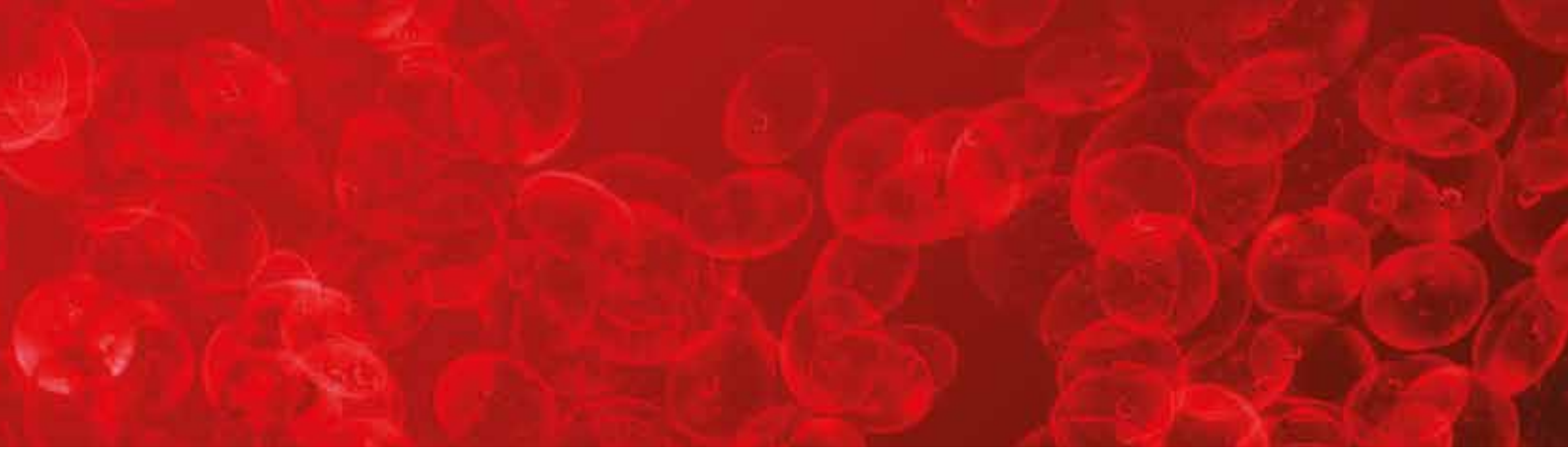

ANNUAL SHOT REPORT 2011

Affiliated to the Royal College of Pathologists

The Steering Group includes members representing the following professional bodies:

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

SERIOUS HAZARDS OF TRANSFUSION SHOT

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Contents

Page	Chapter
5	**1.** Foreword – *Paula Bolton-Maggs and Hannah Cohen*
7	**2.** Participation in SHOT Haemovigilance Reporting Scheme – *Debbi Poles and Paula Bolton-Maggs*
12	**3.** SHOT Updates and Developments – *Paula Bolton-Maggs and Hannah Cohen*
16	**4.** Summary of Main Findings and Cumulative Results – *Paula Bolton-Maggs and Hannah Cohen*
21	**5.** Key Messages and Recommendations – *Paula Bolton-Maggs and Hannah Cohen*
	Analysis of Cases Due to Errors
26	**6.** Incorrect Blood Component Transfused (IBCT) – *Julie Ball and Paula Bolton-Maggs*
35	**7.** Errors Related to Laboratory Practice – *Deborah Asher and Hema Mistry*
53	**8.** Errors Related to Information Technology (IT) – *Megan Rowley*
64	**9.** Inappropriate, Unnecessary or Under/Delayed Transfusion (I&U) – *Julie Ball and Paula Bolton-Maggs*
74	**10.** Right Blood Right Patient (RBRP) – *Alexandra Gray*
77	**11.** Handling and Storage Errors (HSE) – *Alexandra Gray*
82	**12.** Adverse Events Related to Anti-D Immunoglobulin (Anti-D Ig) – *Tony Davies*
	Analysis of Cases Due to Pathological Reactions
92	**13.** Acute Transfusion Reactions (ATR) – *Hazel Tinegate and Fiona Regan*
101	**14.** Haemolytic Transfusion Reactions (HTR) and Alloimmunisation – *Clare Milkins*
	Pulmonary complications:
110	**15.** Transfusion-Related Acute Lung Injury (TRALI) – *Catherine Chapman*
114	**16.** Transfusion-Associated Circulatory Overload (TACO) – *Hannah Cohen*
119	**17.** Transfusion-Associated Dyspnoea (TAD) – *Hannah Cohen*
123	**18.** Post-Transfusion Purpura (PTP) – *Catherine Chapman*
126	**19.** Transfusion-Associated Graft Versus Host Disease (TA-GvHD) – *Catherine Chapman*
128	**20.** Transfusion-Transmitted Infection (TTI) – *Claire Reynolds*
133	**21.** Cell Salvage and Autologous Transfusion (CS) – *Joan Jones*
	Special Clinical Groups
138	**22.** Paediatric Cases – *Helen New*
147	**23.** Transfusion Complications in Patients with Haemoglobin Disorders – *Paula Bolton-Maggs*
152	**24.** MHRA Regulatory Haemovigilance – *Judy Langham*
165	**25.** Near Miss (NM) Reporting – *Alison Watt*
178	Acknowledgements
179	References
184	Glossary

1. Foreword

Authors: Paula Bolton-Maggs and Hannah Cohen

The 15th Annual SHOT Report is compiled from data received between January and December 2011 by the SHOT UK national haemoviligance scheme. We are approaching universal participation with 98.4% of National Health Service (NHS) Hospitals, Trusts and Health Boards across the UK now being registered to report to SHOT. Registrations for independent organisations have also increased. The number of reports has increased to a total of 3038 in 2011 (this total includes 'near miss' and 'right blood right patient' events which by definition caused no harm) which represents an increase in analysed reports of 23.3% (3038 vs 2464) compared to the 2010 Annual Report. This year we have also received a small number of reports which refer to more than one patient, which brings the total cases analysed to 3054 overall. These multiple reports are detailed further in the Anti-D and Handling and Storage Errors (HSE) chapters. We are pleased that for the second year that there have been no cases of transfusion-transmitted infections (TTI) and also that the reduction in transfusion-related acute lung injury (TRALI) since 2003/2004 has been maintained. However, the reduction in incorrect blood components transfused resulting from clinical and laboratory errors has not been maintained and causes for this are discussed.

The increased participation is pleasing, both in terms of numbers of organisations and numbers of reports. Benchmarking data are now presented in the report, and have been sent out to participating establishments so that they can compare their rates against others. There is no right level of reporting. The important principle is to learn from things that go wrong or that cause harm so that patients can be safer. The record of transfusion is very good, with about 3 million components issued in the UK per annum, and a very low rate of death (8 in 2011 with imputability of 3 in 2) and major morbidity related to the transfusion. Furthermore, there is a continued decrease in the proportion of deaths and major morbidity, 34% in 1996/7, 7.8% in 2010 and 6.9% in 2011, which is a testament to successful haemovigilance.

For the first time this year there is a report from the Medicines and Healthcare products Regulatory Agency (MHRA) Serious Adverse Blood Reactions and Events (SABRE) reporting system, and work has begun to see to what extent our two systems for haemovigilance can be harmonised. The activities of MHRA are mandated by the EU Directives[1-4] transposed into UK law whereas SHOT, professionally mandated and a requirement of Clinical Pathology Accreditation[5], Health Service Circulars[6-8] and in the Healthcare Standards for Wales and Scotland[9 10], has a wider and potentially more variable remit enabling modification and addition of reporting categories.

About half the reported events are due to mistakes. Analysis of the 'near miss' data for the past two years indicates that for every 'wrong blood in tube' error that results in a wrong blood incident, there are about 100 'near miss' sample mistakes. It is interesting to see that most of the events reported to MHRA are also based on human error. We must all work together to reduce this, which means continued examination of our hospital transfusion processes. It is clear from the data reported here that identification of the correct patient remains a key issue and that this must become a core clinical skill.

The need for education and training about blood transfusion has been a recurring theme in SHOT reports, and competency assessment was first recommended in the 2001-2 report[11]. Although progress is being made with this, it is clear that it is still not sufficiently effective, and that it needs to be underpinned by better knowledge and understanding of transfusion serology in the laboratory and of transfusion medicine in the clinical arena. Work is therefore in progress through the CMO's National

Blood Transfusion Committee (NBTC) subcommittees and the UK Transfusion Laboratory Collaborative (UKTLC) with UK National External Quality Assessment Scheme (NEQAS) Blood Transfusion Laboratory Practice (BTLP) to assess knowledge and to develop better competency assessments. To limit avoidable patient morbidity and mortality arising from blood transfusion, including in relation to inappropriate and unnecessary transfusions, it remains essential that knowledge of transfusion medicine must be part of the core curriculum for all clinicians, as was recommended for doctors in training last year[12]. Knowledge of prescribing or authorising of blood components should also be recognised as a core clinical requirement. The education subgroup of the NBTC is evaluating the transfusion medicine content of undergraduate, postgraduate and specialty training curricula to ensure that there is adequate educational content.

Acute transfusion reactions (ATR) provide the largest category of pathological and unforeseen events, and are the leading cause of major morbidity in 2011. Analysis of these events in this report is accompanied by further guidance on classification which will also be published in forthcoming British Committee for Standards in Haematology (BCSH) guidelines for the management of these reactions[13]. Transfusion-associated circulatory overload (TACO) remains an important cause of potentially avoidable major morbidity and death, and an amendment to the BCSH guidelines on blood administration[14] on measures to avoid TACO is planned.

Paula Bolton-Maggs DM, FRCP, FRCPath
Medical Director, Serious Hazards of Transfusion

Dr Hannah Cohen MD FRCP FRCPath
Chair, SHOT Steering Group

2. Participation in SHOT Haemovigilance Reporting Scheme

Authors: Debbi Poles and Paula Bolton-Maggs

Introduction

The quality of SHOT data can only be assured if there is active engagement in the haemovigilance process by all participants. In 2011, 3435 reports were made to the scheme, of which 2768 potentially hazardous events were analysed. The remaining 667 reports were either withdrawn because they did not meet the SHOT criteria or were incomplete and will be included in the 2012 report.

The total number of reports analysed for 2011 was 3038 (this total includes 'near miss' and 'right blood right patient' events which by definition cause no harm), 270 of which were first reported in 2010 but only completed during 2011. Overall, this represents an increase in analysed reports of 23.3% (3038 vs 2464) compared to the 2010 Annual Report.

Number of reports by UK country

Table 2.1 Total number of reports to SHOT by UK country 2008-2011

	2008		2009		2010		2011	
	Number	%	Number	%	Number	%	Number	%
England	1816	83.4	1983	80.2	2511	78.5	2749*	80.0
Northern Ireland	68	3.1	70	2.8	154	4.8	150	4.4
Scotland	148	6.8	189	7.6	332	10.4	352	10.2
Wales	145	6.7	233	9.4	203	6.3	184	5.4
United Kingdom	**2177**	100.0	**2475**	100.0	**3200**	100.0	**3435**	100.0

**Includes 2 reports from MOD overseas*

Table 2.2 Total issues of blood components from the Blood Services of the UK in calendar year 2011

Blood Service	Red blood cells	Platelets	FFP	SD-FFP	MB-FFP*	Cryoprecipitate	Total
NHS Blood & Transplant	1,829,951	260,278	248,163	53,362	12,653	122,516	2,526,923
Northern Ireland Blood Transfusion Service	53,318	7,313	6,266	2,842	395	1,043	71,177
Scottish National Blood Transfusion Service	191,037	24,907	21,596	4,680	1523	2,254	245,997
Welsh Blood Service	87,831	9,130	12,217	2,330	389	357	112,254
TOTAL	**2,162,137**	**301,628**	**288,242**	**63,214**	**14,960**	**126,170**	**2,956,351**

** Paediatric/neonatal MB-FFP are expressed as single units; all other components are adult equivalent doses*

The number of reports of pathological reactions should correlate with the number of components issued. Using the number of components issued as a comparator, the number of reports per 10,000 units has again increased, but there remains a difference in the rate of reporting by the four UK countries.

Table 2.3 Total number of reports per 10,000 components by UK country 2007-2011

	2007	2008	2009	*2010	**2010	2011
England	4.6	7.7	8.1	8.9	10.1	10.9
Northern Ireland	6.6	10.0	10.5	16.0	20.8	21.1
Scotland	3.1	5.4	6.8	10.6	12.2	14.3
Wales	8.4	12.3	19.6	15.2	18.1	16.4
United Kingdom	**4.8**	**7.8**	**8.5**	**9.5**	**10.9**	**11.6**

** Column 1 for 2010 reports is calculated using the total number of completed reports in 2010, which is directly comparable to the historical data.*

*** Column 2 for 2010 is calculated using the total number of reports that have been started in 2010 (3200), including those which are not completed and were therefore not analysed in the rest of the 2010 report. These figures are not directly comparable to historical data, but are more indicative of the actual participation in 2010 and correlate to the figure used to monitor participation 2011 and forthcoming years.*

Total number of reporting organisations

The total number of reporting organisations registered on Dendrite in the SHOT database has risen to 225 in 2011 from 208 in 2010. Of the 225 organisations reporting to SHOT, 186 are NHS Trusts or Health Boards and 38 are independent hospitals or laboratories, others relate to the Ministry of Defence blood supply. As there are a total of 189 NHS organisations in the UK, this represents a participation rate of 98.4% for NHS organisations using the Dendrite reporting system since its inception. Table 2.4 demonstrates that there were only 8 UK NHS organisations who did not submit any reports in 2011 compared to 10 in 2010. Of the 38 independent organisations, 25 of these submitted reports in 2011.

Table 2.4 NHS Trust/Health Board participation in the UK in 2011

	Number of NHS organisations	Organisations registered on Dendrite	Organisations with no reports made in 2011
England	163	160	6
Wales	6	6	0
Scotland	15*	15	2
Northern Ireland	5	5	0
TOTAL	**189**	**186**	**8**

** This figure includes 1 Special Health Board that has also made reports to Dendrite.*

Categorisation of incidents reported

In order for SHOT incident specialists to analyse reports received it is important that as much information as possible is gathered, and all questionnaires are completed as fully as possible, and in the appropriate category. The full set of questions for each category are now available to download from the Dendrite reporting database under the 'Documents' section on the Main Menu. If reporters are uncertain, they might find it helpful to look at these before completing their reports.

In 2011 204 (5.9%) reports were initially reported in an inappropriate category (see Table 2.5) and required further information or a new questionnaire to be completed by the reporter. A number of these reports were not completed in time to be included in this year's report, so will roll over to the 2012 report.

Decisions about the primary cause of a reaction can be difficult and would be helped by having more details in many cases. The incident specialists are happy to discuss cases, and reporters are encouraged to modify their reports if further information becomes available. If necessary, closed cases can be reopened by contacting the SHOT office.

Cases with pulmonary symptoms can be particularly difficult to classify and for that reason we have a more detailed questionnaire in the Dendrite database for these from January 2012. Table 2.5 shows that 16 cases initially classified as acute transfusion reactions (ATR) had pulmonary features and were moved to 'transfusion-associated dyspnoea' (TAD). Twelve cases initially classified as 'previously uncategorised complication of transfusion' (PUCT) were reclassified as ATRs. Reporters are urged to obtain as much information as possible particularly for cases associated with major morbidity or death so that we can be clear whether the transfusion event played a part and attribute the correct level of imputability.

Table 2.5
Number of reports transferred between categories in 2011

Original category	Transferred to category											
	Anti-D	ATR	CS	HSE	HTR	I&U	IBCT	NM	RBRP	TAD	TACO	Total
Anti-D								44				**44**
ATR			2	1	1					16	9	**29**
HSE						4	9	4	8			**25**
HTR		5										**5**
I&U				4			5				1	**10**
IBCT				6	1			1	5			**13**
NM	1			3	1	3	3		1			**12**
PUCT		12									1	**13**
RBRP		6		8		6	16	5				**41**
TAD											3	**3**
TACO										2		**2**
TRALI										1	6	**7**
Total	**1**	**23**	**2**	**22**	**3**	**13**	**33**	**54**	**14**	**19**	**20**	**204**

Benchmarking participation data 2010

Individual participation data have now been produced for each reporting organisation to enable users to monitor their own reporting frequency against comparable establishments.

Reporting organisations are grouped in two separate ways:

- Clustered by size according to their usage of blood components.
- Geographically, grouped according to their UK country or Regional Transfusion Committee (RTC).

A summary report has been distributed to each NHS organisation showing their participation levels, split by category of report. Examples of the graphs for geographical location, and usage clusters are displayed below. However, independent organisations will only receive an individual summary report due to the difficulty in obtaining usage data and representing some of the very low usages in a meaningful way.

Figure 2.1
RTCs & countries reports per 1000 components issued by category
*Anti-D reports per 100 doses issued

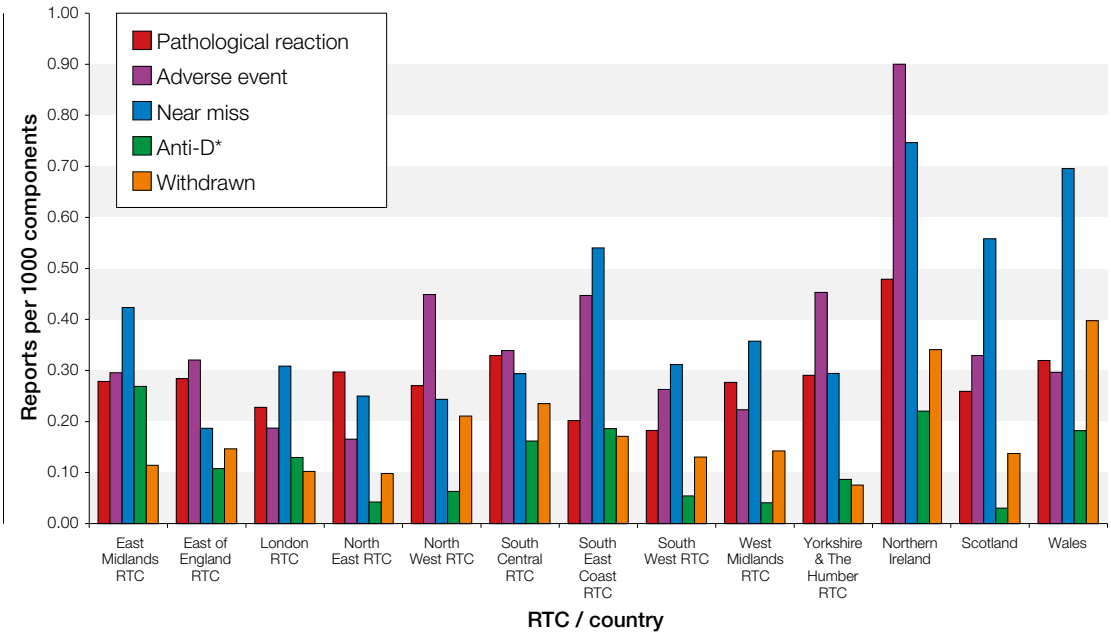


Figure 2.2–2.5
2010 participation

Total reports
per 1000 blood
components issued

Figure 2.2 Low usage organisations

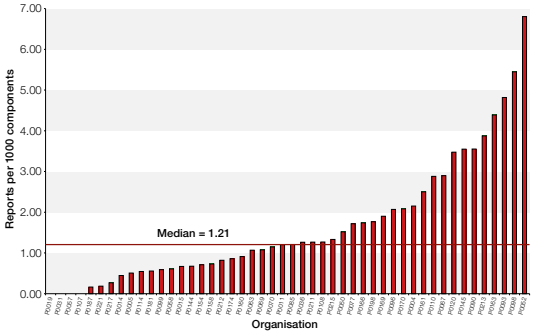


Figure 2.3 Medium usage organisations

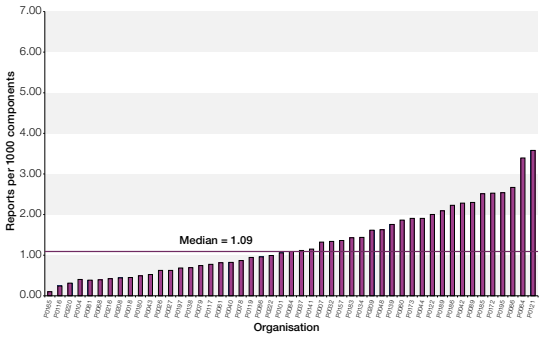


Figure 2.4 High usage organisations

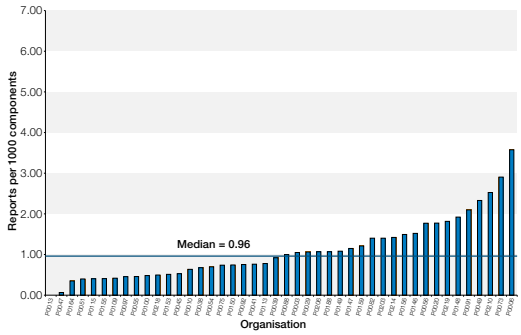
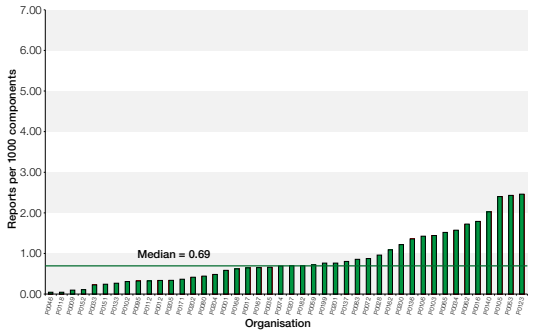


Figure 2.5 Very High usage organisations



COMMENTARY

Although there has been an increase in the total number of reports submitted to SHOT and more organisations are reporting all types of incidents, there are still 8 UK NHS organisations who have not participated in the SHOT haemovigilance scheme during 2011. This is surprising since 3 of these are high users of red cells, however 2 are very small users and 3 appear to be supplied from other hospitals, so might have made reports via their suppliers.

