes BNP/NT-pro BNP as an 'additional' criterion to support TACO. The role of BNP is to regulate blood pressure and blood volume. Only 3/110 (2.7%) cases reported to SHOT in 2018 provided BNP/NT-pro BNP test results. This information is especially useful when data for other criteria are not available, for example when a chest X-ray has not been performed, fluid balance not recorded or uncertain response to diuretics (especially when given in combination with allergy medications). NT-pro BNP is available on most biochemistry platforms (requiring a serum or ethylenediaminetetraacetic acid (EDTA) sample). Most laboratories will offer the test as part of primary care heart failure diagnostic service, or will be able to refer tests. It is valuable for professionals with haemovigilance responsibilities to enquire about their local services and the possibility of testing suspected TACO cases, which would only comprise a small number. The test is generally performed on an EDTA sample and therefore convenient to test the pre and post-transfusion samples without the need for separate samples to be taken. Non-cardiac comorbidities and pre-existing cardiac disease can raise NT-pro BNP. It is worth noting that NT-pro BNP is affected by a number of conditions not related to LAH. Further information can be accessed here: https://fpnotebook.com/cv/lab/BrnNtrtcPptd.htm. Scale change is important with a >1.5x increase from pre-transfusion value supporting TACO. A post-transfusion value in the normal range is not compatible with TACO and is therefore a good negative predictor.

Illustrative cases

Case 17b.1: Rapid correction of anaemia can precipitate TACO in the absence of other comorbidities and risk factors

A male in his 50s presented to the emergency department (ED) with a 3-4-week history of weakness and dizziness, and had felt unwell for the past 6 months. He was hypotensive (blood pressure (BP) 92/47) but did not show signs of acute haemorrhage though there was some altered blood on rectal examination. On admission his haemoglobin (Hb) was 34g/L, ferritin 26micrograms/L and the electrocardiogram (ECG) showed cardiac ischaemia. He was transfused two units of red cells with a plan for endoscopy and intravenous (IV) iron the following day. A third unit was planned if the post-transfusion Hb was <60g/L. The first unit was transfused over 31 minutes and the second over 65 minutes. After the second unit his oxygen saturations began to fall despite being on supplemental oxygen and his post-transfusion Hb was 51g/L. A third unit was transfused over 125 minutes and he developed worsening hypoxia, dyspnoea and crackles on chest auscultation. The chest X-ray showed an enlarged cardiac silhouette and pulmonary congestion. He was treated with diuretics and improved. Fortunately, the attending doctor cancelled the fourth unit which had been planned.

This patient certainly required transfusion to treat the symptoms of severe anaemia and cardiac ischaemia prior to IV iron replacement. The case is a good example of the risk of rapid correction of severe anaemia in the absence of haemorrhage. This patient had no other comorbidities or risk factors predisposing circulatory overload except severe anaemia. There was no indication for rapid transfusion. The development of increasing hypoxia after the second unit was a warning of TACO developing in this patient. In the absence of bleeding, the speed of correction should be commensurate with the pre-transfusion Hb level. This patient had iron deficiency anaemia, but it is worth noting that severe megaloblastic anaemia can cause cardiomyopathy, thereby increasing the risk of circulatory overload. Red cell transfusion should be avoided or minimised in these patients.

Case 17b.2: Excessive red cell volume given to an overloaded small patient where TACO was not initially suspected

A female in her 80s was admitted with a fractured neck of femur. She weighed 40kg and had a preoperative Hb of 109g/L. She received 2L of Hartmann's in theatre and returned to the ward with a positive fluid balance (+2425mL). Her postoperative Hb was 65g/L and she was haemodynamically stable. She was prescribed three units of red cells and her pre-transfusion vital sign observations were normal. Her vital sign observations after the first unit were normal but her fluid balance was then +3454mL. The second unit was given after which she became shaky and developed hypertension (175/82), pyrexia (38°C), tachycardia (102 beats per minute), tachypnoea (22 breaths per minute) and her oxygen saturation was 96% on 5L of oxygen. This was reported to the on-call orthopaedic doctor who requested further fluid to be administered stat (250mL Hartmann's) which resulted in a further deterioration of her respiratory status. The attending doctor suspected acute lung injury or sepsis (not circulatory overload). A chest X-ray was performed on the advice of the consultant haematologist whose opinion had been sought for a possible transfusion reaction. This was consistent with pulmonary oedema.

There were two striking aspects to this case. Firstly, was the choice of volume of red cells to correct the surgical anaemia. The calculation below is based on 4mL/kg raising the Hb by 10g/L (Norfolk, 2013), with a target Hb of 80g/L (cardiovascular risk factors have been assumed in a patient in her 80s).

Target Hb (g/L) – actual Hb (g/L) x [body weight (kg) x 0.4mL] = volume of red cells to transfuse to meet target Hb (mL)

80g/L – 65g/L x [40kg x 0.4mL red cells] = 240mL

This is equivalent to a single unit of red cells for a patient of this body weight. Three units are certainly excessive underlining the importance of weight-adjusted red cell dosing for non-bleeding patients. Although Norfolk states that 4mL/kg 'should only be applied as an approximation for a 70–80kg patient', Grey et al. (2018) have shown that the above calculation achieves the post-transfusion Hb target in around 90% of patients across a range of body weights.

The second aspect is failure to suspect circulatory overload in this patient. The patient already had a significantly positive fluid balance before transfusion and this had increased after the first unit of red cells. The development of deteriorating respiratory status, with hypertension, tachycardia, and pyrexia was interpreted as acute lung injury or sepsis and was treated with fluids which clearly exacerbated the circulatory overload. This illustrates the importance of measuring (and assessing) the fluid balance, and that the presence of pyrexia does not exclude TACO. Indeed, there is an increasing recognition that TACO may have an inflammatory component (see 2017 Annual SHOT Report (Bolton-Maggs et al. 2018)).

Case 17b.3: A complex presentation with difficult decision-making

A male in his 60s with history of factor XI deficiency and chronic obstructive pulmonary disease (COPD) had been referred to the colorectal team on a two-week pathway for investigation of anaemia (Hb 82g/L, platelets 92x10^9/L). He had felt increasingly unwell and presented to the ED. His Hb was 34g/L, platelets 27x10^9/L, neutrophils 0.58x10^9/L, he had renal failure (eGFR 36mL/min), hypoalbuminaemia, and prolonged clotting times (prothrombin time (PT) 23.1 seconds (s) and activated partial thromboplastin time (APTT) 90s). Per rectum examination showed melaena and endoscopy was planned for the following day. He had tachycardia and hypotension. The ED consultant suspected acute gastrointestinal bleeding and the patient was transfused a total of four units of red cells, three units of fresh frozen plasma (FFP), and one dose of platelets over 9 hours (total >2L in volume). He developed hypoxia (oxygen saturations <70%) and bradycardia (heart rate 35 beats per minute), and was pale and clammy. He was given oxygen therapy (15L) and diuretics which produced a good diuresis. He received cardiac monitoring and was transferred to the intensive therapy unit (ITU). The chest X-ray was consistent with pulmonary oedema and peripheral blood film was reported later and showed blast cells.

This was a complex presentation and although the local reviewer found rapid multi-component transfusion to be clinically justified at the time of admission, unfortunately the patient was later found not to have acute bleeding and developed TACO. The presence of blast cells in the peripheral blood was more suggestive of bone marrow failure as the cause of pancytopenia. The reviewer identified hypoalbuminaemia and renal failure as risk factors for TACO, but in common with Case 17b.2, severe anaemia is also a risk for TACO. However, if major bleeding was suspected, recognition of this may not have changed the course for this patient. The reviewer correctly stated that TACO may not be avoidable in major haemorrhage where a risk-balanced decision has to be taken for the consequences of major bleeding versus TACO. Local review identified the need for clinical reassessment after each unit which was not documented in this case, especially in the absence of signs of ongoing bleeding. It is easy to focus on the blood transfusion and clinical management aspects of TACO cases, but establishing a timely diagnosis can also have a critical role. An early blood film report has the potential to significantly change the management of a patient, and in this case may have led to more conservative blood component transfusion. This is not to say a patient with leukaemia could not also have acute gastrointestinal bleeding!

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Transfusion-Associated Dyspnoea (TAD) n=8

17c

Author: Paula Bolton-Maggs

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).

There were 8 cases included as TAD for 2018, with only 2 of these initially reported as TAD. The other 6 cases were transferred from other reporting categories; 3 from TRALI and 3 from TACO.

Other cases reported initially as TAD were transferred to other categories, 1 case transferred to TRALI and 4 to febrile, allergic and hypotensive reactions (FAHR).

These transfers and the lack of data for many of the cases make it difficult to draw conclusions for the category of TAD. All cases are described in order to build up the series of cases over time. Cases related to death or major morbidity are included below, with the remaining 5 cases available on the SHOT website. This category is likely to be affected by the revised definitions of TRALI and TACO. (Vlaar et al. 2019; Wiersum-Osselton et al. 2019).

Deaths n=2

Case 17c.1: Death possibly related to the transfusion (transfer from TACO)

A woman in her 80s under investigation for pancytopenia developed bruising and a petechial rash. She was transfused with red cells (haemoglobin (Hb) 58g/L) and later with platelets but developed fever and was admitted. She became increasingly hypoxic with oxygen saturation falling to 76%. Chest X-ray showed widespread patchy shadowing. She had a cough with haemoptysis and chest pain. She also received intravenous immunoglobulin (IVIg) 1g/kg. Chest X-ray did not show evidence of fluid overload or consolidation. She declined further active intervention and died 2 days after admission. The TRALI review panel agreed that this case was more likely to be a combination of fluid overload and progressive lung infection on a background of pre-existing pulmonary fibrosis. The causes of death were recorded as 1a acute respiratory distress syndrome (ARDS), 1b pulmonary haemorrhage, TRALI and 1c immune thrombocytopenia.

Case 17c.2: An elderly man with haemorrhage who developed pulmonary and renal complications (transfer from TRALI; death possibly related to transfusion)

A man in his 80s was admitted to the intensive therapy unit from the emergency department with multiple organ failure following admission with hypovolaemic shock and a burst varicose vein. The major haemorrhage protocol was activated, and he rapidly received seven units of red cells (15-30 minutes per unit) in addition to four units of fresh frozen plasma and one of platelets. The pre-transfusion Hb was 110g/L. He was noted to have bilateral pulmonary infiltrates and crackles on auscultation. His troponin increased from 55 to 208ng/L and his pro-B-type natriuretic peptide (BNP) from 551 to 973pg/L and he required renal dialysis. He died within 24 hours of admission. This reads more like circulatory overload.

This case was considered for inclusion as a case of TACO but cardiovascular changes were not recorded and may have been modified by haemodynamic instability due to bleeding. There was also no record of fluid balance, no change in clinical condition with diuretic, and although there was some increase in BNP this was not >1.5 times the upper limit of normal. This patient probably had acute coronary syndrome which is consistent with the troponin results. The raised BNP may have been as a result of this event, worsening of pre-existing heart failure or failure to clear BNP because of renal failure. Although there is an increase it is difficult to interpret due to the other factors. Therefore, the case did not meet the ISBT criteria for TACO and was rejected by TRALI as the advisory team felt this was more likely to be circulatory overload.

It is inevitable that some cases with confounding factors or lack of clinical information provided will not strictly fit TACO or TRALI. Although these cases cannot be precisely classified it is important that they are acknowledged as this will help us understand the limitations and improvements needed in the other classifications.

Major morbidity n=1

Case 17c.3: Transfusion for menorrhagia results in respiratory failure (transfer from TRALI; major morbidity)

A woman in her 40s received a transfusion of six units of red cells for menorrhagia (continuous bleeding for 22 days). Her Hb was 45g/L (90g/L post transfusion). She had a history of chronic anaemia and previous transfusions. A pre-transfusion chest X-ray showed diffuse patchy infiltration/ consolidation. She developed shortness of breath within 2 hours of transfusion with saturation of 90%, no fever, heart rate 87 and normal blood pressure. Chest X-ray post transfusion showed asymmetrical pulmonary oedema. She required continuous positive airway pressure (CPAP) and then mechanical ventilation for 3 days. Her condition worsened despite steroids and diuretics. The donor of the triggering unit was an untransfused male so the local Blood Service decided this was not TRALI.

There was no improvement with diuretics which does not fit the criteria for TACO. However, this case is similar to TACO Case 17b.1, and is a warning to assess the need for transfusion of repeated units in patients with chronic anaemia who decompensate if transfused too much too rapidly.

Other cases

Further TAD cases can be found in the supplementary information on the SHOT website www.shotuk.org.

Commentary

Several cases with pulmonary features are moved between categories particularly when their descriptions do not meet the definition criteria. It is very helpful when reporters are able to provide as much detail as possible. There are cases both this year and in 2017 where further investigation for TRALI might have been warranted. It will be important to consider how the new international definition of TRALI impacts on these cases.

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Haemolytic Transfusion Reactions (HTR) n=35

18

Authors: Tracey Tomlinson and Anicee Danaee

Definition:

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.

Simple serological reactions (development of antibody with or without a positive DAT but without clinical or laboratory evidence of haemolysis) are defined as alloimmunisation: these data are no longer collected by SHOT.

Key SHOT message

- Hyperhaemolysis is one of the main causes of major morbidity reported in haemolytic transfusion reactions. Hyperhaemolysis is usually reported in patients with haemoglobinopathies, however it has also been observed in non-haemoglobinopathy patients. It is therefore 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 investigated

Number of cases n=35

A total of 35 cases have been included, 7 acute and 28 delayed reactions (including 5 cases of hyperhaemolysis). The number of delayed reactions reported is comparable to the number reported the previous year however the total number of reactions reported has reduced. There were 3 cases of acute reactions reported in which antigen-positive blood was transfused with the knowledge that the patient had the antibody. In 2 of these this was due to the clinical urgency requiring the use of emergency O D-negative blood. The third case was the result of a laboratory error.

Age range and median

There were no paediatric cases reported this year (age less than 18 years). The overall age range was 19 to 88, with a median age of 45.

Deaths n=2

In 2 cases, the patient deaths were attributed to the transfusion reactions. Both occurred following episodes of hyperhaemolysis. See Case 18.1 and Case 18.2 for details.

Major morbidity n=4

There were 4 cases reported with major morbidity, and 3 of these were hyperhaemolysis cases. One case was due to the emergency transfusion of Jk^a-positive emergency O D-negative units to a patient with known anti-Jk^a following a postpartum haemorrhage. The patient experienced an acute transfusion

reaction and required ventilation and admission onto the intensive care unit due to renal impairment. The patient made a full recovery.

Hyperhaemolysis and major morbidity

Hyperhaemolysis syndrome has previously only been reported to SHOT in patients with sickle cell disease. However, in 2018, 2 cases were reported in other patient types. In both cases the reaction resulted in patient death.

Case 18.1: Hyperhaemolysis post allogeneic stem cell transplant

A haematology patient with T-cell lymphoma post stem cell transplant developed symptoms consistent with hyperhaemolysis following a four-unit red cell transfusion. The patient was transfused a further five red cell units, but the bilirubin continued to rise and the Hb to fall. The patient developed impaired renal function and died 9 days later.

Case 18.2 Hyperhaemolysis in a patient with Rosai-Dorfman Syndrome

A patient with known Rosai-Dorfman syndrome was admitted with symptomatic anaemia, and a Hb of 24g/L. The patient had previously confirmed autoimmune haemolytic anaemia. The patient was treated with steroids, erythropoietin and rituximab in addition to red cell transfusion. Within 7 hours of transfusion the patient experienced fever, back and chest pain, dyspnoea and haemoglobinuria. The patient's Hb dropped from 81g/L immediately post transfusion to 20g/L, the bilirubin and LDH became raised and spherocytes were detected on the blood film. The patient developed impaired renal function and died 6 days later.

A further 3 cases of hyperhaemolysis were reported in patients with sickle cell disease.

The diagnosis of hyperhaemolysis remains a challenge. 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. Therefore, for analysing the SHOT data cases reported as hyperhaemolysis by the reporter but in which the serology supports a conclusion of antibody mediated haemolysis have been classified as a haemolytic transfusion reaction.

SHOT considers that all reported cases of probable hyperhaemolysis where there is a significant fall in Hb should be considered as major morbidity. Following application of this criterion 3 cases of hyperhaemolysis reported with 'minor morbidity' were upgraded.

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). All of the hyperhaemolysis cases reported to SHOT occurred within 7 days of the transfusion episode and are therefore characterised as acute.

Learning points

- Hyperhaemolysis remains a cause of transfusion-related mortality and major morbidity. Patients with haemoglobinopathies should be monitored for signs and symptoms of haemolysis following transfusions and diagnosis of hyperhaemolysis considered early. It is important that patients are educated about signs and symptoms they might develop when discharged home so they can present early should any of these occur, including signs of haemoglobinuria
- Hyperhaemolysis can also occur in non-haemoglobinopathy patients therefore 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 and investigated

Clinical and laboratory signs and symptoms

Acute haemolytic transfusion reactions n=7

There appears to be no typical set of clinical symptoms associated with an acute haemolytic reaction.

Delayed haemolytic transfusion reactions n=23 (excluding cases of hyperhaemolysis)

No clinical symptoms of a transfusion reaction were reported in 10/23 delayed haemolytic transfusion reaction cases submitted to SHOT. Where clinical symptoms were reported, fever and haemoglobinuria occurred the most frequently. The clinical symptoms that were observed are shown in Figure 18.1.

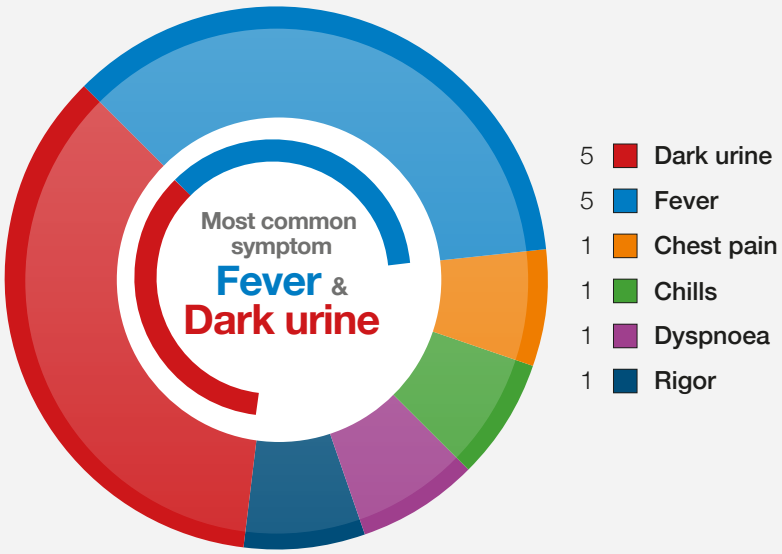


Figure 18.1: Clinical symptoms associated with DHTR

Delayed haemolytic transfusion reactions were more frequently diagnosed based on the laboratory indications. The main indicators and frequency reported are shown in Figure 18.2.

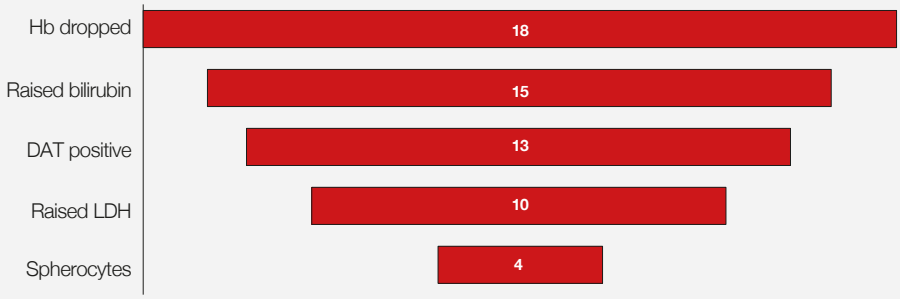


Figure 18.2: Laboratory indications detected in DHTR

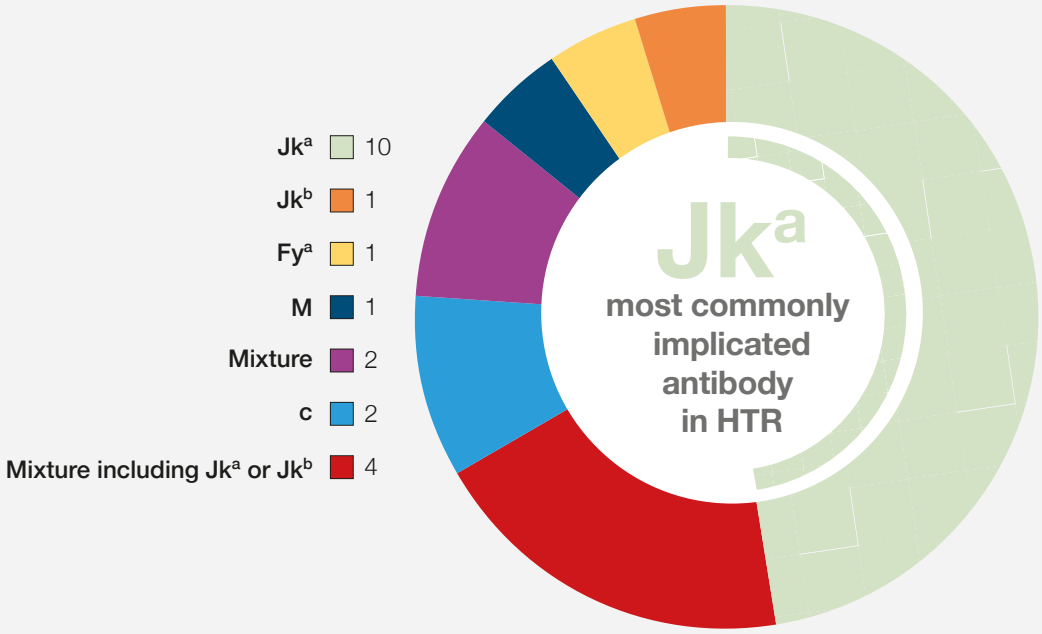
DAT=direct antiglobulin test; Hb=haemoglobin; LDH=lactate dehydrogenase

Laboratory investigation of haemolytic transfusion reactions

In 7/35 (20.2%) haemolytic reactions reported, no eluate had been tested despite the patient developing a positive DAT post transfusion. 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.