The benchmarking graphs show a range of 0.69 to 1.21 for the median number of reports per 1000 components issued, with a range in each category from 0 to 6.8 for low users, 0.10 to 3.58 for medium users, 0-3.58 for high users and 0.04-2.46 for very high users.

New guidance on safety and quality from the General Medical Council – 'Good Medical Practice 2012'

Reporting of adverse events and reactions should be part of any medical organisation's activity and culture. It is disappointing and worrying that this year we have been informed of a number of serious events where the organisations were reluctant to permit reporting to SHOT. In October 2011 the General Medical Council issued new draft guidance – 'Good Medical Practice 2012'[97]. This includes a section on a doctor's duty to report poor practice (Domain 2: safety and quality). Doctors are reminded that they 'must help to reduce risk to patients by…providing information for confidential inquiries and significant event recognition and reporting'. Doctors are also reminded that they must respond to risks to safety, including drawing such matters to the attention of the employing body and further if necessary by obtaining independent advice. A more detailed guidance document, ' raising and acting on concerns about patient safety' gives more information on how and what to report[98]. The need for a supportive culture is helpfully discussed by James 2012[99]. The nursing and midwifery council (NMC) standards also include the importance of recognising and acting on any observed practice where patients are put at risk (standards 32-34)[100]. SHOT therefore encourages staff participating in the transfusion process to continue to report adverse events in order that we continue to learn how to improve transfusion safety.

Recommendations

- All hospitals/Trusts and Health Boards where transfusion activity takes place should be vigilant for errors in the transfusion process and also report unexpected pathological reactions to SHOT and the Medicines and Healthcare products Regulatory Agency (MHRA) in accordance with European Union (EU) directives transposed into UK law and recommendations from professional bodies.

  Action:Trust/Hospital/Health Board chief executive officers (CEOs), hospital transfusion teams (HTT).

- Reporters should gather as much information as possible about the events they report, and complete the relevant questionnaires on Dendrite fully. This enables the SHOT incident specialists to evaluate the event and ensure it is in the appropriate category.

  Action: HTT

For active recommendations from previous years and an update on their progress, please refer to the SHOT website

3.

SHOT Updates and Developments

Authors: Paula Bolton-Maggs and Hannah Cohen

Dendrite updates

At the end of 2011 several modifications were made to the Dendrite database, which came into operation on January 1st 2012. A new questionnaire has been included to capture more information about patients who develop respiratory symptoms during or after transfusion. This will help to attribute cases more easily to the categories of transfusion-related acute lung injury (TRALI), transfusion-associated circulatory overload (TACO) and transfusion-associated dyspnoea (TAD), and also to differentiate those with respiratory symptoms from other types of acute transfusion reactions. We welcome feedback on these changes. The full questionnaires for all the reporting categories can be downloaded from the Dendrite SHOT database.

There have been minor changes to some definitions in the delayed haemolytic transfusion reaction (HTR) category – those reactions with development of an antibody with a positive direct antiglobulin test (DAT) but no clinical or laboratory evidence of haemolysis should be reported as alloimmunisation. When reporting acute transfusion reactions, it is important to assess the grade of severity. Definitions are provided in the 'Definitions of Current SHOT Categories and What to Report' document on the website (and these are in accordance with the forthcoming British Committee for Standards in Haematology (BCSH) guideline on acute transfusion reactions[13]). We have included haemosiderosis. This is included in the International Haemovigilance Network (IHN)/International Society of Blood Transfusion (ISBT) definitions[15] and there are concerns that transfusion overload may be missed, particularly in young survivors of leukaemia and others who are frequently transfused. However, SHOT does not want to include patients with haemoglobin disorders on long-term transfusion regimens with chelation.

Collaboration between SHOT and the Medicines and Healthcare products Regulatory Agency (MHRA)

From September 2011 a series of meetings have taken place with SHOT and MHRA staff to work together towards a more integrated haemovigilance system. However, the objectives for the two systems, and the methods of analysis of the data are different, with MHRA data collection being governed by the requirements of European Union (EU) Directives[1-4] while SHOT records clinical events in detail and has the freedom to add or change categories. The reports submitted to SHOT are not visible to MHRA. Judy Langham (MHRA) explains some of the differences in Chapter 24. In future, meetings will take place quarterly to compare mortality and major morbidity data to see if any differences in classifications can be reconciled. In the short term we hope to have a single entry portal to avoid reporters having to undertake duplicate entry of demographic and age data, and in the long-term a single system with different algorithms for SHOT and MHRA. Reporters should be reassured that this will not result in more inspections or punitive actions.

Working with specialist societies and colleges

There is interest in examining SHOT data by specialty area, for example to see how many events occurred in theatres (of interest to surgeons and anaesthetists), or in intensive care, or in medical wards. We have met with representatives of several Colleges and plan to submit articles to some of their bulletins and journals to bring SHOT data and the need for education and training to their attention.

Publications group

A publications group has been formed to oversee the use of SHOT data in publications and to ensure a high standard and appropriate placement. This is chaired by Hannah Cohen.

New reporting categories

There is ongoing concern about the RhD negative mothers whose anti-D Ig prophylaxis is delayed or missed, and who are at risk of sensitisation with possible consequences in future pregnancies. Although we ask for follow-up data from these women, very little information is returned, and there is reluctance to test. The current prophylactic regimens, even if given appropriately, may not provide adequate protection against sensitisation[16-18]. A checklist for anti-D administration is available on the SHOT website to assist practitioners to get this right (www.shotuk.org/resources/current-resources/). From the beginning of 2013 we will be seeking additional information about women who are found at booking, during pregnancy or at delivery to have developed a new anti-D. Two such cases were reported to SHOT in 2011, and there were a further 7 cases where an immune anti-D detected in pregnancy was assumed to result from previous prophylactic treatment earlier in pregnancy (but this treatment had not taken place). Six infants were born with haemolytic disease of the fetus and newborn (HDFN), 3 requiring transfusion (see Chapter 12).

Prothrombin complex concentrates (PCC) are increasingly being used in warfarin reversal in line with BCSH recommendations[19], and fibrinogen concentrate for other indications, particularly massive haemorrhage. There are currently no reporting mechanisms for errors in the administration of these products. Adverse events could be reported through the MHRA 'yellow card' system, but for example, delayed administration of PCCs to patients with warfarin-induced haemorrhage can be dangerous, and both PCCs and fibrinogen concentrate have a risk of thrombotic complications. We are considering whether to accept reports from adverse outcomes associated with these products.

General updates

There have been two important updates from the Advisory Committee on the Safety of Blood, Tissues and Organs (SaBTO).

Consent for transfusion

Following extensive consultations in 2010, SaBTO published their recommendations on consent for blood transfusion in October 2011. Valid consent should be obtained for blood transfusion and documented in the patient's case notes according to General Medical Council (GMC) standards. This does not require a signed form. There should be a modified form of consent for long-term multi-transfused patients. There should be standardised information resources for clinicians indicating the key issues to be discussed by the healthcare professional when obtaining valid consent from a patient for blood transfusion. There should be standardised sources of information for patients who may receive a transfusion, and patients who have received a blood transfusion, and who were unable to give valid consent prior to transfusion should be provided with information retrospectively. This report can be downloaded from the SaBTO website[20].

SaBTO recommends improved knowledge of consent and its relevance to transfusion and that a new module of training be prepared as part of the e-learning package (www.learnbloodtransfusion.org.uk) which should also be included in undergraduate curricula.

Changes to recommendations for cytomegalovirus (CMV) screening

In March 2012 SaBTO published a position statement on CMV tested blood components. The current leucodepletion specification of $<5x10^6$ white cells per unit (a 3-log depletion of 99% components with 95% confidence) is generally accepted as the level which renders components 'CMV safe'. The recommendations are that CMV seronegative components should continue to be provided for intra-uterine transfusions and for neonates (i.e. defined here as up to 28 days post expected date of delivery), and for elective transfusions during pregnancy (but that they are not essential for emergency transfusions during pregnancy). A search for evidence led SaBTO to conclude that there is no support for using CMV seronegative components for immunodeficient patients and that CMV seronegative components are therefore not necessary following haematopoietic stem cell transplantation (HSCT), but CMV PCR

monitoring should be considered for all patients to allow early detection of any possible CMV infection (whether transfusion-transmitted or not).

Cases of suspected transfusion-transmitted CMV infection are, and always have been, reportable to SHOT. The changes in the recommendations will mean that the issue of non-CMV screened components to immunodeficient or HSCT recipients will no longer be regarded as 'special requirements not met' even if there are local policies in place which still require CMV seronegative components. Where errors are made according to local policies, they should be reported and investigated locally, but are still reportable to SABRE under failure to supply as per local policy.

CMV is the most frequent infection following solid organ transplant but there is no evidence that this is related to transfusion transmission, and therefore organ transplant recipients do not need CMV seronegative blood components.

Recommendation

- Suspected transfusion-transmitted cytomegalovirus (CMV) infection should continue to be reported to SHOT and the Medicines and Healthcare products Regulatory Agency (MHRA).

  Action: Hospital Transfusion Teams (HTTs)

Allergic reactions to methylene blue FFP (MB-FFP)

The French haemovigilance group, agence francaise de sécurité sanitaire des produits de santé (AFSSAPS) have phased out production of MB-FFP because of reports of severe allergic reactions. The question of allergic reactions to MB-FFP has been considered in detail by JPAC (the Joint UK Blood Transfusion Services and National Institute of Biological Standards and Control Professional Advisory Committee) who will publish a position paper on their website. At present there are no changes to UK policy. SHOT data do not show significant differences in allergic reactions to MB-FFP from standard FFP.

Recommendation

- Any reactions to fresh frozen plasma (FFP) (all types) should be reported to SHOT and investigated in detail (see Chapter 13).

  Action: Hospital Transfusion Teams (HTTs)

Update on the 2010 recommendations

Last year SHOT made several recommendations and progress on these is highlighted below.

Implementation of National Patient Safety Agency (NPSA) safer practice notice (SPN) 14 Right Patient, Right Blood[21]
Education in transfusion practice and the practical aspects of SPN14 have been reviewed by subgroups of the National Blood Transfusion Committee (NBTC), further work is underway, and competency is further discussed in Chapter 4.

Rapid Response Report NPSA/2010/0171[22]
An increase in reporting of delayed or under-transfusion has occurred in 2011 in keeping with the 2010 recommendations. The importance of this is demonstrated by the death of one patient caused by under-transfusion reported in Chapter 9.

Improving laboratory standards
The UK Transfusion Laboratory Collaborative (UKTLC) met in January 2012 and discussed the concerns about competency particularly as the number of laboratory errors has increased in 2011 (see Chapter 7). The UKTLC plan to address this in association with UK National External Quality Assessment Service for Blood Transfusion Laboratory Practice (UK NEQAS BTLP). Case-based scenarios will be developed and

recommendations will be made to encourage the wider use of root cause analysis when incidents and near miss events occur. The UKTLC also plan to assess the applicability of their published recommendations[23] to the developing 'hub and spoke' models for transfusion.

Concerns about the reliability of point of care testing for Hb assessments have begun to be addressed by a pilot study undertaken by UK NEQAS (General Haematology). A preliminary study of blood gas analysers and HemoCue® machines has demonstrated a wide variation in results obtained and therefore a need for wider training and QC assessments (B. De la Salle, Scheme Manager UKNEQAS General Haematology, personal communication).

The clinical assessment and management of patients receiving blood transfusion

An amendment to the BCSH guidelines on blood administration[14] on measures to avoid TACO is planned.

Clinical knowledge and handover

Following a meeting with the President of the Royal College of Physicians and colleagues SHOT will prepare the key messages for dissemination in various formats (e.g. 'top tips', a 'concise guideline'). In addition, a teaching slide set will be prepared that can be downloaded from the SHOT website.

4. Summary of Main Findings and Cumulative Results

Authors: Paula Bolton-Maggs and Hannah Cohen

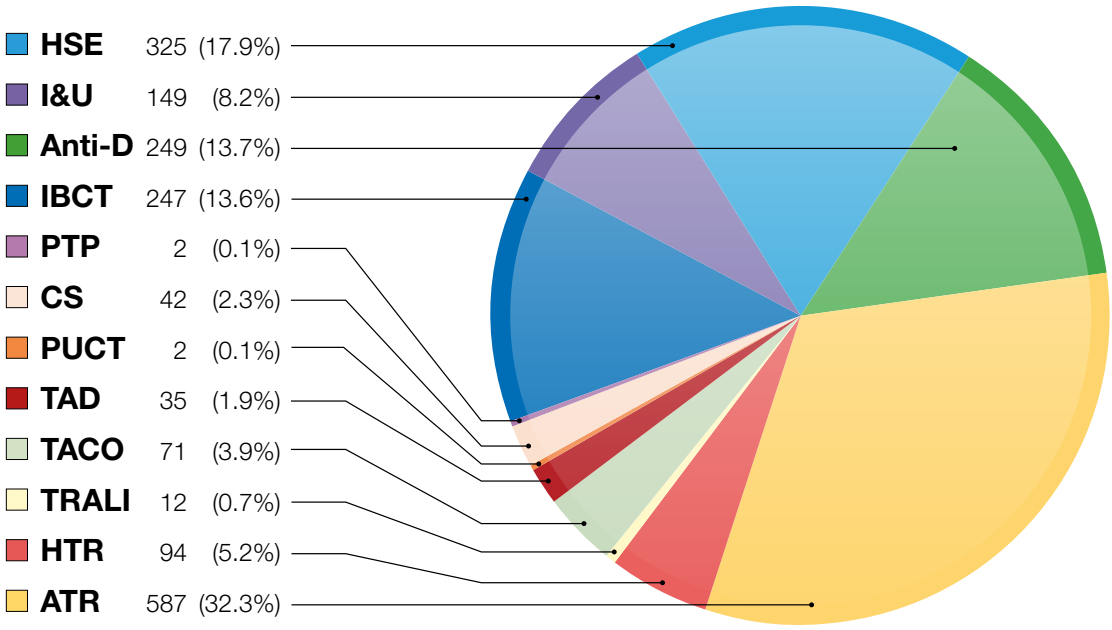


Figure 4.1 Cases reviewed in 2011 (excluding near miss and instances where the patient received a correct component despite errors having occurred – RBRP) n=1815

An increased number of reports were submitted for 2011 compared to previous years. The age range of patients who were the subject of SHOT reports in 2011 was wide, from birth to aged 103 years. The median age was 61 years. Younger patients featured in the anti-D Ig errors (median age 29 years, range 15 to 58) and in the haemoglobinopathy group (median 28 years, range 1-50). As in previous years the patients with transfusion-associated circulatory overload were older with a median age of 72 years.

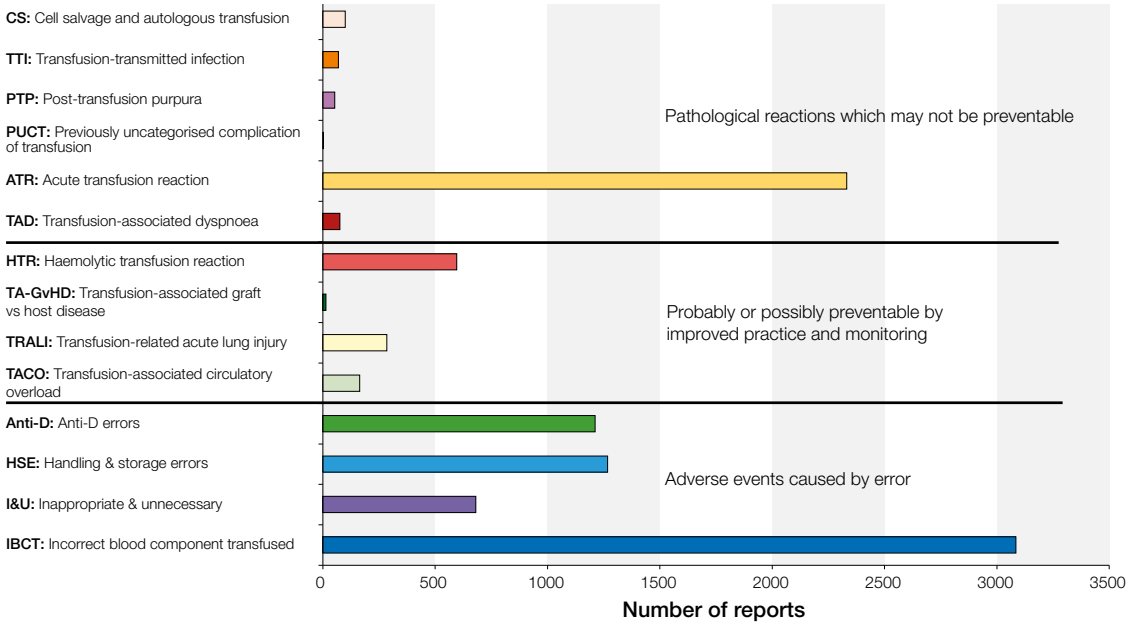


Figure 4.2 Cumulative data for SHOT categories 1996/7-2011 n=9925

Blood and blood component transfusion in the UK is very safe considering that about 3 million components are issued each year. It is good to report overall a progressive reduction in deaths (13 in 2010 and 8 in 2011) related to transfusion. There was a slight increase in major morbidity (from 101 in 2010 to 117 in 2011). The proportion of deaths and major morbidity continues to decrease: 34% in 1996/7, 7.8% in 2010 and 6.9% in 2011.

Figures 4.1 and 4.2 show that both in 2011 and in the cumulative data about half of all the reports are of adverse events caused by errors (excluding the reports of 'near miss' and 'right blood right patient' events which are also errors). These should all be preventable. In addition to these, cases of transfusion-associated circulatory overload should be avoidable by careful pre-transfusion assessment, an appropriate rate of transfusion and fluid balance monitoring. Some cases of haemolytic transfusion reactions can be prevented (e.g. by ensuring appropriate selection of red cells for those with a known history of irregular antibodies, or who are at particular risk such as those with sickle cell disease). Transfusion-related graft versus host disease has been prevented by leucodepletion and irradiation of cellular products. Other changes in transfusion centre practice have led to prevention or reduction in other adverse reactions - transfusion-related acute lung injury and post-transfusion purpura.

Table 4.1 Comparison of report types 1996-2011

Year/ Category	IBCT	I&U	HSE	Anti-D	ATR	HTR	TRALI	TACO	TAD	PTP	PUCT	TA-GvHD	TTI	CS
2011	247	149	325	249	587	94	12	71	35	2	2	0	0	42
2010	200	110	239	241	510	58	15	40	35	1	0	0	0	15
2009	282	92	196	186	400	47	21	34	4	0	0	0	3	14
2008	262	76	139	137	300	55	17	18	1	1	0	0	6	28
2007	164	50	118	63	114	23	24	0	0	2	0	0	3	0
2006	198	51	74	77	85	34	10	0	0	0	0	0	3	0
2005	252	67	79	87	68	28	23	0	0	2	0	0	5	0
2004	262	56	54	67	34	43	23	0	0	0	0	0	2	0
2003	252	29	43	24	39	25	36	0	0	1	0	0	9	0
2001/2002*	303	0	0	43	48	47	33	0	0	3	0	0	6	0
2000/2001	173	0	0	17	31	39	13	0	0	3	0	1	6	0
1999/2000	188	0	0	12	33	24	18	0	0	6	0	2	6	0
1998/1999**	131	0	0	5	34	30	16	0	0	11	0	3	9	0
1997/1998	107	0	0	3	24	25	14	0	0	9	0	3	3	0
1996/1997	63	0	0	0	24	23	9	0	0	11	0	4	8	0
TOTAL	**3084**	**680**	**1267**	**1211**	**2331**	**595**	**284**	**163**	**75**	**52**	**2**	**13**	**69**	**99**

** 2001–2002 figures covered a 15 month period. ** Total excludes 7 cases that were not classified. CS=cell salvage autologous transfusion*

Table 4.2 Cumulative mortality/morbidity data 1996–2011
NB. TACO, TAD and autologous are new since 2008, and HSE and I&U were separated from IBCT in 2008.

	Total	IBCT	I&U	HSE	ANTI-D	ATR	HTR	TRALI	TACO	TAD	PTP	PUCT	TA-GvHD	TTI	CS
Death in which transfusion reaction was causal or contributory	159	27	8	0	0	24	12	44	13	0	2	1	13	15	0
Major morbidity probably or definitely attributed to transfusion reaction (imputability 2/3)	713	120	12	0	35	168	61	186	57	10	14	1	0	48	1
Minor or no morbidity as a result of transfusion reaction	9038	3882	407	899	841*	2136	521	54	93	65	36	0	0	6	98
Outcome unknown	15	11	0	0	0	3	1	0	0	0	0	0	0	0	0
TOTAL**	**9925**	**4040**	**427**	**899**	**876**	**2331**	**595**	**284**	**163**	**75**	**52**	**2**	**13**	**69**	**99**

** Cases with potential for major morbidity are included in minor or no morbidity. **Total excludes 7 cases from 1998-1999 that were not classified. CS=cell salvage autologous transfusion*

Table 4.3 Mortality/morbidity data 2011

	Total	IBCT	I&U	HSE	ANTI-D	ATR	HTR	TRALI	TACO	TAD	PTP	PUCT	TA-GvHD	TTI	CS
Death in which transfusion reaction was causal or contributory	8	0	2	0	0	2	0	1	2	0	0	1	0	0	0
Major morbidity probably or definitely attributed to transfusion reaction (imputability 2/3)	117	2	5	0	9	53	11	8	24	3	1	1	0	0	0
Minor or no morbidity as a result of transfusion reaction	1690	245	142	325	240*	532	83	3	45	32	1	0	0	0	42
TOTAL	**1815**	**247**	**149**	**325**	**249**	**587**	**94**	**12**	**71**	**35**	**2**	**2**	**0**	**0**	**42**

** Cases with potential for major morbidity are included in minor or no morbidity. CS=cell salvage autologous transfusion*

Deaths n=8

There were 8 deaths where transfusion played a role. Two were imputability 3 (i.e. certain) and both were in the I&U category. The other 6 deaths were all imputability 1 (i.e. possible). Details were as follows:

Inappropriate and unnecessary under/or delayed transfusion (I&U) n=2 (2 in 2010)

A woman died in childbirth because the extent of her major obstetric haemorrhage was not fully appreciated so that adequate transfusion was delayed, she arrested in shock 2 hours later and could not be resuscitated.

The second case was an elderly woman who was transfused excessively in relation to her low body weight; she developed TACO and died. Both these cases were imputability 3.

Acute transfusion reactions (ATR) n=2 (3 in 2010)

One death occurred in an elderly man with possible anaphylaxis, who sustained a cardiac arrest in association with a florid rash 15 minutes after starting FFP.

The second case was a man who developed a febrile reaction in association with respiratory distress and died within 4 hours.

Transfusion-related acute lung injury (TRALI) n=1 (1 in 2010)

An elderly man who was already unwell with haematological malignancy and sepsis developed breathlessness during a second red cell unit and died later the same day. TRALI was not proven (one donor had HLA antibodies, patient sample not available).

Transfusion-associated circulatory overload (TACO) n=2 (6 in 2010)

These two cases had an imputability of 1. Both patients had malignancy, one haematological. Both were elderly with additional risk factors for TACO, fluid overload in both, and also hypoalbuminaemia in one. In both patients the onset of symptoms occurred during transfusion of the second red cell unit.

Previously uncategorised complication of transfusion (PUCT) n=1

This was a clinically stable 6-week old premature baby who died from necrotising enterocolitis which developed post transfusion.

Major morbidity n=117

Incorrect blood component transfused (IBCT) n=2

Two patients were transfused with ABO incompatible red cells (both group O receiving group A red cells), one after major cardiac surgery resulting in renal dysfunction and a prolonged stay in the intensive therapy unit (ITU); the other sustained an immediate reaction requiring adrenaline and other measures.

Inappropriate and unnecessary or under/delayed transfusions (I&U) n=5

Four of these cases were related to surgery for abdominal aortic aneurysms. One had an inappropriately high Hb post operatively. Three patients suffered major morbidity due to delayed transfusion. The other patient received a substantial extravascular transfusion due to an unnoticed displaced central line.

Anti-D Ig errors n=9

The cumulative number of mistakes with anti-D immunoglobulin administration is striking. There has been no reduction in this despite repeated recommendations in previous SHOT reports and learning events undertaken by the 'Better Blood Transfusion' team and others. The introduction of an anti-D administration checklist (see Chapter 12) may lead to improvements in practice but there is a need to underpin this with better knowledge among midwives, nurses and laboratory staff.

Acute transfusion reactions (ATR) n=53

Reporters initially only identified 7 cases of major morbidity but several others had severe or life-threatening reactions including features of anaphylaxis. The reaction is classified as major morbidity on the basis of severity, even if short in duration, and if it requires treatment with vasopressors.

Haemolytic transfusion reactions (HTR) n=11

Two patients with acute HTR developed impaired renal function. Nine patients with delayed HTR suffered major morbidity, 5 with sickle cell disease, one with the Hb falling to 3.5 g/dL 11 days post transfusion and 3 with renal impairment.

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

No cases were proven serologically and the hypoxia requiring ventilation may have had alternative causes.

Transfusion-associated circulatory overload (TACO) n=24

23 cases required intensive care or high dependency unit (HDU) admission, and one required emergency renal dialysis.

Transfusion-associated dyspnoea (TAD) n=3

This is a difficult group to classify and contains patients with features of respiratory distress who do not fit into other categories. One case followed transfusion of several components after major obstetric haemorrhage; the second case was a patient with an inherited platelet function disorder who experienced a respiratory arrest following one of his regular platelet transfusions. A third was a patient who developed respiratory distress 16 hours after major surgery including transfusion of several components. It is interesting that all patients had received multiple or repeated components.

Post-transfusion purpura (PTP) n=1

A 68 year old woman developed PTP requiring platelet transfusion support. This was associated with a reaction requiring admission to HDU. She made a full recovery with IVIg and steroids.

Previously uncategorised complication of transfusion (PUCT) n=1

A premature neonate with necrotizing enterocolitis whose symptoms began during red cell transfusion required ventilation and bowel surgery.

Categories of reports where no harm was done

Near miss events n=1080

Each year the number of reports of 'near miss' events is about a third of the total (863 analysed in 2010 and 1080 in 2011). Half of these are sample errors, mostly incidents of 'wrong blood in tube', and 38% of these were samples taken by doctors compared to 6.8% by phlebotomists.

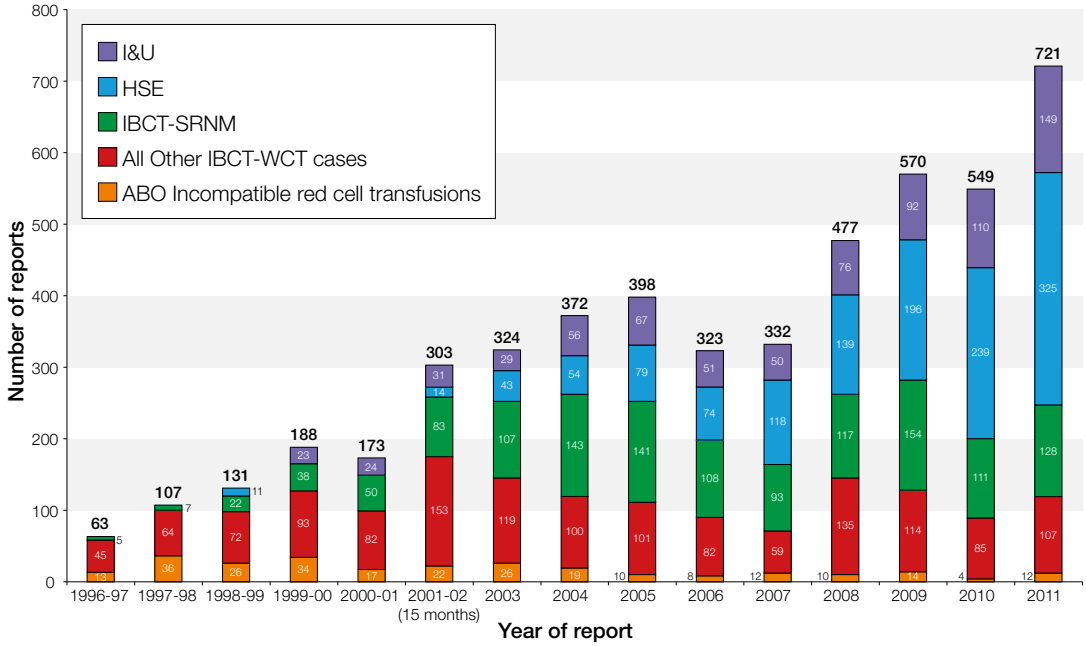
Right blood right patient n=159

Many of these relate to failure of full patient identification at all stages of the process.

Reports caused by human error

It is disappointing that about 50% of SHOT reports are caused by human error (970/1815 excluding 'near miss' and 'right blood right patient' events). In addition, the 'near miss' events (n=1080) are all related to mistakes. The MHRA has reported similar rates of error (in 788/812 SAEs in 2011 – Chapter 24) and note the influence of distraction, interruptions, lapses in concentration, rushing, cutting corners and understaffing in their list of top causes.

Figure 4.3 Incorrect blood components transfused (IBCT) either due to wrong component (WCT) or where special requirements were not met (SRNM), handling and storage errors (HSE), showing the number that resulted in ABO-incompatible transfusions



A cumulative summary of events related to error is shown in Figure 4.3 which also includes data for inappropriate and unnecessary transfusions (I&U).

Competency based training, first recommended by SHOT in the report for 2001/2[11], and reinforced in 2008[24] and by the National Patient Safety Agency Safer Practice Notice (NPSA SPN) 14[21], may not be enough to prevent errors. SHOT asks for information about competency training in the following categories: Anti-D reports, for laboratory errors where special requirements are not met, and for events where an incorrect component was transfused. Review of these events (Table 4.4) shows that almost 70% of errors were made by individuals who had completed their competency assessment.

Table 4.4 Many errors were made by individuals who had been competency assessed

	Number	Competency assessed	Not competency assessed	Not known or blank
Errors with Anti-D Ig				
Pre-administration sample	18	3	2	13
Laboratory procedures	53	40	5	8
Collection of anti-D Ig	20	11	4	5
Laboratory errors where the special requirements were not met	57	47	7	3
Incorrect blood component transfused				
Sample collection	8	2	1	5
Laboratory errors	68	52	9	7
Collection	11	9	2	
TOTAL n=235	**235 (100%)**	**164 (69.8%)**	**30 (12.8%)**	**41 (17.4%)**

5.

Key Messages and Recommendations

Authors: Paula Bolton-Maggs and Hannah Cohen

Back to basics

Overall transfusion is very safe, in the context of the issue of about 3 million components across the UK per annum. In relation to this, events resulting in death or major morbidity are very few. In 2011 there were 8 deaths in which transfusion or lack of it played a role, and 117 instances of major morbidity. In the context of 2,956,351 components issued,

- the risk of death is 0.0027 per 1000 components issued
- the risk of major morbidity 0.0399 per 1000 components issued.

However, preventable mistakes, particularly those resulting in death or morbidity from ABO incompatible transfusion (a Department of Health 'Never Event') should not occur[25].

It is encouraging that again this year there were no cases of transfusion-associated graft versus host disease (TA-GvHD) despite several cases of missed irradiation of components for patients at risk (77 in 2011 and more than 700 in the past decade). These cumulative data suggest that leucodepletion provides a high level of protection but it remains essential to comply with the British Committee for Standards in Haematology (BCSH) recommendations that irradiated components should be administered to all recipients at risk of TA-GvHD[26]. It is also encouraging that there were no transfusion-transmitted infections (TTI) for the second consecutive year, and again reduced numbers of transfusion-related acute lung injury (TRALI) and post-transfusion purpura (PTP). However, transfusion-associated circulatory overload (TACO), which is probably under-reported, remains an important cause of potentially avoidable major morbidity and death. Additionally, inappropriate and unnecessary transfusions, where many cases occur as a result of poor understanding and knowledge of transfusion medicine, continue to increase.

The continued level of errors resulting in wrong transfusions, inappropriate, unnecessary and under/delayed transfusions, poor handling of components and the high proportion of 'near miss' reporting is disappointing because of the repeated efforts to improve transfusion safety by many different initiatives including 'Better Blood Transfusion' strategies[6-8], National Patient Safety Agency (NPSA) safer practice notice (SPN) 14[21] and the introduction of transfusion practitioners into nearly all Hospital Trusts and Boards. For every one episode where a patient received an incorrect blood component, there are approximately 100 near misses where the wrong patient identification has been made, but this was detected in the laboratory prior to testing (see Chapter 25).

Similar problems with drug prescribing have also been examined. The level of errors in prescription of medications has been reported by the General Medical Council recently[101], with the highest error rate in foundation year 1 (8.4%) and year 2 (10.3%). The authors note 'that a 'safety culture' was conspicuous by its absence' in the reports and discussions, and that 'errors resulted from complex adaptive systems'. There were 'understandable adaptations to busy and stressful working conditions rather than aberrations', and also quote the effect of miscommunication by third parties. As a result of this research the authors identified a need to target undergraduate and foundation year education programmes at the very least.

Patient identification

This year therefore, we again need to emphasise the importance of the basic steps in the transfusion process, namely correct identification of the patient at the time of blood sampling, appropriate request for special requirements if any, correct laboratory procedures, collection of the right product, and critically, the importance of correct steps for checking identity of the patient at the beside. In addition it is important that each individual takes responsibility for their own checks and not rely on the steps before or after. It is dangerous to make assumptions. For the first time this year we include a chapter on the work of the Medicines and Healthcare products Regulatory Agency (MHRA). This shows that the majority of reports are also due to human error. These may be related to poor systems and root cause analyses will assist improvements in quality, but the MHRA clearly report the influence of distraction, interruptions, and rushing or cutting corners related to urgency or lack of staffing.

Identification of the right patient: At each step of the transfusion process, and every other intervention in medicine, identification of the right patient is an absolute essential. SHOT in 2009[27] recommended a campaign to emphasize this – to 'empower recipients of blood transfusion, and all patients undergoing tests, procedures and surgery, or receiving drugs and therapies, to ask the staff, before they carry out the intervention - "Do you know who I am?" '. The Appropriate Use of Blood Group will work on this during 2012 (http://hospital.blood.co.uk/safe_use/index.asp).

Patients are vulnerable to misidentification for many reasons: transfer between wards and medical/surgical teams, the shift systems for doctors and nurses both resulting in a loss of continuity of care. Handovers need to be improved and to include transfusion where relevant as recommended last year[12]. These problems are not unique to the transfusion process, and following the example of the aviation industry checklists have been introduced for surgical patients which have had a strong beneficial effect in reducing mortality and morbidity[28]. SHOT has previously recommended the development of a transfusion checklist[27]. A template is available on the SHOT website which can be adapted for local use. A checklist has also been developed for the administration of anti-D immunoglobulin (see Chapter 12). http://www.shotuk.org/resources/current-resources/

Key Recommendation

- Correct patient identification should be a core clinical skill. Errors of identification impact on every area of medicine. This should be given formal consideration by the GMC and NMC.

  Action: Trust/hospital/Health Board Chief Executive Officers (CEOs); for formal consideration by the General Medical Council (GMC); Nursing and Midwifery Council (NMC)

- The use of a transfusion checklist across the complete transfusion process is recommended to ensure correct completion of each step. A model template can be found on the SHOT website at www.shotuk.org/resources/current-resources/

  Action: Trust/Hospital/Health Board Chief Executive Officers (CEOs)

Staff knowledge vs competency

It is clear that the ability to pass competency assessments does not necessarily result in correct and safe transfusion practice. Last year SHOT recommended a review of the practical implications of NPSA SPN 14[21] because of difficulties in delivering the training. Following recommendations from SHOT[12] that competency training needed reassessment, the Chief Medical Officer's National Blood Transfusion Committee (NBTC) has tasked two subgroups to review firstly how transfusion education and training is delivered in undergraduate and postgraduate curricula in all relevant specialties and secondly how the competency training defined in NPSA SPN 14[21] needs to be revised. Both groups are clear that a better basic knowledge of transfusion (and serology for laboratory staff) must underpin competency testing as recognised elsewhere[29]. Unless there is a good basic understanding and knowledge of transfusion physiology competence assessment is not sufficient.

The curriculum for higher specialist training in anaesthetics[30] contains the following observation:

> 'Checking competencies can provide spurious evidence of competence:
> It is tempting to try to make assessment by observation more reliable by 'unbundling' the competencies into separately assessed sub-competencies. This, however, encounters the problem that it is possible to be competent in each of the individual components of a clinical process whilst the performance of the whole remains inadequate. The Tooke report has specifically identified the competence approach to learning as one of the possible root causes of mediocrity'.

The preliminary report from the NPSA SPN group recommends that:

- The NPSA SPN competence assessment frameworks need revising and updating in line with recent guidance, specifically the guideline on Administration of Blood Components BCSH 2009[14].
- More emphasis should be placed on underlying knowledge and understanding of transfusion theory.
- Standardised knowledge tests should be developed relating to the competencies. These revised competence frameworks and assessments should not be amended by local Trusts, allowing confidence in transferable competencies for staff changing employment as SHOT has previously recommended[24].
- New staff should undergo a knowledge test and observational assessment in relevant tasks when joining the Trust unless there is evidence of satisfactory completion of the knowledge test within the previous 3 years. Trusts may wish to carry out an observational assessment competency assessment for new staff to ensure that they are familiar with local policies.
- These observational assessments should be carried out by departmental staff trained as assessors. Most nurses will hold an assessor qualification, phlebotomists; doctors; biomedical scientists, and porters can also be trained to be assessors.
- The requirement for observational assessment every 3 years should be discontinued and replaced by the knowledge test. This should be at a minimum of 3 yearly, but could be more frequent to link with national transfusion guidance and MHRA requirements.
- Observational assessments can be repeated at any time if necessary, e.g. following an incident.
- Knowledge tests should be available as e-learning. Training of staff should continue every 2 years in line with recent BCSH guidance[14]. This can be e-learning, classroom based, and individual teaching, as necessary for local needs. Transfusion practitioners should provide the training and support for the assessors.

The NBTC has agreed that this work be taken forward in 2012.

In addition, following discussion by the UK transfusion laboratory collective (UKTLC), it was agreed that the next phase of the collaborative work would be to address competency. This is particularly important because of the development of laboratory networks, or 'hub and spoke' working arrangements which may mean that expertise is concentrated in a smaller number of centres. SHOT analysis of the reports of laboratory events suggest a lack of understanding of traditional serology (Chapter 7). The UK National External Quality Assessment Scheme for Blood Transfusion Laboratory Practice (UK NEQAS BTLP) is currently undertaking a feasibility study on the development of a knowledge-based competency assessment scheme. The outcomes of this study will inform the launch of a scheme that focuses on blood transfusion knowledge and its application to both laboratory and clinical actions. Assessments, concentrating on the key aspects and critical processes, will be linked to electronic training resources, and once fully developed, will target the differing staff groups in the blood transfusion laboratory. It is hoped that this initiative will contribute to the basic understanding and application of key blood transfusion principles, the lack of which becomes apparent when reviewing the causes of laboratory errors reported to SHOT, reported in Chapter 7 of this report.

Key Recommendations

- Education and competency in blood transfusion safety remains a key issue in patient safety. Competency assessment must be underpinned by an adequate and assessable knowledge base for both laboratory and clinical staff at every level.

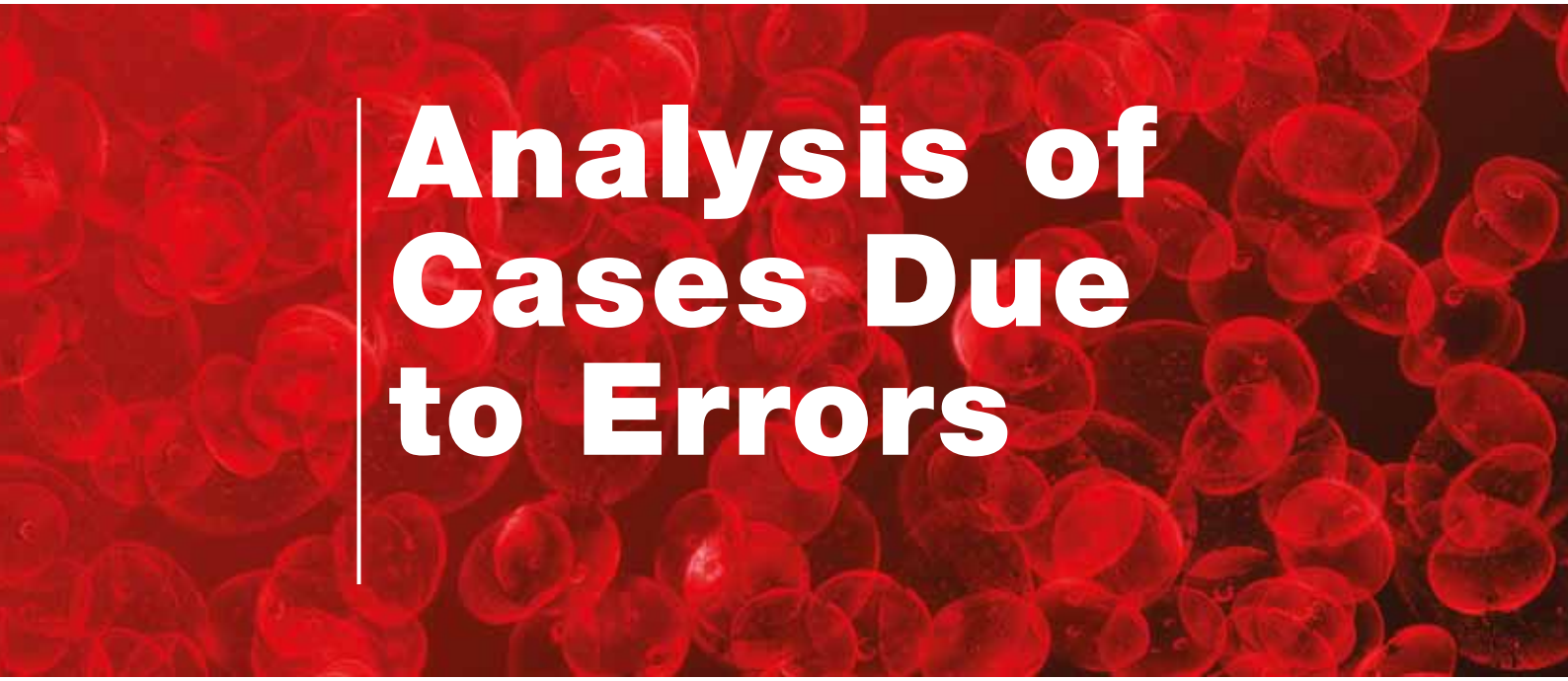
  Action: UK Transfusion Laboratory Collaborative (UKTLC), UK National External Quality Assessment Service for Blood Transfusion Laboratory Practice (UK NEQAS BTLP), Education subgroup of the National Blood Transfusion Committee (NBTC)

- Knowledge of transfusion medicine and prescribing of blood components are essential core requirements for any practitioner (medical and nursing) who prescribes or authorises blood components.