Antibodies implicated in haemolytic transfusion reactions

Figure 18.3: Antibodies implicated in DHTR



Learning point

- In cases where there is evidence of red cell haemolysis, elution studies should be included in transfusion reaction investigations as these can help reveal antibody specificities not detectable in the free plasma and can provide confirmation of the specificity of antibodies implicated in the transfusion

HTR due to preformed antibodies

There were 17/23 (73.9%) cases reported as DHTR which followed the classic pattern of a negative antibody screen on the pre-transfusion sample and the identification of an alloantibody in the post-transfusion sample. A further 2/7 AHTR had a negative antibody screen reported in the pre-transfusion sample and anti-Jk^a detected in the post-transfusion sample. However, on repeat testing of the pre-transfusion sample, the antibody was detectable in the 2 acute cases.

Case 18.3: Antibody detectable pre transfusion in eluate

The patient was admitted for laparotomy for a small bowel obstruction. Fully automated pre-transfusion testing was performed, and a negative antibody screen result obtained using the Ortho AutoVue Innova. Blood was crossmatched by electronic issue. During the transfusion the patient's heart rate increased and their temperature rose by 2°C. The transfusion was stopped, and a transfusion reaction investigation requested. As part of the investigation the antibody screen on the pre-transfusion sample was repeated as negative, however a DAT was also performed on this sample. The DAT was positive and anti-Jk^a was detected in the eluate. Anti-Jk^a was also detected in the post-transfusion sample and in an eluate performed from this sample. One of the units transfused was confirmed as Jk^a-positive.

Case 18.4: Discrepant pre-transfusion results obtained using automated analysers

Blood was issued by electronic crossmatch following a negative antibody screen result using the Ortho AutoVue analyser. Ninety minutes post transfusion the patient experienced rigor, back pain and fever. Samples were sent to the laboratory for investigation of a transfusion reaction. Pre- and post-transfusion samples were tested on a second Ortho AutoVue analyser. They both gave positive reactions and anti-Jk^{a} was subsequently identified. This was reported to the analyser manufacturer for investigation. Following testing of the antibody titre it was concluded that the antibody was at a level that was below the minimum level for detection.

Learning point

- 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

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19 New or Unclassifiable Complications of Transfusion (UCT) n=8

Author: Paula Bolton-Maggs

Definition:

Occurrence of an adverse effect or reaction temporally related to transfusion, which cannot be classified according to an already defined transfusion event and with no risk factor other than the transfusion, and no other explanation.

There were 4 cases transferred to UCT from the febrile, allergic and hypotensive reactions (FAHR) category. A number of cases were initially reported as UCT, but subsequently transferred to other reporting categories. These included 3 cases involving prothrombin complex concentrate (PCC) transferred to the section on avoidable, delayed and under or overtransfusion (ADU), 1 case to cell salvage (CS) and 1 to haemolytic transfusion reactions (HTR). A further 2 cases were withdrawn; 1 seemed likely to be a vasovagal reaction, and the other was referred to transfusion-associated dyspnoea (TAD), but eventually withdrawn due to a lack of information.

The age range of the 8 cases included in UCT was 1 month to 84 years.

Deaths n=0

There were no transfusion-related deaths this year in this category.

Major morbidity n=3

There were 3 cases reported in preterm infants, all with major morbidity. Two were confirmed as due to necrotising enterocolitis (NEC) and the third was probably due to NEC, but the diagnosis was not confirmed. For further details see Chapter 23, Paediatric Cases.

Other UCT cases

Case 19.1: Reaction to platelets (transfer from FAHR)

A neutropenic man in his 20s on chemotherapy for Hodgkin lymphoma reacted to a platelet transfusion with tachycardia (from 90 to 150 beats per minute), anxiety and flushing after 10 minutes. The transfusion was stopped. He was treated with intravenous antihistamine and hydrocortisone (HC). The following day he received another unit of platelets uneventfully with HC and antihistamine cover.

Case 19.2: Pain associated with transfusion

A man in his 50s admitted with abdominal pain, jaundice and fever and many co-morbidities developed pain in his hands and leg with cramping during transfusion after the fourth and fifth units. The local review suggested the cause might be citrate toxicity as the symptoms could be reproduced by tourniquet application. It was decided to minimise transfusion and to transfuse in future with medical supervision and electrocardiogram (ECG) monitoring.

Citrate toxicity in this setting would be very unlikely as there is a very minimal amount of citrate remaining in red cells (which are suspended in optimal additive solution). Pain associated with transfusion is rare but has been noted in previous Annual SHOT Reports (Bolton-Maggs et al. 2016, Bolton-Maggs et al. 2013) and it has been described in the literature (Green et al. 2014, Haines et al. 2013).

Case 19.3: Severe adverse reaction after a platelet transfusion

A woman in her 60s reacted to platelets with vomiting and was faecally incontinent. She was on therapy for leukaemia and already had infection and diarrhoea 1 week post chemotherapy. This may have been a vasovagal response but is reported here as it was severe and incapacitating.

Case 19.4: A reaction to platelets

An elderly woman on treatment for myelodysplastic syndrome (MDS) developed a reaction to platelet transfusion with agitation, flushing and respiratory distress. She had previously had a minor reaction to platelets and so had received premedication before transfusion. She was treated with chlorpheniramine and hydrocortisone and recovered. Investigations for allergy and transfusion reaction were negative. It was decided that she should receive washed platelets in future.

Case 19.5: Reaction without symptoms but change in vital signs

A man in his 80s with haematuria due to bladder cancer received red cells. An hour into transfusion the patient developed fever, 38.4°C, tachycardia and an increased respiratory rate with a rise in blood pressure. He had no symptoms. This was thought at the time to be an anaphylactic type of reaction but this was not confirmed.

This reaction did not fulfil the criteria for FAHR. There was no swelling or rash, no wheeze and the temperature elevation was minor.

Commentary

Reporters are encouraged to continue to report cases with unusual reactions to transfusion and also of transfusion-associated necrotising enterocolitis in infants. The role of transfusion as a trigger remains unclear (Hilditch and Keir 2018; Saito-Benz et al. 2018). A randomised trial is being piloted to compare normal feeding versus withholding feeds around to transfusion to see if this affects the incidence of NEC in preterm infants (the WHEAT study). Further information about the study and NEC can be found in the trial protocol. (Hilditch and Keir 2018; Saito-Benz et al. 2018).

Pain in relation to transfusion is rare, but may be severe and is not understood.

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20 Transfusion-Transmitted Infections (TTI) n=3 (1 confirmed, 2 probable)

Authors: Joe Flannagan and Su Brailsford

Definition of a TTI:

A report was classified as a TTI if, following investigation:

- **The recipient 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 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**

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 prolong 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.

Introduction

This chapter describes suspected transfusion-transmitted infection incidents investigated by the United Kingdom (UK) Blood Services and reported to the National Health Service Blood and Transplant (NHSBT)/Public Health England (PHE) Epidemiology Unit in 2018.

The risk of a TTI in the UK remains very low. During 2018 3 TTI were recorded as probable or confirmed. Investigations of these TTI have shown that none occurred due to errors in donor selection or testing.

Summary of reports made to the NHSBT/PHE Epidemiology Unit in 2018

During 2018, UK Blood Services investigated 97 suspected bacterial cases and 8 suspected viral incidents (Figure 20.1). From these suspected cases, there has been:

- One confirmed transfusion-transmitted hepatitis E virus (HEV) incident reported by NHSBT
- One probable transfusion-transmitted *Staphylococcus epidermidis* incident reported by NHSBT
- One probable transfusion-transmitted hepatitis B virus (HBV) incident reported by NHSBT
- One late detection of *Staphylococcus aureus* incident reported by NHSBT (no evidence of a TTI)

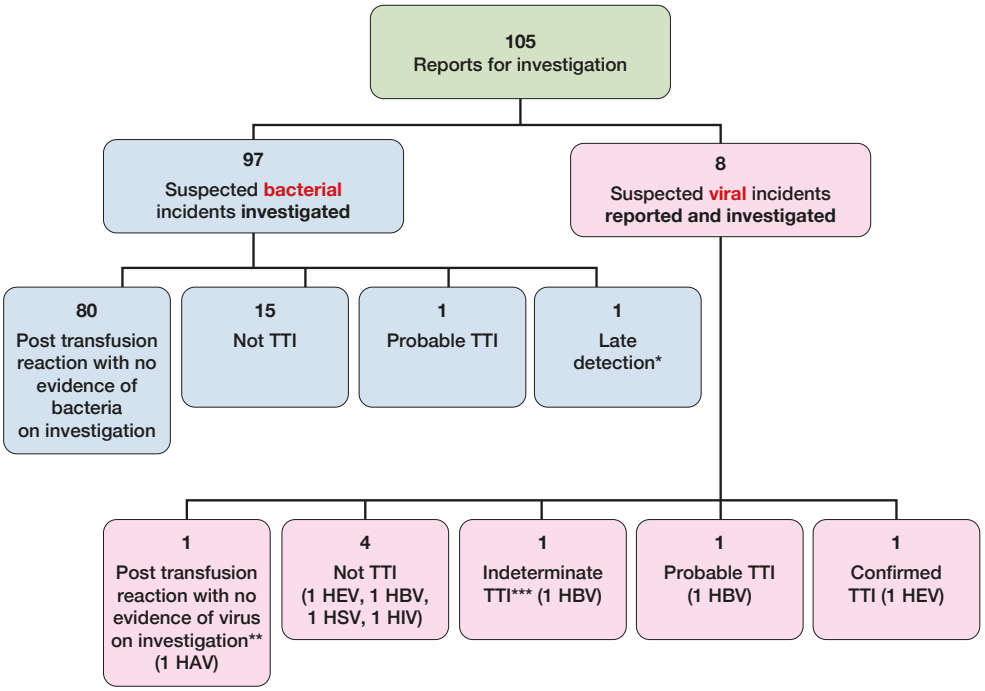

Figure 20.1: Outcome of reports of suspected TTI made to the NHSBT/ PHE Epidemiology Unit in 2018

TTI=transfusion-transmitted infection; HAV=hepatitis A virus; HBV=hepatitis B virus; HSV=herpes simplex virus; HIV=human immunodeficiency virus; HEV=hepatitis E virus

**The BacT/ALERT system flagged as positive after the associated platelets had been issued and transfused however no evidence of a TTI was found*

***Reported based on a clinical diagnosis of HAV, but this was not confirmed by further laboratory testing*

****Due to the time elapsed since transfusion archive samples were not available for half of the implicated donations*

Death n=1

A patient with a probable case of transfusion-transmitted HBV died after being transfused in 2018 (Case 20.3).

Bacterial TTI reports 2018

In 2018, no reported suspected bacterial TTI cases were confirmed, but 1 incident reported by NHSBT is assigned as probable. The four UK Blood Services all use the BacT/ALERT system for bacterial screening which has reduced the number of confirmed bacterial TTI since its introduction in 2011 (McDonald et al. 2017). Sampling methods vary slightly across the four countries, details of which are described in Table 20.1.

Case 20.1: Probable *Staphylococcus epidermidis* (Morbidity: moderate; imputability: 2-probable)

A young child received one standard unit of a 7-day old apheresis platelet. The child was receiving blood components due to ongoing chemotherapy for an underlying medical condition. Three hours prior to the platelet transfusion they had received a unit of red cells through a tunnelled central venous catheter with no adverse reaction. Within 5 minutes of the platelet transfusion being started the child experienced an anaphylactoid reaction including a rise in temperature to 40°C that lasted for 24 hours. This was treated empirically with intravenous antibiotics to cover the possibility of either a bacterial TTI or a central line infection. The patient made a good recovery and was discharged home within days to complete a week of antibiotics. Staphylococcus epidermidis was repeatedly isolated from recipient blood cultures and a transfusion reaction investigation was commenced by NHSBT.

Routine bacterial screening of the transfused platelet unit was negative but on return to the NHSBT national bacteriology laboratory Staphylococcus epidermidis was isolated from the index pack. This isolate was sent for typing along with isolates from the recipient's blood cultures and they were shown

to be indistinguishable. Associated components were recalled, however one associated 4-day old platelet unit had already been transfused into a patient in whom no adverse reactions were reported. It is possible that this does not represent a TTI, but rather a central venous catheter infection in the recipient. In this case, the isolate in the recalled index pack might represent contamination with blood from the recipient. However, the chronology of the presentation, the clinical picture and the lack of reaction during an earlier red cell transfusion make a bacterial TTI probable in this case. Donor investigations are ongoing.

Late detection: Staphylococcus aureus

An aerobic initial reactive bottle (IR) alert was issued on a unit of pooled platelets after one of the BacT/ALERT bottles flagged positive. Platelets are issued by NHSBT if bacterial screening remains negative after 6 hours' incubation (see Table 20.1), but the bottles remain incubated until the end of the platelet shelf-life (7 days). The IR flag came just over one hour after the pooled platelets had been issued but despite an immediate recall the platelets had already been transfused to a surgical patient in their 60s. However, three associated red cells units were returned and one discarded at the hospital to which it had been issued. *Staphylococcus aureus* was subsequently isolated from the IR bottle but could not be confirmed in the red cell units so a final result of indeterminate positive was concluded. Follow up with the local transfusion practitioner and NHSBT patient consultant revealed that the recipient had not experienced any transfusion reaction and had been discharged from hospital. They had not received any antibiotic therapy during their hospital admission.

There were four donors implicated in the donation, all of whom were followed up and asked to consent to take self-sampled nasal swabs. Three returned their swabs with nothing being received from the fourth donor despite agreeing to the sample, *Staphylococcus aureus* isolated from one swab. The isolate cultured from the bacterial screening bottles of the implicated donation and the isolate cultured from the donor swab were sent for molecular typing. On the basis of the typing results it seemed unlikely that this donor was the source of the platelet contamination, however, it was decided that the donor should be withdrawn.

Bacterial TTI 1996 – 2018

Screening of platelet components cannot guarantee freedom from bacterial contamination. Packs are released for issue as 'negative-to-date', which may be before bacteria have multiplied sufficiently to trigger an initial screening reaction. There have been nine bacterial near misses, all but one in platelet components, reported to the unit between 2011 and 2018. 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.

Haemovigilance systems for bacterial TTI are passive and as such rely on clinical colleagues to report suspected TTI. Following the introduction of bacterial screening of platelets, colleagues were reminded that there was still the possibility of TTI occurring from both platelet and red cell transfusion and the number of reported suspected TTI has remained almost constant. 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 TTI become unwell very rapidly.

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

**Screening methods in Wales changed mid-year from testing on day 1 and day 4 to testing on day 2 only*

NIBTS=Northern Ireland Blood Transfusion Service; SNBTS=Scottish National Blood Transfusion Service; WBS=Welsh Blood Service

Viral TTI reports 2018

In 2018, there was 1 confirmed transfusion-transmitted HEV incident, 1 probable transfusion-transmitted HBV incident, and 1 indeterminate HBV incident.

Case 20.2: Indeterminate viral HBV TTI case 1: (Morbidity: minor; imputability: N/A)

In 2011, a man in his 40s received multiple blood transfusions over the course of 3 months, amounting to three units of pooled platelets and four units of apheresis platelets. The transfusions were given during treatment for Hodgkins lymphoma. Many years later in mid-2018 the patient was tested for HBV following a prolonged period of raised alanine aminotransferase (ALT) and was found to have HBV markers for chronic infection (HBsAg positive, HBeAg positive, core antibody positive, IgM negative). Following this an investigation was launched into blood components as a possible source of the infection.

Given the time period, there were no index samples available for testing, but 16 donors were identified that related to the seven units the patient received. Half of these donors had donated in the past three years and so had a recent archive sample available for testing, all of which had negative results for HBV. The other eight donors had not recently donated due to personal choice or medical reasons (unrelated to hepatitis B) and so no samples were available for testing for them. Of these seven had returned at least once since the implicated donation. This meant NHSBT were unable to ascertain whether transfusion was the source of this patient's HBV infection and a classification of indeterminate was therefore assigned.

Case 20.3: Probable viral HBV TTI case 2: (Morbidity: major - death; imputability: 2-probable)

After being admitted to hospital in late 2017, a woman in her 70s received two units of red cells in response to a low haemoglobin level of 83g/L. She had multiple medical conditions including liver cirrhosis due to non-alcoholic steatohepatitis (NASH). Approximately 6 months later she was re-admitted to hospital with acute hepatitis and diagnosed with acute hepatitis B infection. She developed acute-on-chronic liver failure and unfortunately died about 5 weeks after the HBV diagnosis. The patient had tested negative for HBV infection in late 2016 and further samples from the patient were deemed to be consistent with a recent HBV infection (anti-HBcore IgM antibodies detected and anti-HBcore antibody avidity results compatible with a recent HBV infection). The virus was identified as genotype D2. Investigations external to NHSBT took place which looked at the hospital and lifestyle as possible sources of infection, these were excluded as possible sources. Blood transfusion was therefore the only risk factor identified and an investigation was launched by NHSBT.

The two donors associated with the units transfused to the patient were identified. One was a repeat donor who had an archive sample from the implicated unit and another archive sample for a subsequent donation; both tested negative for HBV. The other donor was a new donor, the archive sample from the implicated donation was retrieved and tested positive for anti-HB core antibodies with anti-HBs of 9.60 mIU/mL but negative for HBV deoxyribonucleic acid (DNA) using singleton nucleic acid testing (NAT). The donor kindly provided a large volume sample which was concentrated and then tested. In this concentrated sample, HBV DNA was detected at a level below the level of detection of our routine screening tests, and even if singleton testing had been used in screening it is unlikely DNA would have been detected. The concentrated sample was sent for confirmatory testing but unfortunately this was unable to detect HBV DNA and unable to perform sequencing. Investigations confirmed that this donor had an occult HBV infection and he had likely had a completely asymptomatic HBV infection as a child, as he was born in HBV endemic country. For these reasons, this infection could not have been picked up by donor questionnaire or by testing. It was noted that this donor was born in a region where genotype D2 HBV infection is prevalent.

Since it was not possible to sequence the sample, transmission cannot be confirmed. However, since no other risk factors were identified in the recipient, despite extensive investigations, and because the virus found in the recipient had a genotype prevalent in the donor's country of birth, it is was concluded probable that the blood transfusion was the route of HBV transmission.

Case 20.4: Confirmed viral HEV TTI case 3: (Morbidity: major; imputability: 3-confirmed)

In late 2018, as part of routine screening, NHSBT identified a regular apheresis platelet donor who tested positive for HEV ribonucleic acid (RNA), indicating an acute HEV infection, and this donation was discarded. The donor had donated in the previous month and following the usual lookback process an archive sample from this previous donation was tested and found to be HEV RNA positive with a very low viral load. This previous donation had been tested for HEV in a pool of 24 donations, as per normal screening procedures, and was issued as screen negative at the time. The low viral load detected in individual screening would have been below the level of quantification in the pooled screening, hence the screen negative result. Based on previous work this viral load was thought to be very unlikely to transmit by transfusion (Tedder et al. 2017). Both platelet packs from the previous low-level HEV-positive donation had been issued and the hospitals were contacted and recipients identified.

One recipient had died shortly after the transfusion from their underlying conditions. The other platelet recipient was a haematology patient undergoing chemotherapy at the time of the transfusion. The patient was informed and a blood sample was taken 11 weeks post transfusion, this tested positive for HEV RNA. Samples from the donor and recipient were sequenced and the hepatitis E virus isolated was found to be identical at the nucleotide level therefore making this a confirmed TTI. Testing of a follow-up sample from the donor indicated that they had cleared the infection and, at the time of writing, the recipient had not experienced symptoms of HEV infection, but they continue to be monitored. This is the first recorded case of an HEV TTI since universal screening was introduced in April 2017.