  Action: For formal consideration by the General Medical Council (GMC) and the Nursing and Midwifery Council (NMC)

- Clinical and transfusion laboratory handover templates should be improved to include information about diagnosis (particularly haemoglobinopathies), irregular antibodies and special requirements. Patients are vulnerable with the increase in shared care between hospitals, within a hospital particularly between shifts, and between hospital and community. (A handover tool kit for acute care is available at http://www.rcplondon.ac.uk/resources/acute-care-toolkit-1-handover)

  Action: Trust/hospital/Health Board Chief Executive Officers (CEOs), General Practitioners (GPs)



Analysis of Cases Due to Errors

Page	Chapter
26	**6.** Incorrect Blood Component Transfused (IBCT) - *Julie Ball and Paula Bolton-Maggs*
35	**7.** Errors Related to Laboratory Practice - *Deborah Asher and Hema Mistry*
53	**8.** Errors Related to Information Technology (IT) - *Megan Rowley*
64	**9.** Inappropriate, Unnecessary or Under/Delayed Transfusion (I&U) - *Julie Ball and Paula Bolton-Maggs*
74	**10.** Right Blood Right Patient (RBRP) - *Alexandra Gray*
77	**11.** Handling and Storage Errors (HSE) - *Alexandra Gray*
82	**12.** Adverse Events Related to Anti-D Immunoglobulin (Anti-D Ig) - *Tony Davies*

6. Incorrect Blood Component Transfused (IBCT)

Authors: Paula Bolton-Maggs and Julie Ball

Definition

The category Incorrect Blood Component Transfused (IBCT) includes all reported episodes where a patient was transfused with a blood component that was intended for another patient or which was of inappropriate specification and did not meet the particular requirements of the patient.

Chapter 6 only includes analysis of clinical IBCT cases. Laboratory IBCT cases are analysed in Chapter 7, which this year has a full discussion of all laboratory errors, including those counted in other categories, such as handling and storage errors (HSE) and anti-D.

DATA SUMMARY - IBCT combined clinical and laboratory
Total number of cases: 247

Implicated components		Mortality/morbidity	
Red cells	192	Deaths due to transfusion	0
FFP	9	Deaths *probably/likely* due to transfusion	0
Platelets	32	Deaths *possibly* due to transfusion	0
Cryoprecipitate	3	Major morbidity	2
Red cells & platelets	10	Potential for major morbidity *(Anti-D or K only)*	12
Platelets, FFP & Cryo	1		

Gender		Age		Emergency vs. routine and core hours vs. out of core hours		Where transfusion took place	
Male	128	≥ 18 years	216	Emergency	32	A&E	15
Female	113	16 years to <18 years	2	Routine	153	Theatre	17
Not known	6	1 year to <16 years	16	Urgent	44	ITU/NNU/HDU/Recovery	27
		>28 days to <1 year	3	Not known	18	Wards	143
		Birth to ≤28 days	6			MAU	15
		Not known	4	In core hours	185	Community	1
				Out of core hours	45	Outpatient/day unit	21
				Not known	17	Antenatal Clinic	1
						Not known	7

In 2011 there were 247 cases which is an increase from 200 in 2010. The number of ABO incompatible transfusions also increased from 4 in 2010 to 12 in 2011.

Clinical IBCT wrong component transfused (WCT) events n=35

Overview

There were 35 reports analysed in this subcategory this year. Nineteen reports related to male and 16 reports to female patients. The median age was 65 years and the range was 0-85 years. Four reports related to patients <18 years old. The first was a 2 day old neonate who received platelets instead of the prescribed fresh frozen plasma (FFP), in the second case during an emergency with multiple casualties the staff member administering the component confused the patient ID which lead to an incorrect but compatible transfusion. In the third case, an RhD positive component was supplied for a patient who was now RhD negative following haemopoietic stem cell transplant (HSCT) seven years previously, and

in the fourth case adult emergency O RhD negative blood was collected and administered to a neonate when crossmatched blood was available. These cases are discussed further in the paediatric chapter (Chapter 22).

Table 6.1 Summary of Clinical Errors leading to IBCT WCT

Type of error	Number of cases in 2010	Number of cases in 2011
Wrong blood in tube (WBIT)	3	5
Collection and administration	7	21
Administration alone	8	8
No information provided to the laboratory concerning the required group change following HSCT	1	1
TOTAL	**19**	**35**

Table 6.2 Summary of ABO and RhD mismatches resulting from Clinical cases of IBCT WCT

Incompatibilities	Number of cases in 2010	Number of cases in 2011
ABO incompatible	3	6
RhD incompatible	3	2
ABO and RhD incompatible	0	2
ABO and RhD compatible	13	25

Deaths n=0

There were no deaths that were directly attributable to transfusion.

Major morbidity n=1

There was 1 case of major morbidity as a result of an ABO incompatible transfusion.

Potential for major morbidity n=2

Both cases in this category were women of child bearing potential who were RhD negative and received RhD positive components.

Case 1 Major Morbidity

Transposed patient ID during phlebotomy leads to ABO incompatible transfusion

Patient A, blood group O RhD negative, was transfused 2 units of A RhD positive blood during cardiac surgery (mitral valve replacement and coronary artery bypass grafting) On arrival in the critical care unit he received two more group A units without apparent adverse events. Following transfusion, the patient showed evidence of haemolysis, with a fall in Hb requiring further transfusions, and rise in bilirubin to 241micromol/L within 6 days and an extended stay in the intensive therapy unit (ITU).

Blood samples were taken from patient A and patient B at the same time in the preoperative clinic. The nurse was distracted in the middle of bleeding the first patient, did not complete the process at the bedside, and so patient details were transposed when labelling the samples. Patient B's mislabelled sample was detected by the biomedical scientist (BMS) because a historical group was available. Patient A had no historical group and was therefore not initially implicated in the mix-up. Patient A's repeat sample grouped as O RhD negative when he required further transfusion.

This case was one of 5 wrong blood in tube (WBIT) incidents that led to an incorrect blood component being transfused. In 3/5 cases the patient group and the component group were fortuitously compatible. Instances of wrong blood in tube are discussed in more detail in the near miss chapter (Chapter 25).

ABO and/or RhD incompatible transfusions n=10

In addition to the two cases of incompatible components transfused due to WBIT above, there were 8 other reports where incompatible components were transfused.

Case 2

ABO incompatible unit of blood transfused after a failure in all blood collection and administration checks

Two patients had been crossmatched. These patients had the same surname but different date of birth, hospital numbers, forenames and blood groups. A health care assistant (HCA) collected the blood for patient A, only checking the surname and no other demographics. The bedside checks, involving two registered midwives, were incorrectly carried out. The error was detected by a staff nurse from a different ward when she went to return a wrong blood unit that she had collected; she found no units available for her patient B and queried where they were. Patient A was O RhD positive and the donor unit was A RhD positive. Fortunately, less than 50mL was transfused before the error was discovered and the patient suffered no adverse effects.

The vignette above identifies four separate errors. The initial collection and administration error involved three people, none of whom were following the correct basic procedures. The fourth error was by a staff nurse from another ward who realised the wrong component had been collected before it was transfused to a patient.

Combined blood component collection and administration errors n=21

The wrong component was collected on 21 occasions and the implicated staff members were 2 HCAs, 5 porters, 2 nurses, 1 student operating department practitioner (ODP), 1 ODP, and 1 theatre nurse. No details were given for the other 9/21 collections. Collection of the correct blood component is a crucial part of the transfusion process and staff administering the component should not presume that this step has been completed correctly. The correct blood component should be verified by completing an adequate final ID check at the patient's side prior to transfusion. The final ID check is the last opportunity to prevent an incorrect blood component being transfused. Incorrect blood components transfused as a result of WBIT cannot be identified at the bedside (as in case 1).

Case 3

Collection and transfusion of the wrong unit

A nurse collected the wrong unit of blood for patient A. The nurse returned to the ward and started transfusion of the blood to patient A. It was not until the same nurse went to the blood bank to collect a unit for patient B (on the same ward), that she realised she had taken the wrong unit for patient A as there was no blood for patient B. The nurse only used the first 3 digits of the hospital number to identify the unit. Patient B also had the same first 3 digits for the hospital number.

In addition to collecting the wrong unit, where there was failure to check the documentation against the unit of blood, the bedside checks were not done properly (where the mistake would have been identified prior to transfusion). Fortunately, the unit was compatible with the patient's group.

In 8 cases the wrong component type was administered to the patient, for example red cells when platelets had been prescribed.

Table 6.3 Discovery of the error in cases where the wrong component type was transfused

Prescribed component	Administered component	How was the error discovered?
Platelets	Red blood cells	BMS contacted the ward to enquire if the platelets were still required
FFP	Red blood cells	Patient was transferred to another ward and error noted when prescription chart checked
Platelets	FFP	Signatures against platelet prescription. Both FFP and platelets were prescribed – realised incorrect after 8mL FFP transfused
Platelets	Red blood cells	Noted by anaesthetist when patient was admitted to theatre
FFP	Platelets	Noted by nurse that platelets had been given (not prescribed) when she was about to send for prescribed FFP
Platelets	Red blood cells	Theatre staff noted error when patient transferred to theatre
FFP	Cryoprecipitate	Staff called BMS to request cryoprecipitate. BMS queried if clotting had been checked as cryo had already been given when FFP had been prescribed
Red blood cells	Platelets	When patient was reviewed it was noted that platelets had been running for an extended period

Case 4

Patient received red cells instead of platelets

A 66 year old female patient was scheduled for hemiarthroplasty. She had been prescribed platelets on haematological advice because she had a low platelet count of 86x10^9/L. The patient received red cells instead of platelets pre-operatively which were checked by two staff members. She arrived in theatre with red cells in progress. The patient was already anaesthetised when this was noted. Surgery went ahead. The patient bled during the operation and the Hb dropped by 5 g/dL which required further transfusion.

In 3 cases, the collection of multiple units at the same time was identified in the root cause analysis as a contributing factor in the incorrect blood component being transfused.

Case 5

Collection of blood for several patients leads to transfusion to the wrong patient

Nurse A set up a unit of blood for patient M. Nurse B realised that the wrong patient was being transfused immediately and stopped the transfusion when only 1mL had been administered. Nurse B had noticed the error as she prepared to start transfusion of a unit of blood for patient R but found that the unit was labelled for patient M in the next bed.

Due to the high volume of transfusions in this clinical area, it had become common practice for several units of blood to be collected for different patients at the same time and left in a cool box placed centrally on the ward. The error was compounded by the failure to complete a correct final ID check at the patient side prior to starting the transfusion.

The findings from the root cause analysis (RCA) conducted following the event have initiated a change in practice to reflect the Trust transfusion policy which is to collect a single unit for a single patient at a time as is recommended practice according to British Committee for Standards in Haematology (BCSH) guidelines[14].

Administration errors alone n=8

In these cases, the correct component was collected or delivered but failure of the final ID check at the patient's side led to the component being transfused to the wrong patient.

Case 6

Assumption that unit of blood was for emergency patient

Blood was delivered to the ward for patient X but had not been handed over to a nurse. Patient Y on this ward had arrested following sudden haematemesis. The unit for patient X was put on the bed of Patient Y. Emergency O RhD negative had been ordered for Patient Y and because the unit for patient X was group O it was assumed that this blood was the urgent blood ordered for patient Y. The blood was not checked against details for patient Y and was transfused. Patient Y was group B RhD positive and the unit group was O RhD positive and therefore the unit was fortuitously compatible. Patient Y was transferred to ITU post arrest and survived.

It is important that when a component is delivered to the clinical area, a trained and competent member of staff should receive it and ensure it is correct (National Comparative Audit (NCA) bedside audit[31], BCSH administration guidelines[14]).

Evidence of wristbands/other ID

Wristbands were documented as present and correct in 21/34 cases, missing in 3/34 and in 10/34 reports, no patient ID information was provided.

Case 7

Multiple unknown patients result in identity confusion

A member of staff was called to Accident and Emergency (A&E) to assist with multiple unknown patients following a major road traffic accident (RTA). The member of staff was attending to a 2 year old unknown female child who had received O RhD negative blood followed by a unit of blood labelled 'unknown female 2'. Subsequently, it was realised that 'unknown female 2' was the baby's mother and the baby was identified as 'unknown female 1'. The blood was discontinued. The baby was group A RhD positive and the blood given was fortunately compatible as it was O RhD positive but it was not intended or labelled for that child who was not wearing a wristband.

Case 8

Duplicate paperwork for trauma patients

A 23 year old man with multiple injuries was admitted to a trauma bay and the prepared identity documents and wristband attached to him. However, the same registration had already been issued to the previous occupant of that trauma bay. The paperwork is prepared and left in the trauma bay ready for emergency admissions but was not cleared after the previous patient had been discharged. An incompatible component was collected and transfused to the second patient using the details for the first patient. The second patient received 2 units of group A RhD positive blood when his own group was O RhD positive. All the checks for identity at collection and administration were correctly performed. The patient suffered a coagulopathy (which was likely multifactorial in association with extensive trauma and massive transfusion) and haemoglobinuria but recovered.

Review of this case resulted in a change in practice to ensure that all paperwork and documentation is cleared from each trauma bay after patient discharge.

Total bedside administration errors n=29

Table 6.4
What was the pack ID (issue label/ compatibility label) checked against?

Checks reported	Number of cases
Reporter documented no checks carried out	8
Compatibility form alone	3
Compatibility form and patient notes	1
Prescription	1
Refrigerator sign out sheet	1
Patient verbal confirmation of name & DOB	1
Patient verbal confirmation of name & DOB and compatibility form	1
Patient ID band and prescription	1
Patient ID band, verbal confirmation of name & DOB and prescription chart	2
Patient ID band	2
Patient ID band, compatibility form, patient label and case notes	1
Patient ID band and verbal confirmation of name and DOB	1
Patient ID, case notes and prescription	1
Unknown	5
Total	**29***

** In 11/29 cases the patient was unable to participate in the final ID check*

There were 13 different procedures used for the final check prior to transfusion taking place. In 16 cases the process definitely did not include confirmation of the patient ID by checking the wristband. It is evident that the compatibility form is still being used for part of the final check (6/29 reports) despite National Patient Safety Agency (NPSA) SPN 14 and learning points in the 2010 Annual SHOT Report[12]. All those involved in transfusion must fully identify the patient at every step of the process[8]. It is of particular concern that in 8 cases, the reporter commented that there were no checks completed at all. In 11/29 cases the patient was unable to participate in the final ID check but the patient wristband was only documented as being used in 4/11 of these cases.

Table 6.5 Volume of wrong component transfused

Volume given	Number of cases
< 50mL	8
50 - 99mL	4
100mL	6
Whole unit	6
> 1 unit	5
Unknown	1

COMMENTARY on clinical IBCT WCT errors

It is disappointing that individuals participating in the transfusion process still make assumptions about patient identity and fail to perform each step of the process rigorously. Patients should always be asked to identify themselves where possible. These errors occurred despite the presence of two checkers in the majority, 18/29 cases. It is likely that each assumes the other is correct. As indicated in the BCSH guidelines a single person checking can be as safe or safer as he/she knows that he/she has full responsibility[14]. A systematic review found no evidence of a difference between 1 and 2 checkers[32].

Emergency situations are associated with heightened anxiety, rushing and a tendency to take short cuts. Emergency departments must have a robust system of emergency numbering for multiple unidentified victims of trauma.

In 3/35 cases confusion over emergency numbering played a part in the incorrect administration of components. This included duplicate numbers being issued to two separate patients, confusion around emergency numbers versus the patient age (‘unknown female 2’ above) and patients labelled as ‘unknown/unknown’.

There are two particular areas of concern.

1) In case 5 above the child was not wearing a wristband, which was against local and national guidelines, and which should apply in an emergency.

2) The numbering system used by Trusts/Hospitals/Health Boards for unknown patients attending A&E needs to be reviewed in order to identify patients more clearly. It was not Trust policy in the case above to identify patients as ‘unknown female 1,2,3’ etc.

Patients are receiving the wrong components due to failure of the checking process at several points.

Clinical cases where special requirements were not met n=77

In 77 cases special requirements were not met (39 male, 37 female patients and 1 gender not specified). The median age was 56 years and the range was 0-87 years. There were 5 reports related to patients <18 years of age (one 23-day old neonate, one 1-year old, two 3-year olds and one 6-year old). The majority of cases occurred in normal working hours 63/77 (82%) and 11/77 (14.3%) took place out of normal working hours. Most of these cases - 40/75 occurred in haematology departments and mainly relate to failure to request irradiated components (33/40).

Table 6.6 Special requirements not met where the error was clinical

Category of error	No. of clinical cases
Required irradiated components	52
Required cytomegalovirus (CMV) negative components	10
Required both irradiated and CMV negative components	7
Phenotyped and HbS negative units required for patients with sickle cell disease	2
Required human leucocyte antigen (HLA) matched platelets	2
Required phenotyped & K negative <7 days old for a patient with thalassaemia major	1
Blood warmer required for patient with cold agglutinins	2
Washed platelets	1
Total	**77**

Of the 59 clinically based omissions for irradiated components (52 + 7 who required CMV negative in addition to irradiation), the indications for transfusion are as follows:

- 30 treated with fludarabine or other purine analogues
- 9 Hodgkin lymphoma
- 7 pre/post solid organ or HSC transplant
- 3 recipients of antithymocyte globulin
- 3 immunodeficency
- 3 leukaemia
- 1 recipient of Campath®
- 1 baby who had received a previous Intra-uterine transfusion
- 2 unknown

Table 6.7 Location of the patient for whom irradiated components were indicated but not provided

Location	No. of clinical cases
Haematology ward	33
Oncology ward	3
Critical care	5
Neonatal intensive care unit (NICU)	1
Paediatric intensive care unit (PICU)	1
Medical assessment unit (MAU)	5
Theatre	1
General medical ward	2
Respiratory medical ward	1
Renal medical ward	2
Renal surgical ward	2
Trauma and orthopaedic	1
Gynaecology ward	1
Care of the elderly ward	1
Total	**59**

Case 9

Failure to provide irradiated products

An elderly man was admitted after a fall to a 'care of the elderly' ward. He was transfused 9 units of blood for chronic anaemia. Subsequently a haematology registrar found that he had been treated with cladarabine several years before.

In addition to the above, there was one instance where a patient had a stem cell harvest which had to be repeated due to failure to provide irradiated products.

Failure to request appropriate red cells for patients with haemoglobin disorders

There were three patients with haemoglobin disorders whose requirements were overlooked. As a consequence one patient with sickle cell disease (SCD) developed an irregular red cell antibody. The two SCD cases are discussed in the chapter on haemoglobin disorders (Chapter 23). The other was a woman described below:

Case 10
Failure to inform the laboratory of the diagnosis of beta thalassaemia major
A 33 year old woman with beta thalassaemia major was referred from another hospital. There was no documentation of transfusion special requirements in the referral paperwork.

She should have received K negative/C negative/e negative red cells less than 7days old but this was not discovered until the patient had received 63mL of red cells not meeting these requirements

COMMENTARY on SRNM clinical cases

Failure to provide irradiated components where indicated remains the most common omission, as in previous years. In 67/77 (87%) of cases, the origin of the error was in the request or the prescription. This included cases where the transfusion laboratory was not informed about the patient having special requirements. Communication between clinical and laboratory staff is a key element to ensuring that patients' special requirements are met.

Many cases of failure to request irradiated products originate in haematology wards or departments. These demonstrate a lack of adequate knowledge in clinical staff and frequent failure to communicate properly to the laboratory.

Further problems arise when patients who have historical reasons for continued provision of irradiated components (e.g. a history of Hodgkin lymphoma, history of treatment with fludarabine) are admitted acutely with new problems, or to another hospital or department. There is also failure to communicate between teams where patients are under shared care.

There were 17 cases where patients should have received CMV screened components but did not. Although SHOT collects this information, there have been no reports of CMV infection or activation. The infections questionnaire asks for 'viral infections' but not for CMV specifically. Recommendations for CMV screened components have been revised by the Advisory Committee on the Safety of Blood, Tissues and Organs (SaBTO)[33]. As leucodepletion has reduced the risk on CMV transmission, CMV negative products are no longer required for patients receiving HSCT, but are retained for neonates, intrauterine transfusion (IUT) and exchange transfusion. Pregnant women requiring elective transfusion should also receive CMV negative products but this may not be possible for emergency transfusions in pregnancy or at delivery. SaBTO recommends CMV polymerase chain reaction (PCR) monitoring of HSCT and solid organ transplant recipients to detect infection. Transfusion-transmitted CMV infection should be reported to SHOT and Serious Adverse Blood Reactions and Events (SABRE).

Patients with haemoglobin disorders need phenotyped blood which will not be provided if the laboratory staff are not aware of the diagnosis.

Learning points

- Clinical staff have a duty of care to the patients to ensure that all requests for blood and blood components are properly completed and include any information indicating special requirements.
- Clinical staff in haematology departments continue to forget to inform laboratories of patients' special and changing requirements.
- Patients transferred between departments and between hospitals are at particular risk that the documentation of special requirements will be missed.
- Patients with a history of disease or treatment requiring lifelong irradiation of cellular products[26] are at risk of this being missed when admitted for other reasons and to other departments or hospitals.

Recommendations

- Every person involved in the transfusion process must perform rigorous identity checks at each point and ensure that the component collected is the one prescribed (see Chapter 5 - Back to Basics).
- Emergency numbering systems must be robust, and particularly in an emergency all patients must have wristbands issued with a unique ID. Emergency numbers should be ideally random numbers rather than sequential ones, and as much identification information as possible should be included e.g. sex, approximate age, and time of admission.

  Action: Trust/Hospital/Health Board CEOs, Transfusion Laboratory Managers, Accident and Emergency Medicine and Trauma departments

Care needs for patients with special transfusion requirements

- Patients who require irradiated and other special products should be provided with an appropriate card as recommended by the British Committee for Standards in Haematology (BCSH)[26 34].

  Action: Hospital Transfusion Teams (HTTs)

- Patients with cards noting special requirements should be educated about their meaning and importance, in particular always to show these to clinical staff on admission to any hospital.
- Haematologists are advised to confirm that there has been appropriate handover of information and to audit this process.

  Action: HTTs, Consultant haematologists

- Patients with Sickle Cell Disease should be identified to the transfusion laboratory whenever admitted to hospital.

  Action: HTTs

- All patients with irregular antibodies should be issued with antibody cards, and be educated about their importance. General practitioners can also note important transfusion requirements, and include these in any referral to hospital whether emergency or elective.

  Action HTTs

- Suspected transfusion-transmitted cytomegalovirus (CMV) infection infection should continue to be reported to SHOT and the Medicines and Healthcare products Regulatory Agency (MHRA) via SABRE.

  Action: HTTs.

Recommendations still active from previous years:

Recommendations made in the SHOT reports for 2007 and 2009 are still applicable. These are:

2007 - Education of doctors and nurses involved in transfusion must continue beyond basic competency to a level where the rationale behind protocols and practices is understood. Transfusion medicine needs to be a core part of the curriculum[35].

2009 - The existence, and the importance, of special transfusion requirements must be taught to junior doctors in all hospital specialities. Local mechanisms for ordering and prescribing components need to facilitate correct ordering, and remind clinical and laboratory personnel where possible[27].

Progress with implementation Education is currently under review by a subgroup of the National Blood Transfusion Committee (NBTC) commissioned in October 2011

For active recommendations from previous years and an update on their progress, please refer to the SHOT website

7.

Errors Related to Laboratory Practice

Authors: Deborah Asher and Hema Mistry

IBCT events originating in the hospital transfusion laboratory n=135

In 2011 a total of 135 IBCT cases were reported to SHOT in which the primary error occurred in the laboratory, which represents 55% of the total 247 IBCT cases. All IBCT cases have been summarised in the data summary table at the beginning of Chapter 6.

Overall laboratory errors account for 217 of the total 1815 cases (excluding near miss (NM) and right blood right patient (RBRP)) included in the 2011 Annual SHOT Report (12% of all reports). These consist of 135 IBCT events, which include 51 cases of special requirements not met, 20 anti-D Ig related events, 60 handling and storage errors and 2 I&U laboratory errors.

The increase in reporting to SHOT this year (from 1464 to 1815 reports excluding NM and RBRP) stands at 24% while the absolute increase in laboratory-based reports, from 205 to 217, is 5.85%

Table 7.1 Summary of laboratory-related errors n=217

Type of error	Number of cases in 2010	Number of cases in 2011
Wrong component transfused	**21**	**33**
Wrong sample selected	2	1
ABO grouping error	2	7
RhD grouping error	4	8
Incorrect component selected	11	15
Incorrect labelling	2	2
Wrong component selected for HSCT* patient	**15**	**9**
Wrong ABO group selected	9	5
Wrong RhD group selected	2	2
Procedural errors	4	2
Other pre-transfusion testing errors	**34**	**42**
Testing errors	8	8
Procedural errors	26	34
Special requirements not met (SRNM)	**37**	**51**
Due to failure to consult patient records thoroughly	18	28
Due to poor serological knowledge/ failure to recognise the special needs of a specific patient group	19	23
IBCT TOTAL	**107**	**135**
Anti-D Ig related laboratory errors	**45**	**20**
Handling and storage laboratory errors	**53**	**60**
I&U laboratory errors		**2**
GRAND TOTAL OF LABORATORY ERRORS	**205**	**217**

** Haemopoietic stem cell transplant*

Deaths
There were no transfusion-related deaths reported.

Major morbidity n=1
An 11 year old RhD negative girl was wrongly RhD grouped, was transfused with RhD positive units and developed anti-D as a result.

Potential for major morbidity n=6
There were 6 women of childbearing potential (from 5 reports) who produced anti-K as a result of failure to provide K negative units to this group of patients. Six babies were affected by haemolytic disease of the fetus and newborn (HDFN) due to new development of anti-D and are discussed in the Anti-D chapter (Chapter 12).

A group O RhD positive 70 year old patient suffered minor morbidity with rigors following transfusion of 50mL of group A RhD negative blood issued on the basis of a handwritten blood group on the request form and an immediate spin crossmatch.

ABO and RhD incompatibility

There has been an increase in the number of incompatible transfusions due to laboratory errors this year (6 cases – table 7.2) in comparison to 2010 (3 cases). There were 4 ABO-incompatible transfusions (3 red cells and 1 fresh frozen plasma (FFP)) and 2 cases in which RhD positive red cells were transfused to RhD negative females of childbearing potential. One of the ABO-incompatible transfusions was due to the wrong sample being tested resulting in 3 units of group AB RhD positive red cells being transfused to a group A RhD positive patient. The patient did not have a reaction. A further two cases were due to ABO grouping errors, one resulting in 50mL of group A RhD negative red cells being transfused to a group O RhD positive patient, the case of major morbidity, and the other resulting in 80mL of group B RhD positive red cells being transfused to a group O RhD positive patient who suffered no harm - see case studies 1-5 below. In one case group O FFP was transfused to a group B patient because of a component selection error. Again, the patient suffered no harm.

The cases in which RhD positive red cells were transfused to RhD negative females of childbearing potential followed a RhD typing error in one case, highlighted above, which resulted in the formation of immune anti-D, despite the administration of anti-D immunoglobulin once the error was realised. The second case followed a component selection error where RhD positive red cells were transfused to an RhD negative, 10 month old, female patient. In this case anti-D immunoglobulin was administered and no immune anti-D had been formed at the time of reporting.

Table 7.2 Summary of ABO and RhD incompatible transfusions n=6

Type/component	Patient group	Transfused	Reason	Outcome
ABO incompatibility/red cells	A RhD Positive	AB RhD Positive	Wrong sample used	No harm
ABO incompatibility/red cells	O RhD Positive	A RhD Negative	Testing error	Major morbidity
ABO incompatibility/red cells	O RhD Positive	B RhD Positive	Testing error	No harm
ABO incompatibility/FFP	B RhD Positive	O RhD Positive	Selection error	No harm
D incompatibility	D Negative	D Positive	Testing error	Anti-D formed
D incompatibility	D Negative	D Positive	Selection error	No harm to date

Wrong component transfused n=33

There has been an increase in this category this year with 24% (33/135) of laboratory errors resulting in wrong blood incidents compared to 19% (21/107) in 2010.

Table 7.3 illustrates the time and circumstances under which these wrong blood incidents took place.

Table 7.3 Summary representing when incidents occurred and their urgency

	In core hours	Out of core hours	Unknown
Emergency	4	1	1
Urgent	4	2	2
Routine	13	0	3
Unknown	2	1	0
Total	**23**	**4**	**6**

Unlike previous years, the error rate in core hours is greater than that out of core hours. The staff involved included 23 biomedical scientists (BMS) working in the transfusion laboratory during normal working hours, 5 BMS working out of hours who normally work in transfusion, 3 BMS working out of hours who do not normally work in transfusion and 8 cases where the information was not given.

Wrong sample selected n=1

Case 1

Wrong sample selected results in patient receiving an ABO-incompatible transfusion

Due to the wrong sample being selected for testing, a patient was typed as AB RhD positive and transfused 3 units of red cells. The patient's actual group was A RhD positive. The error was detected when a second group and save sample was processed at a later date. The patient suffered no harm.

The hospital involved in this incident did a root cause analysis that explained some mitigating factors:

The sample was treated as urgent so that the transfusion could be started on the same day. This resulted in a BMS processing the request over the poorly staffed lunch time period. The patient received a single unit that afternoon and returned for the other 2 units the next day. The error primarily related to failure to follow the sample checking process as directed by the standard operating procedure (SOP). This failure was probably a result of distractions, including interruptions from staff from other disciplines and phone calls.

A number of tested samples had been left out on the bench. If these had been stored immediately after testing the risk of selecting the wrong sample would have been removed.

Learning points

(taken from the root cause analysis (RCA) performed at the hospital)

- Sample identification is a critical point in the process and must always be ensured at every stage of laboratory testing.
- Define reasonable turnaround times for blood component provision and agree pathways to empower biomedical scientist (BMS) staff to negotiate unreasonable demands.
- Store samples immediately after testing is complete.
- Do not interrupt colleagues when in the middle of a process.
- Following an error of this nature request that the BMS does a piece of reflective writing on what went wrong.

No evaluation of the role automation could have played in mitigating this error was mentioned in either the root cause or corrective actions. The workload of the laboratory is not known.

A further example of samples being transposed in the laboratory was reported in the Anti-D chapter (Chapter 12) where maternal and cord samples were transposed. The ward noted the maternal grouping discrepancy and informed the laboratory but the error resulted in prophylactic anti-D Ig being administered late.

ABO grouping errors n=7

The numbers of ABO grouping errors have increased from 2 cases in 2010 to 7 cases in 2011. All errors involved manual steps that were performed incorrectly. Two ABO grouping errors resulted in ABO-incompatible red cell transfusions. In 5 cases the patient fortuitously received ABO compatible transfusions (4 red cells, 1 FFP).

Six cases involved BMS who normally work in blood transfusion, 3 working during core hours and 3 working outside core hours, and in one case this information was unknown. Four cases occurred during urgent situations. Four cases are discussed in detail below as they raise important learning points:

Case 2

Unacceptable pre-transfusion testing leads to ABO-incompatible transfusion

A patient had frank haematemesis and required 4 units of blood urgently. The ward was advised to send a new sample in order to provide group-specific blood. There were records in the laboratory for this patient who had been transfused one week previously. The doctor sent down the sample and request, giving the blood group as A RhD positive on the request form. The BMS felt rushed as there was a delay in this sample reaching the laboratory. A group A RhD negative unit was 'crossmatched' by 'immediate spin', the result seen as 'compatible' and the unit issued manually using an emergency compatibility tag. Following issue of the blood standard testing for group and an antibody screen was set up - the patient's blood group was found to be O RhD positive, not A RhD positive as written by the doctor on the request form. The blood bank rang the ward immediately and the transfusion was stopped. The patient had received approximately 30mL of red cells and was reported to have experienced rigors.

Learning points

This case highlights the need to adhere to some very important principles, when providing blood in emergency situations. These are made clear in the British Committee for Standards in Haematology (BCSH) Guidelines for compatibility procedures in Blood Transfusion laboratories[36 37]:

- The ABO and RhD group must, wherever possible, be verified against previous results for the patient.
- Emergency groups performed in these circumstances MUST include a test against anti-A, anti-B and anti-D with appropriate controls or a reverse group.
- If there is insufficient time to complete this level of testing group O red cells MUST be issued.

Case 3

Manual transcription error and failure to heed IT alert leads to ABO-incompatible transfusion

A previously unknown oncology patient grouped as O RhD positive but with no anti-B. This group was entered manually on to the laboratory information management system (LIMS) as group B with no anti-B but this result was not authorised. Blood, group B RhD positive, was reserved for the crossmatch prior to the grouping results being authorised. The crossmatch was serologically compatible (as there was no anti-B) and the blood was issued. The BMS issuing the blood overrode the IT alerts which indicated that the group had not yet been authorised. The patient received 80mL of ABO-incompatible red cells before the error was noticed and the transfusion was stopped. There was no transfusion reaction.

Learning points

- British Committee for Standards in Haematology (BCSH) guidelines for compatibility procedures[37] in Blood Transfusion laboratories state: If it is not possible to obtain a reliable reverse grouping result and there is no historical group against which to validate, the cell group must be repeated.
- Red cells, other than group O, should not be issued to a patient until the blood group for that patient has been authorised.
- Short cuts lead to errors. Process, as laid down in standard operating procedures (SOPs), must be followed. This is a primary principle of good manufacturing practice (GMP).

Case 4

Manual transcription leads to a blood group error and the failure to capture the error on that sample

A request for blood was received from the medical admissions unit (MAU). The crossmatch request was urgent. No diagnosis was reported but the national indicator code reported was 'R7 Chronic Anaemia'. There was no previous group on the LIMS. A group and screen and crossmatch were requested on the LIMS and the sample was centrifuged and placed on the analyser for testing. Due to clinical pressure, and trying to ensure that the patient received the blood quickly, once the group had been completed on the analyser these results were manually entered onto the LIMS. The results were entered incorrectly as O RhD positive when they were B RhD positive. Group O red cells were then selected for crossmatch and issued as compatible. The group and screen was completed on the analyser but because the group results were already on the LIMS they were not overwritten. The error was discovered one month later when a repeat sample was tested.

Failure to follow an SOP can lead to one error but, as in this case, also lead to failure of 'alert' systems that would be available if the process was correctly followed.

Case 5

Incorrect blood group result obtained by manual tube group

A patient presented with multiple injuries and was initially grouped by tube technique as O RhD positive. Based on this blood group 4 units of group O RhD negative red cells, 10 group O RhD positive red cells, 4 group AB FFP, 8 group A FFP, 3 group A platelets and 2 group A cryoprecipitate pools were transfused urgently. The patient was later found to be group AB RhD positive.

Investigation into this incident found no written record of the results of the tube group or second check by the Senior BMS as per SOP. The corrective action has been that staff have been reminded not to rush or cut corners and to follow SOPs.

Learning points (Good Practice Points)

- Transfusion laboratories should have standard operating procedures (SOPs) for abbreviated pre-transfusion testing for provision of blood in emergencies.
- Transfusion laboratories should have SOPs for provision of blood following complete testing with published urgent and routine turnaround times.
- Blood should be made available using one of these SOPs and short cuts to any SOP must not be taken.
- If blood cannot be provided in the time taken to follow one of these SOPs then group O blood should be issued.

In the 3 other cases it is unclear how the ABO error occurred although in all 3 cases the incorrect group was manually entered into the LIMS. Two of these cases were during routine provision of blood, one in a pre-op case and one in a dialysis patient, the other involved provision of blood to a neonate.

D grouping errors n=8

There were 8 errors in RhD typing reported. One case involved an old error which could not be investigated, two cases are discussed below. The other 5 errors were either misreading or transcription errors during recording of manual groups into the LIMS.

- Four occurred in an urgent setting and 4 in routine work
- Four occurred in core hours and 4 out of hours
- Out of hours 2/4 BMS usually worked in transfusion and 2 did not
- In 6/8 cases RhD negative patients were transfused with RhD positive red cells
- In 2/8 cases RhD positive patients were transfused with RhD negative blood
- In one case an 11 year old female went on to produce anti-D, case 6 below
- The 7 other cases involved patients who were females >60 year of age (4 cases) or males (3 cases)
- Three of these recipients also produced antibodies: anti-D+C, anti-D+E and anti-D+C+E respectively

Case 6

Female of childbearing potential develops anti-D as a result of a RhD grouping error

2 x 2mL samples were received for group and crossmatch of one unit of red cells for this 11 year old girl (one 5mL sample should have been sent). One sample was placed on the automated analyser but was too small to allow complete testing. (The partial grouping results obtained from the analyser gave the RhD type as RhD negative but these results were not taken into consideration by the BMS.) The sample was then tested manually. Positive RhD typing results of +1 and +2 were obtained which, according to the laboratory SOP, should have instigated further testing but this was not done. No explanation was given in the report as to how/why these 'false' positive results were obtained. One unit of RhD positive red cells was transfused. The error was noticed when a second unit was requested. The patient was immediately treated with high dose IV anti-D immunoglobulin but has since produced immune anti-D.

Learning points

- Acceptance and testing of 'small' samples increases risk as staff revert to manual methods which are more prone to error.
- When weak RhD typing results are obtained appropriate further testing must be undertaken to confirm the RhD status. Until this is completed RhD negative components should be issued.
- Before issuing components all results obtained must be reviewed and any anomalies explained.

Case 7

D grouping error due to misinterpretation of 'mixed field' reaction.

A patient was admitted with a gastrointestinal (GI) bleed and required transfusion. The patient was grouped as O RhD positive and transfused O RhD positive red cells. On routine testing the following day the analyser detected a dual population of cells when testing with anti-D but the patient's group was concluded and reported by staff as O RhD positive without any investigation into the reason for the 'mixed field' result in the RhD type. Later in the year the patient was admitted for transfusion, following a further GI bleed. Group and screen tests confirmed that the patient was O RhD negative and now had anti-C+D+E. It transpired that the presence of RhD positive cells resulted from a recent transfusion the patient had received in Portugal.

Learning points

- Clinical history must always be sought to explain 'mixed field' reactions. This error mirrors a number of interpretation errors made during UK National External Quality Assessment Scheme Blood Transfusion Laboratory Practice (UKNEQAS BTLP) exercises.
- RhD negative components should be given until the history can be ascertained.

A further 4 RhD typing errors were reported in the Anti-D chapter (Chapter 12). In 2 cases maternal blood was erroneously typed and in two cases the baby was erroneously typed. All 4 errors involved manual interventions. In one of the cases an equivocal result was deemed to be positive when it should have been treated as negative. These errors resulted in unnecessary anti-D Ig being given on 2 occasions, failure to give anti-D Ig once and anti-D Ig being given late once.

For all errors associated with anti-D immunoglobulin see Chapter 12.

Incorrect component selected n=15

In 15 cases the incorrect component was selected, 8 of these involved red cells. One case resulted in an RhD-incompatible transfusion when an RhD negative female neonate was transfused RhD positive red cells. Five cases where RhD positive red cells were given to RhD negative male patients, 2 of whom were paediatric haematology patients, 12 and 15 years of age and one who was a male transfusion-dependent renal patient. The final case was due to insufficient training for the NHSBT's Online Blood Ordering System (OBOS) whereby 4 units of large irradiated neonatal red cells were ordered and transfused to 2 adults.

In 2 cases cryoprecipitate was issued when FFP was requested and in 2 further cases cryo-depleted FFP was issued when FFP was required. In one case group O FFP was issued to a group B patient.

Two cases involved platelets. In one case RhD positive platelets were ordered for one patient but issued to an RhD negative patient in error and transfused. In the second case O RhD positive platelets were issued to an A RhD positive patient in error. In both cases alerts on the LIMS were not fully appreciated by the BMS or acted on in the appropriate way.

Incorrect labelling n=2

2 cases were reported as a result of incorrect labelling, both of which involved labels being transposed so that blood components were labelled for a patient for whom they were not intended (1 red cell and 1 platelet). The bedside checks did not pick up the discrepancy between the component number on the unit and the component number on the compatibility label. No adverse reactions were reported. Further cases involving mislabelling components are reported under Near Miss (Chapter 25) and under Right Blood Right Patient (RBRP) (Chapter 10).

COMMENTARY on wrong component transfused incidents

The number of laboratory errors contributing to wrong blood events has increased this year. Overall there was an increase in the number of ABO and RhD grouping errors, from a total of 7 cases (33% - 7/21) reported in 2010 to 16 cases (48% - 16/33) in 2011. There was a concomitant increase in ABO and D-incompatible transfusions, 6 cases, compared to 3 cases in 2010.

Table 7.5
Trends in laboratory based ABO grouping errors, with causes

		Causes of ABO grouping errors			Outcomes of ABO grouping errors	
Year	Total ABO grouping errors	Wrong sample tested	Interpretation / transcription errors	Other	ABO incompatible red cell transfusions	Sequelae
2011	8	1	6	1 poor process	4	1 rigors
2010	3	1	1	1	1	No morbidity
2009	7	2	5	0	2	1 AHTR*
2008	8	3	5	0	4	1 AHTR
2007	7	3	4	0	1	No morbidity
2006	6	2	3	1	0	No morbidity
2005	22	9	12	1	3	1 AHTR
2004	18	5	12	1	6	1 death 1 major morbidity
2003	17	8	9	0	6	2 major morbidity

** Acute haemolytic transfusion reaction (AHTR)*

Table 7.6 Trends in laboratory based RhD grouping errors with causes (including those reported in the anti-D Chapter 12)

		Causes of RhD grouping errors			Outcomes of RhD grouping errors	
Year	Total RhD grouping errors	Wrong sample tested	Interpretation / transcription errors	Other	Transfusion of RhD positive to RhD negative individual	Sequelae
2011	13	1	10 (1 weak D)	1 testing error 1 old error not investigated	6	1 11 year old female produced anti-D 3 other patients produced anti-D but were not of childbearing potential
2010	11	0	11 (3 weak D)	0	2	1 patient produced anti-D but was not of childbearing potential
2009	5	1	4	0	2	No morbidity
2008	11	0	11	0	10	3 patients produced anti-D but none were of childbearing potential
2007	4	1	3	0	3 (1 x 33 year old female)	No morbidity

All the **ABO and RhD typing errors** reported occurred whilst carrying out manual interventions. No errors occurred during ABO and RhD typing where full automation was used. As manual testing is more error prone, and therefore more high risk, manual testing should only be used when the clinical situation demands because of the requirement for speed. If the workload in the laboratory does not warrant automation then all reasonable measures must be taken to mitigate laboratory errors as stated in the recommendations of the UK Transfusion Laboratory Collaborative (UKTLC)[23]. Where possible this should include checks of the critical steps by a second person when manual methods are employed.

When performing manual tests the SOP must be followed. This is an important principle of good manufacturing practice (GMP). If there is not time for this then group O blood should be issued. If there is any doubt regarding the RhD type then RhD negative blood should be issued, particularly to females of childbearing potential and those who are transfusion dependent, until absolutely certain of the RhD group.

A number of cases provide useful learning points this year and these have been highlighted following the case studies. The SHOT team hope that these case studies will provide a useful tool for use as examples in teaching and knowledge based competency-assessment.

This year, in both cases that resulted in patient morbidity, BMS staff failed to follow procedure but also failed to consider all the information and/or results available to them. This should have alerted staff to discrepancies and prevented the errors.

Learning points

- Before issuing blood components ensure that all available history and current results have been taken into consideration.
- Group O blood should be issued if there is insufficient time for abbreviated testing to be performed to the level recommended in the British Committee for Standards in Haematology (BCSH) guidelines[36 37].
- Assessing clinical urgency: transfusion laboratory staff are constantly put under pressure to provide components urgently which can lead to short cuts being taken increasing the risk of error. Biomedical scientists (BMS) require knowledge and experience to be able to question clinicians and make robust judgements on appropriate pre-transfusion testing, balancing the risks of delaying the issue of blood against safe pre-transfusion testing practice. To make this judgement they must be aware of the risks. There is a requirement for annual training in GMP. Integral to GMP is the requirement to follow standard operating procedures (SOPs) - 'Say what you do and do what you say'. GMP training could cover the risks of not following SOPs, particularly taking short cuts, and these SHOT case studies provide examples of what can go wrong and the consequences.

Errors in component selection continue to occur. The cases involving red cells and platelets are largely incorrect selection of RhD positive units for RhD negative patients. Some LIMS did not appear to have warnings and corrective actions suggested by reporters included improvements to LIMS alerts. Other LIMS systems had warnings that were overridden. Heavy workload and distractions were cited as contributory factors in some cases, lack of knowledge by BMS staff was an issue in a couple of cases whilst no explanations could be found for other errors.