Viral TTI 1996 – 2018

The year of transfusion may be many years prior to the year in which the case is investigated and reported to SHOT because of the chronic nature, and therefore late recognition, of some viral infections. Since 1996, 34 confirmed incidents of transfusion-transmitted viral infections have been documented, involving 41 recipients. HBV is the most commonly reported proven viral TTI in the UK. This is partly because the 'window period' where an infectious donation from a recently infected donor cannot be detected by the screening tests is longer than for HCV or HIV, despite NAT screening of blood donations.

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) (PHE 2017).

Table 20.2: The estimated risk of a potentially infectious HBV, HCV or HIV window period* blood donation not detected on testing, UK 2015-2017

	HBV	HCV**	HIV
Number per million donations	0.46	0.00	0.051
95% confidence interval	0.11-1.14	0.00-0.00	0.02-0.10
At 2.3 million donations per year testing will miss a potentially infectious window period donation every:	1.0 years	N/A	9.3 years

**The window period is the time at the start of an infection before the tests can detect it*

***Risk cannot be calculated as there were no HCV seroconversions between 2015 and 2017*

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.

Testing and guideline update: 2018

In November 2017, the blood donor selection guidelines for men who have sex with men (MSM) were changed in England, Wales and Scotland from a 12-month deferral since last sex with a man to a 3-month deferral. Similar changes were made for other donor selection criteria related to higher risk sexual behaviours. Since this change, no possible, probable, or confirmed TTI reported to UK Blood Services have related to the changes in the selection guidelines. No changes to virology testing procedures occurred in 2018 but minor changes to the bacterial screening process have been noted in Table 20.1.

Parasitic TTI

There were no reported parasitic infections for investigation in 2018.

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 the Joint UK Blood Transfusion and Tissue Transplantation Services Professional Advisory Committee (JPAC).

Variant Creutzfeld-Jakob Disease (vCJD) 2018

There were no vCJD investigations in 2018.

vCJD 1996-2018

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 the Advisory Committee on the Safety of Blood, Tissues and Organs (SABTO 2013).

Risk assessment and research into vCJD continues. Currently there is no suitable blood test available for screening blood donations for vCJD.

More information can be found here: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/407681/measures-vcjd.pdf

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 2018 (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	-	-
Number of incidents	**41**	**4**	**12**	**2**	**11**	**2**	**2**	**1**	**2**	**3**	**80**	-	-	-	-	-
Number of infected recipients	44	4	14	2	14	4	2	1	2	4	**91**	36	27	20	7	1
Death due to, or contributed to, by TTI	11	0	0	0	1	0	0	0	1	3	**16**					
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	-	2	-	-	-	-	-	**20**					
FFP	-	-	1	-	5	1	-	-	-	-	**7**					
Cryoprecipitate	-	-	-	-	1	-	-	-	-	-	**1**					

Note: Numbers in brackets refer to recipients, and probable incidents are excluded.

** 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*

*** Year of transfusion may be prior to year of report to SHOT due to delay in recognition of chronic infection*

**** HCV investigations where the transfusion was prior to screening are not included in the above figure.*

† The two HIV incidents were associated with window period donations (anti-HIV negative/HIV RNA positive) before HIV NAT screening was in place. A third window period donation in 2002 was transfused to an elderly patient, who died soon after surgery. The recipient's HIV status was therefore not determined and not included

†† In 2004 there was an incident involving contamination of a pooled platelet pack with 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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21 Post-Transfusion Purpura (PTP) n=1

Author: Tom Latham

Definition:

Post-transfusion purpura is defined as thrombocytopenia arising 5-12 days following transfusion of cellular blood components (red cells or platelets) associated with the presence in the patient of antibodies directed against the human platelet antigen (HPA) systems.

There was 1 case of suspected PTP this year.

Case 21.1: Probable PTP in a patient with immune thrombocytopenia

A female patient in her 70s was given one unit of red cells and two units of platelets for acute bleeding. She had a platelet count of 43x10^9/L prior to transfusion, ascribed to immune thrombocytopenia (ITP). Ten days after discharge she was readmitted with abdominal pain and a purpuric rash. Her platelet count had fallen to 5x10^9/L, and anti-HPA1a antibodies were subsequently demonstrated in her blood. She was treated with intravenous immunoglobulin (IVIg) and methylprednisolone, and achieved a platelet count >50x10^9/L 11 days after starting treatment.

This is considered as a probable case of PTP as the timing and serology is classical, although a deterioration of underlying ITP cannot be ruled out. The possible coexistence of ITP is interesting; previous Annual SHOT Reports have commented on a possible interaction, since destruction of autologous platelets is an essential part of the pathogenesis of PTP.

Figure 21.1: The number of cases of PTP with confirmed HPA alloantibodies reported annually to SHOT since 1996, a total of 57 reports. Cumulative data 1996 to 2018

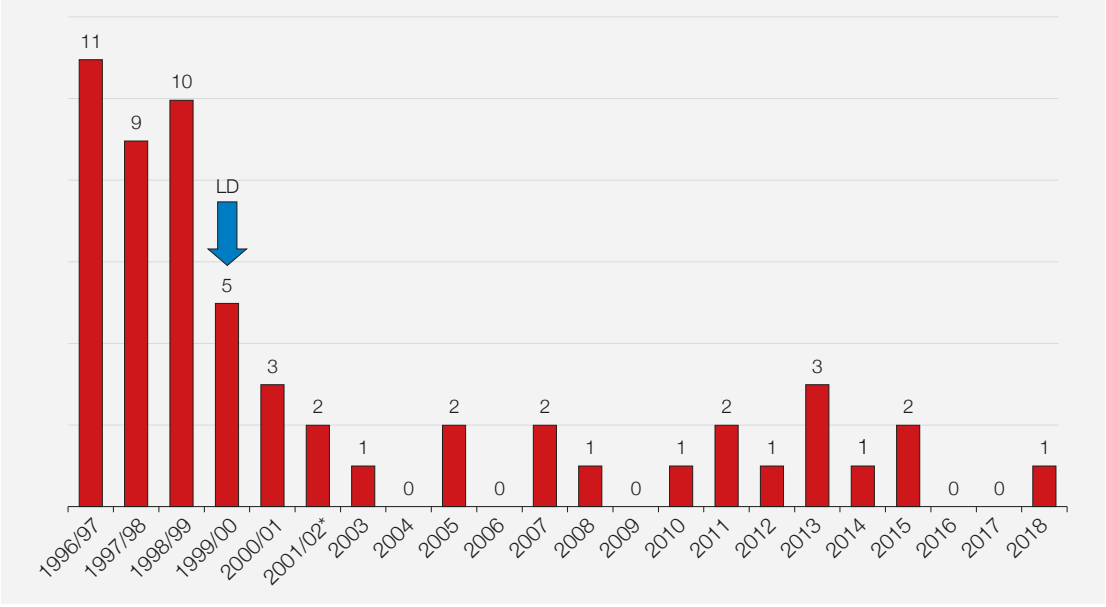

Table 21.1: Cumulative causative antibody specificity 1996-2018

Causative antibody specificity	Number of cases
HPA-1a alone	38
HPA-1a with other HPA antibodies	5
Other HPA antibodies (HPA-1b,-2b, -3a, -3b, -5a, -5b and-15a)	14
Total	**57**

SPECIAL CLINICAL GROUPS

22 Cell Salvage (CS) n=17

Authors: Sarah Haynes and Catherine Ralph

Definition:

Any adverse events or reactions associated with cell salvage (autologous) transfusion methods, including intraoperative and postoperative cell salvage (washed or unwashed).

Key SHOT messages

- The safety of cell salvage is the shared responsibility of all staff within the theatre whose actions can have an impact on the quality of the final product. All staff involved in the process, including anaesthetists, surgeons and scrub staff, should receive cell salvage education and training appropriate to their role
- Institutions should have defined procedures on the infusion of cell salvaged blood which should ideally mirror the guidelines for transfusion of allogeneic blood i.e. a valid prescription, documentation of times and appropriate recorded observations. These procedures should include the management of a transfusion reaction from autologous blood similar to the procedures in place for allogeneic blood

Death n=0

There were no reported deaths associated with cell salvage in 2018.

Major morbidity n=1

There was 1 case of major morbidity in 2018, see Case 22.2. A further 4 patients were classified as having minor morbidity.

Overview

There were 17 cases reported, 12 female patients and 5 male; on review none were withdrawn, nor transferred to other categories. All cases reported were related to the use of intraoperative cell salvage (ICS).

As with last year's Annual SHOT Report, the small number of cases reported raises concerns around under-reporting of cell salvage incidents.

Obstetrics reports continue to dominate. A United Kingdom (UK) survey of 184 maternity units in 2017 demonstrated the availability of cell salvage in obstetrics was the highest it had ever been with 84% having cell salvage available and 50% of centres having 24-hour access (Nelissen et al. 2018). It is likely obstetrics is now one of the main speciality users of cell salvage. Of the 8 obstetrics incidents there were only 2 adverse reactions: a hypotension on reinfusion with a leucocyte depletion filter (LDF) resulting in minor morbidity, and a more serious reaction resulting in major morbidity where no filtration was used.

Incidents related to equipment failure and human error continue to be a feature and the new category of failure of provision of service accounting for 3 reports.

Cell salvage cases by speciality

There were 17 cases reported as shown in Table 22.1 below.

Speciality	Elective	Emergency
Gynaecology	1	0
Obstetrics	3	5
Orthopaedic	3	1
Urology	2	0
Vascular	1	1
Total	**10**	**7**

Table 22.1: Specialty for cell salvage reports

Types of cell salvage

All cases involved the use of washed intraoperative cell salvage techniques. No reports were received for postoperative cell salvage.

Cell salvage adverse events n=12

Equipment failure n=2

Within the category of equipment failure 1 incident was reported as a machine failure and reported to the Medicines and Healthcare products Regulatory Agency (MHRA) Yellow Card Scheme. Another report was made that related to faulty disposable assembly, which although reported to the manufacturer was not taken further.

Learning point

- Cell salvage consumables are also covered by medical device legislation and as such any adverse incident that caused, or almost caused, injury to a patient or wrong or delayed treatment of a patient is reportable under the Yellow Card Scheme (England & Wales) or regulatory equivalent (Scotland and Northern Ireland)

Operator errors n=6

Of the 6 adverse events attributed to operator error, 1 involved incorrect assembly of equipment, in another the misuse of equipment resulted in inadequate washing of the red cells, and in 1 case a LDF was not used where it might have been indicated.

Case 22.1: LDF not used for reinfusion of red cells in a urological case with malignancy

A patient in their 50s undergoing elective open partial nephrectomy with malignancy experienced a major haemorrhage. ICS was being used and autologous red cells were available for reinfusion. The transfusion was initiated without the use of a LDF as the operator was unaware of the patient's malignancy status. Only 20mL was infused before the error was noted. The transfusion was stopped and a LDF used for the remainder of the infusion.

Cell salvage operators and others involved in the process should be aware of all patient specific considerations that might impact on the way cell salvage is performed before surgery starts.

Learning points

- The United Kingdom (UK) Cell Salvage Action Group (UKCSAG) recommends that the intention to use intraoperative cell salvage (ICS) should be stated within the World Health Organisation (WHO) Surgical Safety Checklist 'Time Out' before the start of the intervention to give theatre staff (including the cell salvage operator) the opportunity to discuss any considerations related to ICS
- UKCSAG outputs can be accessed via the Joint UK Blood Transfusion and Tissue Transplantation Services Professional Advisory Committee (JPAC) website:

https://www.transfusionguidelines.org/transfusion-practice/uk-cell-salvage-action-group

The use of LDF in urological malignancy remains controversial. Although generally accepted that the LDF mitigates the theoretical risk of tumour dissemination by transferring malignant cells from the surgical field into the patient's circulation, no substantiated evidence base exists to prove this. Stoffel et al. (2005) showed that in 48 patients undergoing radical prostatectomy with ICS, 88% had prostate specific antigen (PSA)-producing cells in salvaged blood samples after processing. Following reinfusion of the salvaged red cells, without LDF use, three patients (16%) had detectable PSA-producing cells in peripheral blood samples immediately after surgery. At 3-5 weeks after surgery no cells were detected. Aning et al. (2012) report a cohort of 213 patients undergoing radical cystectomy of which 192 received ICS blood without the use of a LDF on reinfusion. The authors stated that this study, along with previous published series in urological malignancy, showed no risk of reduced survival associated with ICS and concluded that there was no evidence of a conferred benefit in terms of patient outcome compared to not using a filter.

Human and organisational factors played a part in an error where the wrong wash solution was connected to the system and the process abandoned in an orthopaedic procedure. In this case the patient was transfused with two units of allogeneic blood which may have been avoidable.

In 2 further cases, the operator misunderstood the way the machine worked and erroneously assumed the cell salvage device was not working correctly before discarding the available red cells. This action could have put the patients involved at risk of needing allogeneic blood transfusion. No adverse clinical consequences related to these errors were reported. All operators involved had been trained and competency-assessed.

Learning point

- Cell salvage operators should be trained and competency-assessed. Monitoring of competency and regular refresher training is advised. Cell salvage operators should be encouraged to identify any individual training needs as part of their professional accountability

Other events n=4

In another incident, the cell salvage operator noticed that saline for irrigation (non-intravenous (IV) grade) was being used in the surgical field and had been aspirated into the cell salvage collection. The blood collection was subsequently abandoned due to potential contamination. Although this was not classed as an operator error by the reporter, it is a reminder that the safe conduct of cell salvage is the responsibility of all staff involved in the process with the cell salvage operator being the final 'gatekeeper'.

Learning point

- Surgeons and scrub staff should be educated as to what can and cannot be aspirated from the surgical field

The further 3 adverse events involved a failure of provision of service due to the lack of a suitably trained operator. In 1 of these incidences the patient was transfused with allogeneic blood which may have been avoidable if cell salvage had been available.

Cell salvage reactions n=5

Case 22.2: Sepsis, disseminated intravascular coagulation (DIC) and renal failure following re-infusion cell salvaged blood (imputability: 1, possible)

A patient in her 20s, undergoing emergency caesarean section (Category 2) for failure to progress following induction of labour for high blood pressure, received a re-infusion of 450mL of cell salvaged blood in recovery. She went on to become septic, developed DIC and renal failure requiring dialysis. Her renal function did not significantly improve leaving the patient in need of a renal transplant.

The caesarean section was performed 22 hours after artificial rupture of membranes and a failed induction of labour. In theatre the heart rate (HR) and blood pressure (BP) were raised until delivery. Cell salvage was used, collecting blood with a single suction and the processed washed collection re-infused without a LDF. Vital signs immediately post surgery showed a raised BP with a tachycardia, poor oxygen saturations and a raised temperature indicative of an infection. Antibiotics were commenced within a few hours of the delivery. It is likely the re-infusion of autologous blood was in progress during this period in recovery, having been started in theatre, although there was no prescription or documentation of the time the re-infusion was completed. Without a LDF the re-infusion would normally be completed within a short time frame and should have been monitored according to hospital policy for allogeneic blood transfusions with any suspected transfusion reaction managed according to this policy.

Over the next 24 hours post delivery, there were worsening signs of sepsis, hypotension and anuria resulting in renal failure requiring renal support and admission to intensive care.

Whilst the efficiency of washing in cell salvage is good, clearance rates of 100% are almost never achieved, and levels of bacterial contamination whilst significantly reduced can still be present in the re-infused product (Teare et al. 2015). The use of a LDF may have reduced the quantity of any contaminants reinfused although any effect on subsequent clinical sequelae would be difficult to predict. SHOT has previously noted a move away from the use of LDF in obstetric cell salvage (Bolton-Maggs et al. 2018).

A relationship between the re-infusion of cell salvaged blood and the development of sepsis in this case cannot be excluded, however, association of re-infused cell salvage blood with sepsis in obstetrics has not previously been noted (Khan et al. 2017; Sullivan & Ralph 2019).

There were 4 further clinical reactions, all of which were classed as having minor or moderate morbidity at the time of the reaction and all recovered.

Case 22.3: Cardiac arrest during re-infusion of cell salvaged blood during nephrectomy (imputability: 0, excluded or unlikely)

A patient in their 80s underwent an elective nephrectomy for malignancy and suffered significant blood loss. Cell salvaged blood was re-infused intraoperatively using a LDF with a member of theatre staff applying manual pressure to speed up the rate of transfusion. Having re-infused 50mL over 5 minutes the patient suffered a cardiac arrest from which they were successfully resuscitated. The patient also became bradycardic and required the insertion of a permanent pacemaker. The anticoagulant used for cell salvage was acid-citrate-dextrose solution (ACD).

It is very unlikely the cardiac arrest was associated with the re-infusion of just 50mL of autologous red cells. However, the administration of blood under pressure through a LDF is not recommended due to the risk of air embolus and potential for interfering with the functionality of the filter in retaining contaminants.

Learning point

- The potential risk of tumour cell dissemination needs to be considered in context and in situations of haemodynamic instability the benefit of removing the filter to re-infuse blood more rapidly is likely to outweigh the theoretical risks associated with tumour cells contaminating the circulation

Case 22.4: Allergic reaction to salvaged red cells (imputability: 2, likely/probable)

A patient in her 30s undergoing myomectomy developed red tracking marks proximal to the cannula on reinfusion of salvaged red cells. The reinfusion was stopped and the marks disappeared only to reappear on resumption of the infusion. The reinfusion was therefore discontinued. There were no further complications and the patient made a complete recovery. The anticoagulant used was ACD.

Whilst it may be unlikely, an allergic reaction to an autologous transfusion is still possible. It is theoretically conceivable that, despite adequate washing, allergens may have remained in trace amounts in the final salvaged red cell product.

Case 22.5: Hypotension on reinfusion of salvaged red cells in an obstetric case with the use of a LDF (imputability: 2, likely/probable)

A patient in her 30s underwent an elective caesarean section where cell salvage was used with ACD as the anticoagulant. On reinfusion of the salvaged red cells via a LDF, the patient's pulse increased from 81 to 130 beats per minute (bpm) and BP dropped from 107/72 to 54/34mmHg. The patient reported feeling light-headed, dizzy and nauseous. The reinfusion was stopped and infusion of clear fluids commenced with continuous patient monitoring. The patient quickly improved and reinfusion of the salvaged red cells was recommenced at a slower rate at the patient's insistence with no further issues.

Case 22.6: Hypotension on reinfusion of salvaged red cells in an orthopaedic case without the use of a LDF; (imputability: 3, certain)

A patient in their 70s underwent revision hip surgery of adverse reaction to metal debris (ARMD). During reinfusion of 240mL of salvaged red cells over 2-3 minutes, the patient exhibited a profound hypotension with systolic BP of 60mmHg for approximately 5 minutes. This was corrected with the use of vasopressors and fluid infusion. The anticoagulant used for cell salvage was ACD.

These 2 cases bring the total number of hypotensive events related to ICS to 29 over the past 8 years. The majority (21) have occurred with the use of a LDF. However, hypotensive reactions can also occur in the absence of the filter with the current case bringing the total to 8 such incidents.

There is very little evidence of how effective ICS is at removing the metal fragments that might be encountered during metal on metal hip revision surgery. Reijngoud et al. (2009) reported greater than 70% removal of the metal but still advised caution. Some companies manufacture a collection reservoir with a finer filter designed to catch the metal debris, or the use of a LDF on reinfusion may prove useful.

Learning point

- There is as yet no evidence to confirm the effectiveness of filtration in removing metal particles. The United Kingdom (UK) Cell Salvage Action Group (UKCSAG) advises avoiding aspiration of blood for the duration of surgery if there is evidence of metallosis as there is a potential risk of contaminating the collection

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23 Paediatric Cases

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

- One death was reported, in part attributable to an error in the process of performing an exchange transfusion. This highlights the need for strict protocols and staff education for such procedures which are now performed relatively rarely
- Four errors were caused by acting on inaccurate or old blood results. It is key that personnel interpreting blood tests understand potential variables which will make laboratory tests unreliable. The importance of repeating unexpected results cannot be overstated
- Errors related to transfusion volumes remain an issue (6 cases). Education of staff members and sharing knowledge of guidelines and resources such as the 'Blood Components Mobile Application' (Blood Components App) is key to reducing these errors in future
- Communication errors continue to be an issue across categories. Patient groups with complex or specific requirements require meticulous communication between specialities
- Paediatric febrile, allergic and hypotensive reaction (FAHR) reports most often occurred following platelet transfusions (21/30; 70.0%), the usual FAHR pattern for paediatrics. The decision to transfuse platelets to non-bleeding patients should be taken with care, as emphasised by the results of the recent PlaNeT-2 study in preterm neonates (Curley et al. 2019)

Recommendation

- Further dissemination of the resources such as the 'Blood Components App' and awareness of British Society for Haematology (BSH) paediatric transfusion guidance (BSH New et al. 2016) should be high priority for paediatric educators (see the SHOT website https://www.shotuk.org/resources/current-resources/)

Action: Hospital Transfusion Teams, Hospital Paediatricians, Medical Educators, Royal College of Paediatrics and Child Health

Introduction and summary

This chapter summarises the reports for patients <18 years old and allows us to highlight specific learning points for clinicians caring for this age group. The general themes from year to year remain similar highlighting the need for ongoing education of colleagues of the potential pitfalls and complexities of transfusion in this age group.