The cases involving plasma are largely due to selection of the wrong component. BMS staff must read the label on frozen components to ensure the right component is being used. It would be helpful if the LIMS alerted when one component had been requested and a different one reserved for a patient.

When analysing this data errors in component labelling do not appear to be an issue, however, when the data from the Near Miss chapter (Chapter 25) are analysed it can be seen that there is a significant number of labelling errors within the transfusion laboratory which are 'caught' at the bedside checking stage. Laboratories must analyse local component labelling errors and take suitable corrective action if required.

Learning points

- Ensure that biomedical scientist (BMS) staff understand when it is appropriate to issue RhD positive components to RhD negative recipients and when it is not, including different selections for patients who are transfusion dependent.
- Ensure appropriate laboratory information management system (LIMS) alerts are in use where available.
- Request appropriate action from LIMS suppliers if useful alerts are not available on the LIMS.
- When issuing components read the component label.

Wrong ABO or RhD type blood components issued for haemopoietic stem cell transplant (HSCT) recipients n=9

This year the errors from these cases are discussed in the section on pre-transfusion testing.

The number of reports received in this section has decreased this year. In 2009 there were 13 cases reported, 15 cases in 2010 and 9 cases this year. All cases, as in previous years, were routine transfusions. Two of the cases were in paediatric patients (9 and 15 years of age) and the rest were in adults. Four of the cases occurred during normal working hours, 1 outside normal working hours and in 3 cases this information was not provided.

Out of the 9 cases, 5 resulted in errors in selection of ABO group components (3 red cells, one FFP and one platelets) and two involved errors in selection of RhD components. In one case cytomegalovirus (CMV) negative components were not given when required and in the final case the correct red cells had been given but had been electronically issued when an indirect antiglobulin test (IAT) crossmatch should have been performed.

Other pre-transfusion errors n=111

In previous SHOT reports pre-transfusion testing errors that have resulted in IBCT errors (including those related to HSCT patients and SRNM) or anti-D Ig related errors have been analysed separately. This year the decision has been made to analyse them in one section as the primary errors are similar in many cases. The classifications of 'testing errors' and 'procedural errors' in table 7.1 at the beginning of this chapter only include errors related to IBCT cases to enable trending from previous years. The discussion that follows is based on primary errors of 111 laboratory errors from all other chapters.

Errors have been divided into:

- **Testing errors**, i.e. the correct tests were performed but incorrect results were obtained due to: wrong patient sample being tested, poor performance of the test, a transcription error or incorrect interpretation of the results.
- **Procedural errors**, e.g. testing unsuitable samples, failure to find historic records, missing vital information on request forms, failure to maintain correct warnings, failure to heed warnings, incorrect test selection, failure to follow procedure, failure to select a component of the correct specification.

Testing errors n=16 (8 IBCT and 8 anti-D)

Wrong sample n=3

Three cases where although the correct sample had been used for determining the ABO group the crossmatch was performed against the wrong sample resulting in units being issued that had not been crossmatched.

Transcription errors during crossmatch n=3

There were 3 examples of transcription errors when putting crossmatch results into the LIMS, either from an analyser or following manual crossmatching. These errors all resulted in incompatible units being issued.

Antibody screening error n=1

One case where manual testing took place because of a power failure and retrospective, automated testing showed that an anti-K had been missed. The patient had been transfused 3 units of red cells by the time the error was detected. Fortuitously these units were confirmed as K negative.

Interpretation error n=9

- A crossmatch was performed in which the control well was positive; this should have invalidated all test results. However not all tests were repeated.
- There were 8 errors in interpretation of antibody identification from the Anti-D chapter this year (Chapter 12). These were all cases of misinterpretation of the antibody as prophylactic anti-D when in fact in 7 cases there was no record of anti-D Ig having been administered and in one case follow up tests should have been performed but were not. In one case a reference laboratory had already reported an immune anti-D. Misinterpretation of anti-D meant that appropriate monitoring of the at-risk fetus was not performed. One fetus required an emergency intrauterine transfusion (IUT), two neonates required top up transfusions positive delivery, three babies were born with symptoms of HDFN, but did not require transfusion, and two babies were unaffected.

COMMENTARY

The main causes of error in this section are selection of the wrong sample and ‘careless’ transcription errors during manual data input. The test methodology and reagents appear to be robust as very few errors of this nature are reported. This year there have been 8 reports of incorrect antibody interpretation through the anti-D related error questionnaires which have had serious consequences.

Learning point

- It is essential that every hospital transfusion laboratory performing antenatal screening for blood group serology understands the importance of ensuring that all relevant history is obtained before interpreting whether the presence of anti-D antibodies may be a result of prophylaxis or immune. Further samples for follow up tests must be requested and tested appropriately.

Procedural errors n=95 (9 HSCT, 34 IBCT pre-transfusion testing errors, 51 SRNM errors and 1 anti-D)

This is the single biggest group of errors and they are many and varied, showing the multiple steps within the laboratory transfusion process that can go wrong.

Testing unsuitable samples n=16

In some laboratories the check of sample suitability is made by the staff and in others by a computer algorithm. In the majority of reports there has been a 'slip' by the BMS involved whilst in 3 reports there has been a lack of understanding on the part of the BMS as to the sample 'suitability' requirements. In one report the patient had been transfused at another hospital and the laboratory was not informed of this.

Learning point

- Computer prompts/warnings/flags are a valuable tool for trying to prevent human error through 'slips' but staff must also have the underpinning knowledge to understand and act appropriately to a warning.

Failure to find historic records n=10, (3 IBCT, 6 SRNM and 1 anti-D)

Relevant historic records were not found on 10 occasions. In 7 cases the search for a historic record on the LIMS was not properly carried out so that duplicate records were missed. In 3 cases there were IT issues that contributed to the failure to find historic records. Some examples are given below to highlight some pitfalls when searching for historic records and the ensuing risk from failing to find records:

- In one case a BMS searched on sample records, not patient records, entered an incorrect sample number and failed to find the history. This appeared to be the laboratory policy. As a result an unsuitable sample (too old) was used to issue blood.
- Six cases where duplicate records were present for a given patient, but were not found for various reasons, resulting in missed antibody history or missed special requirements:
- A BMS in another pathology discipline created a new record for a patient, which did not include the patient's antibody history of anti-Jk^a, resulting in the patient receiving 3 units of red cells which had not been typed for the Jk^a antigen.
- A patient was transferred from another hospital and a sample was received and processed, blood requested and issued. Only after the units had been transfused did the ward notify the laboratory that the patient had sickle cell disease (SCD). The transfused units were not Rh matched or HbS negative. It transpired that the patient did have historic records on the LIMS that gave the diagnosis and special requirements but these had not been found due to a name change and the manner in which the LIMS was set up in 2004. The records were not linked and the requirements were omitted from all later samples.
- In 4 further cases the failure to search the LIMS database properly resulted in:

– a patient with anti-Jk^a receiving units that had not been phenotyped for Jk^a;

– a patient with a history of a positive direct antiglobulin test (DAT), an auto-anti-M and non-specific IAT antibodies having blood electronically issued;

– failure to provide irradiated blood to a patient who required irradiation;

– failure to give anti-D Ig to a woman who was a known RhD variant. She had typed as RhD positive but previous history was available but not found.

- In 3 cases 'issues' with the LIMS, or access to it, meant that historic records were missed:

– In one case blood was required when IT systems were down and blood was issued without checking the historic, paper antibody record. This stated that the patient had an anti-E. Fortuitously E negative units were issued.

– In a second case the cause of the failure to find historic records was that the BMS had not kept his computer software access rights up to date. This resulted in the BMS being unable to look at the 'hospital patient master index'. Secondary to this was a fault on a particular PC within the laboratory which could have been worked around by going to another PC in the area (4 others available). The patient had an anti-Fy^a in 2002. The units issued were not phenotyped for Fy^a.

– In the third case a record was missed because of a 'glitch' in pulling patient records from an old LIMS database into a new one. This case is further described in the IT chapter (Chapter 8) and exemplifies the need for thorough validation of all scenarios.

Learning points

- Transfusion laboratories must have a robust search protocol in place to identify previous patient history, prior to booking in samples, taking into account the fact that duplicate hospital numbers DO exist and name changes WILL occur.
- Maintaining an accurate patient database is a critical safety measure in the safe treatment of patients.

Failure to notice information on the request form n=11 (1 HSCT, 1 IBCT and 9 SRNM)

- In one case the BMS failed to notice the antibody history noted on the request form.
- In 7 cases laboratory staff failed to notice a special requirement ticked on the request form. This appeared to be the primary method for alerting the laboratory to the need for the special requirement.
- In 3 further cases the need for a special requirement, ticked on the request form, was missed by the laboratory but this was not the primary method of informing the laboratory of special requirements, meaning that clinicians were also at fault in these cases.

These errors resulted in 6 cases of failure to give irradiated components, 2 cases of failure to give CMV negative components and 1 case of failure to give irradiated and CMV negative components, when required.

Learning points

- Hospital Transfusion Teams (HTTs) should perform a local risk assessment on the way in which the transfusion laboratory is informed by clinicians of either special requirements, or previous history provided by patients direct to clinicians. For example, having a robust process to inform the laboratory when treatment on purine analogues starts, rather than when blood is requested, has merit.
- If 'tick boxes' on request forms are used they should stand out.

Warning flags not entered accurately or kept up-to-date correctly n=13 (3 HSCT and 10 IBCT and SRNM)

As a result:

- In 2 cases HSCT patients received components of the incorrect ABO group (1 red cell and 1 FFP) and in 1 case red cells of the incorrect RhD type.
- In 4 of these 13 cases the patients received red cells of the wrong phenotype: in 2 cases information from red cell reference laboratories was inaccurately entered onto patient's notes. In one case the 'flag' for a patient with beta thalassaemia was not activated and in another case a flag blocking 'remote' issue of blood for a patient with SCD was not activated. This latter case resulted in the patient receiving blood not only of the incorrect Rh phenotype but also blood that was not HbS negative.
- Three cases where electronic issue (EI) was used inappropriately following manual edits of grouping results. The LIMS in use could not identify the edited results as part of the EI algorithm so the BMS should have added the patients to the EI exclusion list. This had not been done.
- One case where blood was issued by an 'immediate spin' technique despite the patient having an antibody. The antibody status had not been properly recorded in the LIMS so that an automatic flag did not alert the BMS. Fortunately the units selected lacked the required antigen.

- In one case a patient flag was added to the LIMS stating the temporary requirement for irradiated components but on subsequent requests the patient flag did not appear on the request entry screen, or the search screen and the patient received non-irradiated components. Six weeks later laboratory staff became aware of this issue and reported it to the LIMS supplier who could find no explanation.
- One case where the 'special requirement' flag was removed from the LIMS in error when the patient was on bendamustine. From the time the flag was removed to the time this error was discovered the patient had received 15 units of red cells and 5 units of platelets that were not irradiated.

Learning points

Addition of notes and activation of warning flags is another point of manual entry in the transfusion process therefore:

- As with any process the competence of the staff performing this task must be assessed.
- As with other manual interventions one person should perform the task and a second person check that it has been completed correctly.
- The use of 'checklists' may be helpful to ensure that all parts of the process have been completed.
- Use of Electronic Data Interchange (EDI) should be explored where possible e.g. Blood Service to Hospital Transfusion Laboratory.

Warning flags not heeded n=13 (3 HSCT, 10 IBCT and SRNM)

In 13 cases warning flags were missed. These errors lead to 2 HSCT patients receiving red cells of an incorrect ABO group, 1 HSCT patient receiving blood of the incorrect RhD group, 3 patients failing to receive irradiated red cells, 3 patients failing to receive CMV negative red cells, 1 patient failing to receive CMV negative, irradiated red cells, 2 females of childbearing potential receiving K positive red cells and 1 patient with SCD receiving E positive red cells when he was E negative.

They all seemed to be 'slips' on the part of the BMS and mitigating circumstances were cited in some cases e.g. distractions, multiple notes, remembering special requirements from the previous day and not realising more had been added, too many warnings leading to a tendency to push 'escape' perhaps because of the urgency of the case. Some reporters felt that the warning flags on the LIMS were not as good as they could be.

Cases in which blood components were issued following failures to follow the laboratory SOP n=24 (2 HSCT, 8 IBCT, 14 SRNM).

The causes were: incomplete pre-transfusion testing, wrong test selection, failure to select a blood component of the correct specification.

- One case where a patient had not received a HSCT, as recorded on the LIMS, but had received platelets of a group which would have been correct based on the group of the transplant donor.
- Two cases where blood was issued without an antibody panel, following a positive antibody screen, fortuitously antigen negative units were issued on both occasions.
- One case where, following a positive antibody screen, the antibody identification was not authorised because the control kept failing and the sample ran out. Although a repeat sample was requested it did not arrive before the patient's surgery. The panel results showed a clear anti-Jk^{a} in the patient sample despite the failure of the control. The patient went for a caesarean section, bled and was transfused 2 units of emergency O RhD negative blood which was later confirmed to be Jk^{a} positive.
- One case where the antibody status of the mother was not checked prior to issue of blood to a neonate. One unit had been transfused when a sample was requested from mother and found to contain no irregular red cell antibodies.

- Two cases where electronic issue was performed incorrectly: in one case blood was issued to a neonate whose mother had anti-D and the BMS did not seem to realise that an IAT crossmatch was required. The second case was inappropriate as the patient had undergone a HSCT.
- One case where a unit of blood was released and transfused before the compatibility testing had been completed due to the electronic release system being off line. This case is discussed further in the IT chapter (Chapter 8).

In 8 cases the incorrect phenotype of red cells was selected. There were a variety of root causes for these errors from 'slips' to lack of understanding of the need for phenotyped units. The 'slips' included:

- 4 cases of failure to provide K negative units to women of childbearing potential.
- One case where the patient was known to have anti-Fy^{a} but the BMS, who intended to select a Fy^{a} negative red cell, selected a Jk^{a} negative unit in error. As the antibody was no longer detectable the crossmatch was compatible.
- An interesting case where two crossmatches were performed by a reference laboratory for patients who had multiple antibodies. On both occasions, red cell units were issued as least incompatible. As the presence of low incidence antibodies could not be excluded, the routine practice was to type the units for the relevant low incidence antigens to the antibodies that could not be excluded during the investigation. This typing did not take place. On discovery of the error, the red cell suspensions from the crossmatches were retrospectively low incidence antigen typed and all units were found to be negative for Kp^{a}, Lu^{a} and Wr^{a}.
- In two cases the BMS's lack of knowledge was the reason why antigen typed units were not selected for patients who had clinically significant antibodies on file but which were not detectable in the current sample. Case 10 is described in some detail below as it highlights some important issues in terms of transfer of knowledge into practice and communication in the setting of multidisciplinary out of hours work.

In 5 cases there was failure to supply CMV negative units when required.

In 3 cases there was failure to supply methylene blue (MB) treated FFP when required.

Where these special requirements were not met (5+3 cases above) the reporters thought the errors were a result of 'slips' by the BMS in 6/8 cases. The BMS knew and understood the need for the requirement but forgot to provide it. There was no evidence that there were LIMS prompts in place to remind the BMS of the need for the special requirement in any of these cases. For the remaining 2/8, in one case there was no explanation for the error and in the other a paediatric patient did not receive MB treated FFP because the BMS was unaware of this product, only being aware of neonatal MB-FFP and adult FFP.

Learning points

- The laboratory information management system (LIMS) should be used as much as possible to help prevent 'slips' by biomedical scientists (BMS). There are many rules to remember during component selection so that a timely prompt based on, for example, the age and/or sex of a patient can be very helpful.

Case 8

A combination of uncertain understanding, unclear communication and a busy night contribute to an erroneous transfusion

A patient was admitted with a two day history of melaena, with symptomatic anaemia with haemoglobin of 5.4 g/dL. Four units of blood were requested. The multidisciplinary BMS on call (his discipline being biochemistry) was having a busy evening. He looked up the patient history and found a historic record of anti-c+E+S. The BMS understood the need for appropriately crossmatched, antigen-negative blood and believed that this would have to be provided from the blood service. He understood that this would take some time and phoned the ward to ask for two more samples for dispatch to the blood service.

The BMS telephoned the blood service to inform them that samples were being sent. The staff at the reference laboratory asked the BMS to screen the sample and let them know the result. The BMS's recollection of this conversation left him with the impression that the staff at the reference laboratory were 'leaving it with him'. He proceeded to screen the blood for antibodies.
The doctor then phoned the BMS to inform him that the patient's blood pressure was falling and to enquire 'what the backup scenario was'. The BMS informed him that he could crossmatch the blood and issue the most compatible if that was required. He understood that this proposal was accepted by the doctor. The BMS completed the antibody screen and crossmatched the blood. As there were no reactions he issued the four units of red cells.
The reference laboratory staff then called the BMS to check the results of the screening test as they had not heard back from him. They advised that the issued units should be recalled and that they would send 4 units of antigen negative blood. The BMS phoned the ward but did not recall the units. He started to crossmatch the antigen negative blood received from the blood service but ran in to problems with the analyser. He telephoned a colleague at another hospital and was advised not to attempt to fix the analyser but to revert to manual crossmatching. The BMS was not familiar with this process. Nonetheless he found the relevant SOP and tried to proceed with the crossmatch. He then found that the pipette was not working and that there was a reagent problem. He therefore reverted to trying to fix the analyser and reported being increasingly worried and tired and probably increasingly unable to think clearly.
When the day shift took over the units were immediately recalled but 2 units had been transfused. No reaction was reported.

A very comprehensive, local, root cause analysis was undertaken following this incident which raised important issues, a number of which related to multidisciplinary training for out of hours working. The requirement for senior management to take training and competency-assessment of BMS seriously across all their roles was highlighted. The reporters have offered to share this RCA and it can be found on the website under SHOT Annual Reports and Summaries/Report and Summary 2011.

Learning points

- Clear communication is vital, both inter laboratory communication (hospital laboratory staff to reference laboratory staff) and laboratory staff to clinician. Strong theoretical knowledge is required to be able to communicate effectively.
- Regular practice and competency-assessment of infrequently-used manual techniques is important. This means that multidisciplinary staff MUST have regular, high quality training rotations into blood transfusion. UK Transfusion Laboratory Collaborative (UKTLC) guidelines recommend the equivalent of 10 working days per annum supervised working in a hospital blood transfusion laboratory[23].
- At annual appraisal of multidisciplinary biomedical scientists (BMS) the training and competence for work performed 'out of hours' must be assessed as well as their 'primary' role. Effective avenues of line management need to be in place for the full range of duties undertaken by a BMS.
- A formal backup system must be in place that can be accessed should an 'out of hours' lone worker get into difficulty. The means of accessing this advice should be clear and simple.

Unacceptable process - using staff not trained for the level of activity n=2

There were 2 cases where transfusion laboratories relied on medical laboratory assistant (MLA) staff to alert the BMS staff to the need for special requirements.

Case 9
Misunderstanding of instruction by reception staff
A request was received for 6 units of blood for a patient transferred from another hospital. There was a special note in the LIMS stating that CMV negative, irradiated blood should be crossmatched. This was missed by laboratory reception staff, therefore not passed onto the BMS performing the test, and the patient did not receive the correct component.

Case 10

Another misunderstanding by reception staff

Irradiated blood was requested for a patient and written onto the request form but this was missed by the MLA booking in the request. At the time, request forms were not allowed on the crossmatch bench so the BMS was unaware of the need for irradiated blood and issued non-irradiated blood to the patient.

Learning point

- The qualified biomedical scientists (BMS) crossmatching red cells or issuing components must take responsibility for checking all the relevant history on a patient to ensure that they issue components of the correct specification.

Errors in recall of blood components n=2

There were 2 errors in laboratory recall procedures reported this year:

The introduction of extended life platelets by the NHSBT led to a number of platelet recalls. During one day when there was a large number of such recalls, the courier selected the wrong unit from the ward agitator for return. The implicated unit was subsequently transfused. The patient was not affected and NHSBT confirmed that this was a precautionary recall and no further action was required.

The laboratory received a request for non-irradiated components and issued 3 units. The patient informed clinical staff that irradiated components were necessary. 3 units of irradiated red cells were obtained and issued but the laboratory failed to recall the non-irradiated red cells in a timely fashion. There was a shift change on the ward and a nurse collected a non-irradiated red cell unit and administered it to the patient.

Miscellaneous cases n=4:

- The NHSBT sent out a unit that was not negative for the antigen that had been requested. The MLA entered the phenotype incorrectly onto the LIMS and the BMS did not check the phenotype before issuing the red cell unit.
- Failure by a hospital laboratory to irradiate a unit of platelets.
- The late issue of a revised policy lead to 2 patients receiving K positive blood when they should have been given K negative units. The patients involved were over 50 years of age.
- A paediatric platelet pack number 4 was physically issued but on the LIMS pack 1 was issued. Pack 1 was still in the platelet incubator.

Table 7.7
Special requirements not met because of failure to consult patient records thoroughly

Failure to	No. of cases 2010	No. of cases 2011
Failure to provide irradiated components	9	16
Failure to provide CMV negative components	4	11
Failure to provide CMV negative and irradiated components	3	2
Failure to provide human leucocyte antigen (HLA) matched platelets	1	0
Failure to provide human platelet antigen (HPA) matched platelets	1	0
TOTAL	**18**	**29***

** includes one HSCT patient who did not receive CMV negative components*

COMMENTARY on pre-transfusion testing

The search for a historic patient record is an integral part of the group and antibody screen procedure and must be performed according to a robust SOP.

Hospitals must ensure that there is a robust local protocol in place for informing the laboratory of the need for special requirements. Errors in this process continue to occur despite consecutive SHOT reports highlighting this process as an area of weakness in the transfusion pathway. Disappointingly

the number of cases of failure to supply components with the required specification has increased this year (29 cases compared to 18 last year).

The issues with regard to computer warning flags, their maintenance and use, are discussed in the IT chapter (Chapter 8).

Most of the errors in this section appear to be 'slips'. Heavy workload and distractions were cited as mitigating circumstances in a number of cases.

Errors which appear to demonstrate a lack of knowledge by the BMS staff are:

- Cases where identification panels have not been run, despite a positive antibody screen, because the antibody is already known. This demonstrates failure to appreciate that a second antibody might have developed.
- Cases where antigen-negative units have not been selected, despite a history of clinically significant antibodies, on the basis of the current antibody screen being negative. Antigen-negative units are still required in these cases to prevent a delayed haemolytic reaction resulting from a possible anamnestic response.

In order to try and prevent 'slips', warnings/flags/alerts in the LIMS can be helpful and should be in use where possible, whilst trying to avoid unnecessary messages that may lead to 'warning' overload. The requirement to have to positively confirm, in the LIMS, that a component carries the special requirement would be a useful tool in any LIMS upgrade. Some warnings are built into the system as 'logic' rules and must be validated thoroughly when added to the LIMS, other warnings are patient-specific. The addition of these warnings/flags/notes is a manual procedure and is itself prone to error and should be controlled, for example, entered by one BMS and checked by a second.

Learning points

- Distractions must be kept to a minimum.
- Competency-assessment of biomedical scientists (BMS) staff must include pre-transfusion testing and provision of red cells for patients with antibodies, historic and/or current. UK National External Quality Assessment Service for Blood Transfusion Laboratory Practice (UK NEQAS BTLP) are trialling a competency-assessment scheme in the near future which may prove helpful in this area.
- Competency-assessment must include understanding and knowledge as well as simply the ability to perform a standard operating procedure (SOP). An SOP cannot cover every scenario and the ability to apply knowledge and recognise personal limitations are essential requirements of a qualified BMS.
- A common theme running through this report is the failure of BMS staff to take into account all relevant data i.e. patient history, all results including discrepant results, maternal history when providing blood for neonates and this failure has contributed to all cases of morbidity.

Cross reference cases for I&U

There were two interesting cases this year reported in the I&U chapter (Chapter 9), which highlight emerging issues for laboratories and safe, rapid blood provision.

I&U Case 9 (Chapter 9) - There was a delay in the provision of red cells to a bleeding patient due to a 'mixed field' result not allowing 'electronic release' of blood components. The blood was crossmatched at the hub laboratory and couriered to the site. The delay resulted because the laboratory staff member did not realise why the blood could not be electronically released. Emergency O RhD negative blood was available on site but the clinicians decided not to use it.

I&U Case 6 (Chapter 9) - The massive haemorrhage protocol was activated. In this situation all components should have been issued in a cool box packed by a member of laboratory staff. Instead,

the blood units that were issued 'uncrossmatched' were placed into the issue refrigerator via the blood tracking system. When these units were subsequently crossmatched the tracking system 'quarantined' them in the main theatre blood refrigerator so that clinical staff did not have access to them. This led to a delay in blood being available for this patient.

Cases from HSE

These constitute errors in the post-analytical phase of the transfusion process.

The majority of the 60 errors were either:

- Failure to clear blood refrigerators in a timely manner. This led to blood being transfused that had either expired or was past its 'suitability' date or
- Failure to react appropriately to refrigerator 'failures' that meant the 'cold chain' of the blood components could not be assured.

Errors involving Blood Services

- 1 unit issued of the incorrect phenotype.
- 1 case where units were not phenotyped for antigens to low incidence antibodies in 2 patients with multiple antibodies.

Recommendations - see also IT chapter (Chapter 8)

As the specification of transfusion laboratory information management systems (LIMS) is further developed it is vital that:

- As a minimum there is a requirement for positive confirmation, by the biomedical scientist (BMS), at the point of component reservation, that special requirements have been met.
- Preferably, a requirement for a direct check within the LIMS, that the component meets the special requirement on record.
- Warnings must be clear and appear on all relevant screens in the transfusion process.
- Warning flags need a positive response from the user as to why they are being overridden.

Action: Transfusion Laboratory Managers, Pathology IT managers, LIMS Providers

Recommendations from previous years which are still active:

Competency-assessment of staff involved in the transfusion process must be relevant to the person's core role and knowledge requirements. Competency-assessment must be linked to process through clear, unambiguous SOPs but there must be an element of assessment of knowledge and understanding as well as the ability to simply follow the SOP. Competency-assessment of 'soft skills' such as communication should also be incorporated and could be achieved in line with the Knowledge and Skills Framework (KSF) requirements for the relevant BMS band. This is a role for Transfusion Laboratory Managers.

The revised guidelines on pre-transfusion testing are due for publication later this year. There are a number of helpful revisions from the 1996 guidelines, for example, a section on testing in urgent situations and a flow diagram on interpretation of and provision of red cells when weak RhD results are obtained. This is an action for Transfusion Laboratory Managers.

For additional active recommendations from previous years and an update on their progress, please refer to the SHOT website

8. Errors Related to Information Technology (IT)

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

The cases are drawn from the other chapters of this report as shown in Table 8.1. Cases selected include events where IT systems may have caused or contributed to the errors reported, where IT systems have been used incorrectly and now includes cases where IT systems could have prevented the errors but were not used.

Table 8.1 Source of cases included in this chapter

Error	
Incorrect blood component transfused (IBCT)	30
Special requirements not met (SRNM)	28
Right blood right patient (RBRP)	5
Inappropriate and unnecessary or under/delayed (I&U)	4
Handling and storage errors (HSE)	7
Total	**74**

In 2011 there were 74 reported incidents of errors related to IT systems (see Table 8.2), compared with 56 in 2010, 61 in 2009 and 44 in 2008.

In the 2011 data, 65/74 of these incidents originated in the transfusion laboratory. A total of 58 cases involved red cells, 5 both red cells and platelets, 6 platelets only and 5 related to plasma components.

Seven of the 74 cases occurred in children (2 were infants below the age of one year).

Most events, 72% (53/74), occurred during core working hours and 88% (65/74) were due to errors involving the laboratory staff or laboratory systems. In relation to the requests, 43 of the transfusions were considered routine, 16 urgent and 11 were emergencies. In 4 cases the urgency of the request is not specified.

Table 8.2
Categories of IT system errors

Error	Reports	Wrong blood component	Component transfused where special requirements were not met				Wrong group after HSCT	Unit expired or out of temp. control	Inappropriate and unnecessary (including delays)
			Not irradiated	Not CMV neg	Not CMV neg or irradiated	Antigen positive unit			
Failure to consult or identify historical record	6	2				3	1		
Failure to link, merge or reconcile computer records	6	1	2			3			
Warning flag in place but not heeded	12	3	3	3	1	2			
Warning flag not updated	5	1				1	3		
Failure to use flags and/or logic rules	14	8*	2		1	2	1		
Computer or other related IT system failure	9	5				2		1	1
Errors related to computer system	4	2	2						
Errors related to electronic blood management systems	11	4						6	1
Incorrect result entered or accessed manually	7	3				2			2
Total	**74**	**29**	**9**	**3**	**2**	**15**	**5**	**7**	**4**

** includes 2 cases where blood component is non-MB-FFP given to a child*

Deaths

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

Potential for major morbidity

There was 1 case where IT systems contributed to a potential for major morbidity.

A woman of childbearing age was given K positive blood because of the failure to use warning flags to prevent this. She developed anti-K and anti-E.

Errors due to availability or inaccuracy of historical record n=12

This year there were 12 cases where failure to use historical transfusion records resulted in an error of which 6 cases were due to failure to consult the historical record and a further 6 cases occurred because historical records were unavailable because they were not merged or linked.

Failure to consult the historical transfusion record on the LIMS led to the selection of the wrong group of fresh frozen plasma (FFP) in 1 case and on 2 other occasions resulted in inappropriate electronic issue of red cells. Two transfusions took place where antigen-negative blood was not selected for patients with previous alloantibodies. A patient with HbSC disease, with no alloantibodies, would have received extended phenotyped blood, had the clinical history and red cell phenotype been known. Another patient with beta thalassaemia should have been flagged to receive phenotyped blood but the diagnosis was not communicated by the clinicians.

Merging or linking of historical records on the LIMS failed in 2 cases where non-irradiated components were provided for patients at risk of transfusion-associated graft versus host disease (TA-GvHD). One patient transferred to another hospital site within the same organisation and the LIMSs were not linked. Another case had a new computer record set up that was not linked to the record containing details of previous purine analogue therapy. Three transfusions took place where antigen-selected blood was not provided for patients with historical, but currently undetected, antibodies. This information was located in duplicate and unlinked computer records and therefore inaccessible.

These cases demonstrate the importance of access to historical computer records as well as the need to have robust systems for searching for these records with first and last names, date of birth, hospital number and NHS number (if available). This search strategy should be made clear in laboratory standard operating procedures (SOPs), taking account of the way the LIMS has been configured.

Case 1

Failure to find important clinical information because a historical record was not linked to the current episode

A post-partum transfusion was administered to a patient who had transferred from another hospital. The LIMS had no record of the patient's requirements on the current sample, so no alerts were generated. It was subsequently noted that the patient had sickle cell disease and had historical transfusion records. These had not been linked to the current record because the patient's name had changed.

Case 2

Failure to transfer antibody information to a new LIMS

A patient with two clinically significant alloantibodies was flagged in the old LIMS, although the antibodies at that time were not detectable in routine laboratory tests. On the first occasion when the patient was to be tested using the updated LIMS the sample was rejected as 'not acceptable for testing'. The next time a sample was tested the old LIMS system was not accessed because it was assumed that the historical data for this patient would have had been imported on the previous occasion, although it had not. Testing showed the antibody screen was negative and unscreened compatible units were issued for transfusion. One of the original antibodies was detected a month later, thought to be a new antibody, and antigen-negative units were issued for transfusion. Two years later the patient produced an antibody card for both original antibodies, which was when the error was detected and investigated.

This case shows the importance of validation and testing of new IT systems against a number of scenarios and having a robust system for transfer of data from legacy systems.

The strategy for linking and merging records should also be clear. Sometimes new records are created because current demographic data does not match the available historical record and, if these are not searched or linked, important clinical information can be missed.

An unusual error occurred because a biomedical scientist (BMS) used a 'sample ID' search to see if a crossmatch sample was available. The BMS, who did not usually work in the transfusion laboratory, was unaware that this was against the laboratory policy. The sample was available, but no longer valid and was used to issue blood electronically despite the fact that a transfusion had taken place in the interim period. This information would have been available had the search been done using the patient ID.

One patient, with a historical but not currently detectable anti-Fy^{a}, was given antigen-unselected blood because the historical record was not available. This resulted from the BMS not being able to complete the full search of historical records because access rights to all the relevant IT systems were not kept up-to-date. In another case, the historical record was under a different hospital number so the history of anti-M and positive direct antiglobulin test (DAT) was missed as the current antibody screen was negative and blood was inappropriately issued by electronic issue (EI).

Errors due to failure of warning flags or logic rules n=31

This was the commonest category of IT errors this year with 31 cases where warning flags or logic rules failed to prevent errors. In 12 cases a warning flag was in place but was not heeded. In 5 cases the warning flag was inaccurate or had not been updated to reflect the current need. A further 14 cases were identified where the use of a warning flag, or some form of 'logic rules' system, would have prevented errors, had such a system been implemented.

Warning flags are set up in the LIMS to alert the operator when undertaking pre-transfusion testing and selecting blood components for issue. The way the warning flags are configured depends on the LIMS in use; some use warning screens, others messages that have to be acknowledged and others are able to prevent issue of components using algorithms based on logic rules.

In 2 cases a warning flag was ignored when issuing platelets of a different group although both were for routine transfusion to adult males. In 1 case, a thawed sample was used to crossmatch for an urgent request despite a warning that the sample was not suitable.

In 7 patients requiring cytomegalovirus (CMV) negative (3 cases) irradiated (3 cases) or both CMV negative and irradiated (1 case) components, these were not provided because the warning flags were not heeded. In 3 further cases the LIMS warning flags were not set up, with the result that 2 patients had non-irradiated blood and 1 non-CMV negative red cells and platelets. Additional errors by the clinical staff requesting these components also contributed. No adverse outcomes were reported in any of these cases.

Two women of childbearing age were each transfused a single unit of K positive red cells despite warning flags highlighting these units as unsuitable. One woman developed anti-K as a result and but it is not known if the other was sensitised. One hospital, that has now implemented a warning flag to give K negative blood, reported that they identified a patient given one K positive unit out of a four unit transfusion for a post partum haemorrhage 5 years ago but fortunately no antibodies have developed.

It is important that warning flags are set up accurately and reflect the current situation. Two haemopoietic stem cell transplant (HSCT) patients were given the red cells and platelets of the wrong group because the agreed transplant protocol was either not put on the LIMS or had been changed at the last minute and had not been updated in a timely way. In another patient, the transfusion department was not informed of the HSCT two months previously and had not updated the computer records to reflect this. All of these errors arose in routine situations and within normal laboratory hours. The cases also demonstrate that computer systems can only prevent errors if effective communication between the laboratory and the clinicians takes place.

One laboratory failed to select antigen-negative blood for a patient with a recently detected antibody because the appropriate flag had not been set up on the LIMS. The red cells were issued without a serological crossmatch, although subsequently shown to be antigen-negative. In another case the results of a (negative) antibody investigation and recommendation of suggested (own) red blood cell (RBC) phenotype for transfusion were not added to the computer and therefore these instructions were not followed when crossmatching red cells.

In 2 paediatric cases of 14 cases where warning flags or logic rules were not used, their use could have prevented non-methylene blue (MB)-FFP being given. In a recent clarification of the Advisory Committee on the Safety of Blood, Tissues and Organs (SaBTO) advice, children born after 01/01/1996 should be given pathogen-inactivated components so the logic rules and flags should be set up to reflect this, not just the age of the patient, as is the case with some systems.

In 1 renal transplant patient, being prepared for an ABO-incompatible renal transplant, the information about the required FFP group was kept on a notepad rather than setting up a special requirements flag with the result that 1 unit of the wrong group of FFP was issued for plasma exchange before the error was identified and replaced with the correct group.

Case 3

Special requirement flag removed in error

A patient required irradiated blood because of previous chemotherapy. The transfusion laboratory had received notification of this special requirement and added the information to the LIMS. The special requirement flag was subsequently removed from the LIMS in error. From the time the flag was removed to the time it was discovered, the patient had received 15 units of red cells and 5 units of platelets that had not been irradiated.

In some cases the computer software is configured in a way that creates problems. Either because events cannot be flagged or because the way it handles historical groups is inconsistent with preventing wrong blood issue. In one case an incorrect RhD group in a historical record became the default group when entering a manual or abbreviated group from the current sample. This required a software change that had to be completely revalidated.

Laboratory errors arising from manual data entry where electronic transfer of data would have been safer n=5

Although laboratory information management systems (LIMS) control many processes, they remain dependent on manual steps such as entering antibody and phenotype information from tests done by reference laboratories, the requirement for irradiated or CMV-tested blood based on clinical decisions.

There are 5 laboratory errors reported in this category. Errors have occurred despite the presence of warning flags and logic rules because incorrect data has been entered manually and therefore the error is not detected. One example is given below.

Case 4
Wrong phenotype transfused due to multiple errors, including incorrect manual entry of phenotype data
Eight units of extended phenotype and HbS negative blood were requested for an exchange transfusion in a patient with sickle cell disease. An error by the Blood Service meant that one of the units did not meet the requested specification. A member of laboratory staff manually entered the phenotype of the units onto the LIMS and did not notice this error so entered the expected, rather than the actual, phenotype. When the blood was issued the BMS issuing the blood for transfusion did not check the phenotype on the blood bag label.

The electronic delivery note (EDN) provided by Blood Services downloads phenotype information for each donation as the stock delivery is recorded on the LIMS. This reduces the potential for transcription errors and would have prevented this error.

In one case a manual group was incorrectly interpreted and entered manually onto the LIMS. ABO incompatible blood was issued for a patient by overriding the flag that warned the blood group was not authorised. This case is discussed in more detail in the laboratory IBCT section, Chapter 7.

There are further 3 cases where a manual step is required to mark a patient as unsuitable for EI. An automated system to exclude edited or inconclusive groups from EI could have prevented these errors.

Case 5
Failure to add patients to electronic issue (EI) exclusion list results in inappropriate EI
Three patients were inappropriately issued blood by EI rather than serological crossmatch by the same laboratory where the system in place requires the manual addition of patients to an EI exclusion list, which then applies an algorithm on the LIMS to prevent EI. In both cases this manual data entry step was omitted.
The first exclusion was because of an inconclusive RhD group under investigation and the second was a baby with a weak reaction in the control well which was edited to negative. The baby was subsequently found to have a positive direct antiglobulin test (DAT). The third case was an edited group and the BMS did not know it had to be excluded from EI.

In one case, the historical record was under a different hospital number so the history of anti-M and positive DAT was missed as the current antibody screen was negative and blood was inappropriately issued by EI.

Learning points

- Laboratory information management systems (LIMS) logic rules and warning flags that prevent issue of the wrong component should be set up where available.
- New computer systems should be specified to include the capacity to flag existing special requirements and have the flexibility to change to reflect current guidance.
- Each laboratory should have clear policies stating where historical data is held and how it should be accessed, with clear understanding of the way the LIMS stores the data and therefore of the limitations of the search strategy.

Errors due to computer downtime or failure of other systems n=13

Safe blood transfusion relies on interoperability of the LIMS with other systems such as Patient Administration Systems (PAS) and Electronic Blood Management Systems (EBMS) as well as with laboratory analysers and refrigerators. Interoperability relies on robust interfaces and transfer of information with barcode technology where possible. Manual systems are less robust and prone to error.

There were 7 laboratory errors where IT systems were unavailable and manual back-up procedures failed.

Problems during LIMS downtime have resulted in two situations where wrong blood was issued. One was during a major computer system downtime when red cells for a routine transfusion were supplied to a patient with a known antibody without a full crossmatch although the units were antigen-negative. The other was when platelets were issued beyond their expiry date/time during an episode of unplanned LIMS downtime.

One unusual case where there was a delay in provision of blood cites one of several contributing factors being the change from British summertime to wintertime resulting in difficulty accessing the LIMS.

In 1 case blood was transfused before compatibility testing was complete because the electronic blood release system was off-line It is important that all staff know what the downtime procedures are if any part of the system is down. In the laboratory this means reverting to downtime procedures but when remote issue is in place and these systems fail, only emergency blood should be accessible. This case was an emergency.

In 2 cases a temporary loss of power caused equipment failure. In 1 case, the analyser failed and manual testing missed a weak positive antibody screen which was detected when the automation was reinstated. The error would not have occurred if the usual automated procedures were in place. The second case is outlined below.

Case 6

Importance of robust back-up procedures during IT downtime

The laboratory was unable to print compatibility labels for blood bags because the LIMS system lost its connection to the label printer following a power failure elsewhere in the hospital. The back-up application also failed. As a result, 3 digits were omitted from the donor number when handwriting the compatibility labels for an emergency transfusion. This was noticed after the unit had been connected to the patient.

A new online blood ordering system (OBOS) has been implemented by NHSBT with a number of useful features. In one case the wrong component code was used and the wrong component delivered and transfused to two patients. This component was large volume irradiated neonatal red cells therefore there was no risk to the adult recipients.

The error in the final case would have been prevented by the use of an electronic delivery note (EDN) where information is transferred directly into the LIMS rather than by barcode scanning individual information, or entering it manually if the barcode scanners are not working.

Case 7

Failure of barcode reader leads to the wrong component being transfused

Cryoprecipitate was booked into the laboratory system as FFP without the use of a barcode scanner, because this was not working. This unit was stored in the FFP freezer and when a request was made for FFP, the cryoprecipitate unit was issued as FFP.

Learning points

- Contingency plans should be in place for computer or equipment downtime.
- Where possible, manual processes should be kept to a minimum.
- Data should be transferred electronically where possible including the use of on-line ordering and electronic delivery information but training to use these systems should be adequate.

Errors using IT systems outside the laboratory

Electronic blood management systems n=11

This section looks at the errors where the electronic blood management systems (EBMS) should have prevented transfusion of wrong blood, time expired components or components out of temperature control. For the purposes of this summary, only electronic 'blood-tracking' systems are discussed. These record the movement of blood components in and out of blood refrigerators and platelet incubators. A recent IT survey on behalf of the National Blood Transfusion Committee (NBTC)[38] shows that 47% of responding NHS Trusts in England and North Wales have implemented blood-tracking through refrigerators and platelet incubators.

In 2011 there were 11 reports in this category; 6 cases relate to handling and storage errors, 1 incorrect blood component transfused, 3 'right blood right patient' events and 1 delay in provision of blood.

Of the 6 errors where refrigerator tracking failed to prevent transfusion of components that were time expired or out of temperature control, 5 cases involved red cells and 1 case a platelet transfusion. Half of these errors took place outside normal working hours and all except 1 were errors made by staff working outside the laboratory. In half of the cases the transfusion was said to be 'urgent' or 'emergency'. There were no adverse effects on the recipients of these transfusions.

Using a recently implemented refrigerator-tracking system, warning screens were ignored in 3 cases; 1 resulted in transfusion of expired red cells, in another transfusion of red cells that had been out of temperature storage for more than 30 minutes and in a third the wrong red cells were removed and transfused to a patient, fortunately of the same blood group. The staff who overlooked these warning screens had been recently trained but were not sufficiently familiar with the system and further support was provided.

There were two instances of errors where the system had been used incorrectly by staff who were not trained but had gained access by using access cards belonging to others.

Case 8

Other person's access card

A temporary member of staff removed 2 units of red cells from the refrigerator without checking the patient's identifiers or undertaking any checks on the blood component. He was asked to collect the blood by a staff nurse, who gave their access card to the member of staff who was not allowed to collect blood, having had no training or competency assessment.

There was one case where the use of electronic blood tracking was reported to cause a delay in provision of blood. The safety features of these electronic blood management systems are designed to only release blood that is suitable for transfusion. The system was configured to quarantine blood when it was retrospectively crossmatched which is what happened in this emergency situation.