In 2018 123/1659 (7.4%) of total cases were paediatric. If near miss (NM) and right blood right patient categories are included, 241/3326 (7.2%). The total number and percentage of cases was slightly lower than last year.

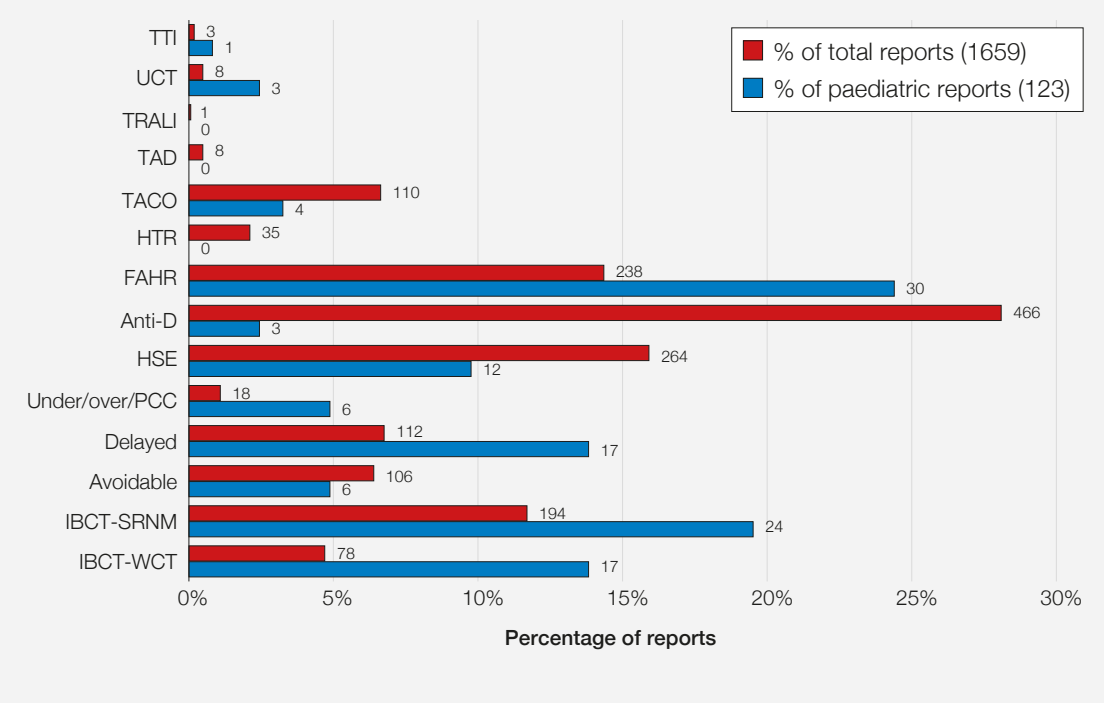


Figure 23.1: Percentages of paediatric and total reports in each category

TTI=transfusion-transmitted infection; UCT=unclassifiable 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 transfusion

Summary data

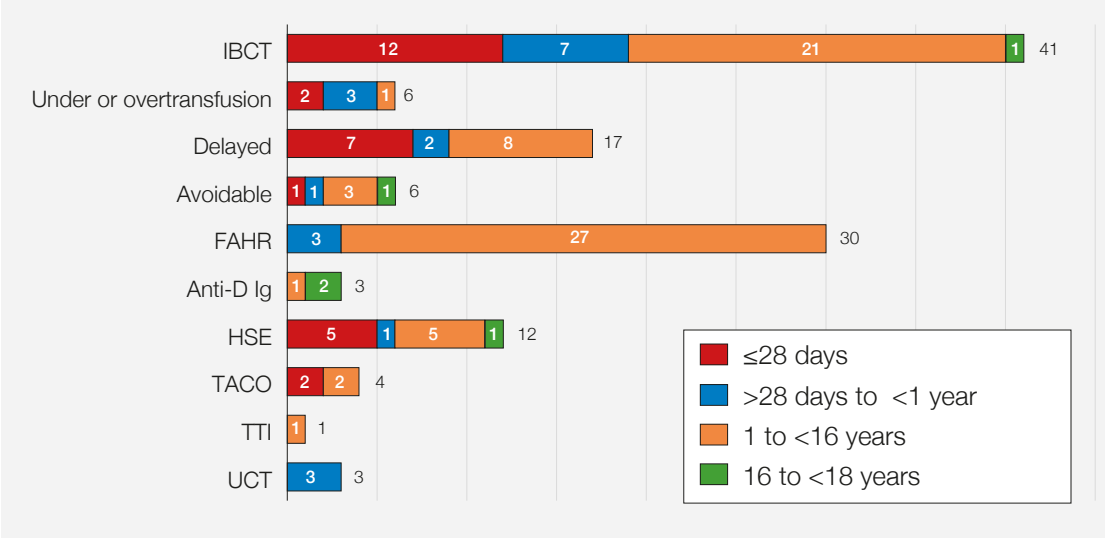
Trends of reporting are summarised in Figures 23.3a-c (b and c are available on the website only) and highlights are discussed by category. There continues to be disproportionate representation of paediatric cases as a proportion of total SHOT reports in three categories (Figure 23.1):

- Incorrect blood component transfused (IBCT) 17/78 (21.8%)
- Specific requirements not met (SRNM) 24/194 (12.4%)
- Avoidable, Delayed or Under/Overtransfusion (ADU) 29/236 (12.3%), and for the under or overtransfusion subcategory 6/15 (40.0%)

The distribution of reports in each category remains broadly similar compared with last year (Figure 23.2).

Errors which were primarily from the laboratory accounted for 40/85 (47.1%) of paediatric error reports (IBCT-WCT 9, IBCT-SRNM 16, ADU 12, HSE 3 and anti-D Ig 0), with the remainder being clinical. This number and percentage of laboratory errors is increased compared to last year, consistent with ongoing pressure in transfusion laboratories.

Figure 23.2: Summary of paediatric reports by category and age for 2018



IBCT=incorrect blood component transfused; FAHR=febrile, allergic and hypotensive reactions; HSE=handling and storage errors; TACO=transfusion-associated circulatory overload; TTI=transfusion-transmitted infection; UCT=unclassifiable complications of transfusion

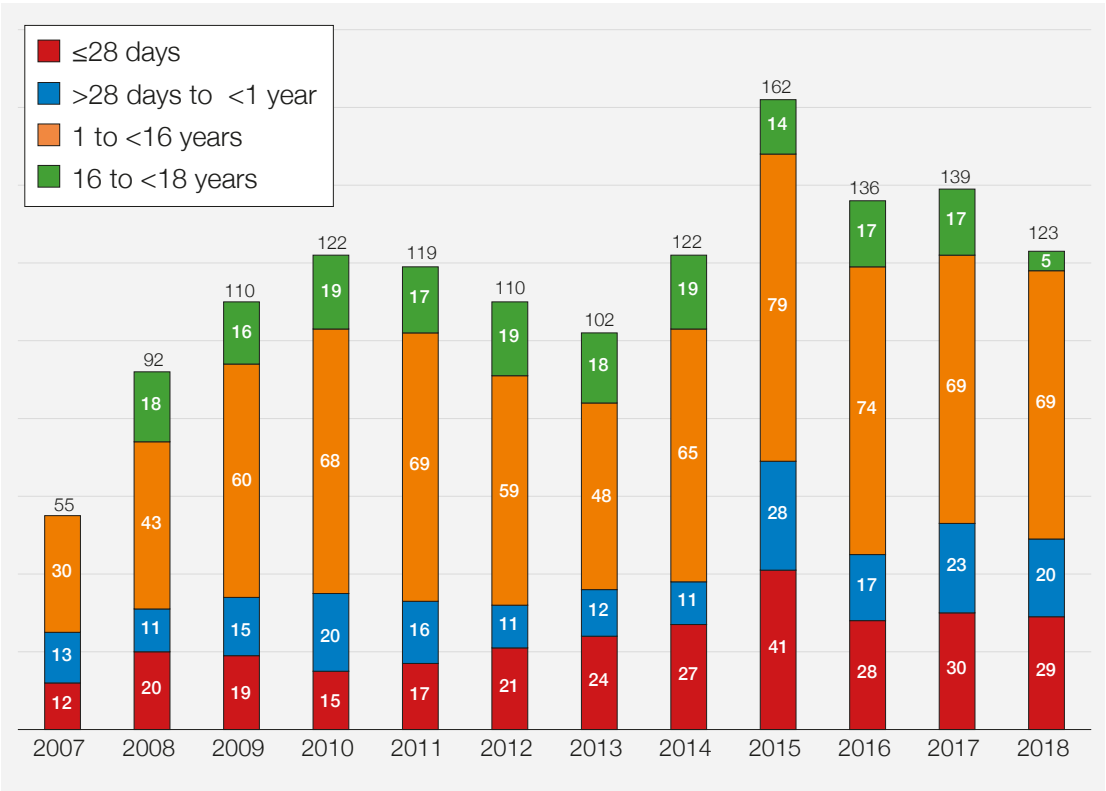
The total number of reports has reduced slightly (Figure 23.3a), mainly due to a reduction of reports in teenagers 16 to <18 years old. There was a small increase in the number of errors due to failure to appropriately supply irradiated components (Figure 23.3b - website only).

FAHR reactions to platelet components continue to predominate in paediatric patients (Figure 23.3c - website only) in contrast to the pattern for adults (Figure 23.6a).

Figures 23.3b and 23.3c for trends in specific requirements not met, and febrile, allergic and hypotensive reactions can be found in the supplementary information on the SHOT website www.shotuk.org.

a. Total paediatric reports subdivided by age

Figure 23.3: Trends in paediatric reports 2007-2018



In 2007 only cases <16 years were included

Summary by SHOT category

Death n=1

There was 1 neonatal death attributable to transfusion in 2018, reported in the transfusion-associated circulatory overload (TACO) category.

Case 23.1: TACO and death following accidental overtransfusion of three times the volume required

A preterm infant required a double volume exchange for high bilirubin. The baby deteriorated markedly 1 hour after the exchange transfusion was commenced. At this point it was noticed that nearly three times the required volume had been administered (175mL) than had been removed (70mL). This was due to three syringes of blood being accidentally run concurrently. The baby developed pulmonary oedema and then an intracranial haemorrhage. The neonatal unit involved performs approximately 5-10 procedures per year but the investigation commented that this is still sufficiently infrequent to mean that many nurses and members of the junior medical team will have limited experience.

This case highlights the hazards around neonatal exchange transfusions, particularly in very preterm neonates.

Learning point

- Neonatal exchange transfusion procedures are now performed infrequently. It is vital that local protocols exist to support the practical process of the procedure and that an accurate real time tally is kept of blood removed and transfused

Major morbidity n=15

There were 15 cases in patients <18 years which resulted in major morbidity or were severe reactions. The details of these are discussed below.

Incorrect blood component transfused (IBCT) n=1

One case of incorrect ABO transfusion in a patient who was post liver transplant, resulted in an acute haemolytic transfusion reaction and significant morbidity.

Febrile, allergic and hypotensive reactions (FAHR) n=10

Of these 8 were severe reactions to platelets and 2 to plasma (1 methylene blue-treated fresh frozen plasma (MB-FFP) and 1 Octaplas®).

Transfusion-associated circulatory overload (TACO) n=1

A teenager developed severe respiratory distress following an apheresis platelet transfusion. They required admission to the intensive care unit and recovered fully with supportive care.

Unclassifiable complications of transfusion (UCT) n=3

There were 3 cases that were reported to have resulted in major morbidity in the UCT category (see Chapter 19, New or Unclassifiable Complications of Transfusion (UCT)) and involve transfusion-associated necrotising enterocolitis (TANEC), of uncertain causal relationship to red cell transfusion in preterm neonates.

In 1 case, a preterm baby had a sudden unexpected deterioration requiring ventilation 2 hours after red cell transfusion completion, and was managed as presumed NEC due to the presence of abdominal distension and discomfort, although abdominal X-ray was not diagnostic.

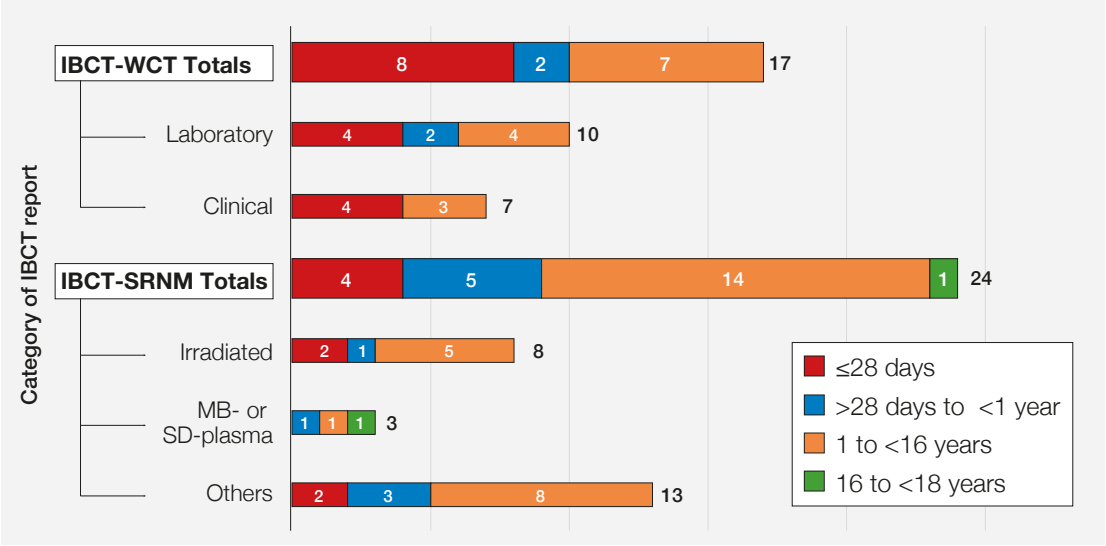
In another, a very preterm infant was diagnosed with NEC several hours after a transfusion given for anaemia (haemoglobin (Hb) 100g/L). The abdominal X-ray was consistent with NEC and the baby required extensive small bowel resection the next day, resulting in short gut syndrome. The baby had had one previous episode of suspected NEC at 10 days of age. The last case, involved a preterm baby who developed NEC 2 days following a red cell transfusion and required a hemicolectomy.

The pathogenesis of TANEC remains poorly understood, and there is uncertainty as to whether feeds should be discontinued around the time that a red cell transfusion is given to pre-term babies. Currently there is heterogenous practice across neonatal units. An ongoing multi centre 'opt-out' randomised control study, the WHEAT trial (Withholding feeds around packed red cell transfusion) hopes to answer this question (Hilditch et al. 2018).

Error-related reports n=85

IBCT-wrong component transfused (IBCT-WCT) n=17

Figure 23.4: 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=7

Adult emergency blood given to neonates n=2

There were 2 reports of inappropriate use of adult group O D-negative units being given to neonates. These illustrate again the importance of clear processes to allow identification of the units for neonatal use in an emergency, highlighted in the learning point from the 2017 Annual SHOT Report (Bolton-Maggs et al. 2018):

'Neonatal/infant specification blood has additional safety features in view of the particular vulnerability of the recipients. Therefore, it is not appropriate to resuscitate neonates with adult red cells unless there is no available paedipack. Mitigations put in place by hospitals to reduce the chance of selecting the incorrect component by clinical staff include having neonatal and adult red cell units placed in containers with visual identifiers to help staff distinguish between them.'

Failure to communicate relevant medical history n=2

Communication failures with regards to key parts of medical history include failure to communicate a past history of stem cell transplantation in 2 reports.

Transfusion process errors/wrong blood in tube n=3

Errors were seen both in sample labelling and in ensuring the correct wristband was on the correct patient. On 1 occasion a child had the wristband of another patient who was due a transfusion on the same day and of note a bedside check was not performed.

On 2 occasions twins were mixed up with 1 case of wrong blood in tube and for another pair of twins the wrong twin was transfused.

IBCT-WCT laboratory errors n=10

Failure to communicate relevant medical history or failure to upload to transfusion record n=4

Two children post liver transplant and 1 post stem cell transplant received blood of the incorrect group; 2 were due to failure to communicate between clinicians and the hospital transfusion laboratory that the patient had received a transplant and 1 was due to failure to record relevant information in the transfusion information technology (IT) system.

In addition, 1 baby had an incorrect blood group assigned post intrauterine transfusion.

Case 23.2: Transfusion of red cells of the wrong group to a neonate due to a failure to communicate the previous intrauterine transfusions (IUT)

A baby received three transfusions of group O D-negative red cells in utero. Following delivery, the baby's group was reported as O D-negative, and group O D-negative plasma and platelets were issued and transfused. In view of the IUT the baby should have received group AB plasma components. This error occurred because the fetal and newborn case records had not been merged.

Learning point

- It is vital the history of in utero transfusions is communicated with the hospital transfusion laboratory staff. If this does not occur errors can be made in assigning the neonatal blood group to the group of the blood given for the intrauterine transfusion (IUT)

Component selection error, incorrect component n=6

Two neonates who were receiving large volume red cell transfusions did not receive the appropriate specialised component available due to failure to select the correct component in the transfusion laboratory. There were also 2 neonates who received cryoprecipitate instead of FFP. For 1 both FFP and cryoprecipitate had been requested but cryoprecipitate was incorrectly located in the laboratory and the collecting staff did not realise they had collected cryoprecipitate not FFP. The baby received double the intended volume of cryoprecipitate. For the second case FFP had been requested but the biomedical scientist (BMS) issued cryoprecipitate instead in error. This was not realised by the staff collecting the unit or the nurses who administered it to the patient.

A D-negative female of childbearing potential received a unit of D-positive platelets with no explanation recorded as to the reason.

Learning point

- Group O plasma can contain high levels of anti-A and anti-B which can cause significant haemolysis of red cells of recipients. Methylene-blue treated fresh frozen plasma (MB-FFP) is not currently tested for high-titre antibodies. Group O FFP should only be given to group O patients (BSH New et al. 2016)

Specific requirements not met (SRNM) n=24

Failure to provide irradiated components n=9

Non-irradiated components were supplied in error in 9 cases. Of note 4 of these were in children with DiGeorge syndrome. Three had received medications associated with a recommendation to use irradiated components, 1 was pre stem cell transplant and 1 was a neonate (who also did not have a valid antibody screen).

Case 23.3: Child with DiGeorge syndrome transfused non-irradiated components

A child was under-going tetralogy of Fallot repair in theatre but the surgical team had not been informed of the diagnosis of DiGeorge syndrome. The genetic results were available but had been filed in a second set of temporary notes for the patient and only the original set was available at time of operation. In addition, the parents had not been informed of the result.

Learning point

- With multiple clinical teams involved in the care of complex patients, timely communication between teams is vital to ensure patient safety. Electronic medical records could help in addressing this issue

Failure to provide extended phenotype blood for sickle patient n=4

For 4 patients with sickle cell disease the communication failure resulted in the provision of non-extended phenotype blood or non-K matched blood.

Learning point

- Transfusions for patients with transfusion-dependent anaemia such as sickle cell anaemia or thalassaemia may take place at non-specialist centres. It is vital therefore that education regarding the specialist requirement for red cell phenotyping is communicated amongst general paediatric teams

Failure to perform antibody screen or inappropriate transfusion of antigen-positive blood n=6

In 3 patients red cell components were issued without a valid antibody screen. One patient with a known red cell alloantibody (anti-Jk^{a}) was transfused antigen-positive blood. This was due to failure to update a laboratory flag; fortunately, there were no clinical sequelae. The remaining 2 children did not have a second group and antibody screen sent.

Failure to provide imported plasma for a recipient born on or after 1 January 1996 n=3

On 3 occasions a standard United Kingdom (UK) component was given to a child born after 1995. Two of these involved standard UK FFP units transfused to paediatric patients. The third was a neonate who received part of a standard pooled cryoprecipitate unit.

Other n=2

A patient requiring human leucocyte antigen (HLA)-matched platelets due to HLA antibodies was given non-HLA matched due to a failure to update the laboratory IT system with the results. Another patient with aplastic anaemia received pooled instead of apheresis platelets due to failure to check for specific requirements on the patient's record.

Avoidable delayed or under or overtransfusion (ADU) n=29

This category highlights the need for ongoing prescribing education for paediatricians/neonatologists and further promotion of tools such as the 'Blood Components App' to try and improve education as to the prescription of correct component volumes.

Avoidable n=6

In 6 patients transfusion could have been avoided. For 1 neonate a low Hb result from the previous day was reviewed and a transfusion commenced even though the baby had already been transfused the previous night. An incorrect decision to transfuse followed erroneous results for 4 children (see Case 23.5), and 1 apparently asymptomatic teenager with iron deficiency received a two-unit red cell transfusion.

Case 23.4: Acting upon erroneous blood test results

A child presented as an emergency. The full blood count showed pancytopenia and a platelet transfusion was administered overnight. When a cannula was re-sited the next day the blood count was repeated and was normal. Blood transfusion was discontinued. The initial sample was erroneous.

Learning point

- Phlebotomy in babies and young children can be technically challenging and sample volumes can be small. Therefore, issues regarding inaccurate results due to pre-analytical variables are potentially overrepresented in this patient group. It is vital that clinicians feel able to challenge unexpected blood test results and understand the role of sampling and testing errors when interpreting results which do not fit with the clinical situation

Overtransfusion n=5

Overtransfusion occurred as a result of miscalculation of volume required in 4 cases and in 1 case was due to mis-setting of a pump which failed to stop part way through a second neonatal split pack. Two of the children who were overtransfused red cells required venesection. A further case of significant neonatal overtransfusion of platelets is detailed in the TACO section.

Case 23.5: Miscalculation of red cell transfusion volume required

An infant requiring transfusion of red cells, weight 6.2kg, Hb 110g/L aiming at 140g/L, was prescribed a unit over 3 hours. The post-transfusion Hb was 190g/L, following a transfusion of over 30mL/kg. The error in prescription was noted the next day resulting in venesection of 50mL and replacement with fluid. The electronic prescribing programme used in this paediatric intensive care unit defaulted to units and the prescriber had to go to a second page, which was not done in this case. The review noted this system was not fit for purpose in paediatrics and was to be entered onto the risk register.

Delay in transfusion n=17 (one of these was also an undertransfusion)

There were 6 cases due to communication errors, 1 of these was when a crossmatched unit was transferred with a patient in an ambulance from another hospital and a delay occurred due to lack of guidance of what to do in this situation. Another 2 were due to issues around IT systems. One case illustrates the key importance of communication of important issues around units supplied to the clinical team: the short expiry of a unit was not discussed between the Blood Service and the hospital transfusion laboratory.

Case 23.6: Failure to communicate short expiry of neonatal exchange red cell unit

The neonatal unit requested red cells for neonatal exchange from the transfusion laboratory. The time that the exchange transfusion was scheduled to occur was later than planned and the red cells provided by the Blood Service had only 4 hours before expiry. The exchange had to be stopped before the full volume had been delivered and further blood had to be crossmatched the next day. The short expiry should have been discussed with the hospital prior to supply of the units.

Pressure of work and failure to follow existing standard operating procedure (SOP) within laboratories featured in 4 reports. In 2 cases there was failure of clinical process; this included a case of failure to follow-up a child with a haemolytic anaemia following early diagnosis of jaundice. This is not a standard SHOT reporting category but is not uncommon in clinical practice.

Another case involved an incorrectly labelled unit and in a further case a sample was sent in the wrong bottle.

Undertransfusion n=1

A child received less than the prescribed volume of red cells due to stopping the transfusion early. The prescribed volume was 450mL, however 385mL was administered.

Handling and storage errors (HSE) n=12

Incorrect pump setting or issues with infusion line n=5

As well as being vulnerable to errors around volume of prescribing, neonatal and paediatric transfusion recipients are at risk of error around incorrect settings on infusion pumps. Three cases were due to incorrect programming of pumps. Two cases involved transfusion of red cells through a non-blood giving set and 1 of these involved infusing red cells alongside a ketamine infusion.

Case 23.7: Incorrect infusion pump settings resulting in three times the rate of infusion intended

A young child (<10 years) was due a unit of red cells (270mL). This was intended to be infused over 3.5 hours. In error the volume to be infused was set as the rate and the volume was infused over 1 hour. The child did not suffer any ill effects.

Transfusion completed over too long a duration or past expiry time n=6

On 4 occasions transfusions were completed over too long a period. One unit had a short expiry time and transfusion was completed past the expiry date of the component. On another occasion blood was crossmatched earlier but transfused to the patient beyond the time that the crossmatch was valid.

Blood refrigerator error n=1

A unit of red cells taken from a blood refrigerator which had alarmed due to high temperature (10.2°C) was transfused to a neonate.

Anti-D immunoglobulin (Ig) administration n=3

There were 3 cases in pregnant older teenagers under the age of 18 years (see Chapter 7, Adverse Events Related to Anti-D Immunoglobulin (Ig) for details).

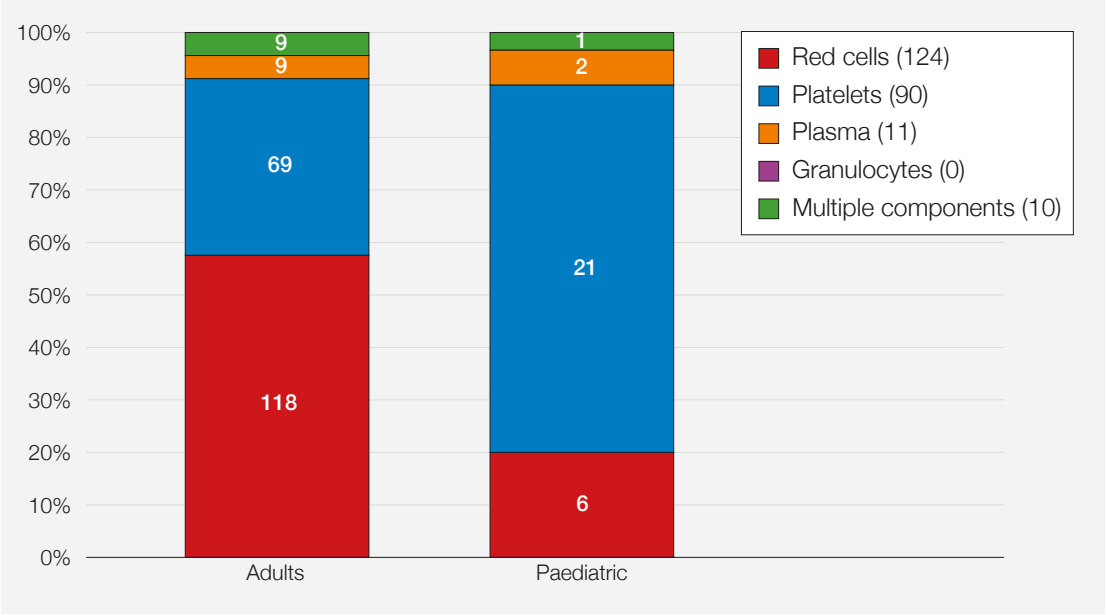
Transfusion reactions n=38

Febrile, allergic and hypotensive reactions (FAHR) n=30

The total number of cases was similar to last year (2017, n=36) with the majority occurring in children over the age of 1 year (27/30). Once again there was a predominance of allergic type reactions to platelet components in 21/30 (70.0%) with the remainder of reports being mostly febrile reactions to red cells (6), allergic reactions to plasma (2) and multiple components (1), (see Figure 23.5b).

One of the plasma reactions was to Octaplas® and one to MB-FFP. A child received Octaplas® during complex spinal surgery and became unwell with hypotension, tachycardia and reduced oxygen saturations. The child who received MB-FFP was also undergoing surgery and developed a rash, hypotension, tachycardia and reduced oxygen saturations after 160mL had been infused. Both children made a full recovery.

a. Comparison of proportions of adult and paediatric FAHR related to different components



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

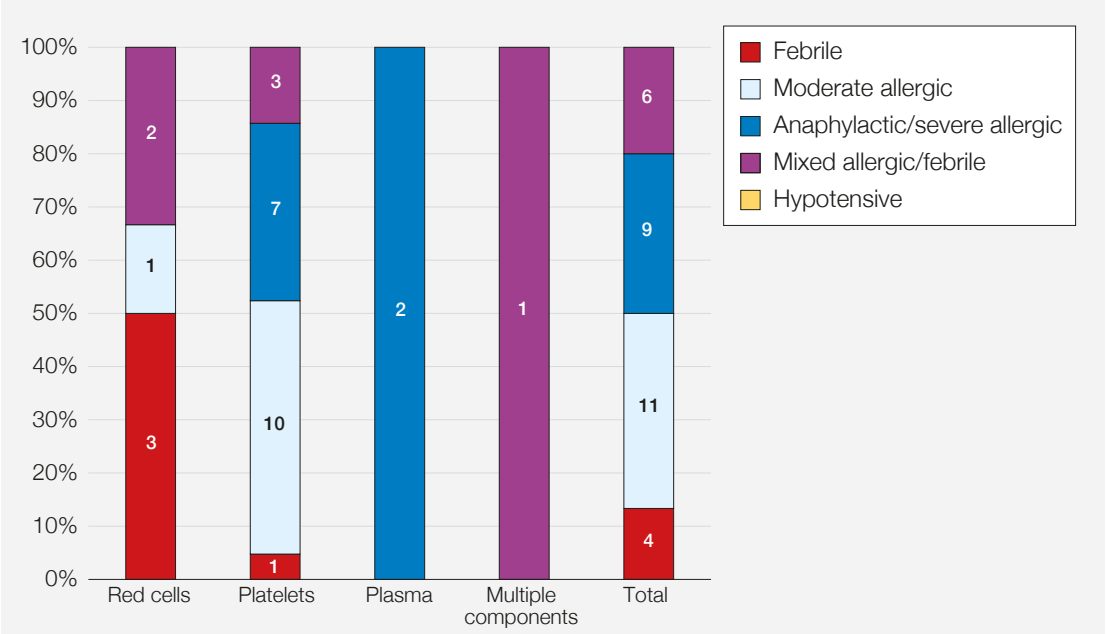


Figure 23.5: Paediatric febrile, allergic and hypotensive reaction (FAHR) reports a. Comparison of proportions of adult and paediatric FAHR related to different components

There were no FAHR reported following neonatal transfusions, as is typical from previous Annual SHOT Reports. It is not known whether this lack of reports from neonates is the result of their immunological immaturity or whether reactions may be missed in babies who are often unwell for other reasons. The results of the recent PlaNeT-2/MATISSE randomised trial of prophylactic platelet thresholds in preterm neonates (Curley et al. 2019) reported an increase in the outcome of major bleeding and mortality in the group receiving more platelet transfusions. The reasons for the evidence of harm with platelet transfusions is not known, but might include an immune-modulatory process.

Transfusion-associated circulatory overload (TACO) n=4

Respiratory complications of transfusion are likely to remain under-recognised, particularly in neonatal or complex patients who may not have risk factors seen more commonly in adult patients.

Two of the reports were due to transfusion of excessive volumes of component in error to neonates. One resulted in death (described at the start of the chapter, Case 23.1). The second excessive transfusion is described in Case 23.8. The remaining 2 cases were in a young child and a teenager and both had been given appropriate volumes.

Case 23.8: Neonate transfused ten times the required volume of platelets

A 2.9kg neonate with thrombocytopenia absent radii syndrome was prescribed 290mL instead of 29mL of platelets to be given prophylactically to cover a procedure. The prescription was written on a paper prescription chart. An adult sized pack of platelets was issued and transfused by the neonatal team. Approximately 200mL was administered before the error was noticed. The child developed respiratory distress and reduced oxygen saturation with chest X-ray changes consistent with fluid overload. Post-transfusion platelet count was 767x10^9/L. Diuretics and supplemental oxygen were given and the baby made a full recovery.

The prescribing error was not picked up by either the laboratory or the ward staff.

Learning point

- Whilst the prescriber is responsible for calculating and prescribing the correct volume of blood component, laboratory staff should be empowered to check and question inappropriate volumes requested, and ward staff administering blood components to neonates and children should be trained in the appropriate volumes to transfuse

Transfusion-transmitted infections (TTI) n=1

In 2018 there was 1 case of TTI reported in the paediatric population. This was probable bacterial contamination of platelets. A child with a brain tumour developed a fever following a prophylactic platelet transfusion. Fever persisted for 24 hours post transfusion and blood cultures were positive for Gram positive cocci (see Chapter 20, Transfusion-Transmitted Infections (TTI), Case 20.1, for further details).

Uncategorised complications of transfusion (UCT) n=3

There were 3 cases in this category, all of which were related to NEC in preterm infants. They all resulted in major morbidity and are highlighted above.

Other reaction categories

There were no cases reported in 2018 of HTR, TAD or TRALI in patients less than 18 years of age.

Near miss n=103

These near miss reports included 46 cases of wrong blood in tube that involved mother and baby samples.

Right blood right patient n=15

For further details of right blood right patient errors, see Chapter 13, Right Blood Right Patient (RBRP).

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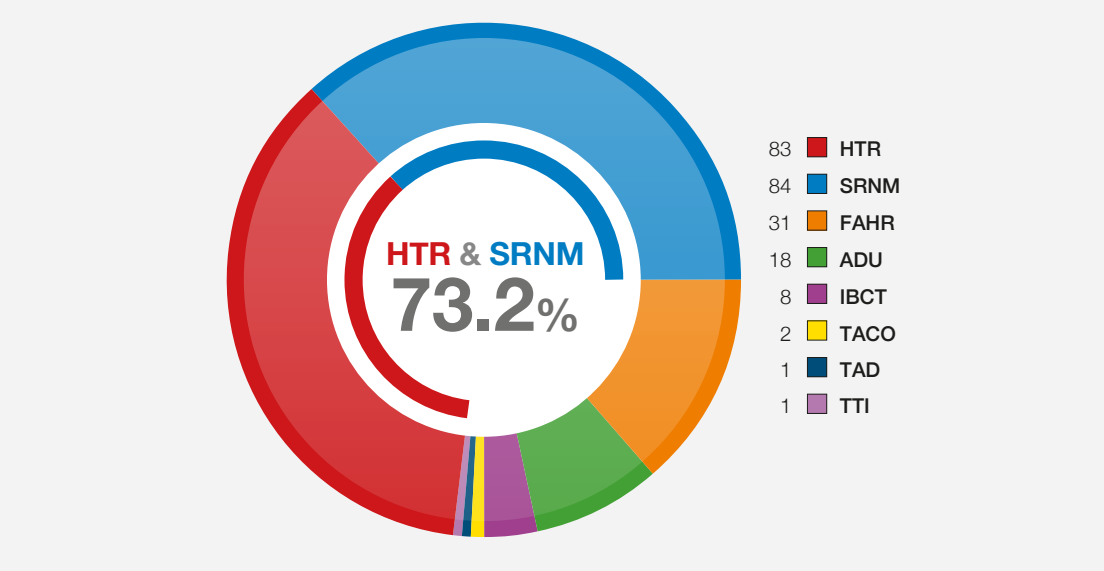
Haemoglobin Disorders: Update 24

Authors: Joseph Sharif and Paula Bolton-Maggs

Thirty-nine incidents were reported in 2018 in patients with sickle cell disease (SCD) and transfusion-dependent thalassaemia (TDT). The most frequently reported incident was specific requirements not met, occurring in 16 cases. There were 9 cases of haemolytic transfusion reactions including 3 cases of hyperhaemolysis. There were no reported deaths directly related to complications of transfusion.

a) Sickle cell disease n=228



b) Thalassaemia n=52

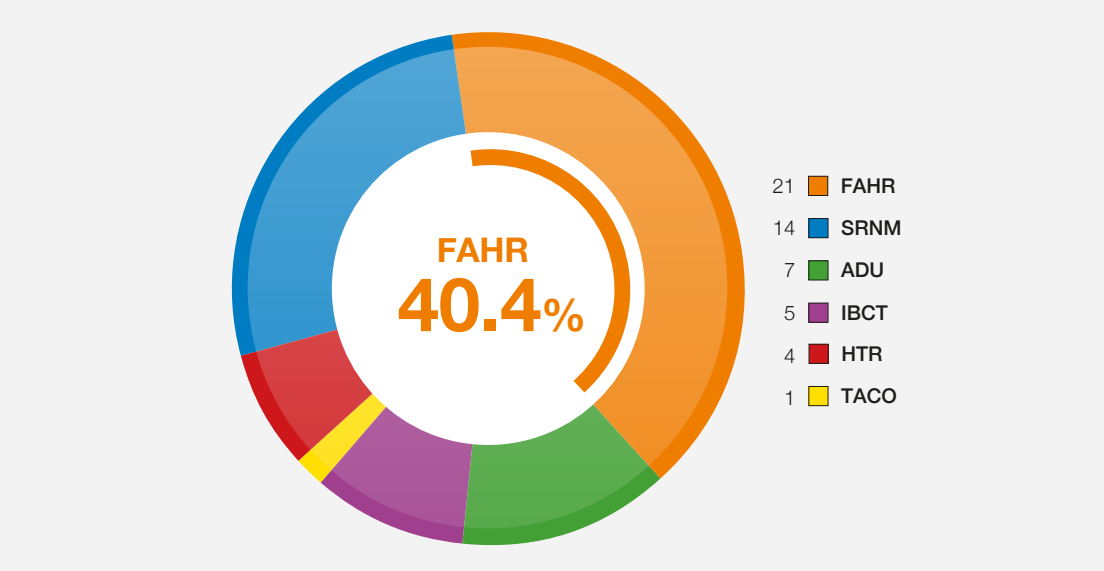


Figure 24.1: Cumulative data for adverse events in transfusion for patients with haemoglobin disorders 2010 to 2018

HTR=haemolytic transfusion reaction; SRNM=specific requirements not met; FAHR=febrile, allergic and hypotensive reaction; ADU=avoidable, delayed and under or overtransfusion; IBCT=incorrect blood component transfused; TACO=transfusion-associated circulatory overload; TAD=transfusion-associated dyspnoea; TTI=transfusion-transmitted infection

Careless practice n=8

An avoidable transfusion occurred in a young woman with SCD who had a haemoglobin (Hb) of 64g/L but no indication for transfusion. The general medical team referred to the generic hospital guidelines, which specified a Hb of less than 70g/L as the justification for transfusion. This guidance does not apply to patients with SCD and in this case the clinical haematology team was not consulted.

There were 7 reports of delayed transfusion. In 2 similar cases there was a delay in emergency transfusion for acute chest syndrome in SCD. In both cases the patient was transferred across sites and due to inadequate handover and careless practice the first patient did not receive the transfusion until the following day and for the second there was a 15-hour delay but no serious adverse outcome occurred.

In a further 5 cases there was a delay in planned transfusions for SCD (4) and TDT (1). In 3 cases the patient required admission to hospital to complete the transfusion.

Specific requirements not met n=16

Clinical causes n=5

In 4 cases of SCD the clinicians did not inform the laboratory of the diagnosis of SCD therefore patients did not receive extended phenotype-matched blood. One of these patients was also pregnant and did not receive cytomegalovirus (CMV)-screened units.

Laboratory causes n=11

The common problem in most cases was the laboratory not acting on the clinical information on the request stating the diagnosis of SCD or TDT. Two patients with SCD subsequently developed Rh antibodies (anti-C and anti-e).

A young man with SCD was having a planned exchange transfusion. The clinical team were not aware the patient had a history of previous antibodies (anti-M and C^w) and also stated that the patient had not previously been transfused. The laboratory did not check Specialist Services electronic reporting using Sunquest's Integrated Clinical Environment (Sp-ICE), which had a record of the previous antibodies, and so the patient received M-positive units. Subsequent antibody screening did detect anti-M; there was no serious adverse outcome.

Wrong transfusion n=1

A child with SCD attending for a routine transfusion was given the identification band of a second child also attending for transfusion. The nurse gave the first child the unit of blood prepared for the second child; the nurse did not use positive identification and the child answered yes to the wrong name or was distracted. The error was discovered during observations after the transfusion of one unit (50mL). Both children were group O D-positive but the child was C-, e- and the unit was C+, e+. The child also had an anti-Kp^a however the unit transfused was Kp^a-negative. There was no reported serious adverse outcome or new antibody development.

Febrile, allergic and hypotensive reactions n=3

There were 3 transfusion reactions reported in patients with SCD requiring discontinuation of transfusion but no serious adverse outcomes.

Haemolytic transfusion reactions n=9

All 9 patients had a diagnosis of SCD (7 female, 2 male).

There were 2 cases of acute haemolytic transfusion reactions both occurring in pregnant women after urgent transfusion. In 1 case the patient had a history of multiple alloantibodies (anti-A1, -M, -S, -Jk^a, -Le^a, -Le^b). She received two units of blood matched for all clinically significant antibodies; one unit was Le^a-positive and one unit Le^b-positive and with both units she developed intravascular haemolysis.

Subsequent Le^a-negative and Le^b-negative units were given without event. This is an interesting case in which antibodies usually deemed not clinically significant and cold-reacting were thought to have caused a reaction.

There were 7 delayed haemolytic transfusion reactions reported, 4 of which occurred after urgent transfusion; 1 of these patients was pregnant and another transfused in the early postpartum period.

Three of the delayed transfusion reactions were deemed to be cases of hyperhaemolysis. These were all non-pregnant female patients, and 2 of these reactions occurred following urgent transfusion. None of these patients had a history of alloantibodies.

Near miss n=2

A young male with SCD was having a planned transfusion but units selected were not HbS-negative; this was noticed by the nurse before the units were given.

Commentary

Red cell transfusions for patients with haemoglobinopathies can be life-saving but there are important risks in this unique group of patients including an increased risk of alloimmunisation and hyperhaemolysis.

It is important to recognise a delayed haemolytic transfusion reaction early so these patients can be managed appropriately with consideration of temporarily withholding further transfusions when safe to do so, to avoid further haemolysis (Pirenne and Yazdanbakhsh 2018).

Revised standards for the clinical care of adults with SCD in the United Kingdom (UK) were published in May 2018 (Sickle Cell Society 2018). These can be downloaded from the Sickle Cell Society website.

Recommendations

- Each transfusion for a patient with sickle cell disease (SCD) should be clearly indicated in line with British Society for Haematology (BSH) guidance (BSH Davis et al. 2016) and must be authorised by the haematology team

Action: Consultant Haematologists and Hospital Transfusion Teams

- All hospital transfusion laboratories should have a robust system to ensure that a haemoglobinopathy diagnosis is highlighted on the blood request form so that mandatory specific requirements are not missed. This is imperative to reduce the risk of alloimmunisation, which can have serious implications for these patients
- Any history of red cell antibodies must be sought out. In England this should include accessing Specialist Services electronic reporting using Sunquest's Integrated Clinical Environment (Sp-ICE) to check for any historical antibodies. The presence of currently undetectable historical antibodies increases the risk of delayed haemolytic transfusion reactions according to many studies (Narbey et al. 2017)

Action: HTT and Transfusion Laboratory Managers

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25 Medicines and Healthcare products Regulatory Agency (MHRA) Report on Blood Safety and Quality Regulation in 2018

Authors: Chris Robbie, Mike Dawe and Shirley Stagg

Acknowledgement to a Blood Science Manager from a Teaching Hospital with a trauma centre for additional data

Introduction

The United Kingdom (UK) Blood Safety and Quality Regulations 2005 (as amended) (BSQR) require that serious adverse events (SAE) and serious adverse reactions (SAR) related to blood and blood components are reported by blood establishments (BE), hospital transfusion laboratories and facilities to the MHRA, the UK Competent Authority (CA) for blood safety. This requirement is enabled by the Serious Adverse Blood Reactions and Events (SABRE) reporting system. All data within this report are correct as of 17/01/2019.

Key MHRA messages

- In accordance with the requirements of the Good Practice Guide (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)
- All staff involved in transfusion must work together to prevent errors at source and use resources appropriately. Detecting and correcting errors made in the clinical areas requires allocation of significant laboratory resource

Summary

The number of SABRE reports, especially SAE has increased in 2018 from last year. These are reports where the confirmation report has been submitted between 1st January 2018 and 31st December 2018. Where this is in part due to one hospital's zero tolerance policies, regarding sample acceptance and component collection error resulting in more reports being generated from them, it does not account for all of the increase. Although the data collected would seem to indicate that SAE are the result of failures in individuals, evidence from other SABRE reports, MHRA inspection reports, MHRA site visits and anecdotal evidence from discussion with reporters, would seem to suggest that the data does not fully describe the whole situation. There is evidence that investigations are not detailed enough to uncover the true root causes of errors. MHRA data and evidence from SHOT, the UK Transfusion Laboratory Collaborative (UKTLC) and other sources would suggest that staffing, skill-mix, education, training, process mapping and procedures all need to be improved to develop, maintain and improve a robust QMS.

SABRE report data

Table 25.1 and Figure 25.1 display the total number of SABRE confirmation reports that were submitted and satisfy the European Commission reporting criteria for SAR and SAE since 2009. Previous years data are live, and subject to amendment, so the table has been updated to reflect changes made to historic reports.

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
SAE	968	889	810	931	705	762	764	1027	1076	1198
SAR	501	549	444	343	345	346	262	464	508	408
Total	**1469**	**1438**	**1254**	**1274**	**1050**	**1108**	**1026**	**1491**	**1584**	**1606**

Table 25.1: Submitted SABRE confirmation reports 2009–2018

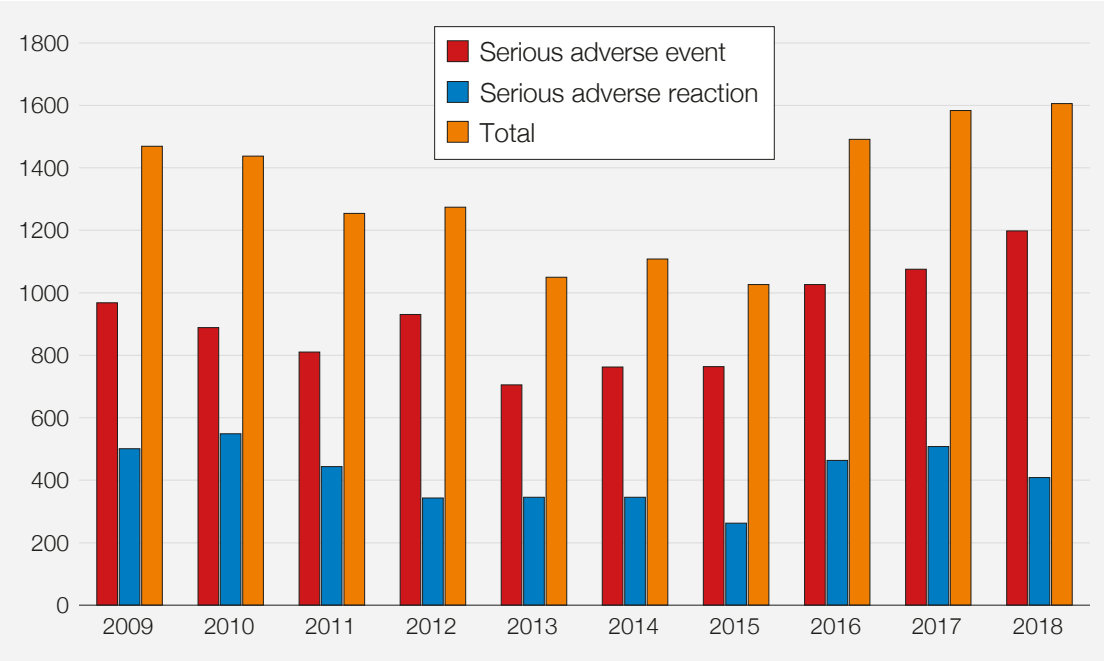


Figure 25.1: Submitted SABRE confirmation reports 2009-2018

There has been a slight increase in the total number of reports received by the MHRA that qualify for onward reporting to the European Union (EU) (1.3%). However, there is an increase (10.2%) in the number of SAE reports and a decrease of (24.5%) in the number of SAR. There are a number of factors which can affect the total number of reports received in any one year which are unrelated to blood safety and quality and transfusion in patients.

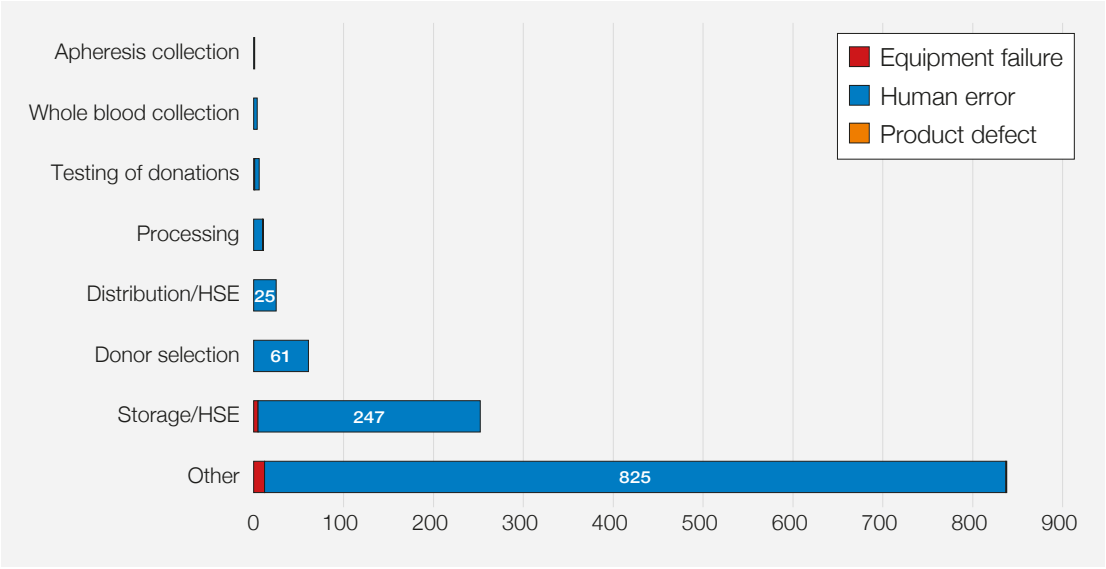
- For SAR, the MHRA is dependent on the process of SHOT questionnaires being completed by reporters, reviewed by SHOT experts and the confirmation reports being completed by the SHOT office prior to the end of December for those reports to qualify in the reporting year. This is not a criticism of the process of reporting, nor SHOT, but should be remembered before comparing year on year data
- For SAE, the factors are more complex. In 2018, one single hospital reported 67 more SAE than in the previous year accounting for over half of the increase in SAE reported. Assessment of this hospital's reports show that this increase is more a reflection of their strict zero tolerance policies to sample acceptance and component collection processes rather than demonstrating a significant deterioration in their QMS

Evidence from the annual summary report exercise shows that the number of components collected by blood establishments is decreasing, yet the number of patients being transfused is increasing. This would suggest that blood management and conservation is improving the use of components by recycling unused blood. It would also suggest workloads are increasing as more patients being transfused would indicate more samples and associated process steps in acceptance, testing, issuing, etc. Therefore, an increase in numbers of SAE reports should not necessarily be seen to be a reflection on overall quality and safety.

Serious adverse events

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.

Figure 25.2: 2018 SAE confirmation reports by deviation and specification



HSE=handling and storage errors

Numbers too small to be annotated on the figure: Apheresis collection: Human error=1, Whole blood collection: Human error=4, Testing of donations: Equipment failure=1; human error=5, Processing: Human error=10; product defect=1, Storage/HSE: Equipment failure=5, Other: Equipment failure=12; product defect=1

Similar to previous years there is no real change in the proportions of each category of reported SAE. 'Other' and storage categories contain the most reports, and factors associated with human error remain the main root cause.

Storage data n=252 (-3)

Storage remains the second largest individual error category and comprises of all BSQR reportable storage SAE in both the laboratory and clinical areas. For a breakdown of handling and storage errors (HSE) please see the relevant sections of Chapter 14, Laboratory Errors and Chapter 9, Handling and Storage Errors (HSE). The MHRA has broken this category down further to try and identify specific storage error subtypes, Table 25.2. For a description of the subcategories used, see Appendix 1.

Table 25.2: SAE storage error subclassifications 2018

Storage subclassification	2018 (+/- 2017)	2017 position
Incorrect storage of component	98 (+30)	2
Component expiry	57 (-17)	1
Sample expiry	41 (-5)	3
Storage temperature deviation	18 (+10)	6
Failure to action alarm	11 (-8)	5
Return to stock error	8 (-11)	4
30 minute rule	8 (+1)	8
Miscellaneous	6 (0)	9
Security	5 (-3)	7
Total	**252 (-3)**	

Although the total number of reports in the storage category remains similar to last year, there are some quite significant changes in the numbers of reports in the subcategories. As discussed in last year's chapter, although component expiry and sample expiry describe different errors, the processes that control

these errors are similar. There has been a reduction (18.3%) in these categories which demonstrates improvements in the processes that identify and remove expiring components has been made.

Further improvements in the laboratory QMS can also be demonstrated by a 50% reduction in the combined failure to action alarm and return to stock error categories.

Unfortunately, there have been some significant increases in some storage SAE subcategories. There is a recorded 44.1% increase in incorrect storage of components. These errors can occur in both laboratory and clinical errors involving laboratory, clinical and portering staff. Analysis of these reports demonstrates that the majority of these errors occur solely in clinical areas, however.

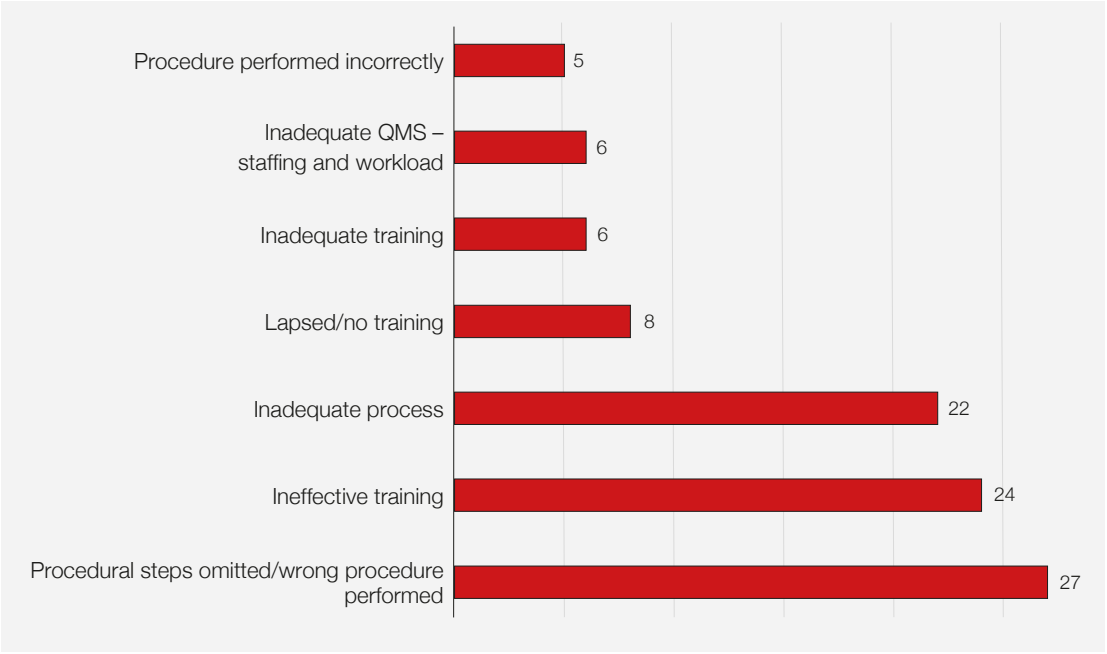


Figure 25.3: Incorrect storage of component by specification 2018

The MHRA defined, 'human error' category (Appendix 3), shows that 24.5% of the errors are the result of staff not following their training and 22.5% of errors were the result of inadequate processes. The resultant investigations showed that the root cause was often due to:

- Procedures, in clinical areas, not being properly planned or defined resulting in staff not being aware of who was taking responsibility for the storage process
- The lack of availability of sufficiently trained staff
- Poor planning and communication
- Regular storage locations being unavailable
- A combination of factors demonstrating an overall lack of an adequate system for controlling the quality and safety of blood and components

The case study below demonstrates some of these factors.

Case 25.1: Lack of adequate transfer and storage procedures

Two units had been removed from the pathology refrigerator and placed in a '30-minute blood box' to transfuse to a patient on the 'cancer bus'. Although the first unit would have been transfused within 4 hours, the second unit would not have been completed in time. Investigation showed that there had been no communication to the blood transfusion laboratory regarding when the transfusion would take place and no risk assessment of the use of blood on the cancer bus had taken place. Consequently, there was no protocol or procedure in place for the transfer and storage of blood in this situation. This demonstrates a failure, or lack of a robust change management procedure.

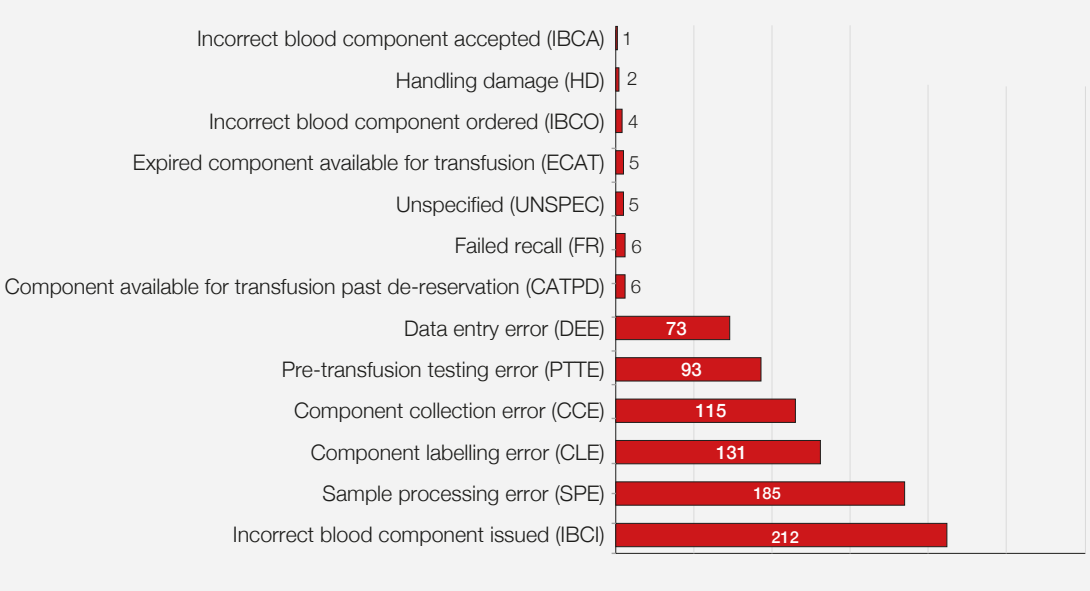
Other n=838 (+112)

Since 'other' is the largest category of SAE reports, the MHRA haemovigilance team has created subcategories to further analyse this type of error, Table 25.3. For a description of subcategories, see Appendix 2.

Table 25.3: SABRE reports, subcategory 'other' 2018

Other subcategory	2018 (+/- 2017)	2017 position
Incorrect blood component issued (IBCI)	212 (+37)	1
Sample processing error (SPE)	185 (+62)	2
Component labelling error (CLE)	131 (+17)	3
Component collection error (CCE)	115 (+21)	5
Pre-transfusion testing error (PTTE)	93 (-11)	4
Data entry error (DEE)	73 (+2)	6
Component available for transfusion past de-reservation (CATPD)	6 (+1)	9=
Failed recall (FR)	6 (-12)	7
Unspecified (UNSPEC)	5 (-4)	8
Expired component available for transfusion (ECAT)	5 (0)	9=
Incorrect blood component ordered (IBCO)	4 (-1)	9=
Handling damage (HD)	2 (0)	12
Incorrect blood component accepted (IBCA)	1 (0)	13
Total	**838 (+112)**	

Figure 25.4: SABRE reports, subcategory 'other', 2018



There has been a 15.3% increase in the number of SAE reports that fall into the 'other' category. Even accounting for the single hospital that reported 67 of the additional 111 reports received, this still indicates a 6.1% increase in the number of SAE reports categorised as 'other'.

Although the spread of reports falling into the individual subcategories has not changed much, the data would show that the QMS needs to improve when it relates to the selection of:

- Components for specific requirements
- Receipt of samples into the laboratory
- Component labelling

The fourth largest category is component collection error. These errors can occur when components are collected directly from the laboratory, or when collected from storage locations. Although a small number of reports involve laboratory error, the majority of these reports concern clinical and/or portering staff.

The data suggests some areas of improvement, specifically concerning pre-transfusion testing errors which may be related to automation and improved process controls, and failed recalls, again demonstrating improved processes once a recall is received from the blood establishment.

Human error category and human factors

The Chartered Institute of Ergonomics and Human Factors definition of human factors is: 'the scientific discipline concerned with the understanding of interactions among humans and other elements of a system.' (CIEHF 2019).

For the purposes of this report the human factors have been assessed in terms of how they affect the way a human thinks and performs, or in other words behaves during a work situation. These will either lead to an action being successful, or it will lead to human error and can be organisational, job-related or related to the individual concerned. In the context of this data analysis, reports that fall into the human error category are not to be seen only as mistakes made by individuals. The sub-categorisation aims to identify QMS failings and improvements before assuming the individual is solely responsible for the human error.

From the Council of Europe Good Practice Guidelines (Council of Europe 2016), the requirements for investigation are;

1.2.13. A formal system for the handling of deviations and non-conformances must be in place. An appropriate level of root-cause analysis should be applied during the investigation of deviations, suspected product defects, and other problems. This strategy can be determined using Quality Risk Management principles. If the true root cause(s) of the issue cannot be determined, consideration should be given to identifying the most likely root cause(s) and to addressing them. Where human error is suspected or identified as the cause, this should be justified having taken care to ensure that process, procedural or system-based errors or problems have not been overlooked, if present. Appropriate corrective actions and/or preventive actions (CAPA) should be identified and taken in response to investigations. The effectiveness of such actions should be monitored and assessed in accordance with Quality Risk Management principles.

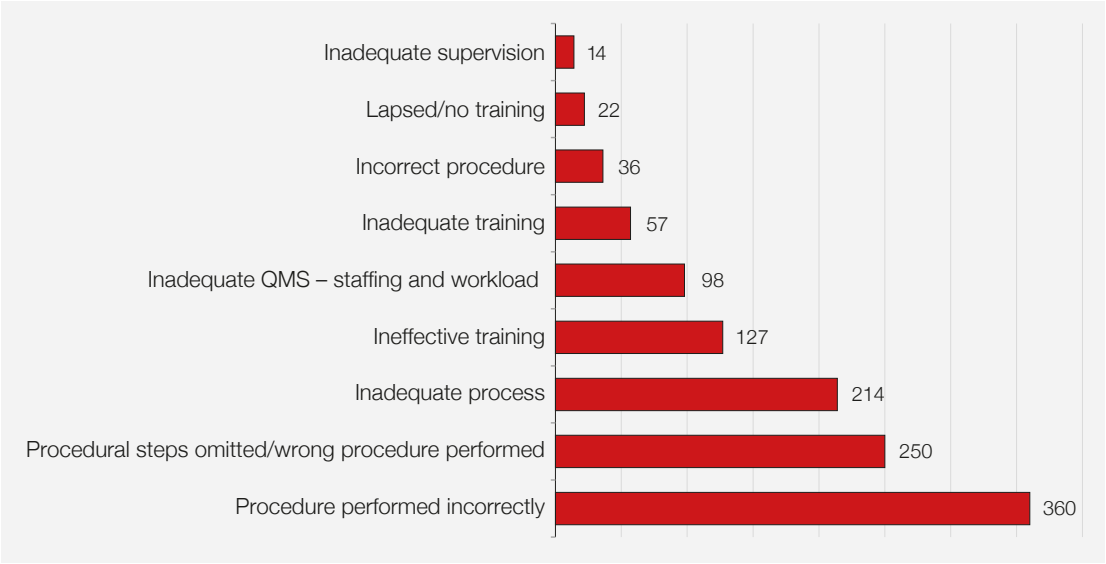
In order to understand reports in the human error category, the SABRE team has continued to use subcategories which can be applied to the report narratives to help understand the human factors involved. For a description of the categories used, see Appendix 3.

Table 25.4 shows the breakdown of reports in the human error subcategories.

Human error subcategory	Total (+/- 2017)
Procedure performed incorrectly	360 (+69)
Procedural steps omitted/wrong procedure performed	250 (+13)
Inadequate process	214 (+3)
Ineffective training	127 (+8)
Inadequate QMS – staffing and workload	98 (+18)
Inadequate training	57 (+11)
Incorrect procedure	36 (-4)
Lapsed/no training	22 (-3)
Inadequate supervision	14 (+5)
Total	**1178 (+120)**

Table 25.4: SABRE reports, human error subcategory, 2018

Figure 25.5: SABRE reports, human error subcategory, 2018



QMS=quality management system

NOTE: These numbers should be used as guidance only. The quality of this data is limited by a number of factors.

- The root causes of incidents are usually the result of many contributory factors. The subcategory chosen reflects the most likely reason for the main SAE category
- The subcategory 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 subcategorised appropriately

The distribution of categories remains similar to previous years. The data suggests that procedures are performed incorrectly, steps missed out, or wrong procedures followed. These are typically errors resulting from slips or lapses of concentration by individuals.

Staff should be able to cope with certain pressures of workload and distractions, and simply being busy should not be used as an excuse for errors. The quality of work is the responsibility of individual staff and they should take time to ensure they 'get it right first time'. Staff should be encouraged to prioritise their workload and use the support mechanisms available, when they need to, such as delaying non-urgent work, or calling staff for extra support from other laboratories.

It would be wrong, however, to suggest that over half of the SAE are the result of poor concentration by staff. Staff are reported to be under pressure from poor staffing levels, inadequate skill mixes and high workloads. Distractions can also affect concentration and can come from interruptions by other staff, telephone calls, equipment breaking down or not being available and multi-tasking. Quality systems should be designed to be robust and help prevent staff from falling victim to slips and lapses. This will include, but is not limited to;

- Adequate working environment (e.g. lighting, space, equipment, logical design)
- Adequate staffing and skill mix
- Appropriate workloads
- Robust processes
- Accurate procedures
- Adequate training
- Access to information and expertise
- Leadership and supervision

Many report narratives hold staff solely responsible for the errors made. While in some cases this may be true, poor quality investigations and reports overlook the reasons that led to staff behaving and acting in the way that led to the error being made. The MHRA will often contact reporters to clarify details of their SABRE reports and discuss improvements to quality systems which may help prevent errors, but this cannot be done for every single report. It is possible that many of the SAE reports which fall into the procedure performed incorrectly and the procedural steps omitted/wrong procedure performed categories could be assigned to different subcategories with a more detailed investigation and SAE report.

Top five SAE

Procedure performed incorrectly and procedural steps omitted/wrong procedure performed account for over half the SAE reported. Since managing these types of error has been discussed above, the top five types of error have been assessed considering the remaining root cause by type only. There are two types of error which are in fifth place, bringing the total number of categories in the top five to six.

Table 25.5: Top five SAE with human error subcategory

SAE deviation subcategory	Specification subcategory
Incorrect blood component issued (IBCI)	Inadequate process
Sample processing error (SPE)	Inadequate process - staffing and workload
Incorrect blood component issued (IBCI)	Inadequate process - staffing and workload
Incorrect blood component issued (IBCI)	Ineffective training
Component labelling error (CLE) Pre-transfusion testing error (PTTE)	Inadequate process - staffing and workload Ineffective training

The following examples have been used to illustrate what might be considered effective CAPA to address the root causes. 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 clearly designed to focus on improvements to systems, practice and transfusion laboratories.

1) Incorrect blood component issued (IBCI) – inadequate process (n=58)

Irradiated components were required for a patient and the clinical area had emailed two biomedical scientists (BMS) with the requirements. One of the BMS had misread a note on the laboratory information management system (LIMS) referring to an atypical antibody and replied to the email stating that the requirement for irradiated components had been entered.

When blood was required for the patient a request form was sent which did not request irradiated blood. The patient was issued with and subsequently transfused with non-irradiated blood.

The investigation revealed that there was no formal process for the laboratory to action information from the clinical area and no instructions how to enter patient requirements into the LIMS.

CAPA required: Develop processes for receiving and actioning patient requirements and produce standard operating procedures (SOP) to detail the steps required to ensure information is added to patient records correctly.

2) Sample processing error (SPE) – inadequate process – staffing and workload (n=21)

A sample was received but the addressograph label had an incorrect date of birth. This was not spotted when the sample was booked in. The error occurred over a lunch time when staffing was low. The sample was booked in by someone who rarely works in transfusion.

CAPA required: Plan staffing levels and breaks appropriately so that sufficient staff are available to cover the work. If support staff are required to cover periods of low staffing, they must have the necessary level of training and experience to perform all tasks required.

3) Incorrect blood component issued (IBCI) – inadequate process – staffing and workload (n=19)

A patient with sickle cell disease required two units of blood. Rh phenotype performed and recorded correctly as R2R2. However, R1R1 blood was incorrectly selected and issued. The error occurred overnight, during a scheduled period of lone working covering transfusion and haematology, but volume of work and clinical pressures were identified as contributing to the pressure on the member of staff.

CAPA required: Staffing levels and workload need to be balanced at all times of the day. Capacity plans are essential for providing the evidence that lone working is acceptable. A risk assessment of lone working was performed, and a business case is to be developed to increase staffing on night shifts.

4) Incorrect blood component issued (IBCI) – ineffective training (n=18)

Irradiated blood was required for a patient, but non-irradiated issued in error. The requirement was on the LIMS but was not clear. It had not been entered according to the SOP, by a member of staff who does not perform the procedure very often.

CAPA required: It is essential that staff are trained to be able to perform the tasks expected of them, even if they rarely perform them. Periods between training and update training need to be considered carefully according to the individual. It may be required to train staff more frequently than other staff if they perform certain tasks less often.

5) A. Component labelling error (CLE) – staffing and workload (n=17)

Platelets Pack 1 and 2 from the same donor were issued to two different patients by a newly qualified trainee BMS under supervision. The BMS had no experience of multiple packs from the same donor. They were labelled separately, but the labels from Pack 1 were attached to Pack 2 and Pack 2 to Pack 1 in error. The supervisor was busy with other routine work and did not notice the error.

CAPA required: Staff turnover can present additional challenges for laboratory staff when managing workload. Training any member of new staff should be done carefully and the supervisor should not be multitasking when doing so. This incident demonstrates a number of failures, but ultimately, they result from an inappropriate level of staff to cope with the workload.

- Staffing levels are insufficient to be able to adequately train and supervise staff, and to complete routine workload
- This has resulted in the experienced BMS multitasking, rushing and not being able to concentrate on all the tasks expected of them
- Training appears to be inadequate if the trainee was not aware of multi-packs and selection and labelling of the correct component when printing labels

Ensure capacity plans include training and education of staff. Plan training for staff so that sufficient attention can be paid to supervision without compromising workload. Ensure training material covers all essential learning and do not assume that ‘newly qualified’ staff are fully aware of the practical aspects of working in the laboratory.

5) B. Pre-transfusion testing error (PTTE) – ineffective training (n=17)

A patient was transfused with emergency O D-negative blood inappropriately following a failure by the locum BMS to correctly test a patient sample. The antibody screen was positive and instead of running a panel, the antibody screen was retested. Blood was required and when requested by the clinical area, historic records were not thoroughly checked. Had they been, the BMS would have noticed the patient had an antibody result from 1989. The delay in performing the correct testing and checking resulted in the patient requiring emergency blood rather than matched blood. During investigation the BMS admitted to having ‘forgotten’ the correct procedures, but also it was noted that the training log did not provide evidence of complete training.

CAPA required: If staff have admitted to forgetting procedures then retraining is appropriate in these cases. However, a review of the training methods should also be undertaken to ensure that there are no training gaps and that any member of staff, locum or otherwise are fully competent to work alone.

Figure 25.6 shows the other subcategory and root cause for all SAE other than procedural steps omitted/wrong procedure performed and procedure performed incorrectly

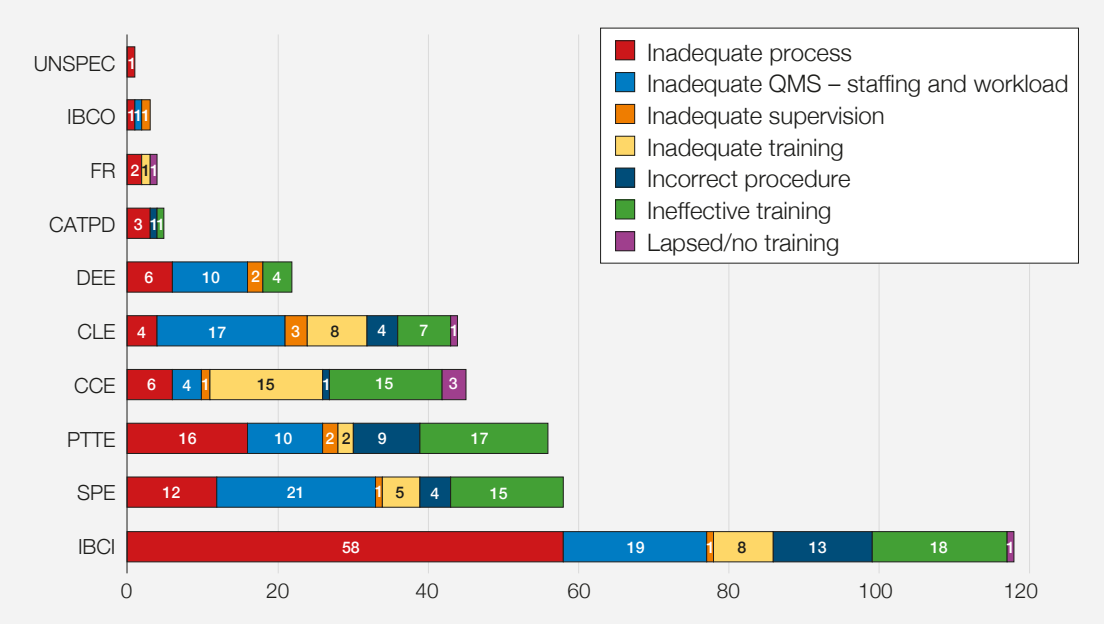


Figure 25.6: Root causes in the 'other' subcategory

See Figure 25.4 for key to category abbreviations

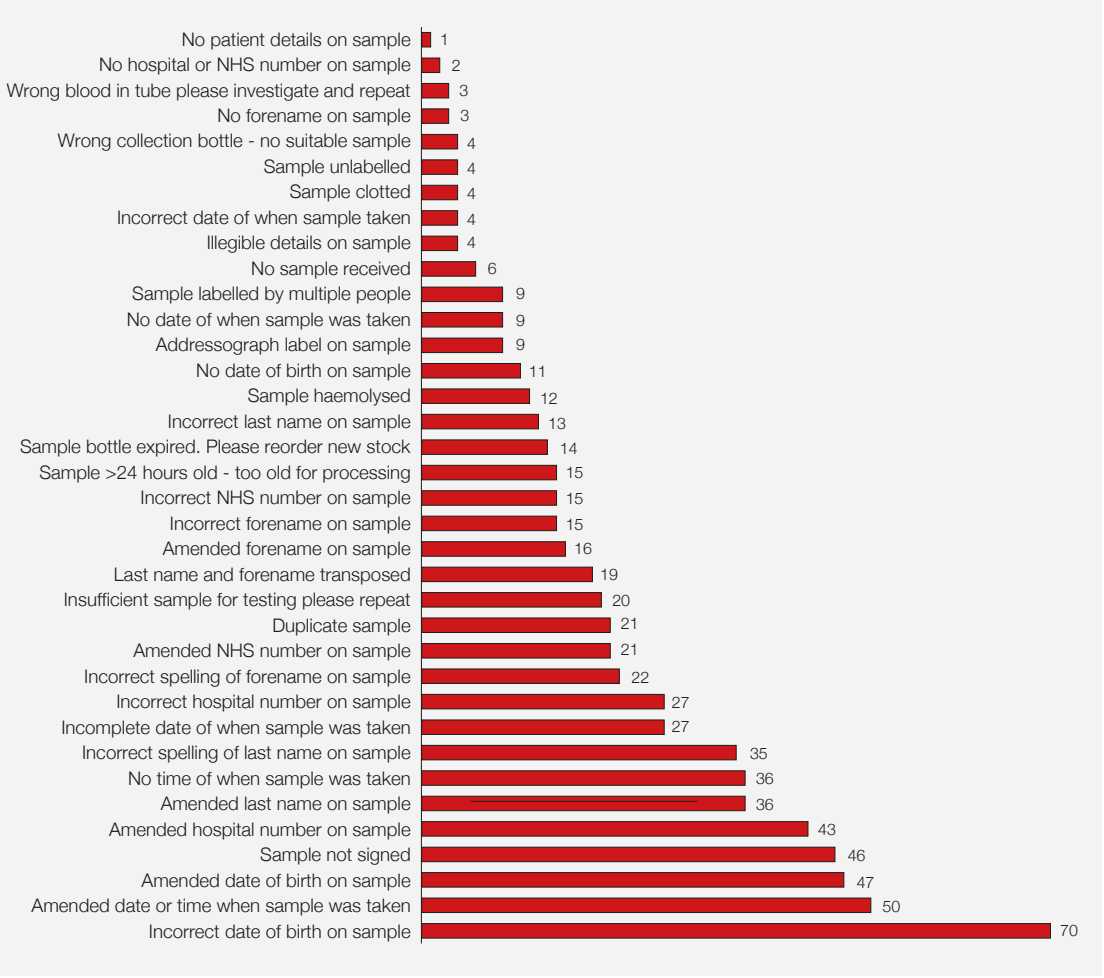
Sample processing errors (SPE) n=185

Following an increase in the numbers of SPE reports received, where discrepancies in sample labelling, forms and LIMS are not spotted when the sample is accepted into the laboratory, data has been obtained from a teaching hospital with a trauma centre to try and demonstrate the impact to the laboratory and resource from rejecting samples and investigating SPE. It is anticipated that readers will be able to assess the situation in their own laboratories to identify their own problems and solutions.

The rejection categories noted here reflect the hospital's own sample rejection policy and is not intended to demonstrate minimum compliance with British Society for Haematology (BSH) Guidelines. It should also be noted that a rejected sample is not reportable to SHOT unless it is a wrong blood in tube (WBIT) nor reportable to MHRA unless it is an SPE (see Appendix 2 for definition).

In 1 month alone, this hospital rejected 693 samples out of 7095 received, Figure 25.7

Figure 25.7: Reasons for rejected samples from blood transfusion



The hospital's own data estimates the cost of each reject to be £13 (to obtain the repeat sample, the cost of the tube, venepuncture, transport, sample receipt and processing, disposal of the rejected sample, contacting clinical areas and reporting). Therefore, this hospital spends £9009 per month on average when dealing with rejected samples.

Furthermore, the hospital estimates that each rejected sample takes around 90 seconds to process (confirm it is to be rejected, book in, result with comment, call and leave details for the clinical area). Therefore, for 693 rejects, this hospital spends around 18 to 20 hours of laboratory time each month, simply processing rejects. This does not include the time taken for the clinical area to collect another sample.

This reporter reported 61 SPE reports in 2018, approximately 5 per month. For each sample error that is not picked up and results in a result or component release a Datix incident is raised and the following occurs.

1. Datix raised=5 minutes
    - Log into Trust system
    - Enter details of error
    - Scan the request card and sample for evidence of the error

2. Transfusion practitioner (TP) team review and send out reflective statement request=10 minutes
   - Review type of error to ensure accuracy to Trusts reporting policy
   - Attach scanned evidence to Datix, including request card, sample image, audit log of staff involved
   - Ensure no impact to patient due to delay in transfusion
   - Email staff involved in the error attaching the witness statement
3. Staff involved in the error completing a review of their actions and sending back the witness statement – difficult to assess
4. Senior staff discussion with individual involved in the error=15-30 minutes
   - Review of the witness statement
   - Initial root cause
   - Recording onto trending spreadsheet
   - 1-2-1 discussion
5. Updating Datix system=20 minutes
   - Uploading statements and completing learning outcomes
   - Providing feedback to individuals in the system
6. Completing SABRE notification and footnotes etc.=10 minutes
   - Confirmation of incident
   - Loading of evidence
   - Additional footnotes if needed
   - Clarification of Trust Datix details and SABRE details and submit
7. Deliver training to individual if required=30-60 minutes depending on error
8. Incident review with clinical lead=5 minutes
9. Incident review with directorate governance=5 minutes

For each SPE, it is therefore estimated to take between 60 minutes to 2 hours to resolve, or 5-10 hours per month of laboratory time.

Finally, the monthly review meeting involves at least 3 senior BMS, a clinical lead, TP, manager and minute taker and can take 20 to 30 minutes, i.e. 2-3.5 hours of total staff time.

In conclusion, around 34 hours per month of laboratory time is spent dealing with rejected samples and investigating SPE in this hospital laboratory at a cost of just under £10,000. In summary, this example elicits the impact that this situation is having on the financial and human resource available at that hospital. It is understood that this case study may not reflect what is happening at every site but it does suggest that if sites carried out a fully joined up audit of the individual elements, both within the laboratory and the clinical areas, that impact on sample processing, resources could be allocated more effectively but more importantly possibly reduce the errors that occur.

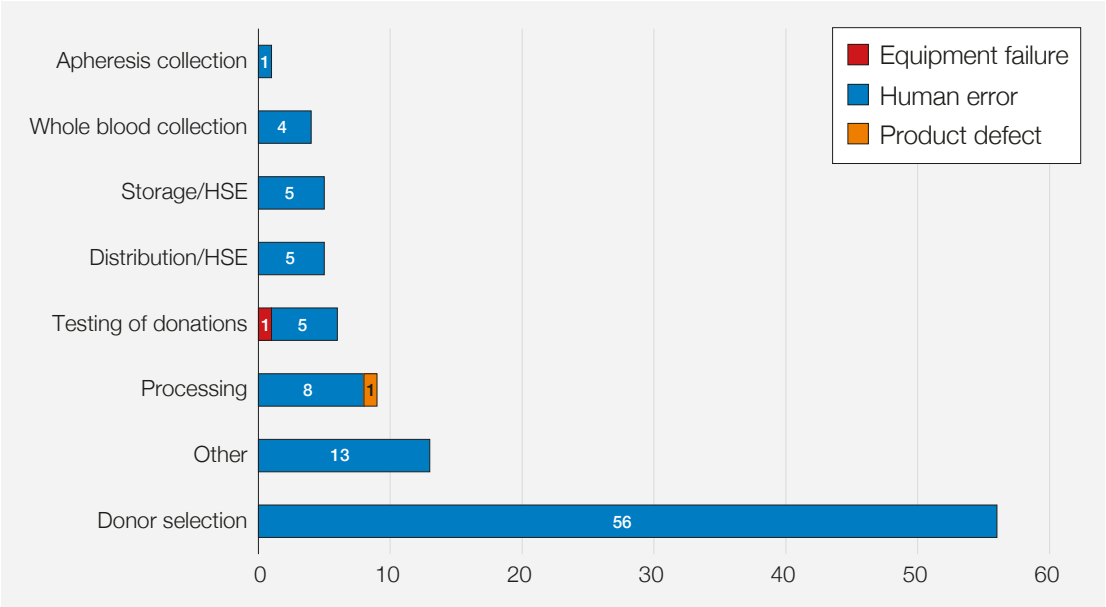
It is suggested that transfusion teams may want to adapt the principles of section 6.2 of the Good Practice Guide (GPG 2018) Collection of Blood and Blood Components to refer to the collection of patient samples.

Blood establishment reporting n=99 (-10)

The majority of SAE reports originate from hospital transfusion laboratories.

Although reports from blood establishments are included in the main analysis, the specific nature of the SAE reports from blood establishments are lost in the greater numbers of reported hospital transfusion laboratory SAE. Figure 25.8 displays the reported blood establishment SAE in 2018.

Figure 25.8: Blood establishment SAE category by specification



HSE=handling and storage errors

The European Commission introduced a new category for reporting BE SAE last year, donor selection. This category covers the appropriate selection or deferral and collection from donors and the identification and set up of discretionary testing for travel or lifestyle reasons. These were originally captured in the whole blood and apheresis collection categories, but now they refer to the collection process only.

Considering the changes to the categories, the spread of reports is virtually identical to previous years. Analysis of the reports which fall into the donor selection category are almost always where failures with previous donations have been identified during the donor's current health check. Many of the errors identified have therefore occurred many months or years previously, involving staff who have left the BE or have little recall of the circumstances. These are therefore hard to investigate thoroughly, but CAPA will invariably involve checking the member of staff is aware of the error and can correctly perform the procedure now. Between the historic error occurring and the identification of the error, collection processes, training and education have been improved as a matter of continuous improvement anyway.

Assessment of the other category, Figure 25.9, shows that the biggest single category is incorrect blood component issued, where incorrect blood has been sent for specific patients and can be either crossmatched or uncrossmatched. Of the 7 reported, 4 of them identified improvements to the process of selection and issue, and one identified a training need in an individual.

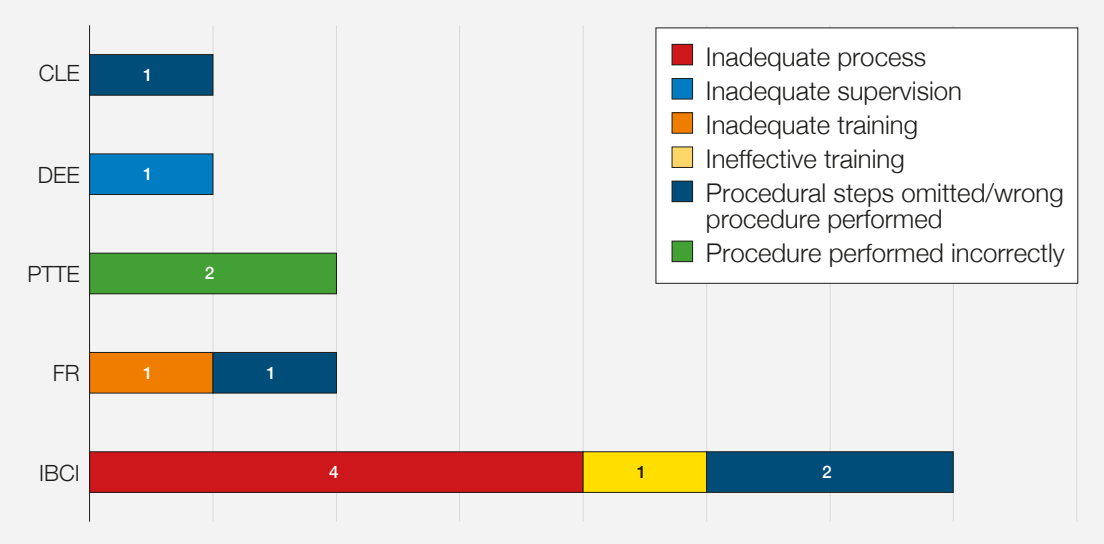


Figure 25.9: BE reports in 'other' category

See Figure 25.4 for key to category abbreviations

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 (CA) 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 immunoglobulin (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).

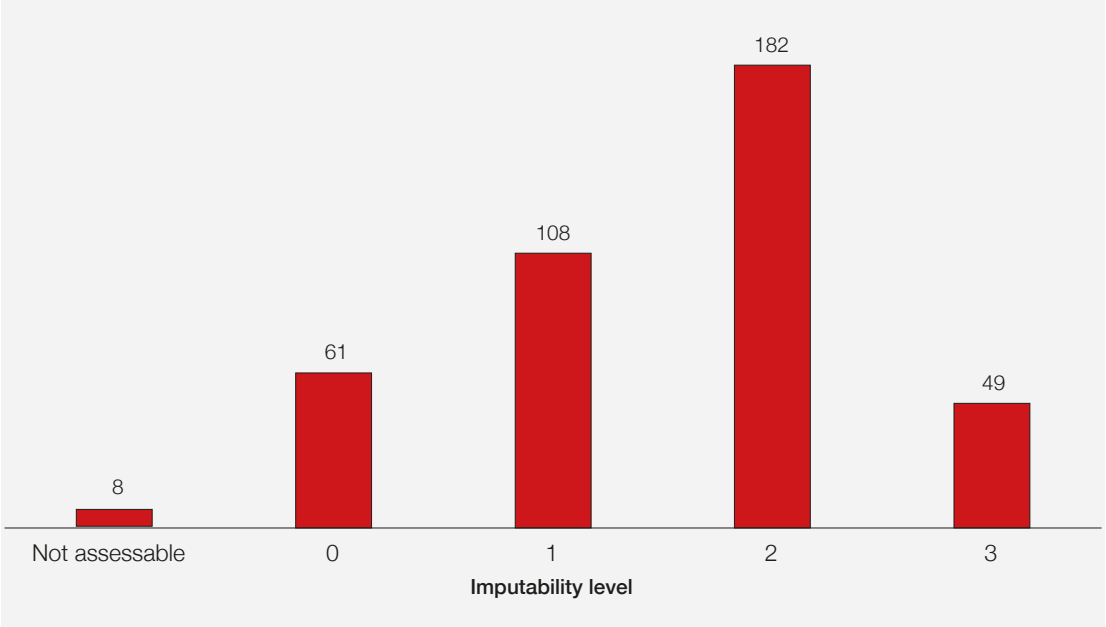
Summary of SAR report data

To avoid any confusion, the MHRA will only supply, in this Annual SHOT Report, total SAR figures reported to Europe, see Table 25.6.

	Imputability score				
	NA	0	1	2	3
SAR reports by imputability score	8	61	108	182	49

Table 25.6: SAR reports, by imputability, reported to SABRE in 2018 (n=408)

Figure 25.10 SAR reports, by imputability, reported to SABRE in 2018



Haemovigilance team managers update

Author: Mike Dawe

The MHRA recruited a new post of Haemovigilance Team Manager in March 2018.

The responsibilities of the post are designed to support the transfusion community in all aspects of the regulatory process that the CA is responsible for whilst ensuring the MHRA remain impartial. The aims of the post are to, provide help and support with QMS development design and maintenance through face to face meetings, workshops and strategies to further regulatory understanding.

The expected deliverables are:

1. Provide information whilst avoiding a conflict of interest relevant to BSQR
2. Provide advice and help within the regulatory framework
3. Create a communication flow where everybody can share success and failure between different sites (anonymised and with permission)
4. Keeping information both relevant, up to date, transparent but consistent and fair
5. Manage expectations of both the MHRA and the transfusion community
6. Removing cultural and fear factors associated with the regulatory process
7. Understanding the reporter's barriers and frustrations

Activity

Table 25.7: MHRA haemovigilance team manager visits

MHRA haemovigilance team manager visits	
Hospital blood banks (HBB)/BE	16
Regional Transfusion Committees/Laboratory managers/TP meetings	11
Manufacturers	6
Total	**33**

Initial findings and recommendations

The following findings have been observed:

- Sites are taking a United Kingdom Accreditation Service (UKAS) International Organisation for Standardisation (ISO) 15189 approach to QMS management, especially if their laboratory has achieved or is preparing for UKAS accreditation, instead of following the good practice guide (GPG)

The MHRA inspect against the GPG and sites must therefore ensure that their blood transfusion QMS complies with these guidelines. While there are similarities between the requirements of ISO 15189 and the GPG in some areas, compliance with ISO 15189 alone will not be sufficient for a site to demonstrate compliance with MHRA requirements.

- Sites are stating that in blood transfusion (BT) UKAS are contradicting the MHRA in their QMS approach i.e. over reporting of incidents

These issues should be referred to the MHRA either through the Haemovigilance Team Manager and/or the GMP inspectors via gmpinspectorate@mhra.gov.uk.

- The blood compliance report (BCR) is confusing and there is a need for a more detailed guide on how to complete it

The BCR guidance document aims to provide sufficient instructions to support completion of the form without containing unnecessary details. We periodically review and update the guidance document in response to feedback, and where clarification is needed this can be requested from gmpinspectorate@mhra.gov.uk. As part of good practice obligations, sites should have appropriate systems and sufficient expertise to be able to provide the requested information.

- Loss of experienced staff in good practice principles
- Lack of available capacity and knowledge to balance operational need with MHRA compliance
- Lack of BT experienced BMS staff to fill vacant spaces

It is the responsibility of the sites executive management to ensure that the appropriately qualified and experienced staff are available to deliver the appropriate level of operational function within their blood transfusion departments. The relevant references within the GPG are, 1.2.2, 1.2.5, and 2.2. Sites are also responsible for ensuring that an effective capacity plan is put in place to demonstrate that the staffing level is enough to cover the workload including out-of-hours working and effective implementation of the quality management system. Where a shortfall is identified, senior management should act to ensure enough resource is available.

Sites are encouraged to contact the Haemovigilance Team Manager directly for any questions that they have regarding good practice principles or alternatively use the MHRA Forum to post their question and/or visit https://www.gov.uk/guidance/blood-authorisations-and-safety-reporting for relevant advice.

Summary

The initial feedback has been very positive and has helped sites and manufacturers understand their regulatory responsibilities.

These services can be accessed by everyone involved in blood transfusion including manufacturers to help support the protection of public health, maintain supply of blood and blood components and try to avoid the need for regulatory action.

For further information, contact the Haemovigilance Team Manager:

E-mail: Mike.Dawe@mhra.gov.uk

Office Telephone Number: 0203 0806239

MHRA inspection activity on hospital blood banks 2017-2018

Author: Shirley Stagg

A total of 304 BCR were submitted for review for the reporting period 01 April 2017 to 31 March 2018. Thirty-one HBB including four 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 BE and HBB.

Inspection outcomes

Inspections for the reporting period 01 April 2017 to 31 March 2018 are performed in the following year, i.e. from 01 April 2018 to 31 March 2019. At the time of writing, a total of 24 inspections had been performed at 24 sites, and the numbers of deficiencies are as follows:

Table 25.8: MHRA inspection deficiencies

Critical	Major	Other
0	41	76

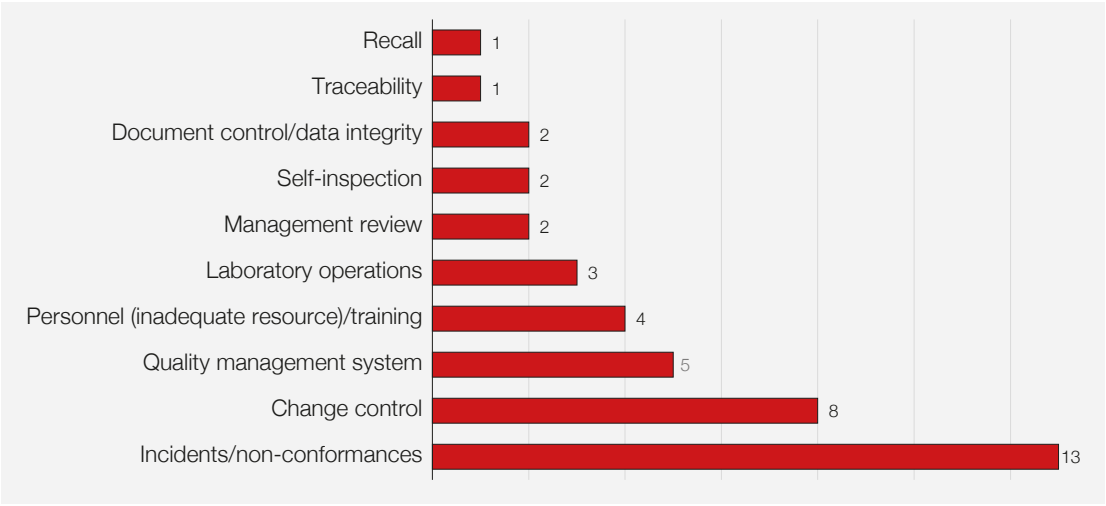
Three HBB had significant deficiency findings related to their operations and were escalated to the CMT. Common deficiency groups from these inspections included:

- Traceability
- Laboratory operations
- Change control and validation*
- Non-conformances/incident/events and CAPA implementation*
- Data integrity
- Self-inspection*
- Training*

Note those marked with * have been the most common deficiencies from inspections escalated to the CMT over the past 3 years.

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/

Figure 25.11: Categories of major deficiencies found



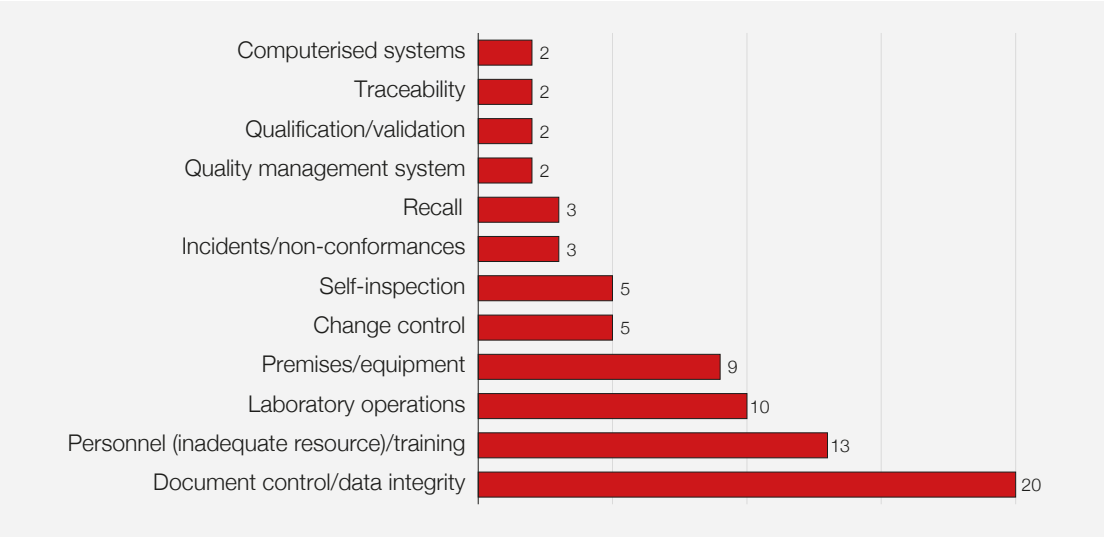


Figure 25.12: Categories of other deficiencies found

Summary of significant issues identified at inspected sites

Quality management systems (QMS)

Senior management has the ultimate responsibility to ensure an effective quality system is in place, adequately resourced and that roles, responsibilities, and authorities are defined, communicated and implemented throughout the organisation. There should be periodic management review and monitoring both of its effectiveness, with the involvement of senior management and of the operation of the quality system. Evidence from inspections showed a lack of senior management review including a failure to identify actions to be taken (with timelines and responsibilities) to address poor performance of the QMS. Items frequently reported to senior management meetings included:

- Insufficient resource to maintain an effective QMS at the same time as ensuring service delivery
- Overdue document review
- Overdue CAPA including MHRA commitments
- Overdue competency assessments for laboratory staff
- Overdue self-inspections

Minutes from quality meetings frequently failed to acknowledge such failures in quality metrics and there were often no documented actions raised to address these issues.

Many transfusion laboratories did not have a system in place for senior management to authorise the formal extension of target dates for CAPA, self-inspection and change control. It is crucial that all overdue quality items should be discussed, and risk-assessed, on the impact caused by the delay in completing the agreed commitments.

Non-conformances/incidents/events

Incident investigations continue to be an area of concern and were the most frequent major deficiency raised during the 01 April 2018 to 31 March 2019 inspection cycle. Example deficiencies include:

- Investigations and root cause analysis lacked adequate depth, detail and scope
- Data from investigations and incidents were not routinely analysed to identify unfavourable trends that may require preventative action
- Where root cause analysis had been performed, the determined root causes were typically human error without adequate justification. This approach failed to ensure that other causes such as system, process and environmental issues were adequately reviewed

An appropriate level of investigation and root cause analysis should be applied during the investigation of incidents; this can be determined using quality risk management principles. There were several examples during inspection that showed that risk assessment did not form part of the procedure for managing non-conformances. Where Trust/Health Board level systems were used to report incidents, severity was frequently linked to the actual harm caused in the incident under investigation rather than the potential harm that the incident could cause. As such the potential for harm was not adequately addressed to guard against harm events in the future.

Change control management

The control of changes continues to be cited in a high number of major deficiencies. Examples of system weaknesses included:

- A failure to raise change controls for significant changes
- A failure to raise change controls at the time the change was proposed
- Lack of formal authorisation or approval of changes
- No user requirement specification (URS) for equipment facilities and systems to form a reference point for qualification and validation activities
- Quality risk management was not used to evaluate planned changes
- Risks that had been identified were not addressed before implementation of changes
- Lack of justification for deviations and failures during the execution of validation
- Significant delays were not authorised or impact assessed

Laboratory operations

Inadequate investigation of analyser internal quality control (IQC) failure continued to be a common finding. Little attention was given to establishing why the IQC had failed before process re-runs were initiated. A single passing repeat could be used to invalidate a failed test. Investigation to identify potential causes of failure was not always evidenced.

Other typical deficiencies seen included:

- Test cards and reagents were stored in unmonitored or poorly monitored locations
- Calibration reports for equipment used for measuring, weighing, recording and control were not reviewed and signed to show acceptance by the laboratory
- Thawer programmes were not validated for use with multiple units at the same time or for all types of components such as smaller paediatric units

Personnel/training/resourcing

Management has the responsibility to determine and provide adequately trained and competent personnel to carry out laboratory activities and to implement and maintain the QMS. The responsibilities placed on any one individual should not be so extensive as to present any risk to quality. There are examples from inspections that showed a failure to determine the required numbers of personnel during each shift in the HBB and no plan of the actions to take should levels fall below the requirements. The inadequate availability of personnel was evident in QMS metrics.

The lack of up to date training and competency records was a common finding during inspections. This applied to laboratory personnel and personnel involved in the distribution of blood components. Personnel awareness of new and updated procedures was often not well controlled with inadequate action being taken to address those individuals that did not acknowledge procedures in a timely fashion.

Consideration must be given to the training requirements of personnel that may work alone or with limited access to other trained individuals for example, overnight in the laboratory. Where procedures require a second check to reduce risk there must be an assessment in place to demonstrate how this risk will be mitigated when a second person is not available.

Documentation and data integrity

Poor documentation practice and data integrity remains the most cited 'other' deficiency. Examples of this included:

- Poor documentation practices such as blank fields, uncontrolled deletions, obliteration and overwriting
- Procedures not always recording all critical steps
- No audit trail functionality for electronic QMS
- Controlled documents overdue their review date
- Login details and access codes not stored securely

Recall

Most deficiencies associated with recall were around the lack of evaluation of the effectiveness of arrangements for recall and the recall system not being used for internal recalls.

Information and guidance

For further information on the 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. http://forums.mhra.gov.uk/forumdisplay.php?60-Blood-Forum.

References

BSQR (2005) The Blood Safety and Quality Regulations. http://www.legislation.gov.uk/uksi/2005/50/regulation/1/made [accessed 31 May 2019].

CIEHF (2019) Chartered Institute of Ergonomics and Human Factors: What is ergonomics? https://www.ergonomics.org.uk/Public/Resources/What_is_Ergonomics_.aspx [accessed 31 May 2019].

Council of Europe (2016) Good Practice Guidelines for blood establishments. https://www.edqm.eu/en/good-practice-guidelines-blood-establishments [accessed 31 May 2019].

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
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

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