Case 9

Electronic blood-tracking system results in delay of emergency blood

In a major haemorrhage call for a ruptured aortic aneurysm, 6 units of emergency blood were put in the main issue refrigerator using an electronic blood-tracking system. These were then removed and taken to the theatre where 2 units were used immediately and the remaining 4 put in the satellite refrigerator, also under control of the blood-tracking system. When theatre staff tried to remove these, the system displayed a message stating that there was no blood in the refrigerator for that patient. Although the laboratory was contacted and remotely opened the refrigerator, there was a delay during which blood was not available for the patient. The manufacturers reconfigured the blood-tracking system so that this situation would not arise again.

Learning points

- There should be adequate resources to train staff to use the electronic blood management systems.
- If the staff ID passes used to gain access to blood refrigerators are linked to successful training and competency assessment they must not be shared.
- Lack of familiarity with electronic blood management systems can cause delay in an emergency.

Clinical systems for viewing laboratory results

In previous reports there have been inappropriate and unnecessary transfusions because the wrong haemoglobin (Hb) result was acted upon. This year there were 2 such cases. One case occurred due to a 'transcription error', presumed to arise because the wrong Hb result was copied into the notes and a transfusion prescribed and administered to a patient with a normal Hb. The second case of unnecessary transfusion resulted from the doctor accessing the wrong patient's Hb on the IT system. On both occasions the error was detected quickly and no more than one unit was given. There were no adverse effects.

Direct transfer of Hb results into a patient's electronic record reduces the risk of transcription errors on the ward but clinical staff should be trained to check that they are using the correct method of searching for patients. Having a second check that the correct result has been accessed is good practice. This could be made routinely by the blood transfusion laboratory staff processing a request or by the staff administering the blood as part of the pre-transfusion check.

Anti-D Ig errors

Table 8.3 IT Errors related to administration of prophylactic anti-D Ig

Error	Reports	Unnecessary anti-D Ig administered	Failure to administer anti-D Ig, or excessive delay
Error when manually transcribing data	1	1	
LIMS not updated with reference laboratory result	1	1	
Failure to consult historical record	4	3	1
Failure of logic rules within LIMS software	1	1	
Total	**7**		

There were 7 reports in 2011 where laboratory IT-related errors or problems led to unnecessary administration of anti-D Ig (6 cases) or delay in giving anti-D Ig prophylaxis (1 case). 70% of these cases occurred within normal working hours and involved staff who routinely work in the transfusion laboratory.

There were two additional cases where a laboratory error, rather than an IT-problem, led to inappropriate anti-D Ig administration and the suggested preventative action in response to the incident was to implement a software change. Rule-based algorithms and logic rules are used in LIMS to control critical processes, including the administration of anti-D Ig prophylaxis. Warning flags and/or prevention of the inappropriate issue of anti-D Ig is an essential function of an IT-system, and is supplementary to adequate knowledge of laboratory and clinical policies. Sometimes these logic rules can fail and such a case is outlined below. This demonstrates how important it is to test all possible scenarios when validating an IT system.

In one case, where administration of anti-D Ig was delayed, a woman was incorrectly assigned a RhD positive blood group in the current pregnancy. The D-variant previously identified was fully documented on the LIMS but this record was not linked to the current episode. Although she had been identified as needing anti-D Ig prophylaxis this information was not accessible. In a second case where anti-D Ig was given unnecessarily, the mother and baby records were not linked correctly resulting in the wrong decision being made in the clinical area.

Whilst IT-systems can be used to control the transfusion process, there are always points where manual steps are required. The procedures to control those manual steps are not always kept up to date. There are three cases that exemplify this. Two mothers were given anti-D Ig unnecessarily because information about immune anti-D was held on an electronic 'note pad' and this was not consulted or taken into account. In another case the result from the reference laboratory was not entered into the LIMS in a timely way.

Another manual step that is prone to error is the transcription of data from the LIMS into a paper record, such as a community or patient-held maternity record, which resulted in an error in one case. The use of electronic patient records with data entered via an interface is more secure although the interoperability of IT systems does not always permit this. There were no cases this year where incorrect data from the mother or baby were transcribed onto the LIMS, as in previous years.

Although most of these errors involve the laboratory, lack of knowledge and incorrect prescribing by doctors and midwives contributed in part to the unnecessary administration of anti-D Ig.

Case 10
Important information about allo-anti-D held on LIMS was not used in decision-making when issuing anti-D Ig
Anti-D Ig was administered post-delivery to a RhD negative woman who had been sensitised during the current pregnancy. The patient 'notepad' on the blood bank computer system stated that an allo-antibody was present and prophylactic anti-D Ig was not required. This information was not in the patient's notes. Anti-D Ig was requested by the midwife and was issued from the laboratory without challenge. The information on the blood bank computer had not been used in the decision making process.

Case 11
LIMS system not updated with results from reference laboratory
In her second pregnancy, a woman who had previously grouped as O RhD negative was suspected of having a weak-D antigen. After confirmation by the reference laboratory it was decided that she did not require prophylactic anti-D Ig, although this had been administered in her first pregnancy. The laboratory information system was not updated with this information and anti-D Ig was issued and administered at 28 weeks. Results of a repeat sample identified this omission and the RhD status was corrected on the LIMS.

Case 12
Failure of logic rules to prevent issue of anti-D Ig to a RhD positive mother
Routine antenatal anti-D prophylaxis (RAADP) was issued to a RhD positive mother after a request was received from a community midwife. The request form stated that the patient was O RhD negative following an incorrectly recorded verbal result in the maternity record and the laboratory did not check the LIMS. Logic rules that had been previously developed to prevent anti-D Ig being issued to RhD positive women had failed. These logic rules have now been amended and work correctly. A recent LIMS software upgrade has added an additional level of safety by flashing up a warning that requires a comment to be added whenever anti-D Ig is ordered against a RhD positive patient.

COMMENTARY

The modern transfusion laboratory is critically dependent on IT and automation. This section of the report is no longer confined to laboratory systems but has now been expanded to include electronic blood management systems and other interoperable systems that support safe transfusion practice. For this reason, the number of transfusion errors related to IT systems has increased this year.

The specification and operation of IT systems in hospital transfusion practice has been covered by a series of BCSH guidelines and the 2006 version is being reviewed along with the BCSH pre-transfusion testing guidelines. BCSH validation guidelines[39] were published highlighting the importance of ensuring that all laboratory systems, including IT systems function in the way they are designed and expected to.

Common causes of wrong blood errors in this report are the failure to use warning flags on the LIMS properly; either because they are not heeded or because they are not correctly set up or updated in a timely way. Other important failures occur when the historical computer record, containing important information to guide selection of the right blood components, is not used or cannot be accessed. These two categories account for nearly 70% of the laboratory errors.

In this reporting year there are several examples where IT systems have failed to exclude an unsuitable patient from electronic issue (EI) or where an unsuitable sample has been used for compatibility testing.

The British Committee for Standards in Haematology (BCSH) guidelines[37] advise the patient selection criteria for electronic issue, and the Medicines and Healthcare products Regulatory Agency (MHRA) has issued further guidance[40] emphasising the importance of EI being under the control of the LIMS *without any manual intervention* to compromise the algorithm that compares current and historical blood groups, antibody screening results and validity of the blood sample. Even if the algorithm for EI is under control of the LIMS, there is often a requirement for manual steps in order to apply the EI algorithm.

A particular feature this year has been that problems with printing compatibility labels have led to errors and potential wrong blood incidents. Firstly, label printing is dependent on an interface to the LIMS and labels cannot be printed if the LIMS system is down or the interface is not working. This year a power failure elsewhere in the hospital prevented compatibility labels being printed in the transfusion laboratory because of a problem with the interface. Some laboratories have back-up systems to print labels and others resort to handwritten labels, which is slow and prone to transposition errors. In the event that compatibility labels have to be reprinted, it is important that the system selected to reprint is secure and that staff are familiar with it.

When new IT systems outside the laboratory are implemented, errors have arisen due to lack of familiarity but it is expected that these systems will reduce manual interventions and improve patient safety. The NBTC IT Survey in England and North Wales shows that blood tracking and electronic bedside administration systems have been implemented or are planned in many Hospitals and Boards and in independent hospital networks[38].

Pathology modernisation is likely to result in networked and merged transfusion services, and has created many challenges. ‘Hub and spoke’ models, remote issue of blood and further integration with reference services are dependent on effective IT systems.

Accurate patient identification is key to safe blood transfusion and can be facilitated by IT systems. The IT survey shows the use of electronic ordering for blood transfusion tests is becoming more common but these systems can be confounded by patients with multiple hospital numbers.

Increasing reliance on IT and automated systems creates problems when these systems are unavailable due to computer or power failure. Lack of familiarity with manual back-up systems without the logic rules and algorithms provided by computers can lead to errors as can the need for handwriting multiple compatibility labels.

Access to the LIMS as well as other interoperable systems needs to be in place for all staff at all times. Lack of access has led to errors in this report. This includes the blood transfusion computer system (where separate from the LIMS), LIMS, PAS, and electronic blood management systems.

Recommendations

- Any future specification written for a laboratory information management systems (LIMS) must state that:
  - A direct check is required, within the LIMS, to ensure that the component selected meets the special requirement on record.
  - If warning flags/alerts are overridden, which they may need to be in a clinical emergency, a positive response as to why they are being overridden must be entered. It should not be possible to simply 'escape' past a warning/alert.
  - Warnings/alerts must be clear and appear on all relevant screens within the LIMS.
- Where possible all critical processes in the transfusion laboratory should be identified and, if possible, should be under the control of the Laboratory Information Management System.
- When new information technology (IT) systems are implemented, and existing systems upgraded, they should be validated using a wide range of scenarios to ensure they are working as intended.

  These recommendations will be included in the revised British Committee for Standards in Haematology (BCSH) IT Guidelines for Hospital Transfusion Laboratories
- Where possible all critical processes in the transfusion laboratory should be under the control of the Laboratory Information Management System.

  ACTION: Transfusion Laboratory Managers, Pathology IT managers, LIMS Providers
- When new IT systems are implemented, and existing systems upgraded, they should be validated using a wide range of scenarios to ensure they are working as intended.

  ACTION: Transfusion Laboratory Managers, Pathology IT managers, LIMS Providers

For active recommendations from previous years and an update on their progress, please refer to the SHOT website

9. Inappropriate, Unnecessary or Under/Delayed Transfusion (I&U)

Authors: Paula Bolton-Maggs and Julie Ball

Definition

- **Transfusions given on the basis of erroneous, spurious or incorrectly documented laboratory testing results for haemoglobin, platelets and coagulation tests.**
- **Transfusions given as a result of poor understanding and knowledge of transfusion medicine, such that the decision to transfuse either puts the patient at significant risk, or was actually harmful.**
- **Under-transfusion or delayed transfusion resulting in morbidity.**

DATA SUMMARY
Total number of cases: 149

Implicated components		Mortality/morbidity	
Red cells	112	Deaths due to transfusion	1
FFP	8	Deaths due to under-transfusion	1
Platelets	23	Deaths *possibly* due to transfusion	0
Red cells and plasma	4	Major morbidity	5
Red cells, plasma & platelets	2	Potential for major morbidity *(Anti-D or K only)*	0

Gender		Age		Emergency vs. routine and core hours vs. out of core hours		Where transfusion took place	
Male	66	≥ 18 years	135	Emergency	52	A&E	18
Female	82	16 years to <18 years	3	Urgent	39	Theatre	22
Not known	1	1 year to <16 years	3	Routine	48	ITU/NNU/HDU/Recovery	14
		>28 days to <1 year	3	Not known	10	Wards	66
		Birth to ≤28 days	2			Delivery ward	6
		Not known	3	In core hours	92	MAU	16
				Out of core hours	54	Community	2
				Not known	3	Outpatient/day unit	2
						Not known	3

Overview

149 cases were analysed this year compared to 110 in 2010, an increase of 35.5%.
The median age was 60 years and the range was 0-94 years. The 11 paediatric cases are included in the paediatric chapter (Chapter 22).

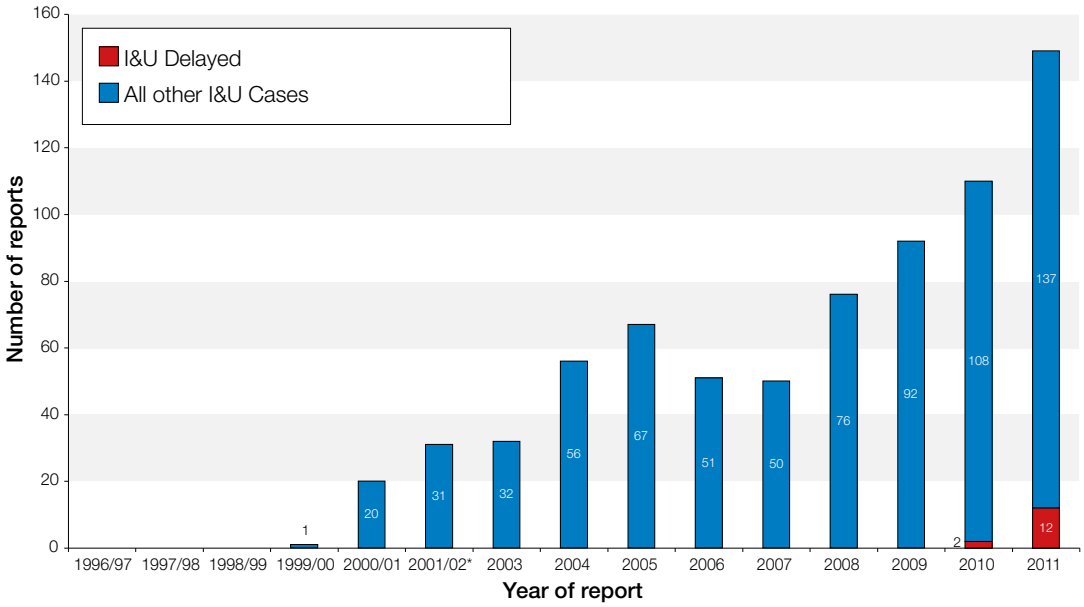
Deaths n=2

There were 2 deaths, in one the patient was excessively and rapidly transfused and an obstetric patient with major haemorrhage received too little too late.

Major morbidity n=5

Four cases were associated with surgery for abdominal aortic aneurysm (AAA) – one patient received excessive red cell transfusion and in 3 cases morbidity was related to delayed transfusion. In the fifth case, seven units of blood were extravasated due to a displaced central line.

Figure 9.1
Total Cases of inappropriate and unnecessary, and delayed or under-transfusion 1996-2011
(Note: reports of delayed transfusions have only been collected for 2010 onwards)



Inappropriate and unnecessary transfusion n=137

Death n=1

Case 1

Haematemesis with excessive transfusion and transfusion-associated circulatory overload (TACO)

A middle-aged woman with known alcoholic liver disease presented with haematemesis estimated to be more than 500 mL and was urgently transfused 7 units of red cells without monitoring of the Hb. The Hb on the previous day was 11.3 g/dL. The patient was not reviewed regularly during transfusion. Her Hb rose to 16.4 g/dL post-transfusion requiring venesection of 2 units and admission to high dependency unit (HDU) for ventilation because of pulmonary oedema. She later died of multi-organ failure. It was felt that death was related to the excessive transfusion.

Major morbidity from excessive transfusion n=2

Case 2

Excessive transfusion of red cells during surgery for abdominal aortic aneurysm (AAA)

An elderly man received red cell transfusions during repair of an abdominal aortic aneurysm which ruptured during surgery. The blood loss was difficult to gauge. His post-operative Hb was 19.1 g/dL but the intended Hb was 10 g/dL according to regional guidelines for management of AAA. The man died within 24h of surgery as a result of multiple organ failure related to his aneurysm. The coroner concluded that death was not related to the excessive transfusion.

During surgery for ruptured aortic aneurysm blood loss and replacement can be difficult to manage. Frequent near-patient testing (e.g. HemoCue®) is essential to avoid over-transfusion, especially if cell salvage is used (with the caveat that such instruments are properly quality assured and used by appropriately trained staff as indicated in learning points below).

Case 3

Unnoticed subcutaneous transfusion

A 59 year old man on the intensive therapy unit (ITU), ventilated and undergoing haemodialysis, with sepsis and multiorgan failure, received 7 units of red cells through a subclavian line over a period of two days for anaemia, but without an increase in Hb. ITU staff realised that the central line had become displaced and blood had leaked subcutaneously. The patency of the line had been repeatedly checked with a saline flush but not with test aspiration. Examination of the patient revealed substantial swelling on the chest wall and axilla. A chest X-ray showed that the catheter tip had been displaced out of the subclavian vein. The patient had also received insulin and antibiotics through this line.

It is surprising that this patient received so many units of blood, antibiotics and insulin before the problem was identified. Every central line should be reviewed for patency if unable to withdraw fluid since this indicates a problem[41]. This case also demonstrates the importance of examining the patient fully every day.

Delay in transfusions n=12

There were a total of 12 delayed transfusions reported in 2011. In all cases the delay was during active haemorrhage as shown in table 9.1

Table 9.1 Speciality related to delay in transfusion during haemorrhage

Specialty where event occurred	Number of cases
Cardiology	
Haemorrhage complicating cardiac catheterisation	**1**
Vascular surgery	
Abdominal aortic aneurysm	**1**
Gastroenterology	
GI bleed	**1**
General surgery	**2**
Post operative bleed	1
Abdominal Aortic Aneurysm	1
Accident and Emergency (A&E)	
Intra-abdominal aneurysm	**1**
Obstetrics	**6**
Bleeding during caesarean section	3
Post partum haemorrhage	2
Post C-section haemorrhage	1
Total	**12**

Death n=1

Case 4

Failure to replace blood volume after post partum haemorrhage

A woman in her mid-thirties had a ventouse-assisted vaginal delivery for fetal distress at term. It was then complicated by massive haemorrhage from cervical lacerations. The major haemorrhage protocol was activated, six units of blood were delivered within 5 minutes and one was started immediately. She was transferred from the delivery room to theatre and the bleeding was controlled within 30 min. The blood loss was unclear with losses recorded in both the delivery suite and theatre. A second unit was commenced. About 2 hours later, she suffered cardiac arrest from which she could not be resuscitated despite transfusion of 12 units of blood and 3 units of fresh frozen plasma (FFP). Coagulation tests done about 30 minutes prior to arrest were abnormal. This may be a result of the massive haemorrhage but analysis suggested she may have had a previously unrecognised coagulation factor XI deficiency. (She had a previous birth by caesarean section without excessive bleeding). The coroner confirmed the cause of death to be cerebral hypoxia secondary to haemorrhage.

Root cause analysis of this case provided important learning points. The estimated blood loss may not have been fully appreciated because she was managed first in the delivery suite and then in theatres. In

addition, point of care tests provided Hb results which led to a false sense of security. Two teams were involved in the management and it was not clear who was the leader; there was poor communication with differences of opinion. There were also changes in shifts during the interval between delivery and arrest so that the full picture was perhaps not appreciated.

Although the major haemorrhage protocol was activated, no coagulation tests were taken at the outset. The haemorrhage was controlled but the red cell and fluid replacement was inadequate.

Major morbidity from delayed transfusion n=2

Case 5

Delay in transfusion; emergency AAA repair – communication confusion

An elderly man was undergoing repair of AAA. There was delay in delivery/transport of crossmatched blood from the laboratory to theatres following issue. Uncrossmatched group O blood was available but not used by clinicians despite the biomedical scientist's (BMS') advice to do so. Transfusion was delayed for 2 hours 20 minutes after laboratory received the sample. The patient sustained a cardiac arrest during the procedure; at this stage he had been transfused with 3 units of red cells. The major haemorrhage protocol was activated only when the estimated blood loss was 3 litres. Other components of the major haemorrhage pack were not issued for an additional hour because of conflicting messages regarding the request received in the laboratory.

Case 6

Delay in patient transfusion during AAA surgery caused by a BMS error and IT malfunction

A 75 year old man was bleeding in theatre during repair of AAA. The massive haemorrhage protocol was activated, and 6 units of group-specific blood were issued to the theatre refrigerator using the electronic blood-tracking system. This was the wrong procedure for major haemorrhage (the required products should have been packed by a BMS into a cool box for immediate transportation). The units were retrospectively crossmatched and results added to the laboratory information management systems (LIMS) which sent a message to the theatre refrigerator to quarantine the units, possibly because the system had received two conflicting messages about the units. Nobody knew what to do. Uncrossmatched blood was placed into the issue refrigerator via the electronic blood-tracking system. When these units were subsequently crossmatched the blood-tracking system quarantined them in main theatre blood refrigerator so staff did not have access to them. Eventually the refrigerator was unlocked remotely and the blood obtained after a 25 minute delay. It was subsequently confirmed that the blood-tracking system had not been properly configured.

Minor morbidity from delayed transfusion n=2

Case 7

Delayed provision of emergency blood due to communication breakdown

A 33 year old woman was admitted as an emergency, hypotensive due to a leaking intra-abdominal aneurysm. There was a 4 hour delay in providing emergency red cell transfusion due to communication breakdown between the emergency department and the laboratory. The patient made a full recovery.

Learning points

- Surgery for aortic aneurysm is associated with a high risk of morbidity and mortality (65% for emergency surgery when ruptured, but 4.3% for elective repair)[42] (www.vascularsociety.org.uk 'outcomes after elective repair of infra-renal abdominal aortic aneurysm'. March 2012). The quality improvement programme for abdominal aortic aneurysm (AAA) repair mandates the availability of cell salvage during surgery and careful pre-operative work-up including a group and antibody screen.
- For emergency AAA repair the laboratory should be informed immediately so that the staff are ready to supply components rapidly. Good communication channels are essential and additional laboratory or portering staff may be required.

Cases of delayed transfusion in obstetrics

Obstetric emergencies can result in dramatic and major blood loss. As well as the death described above, there were 6 other cases with delay due to a variety of causes:

Poor communication:

- A porter failed to read his instructions and collected a single unit of red cells whereas two were required.
- There was a delay in a courier collecting urgent samples for analysis and transport of components back to the obstetric department where the laboratory was off-site.
- There was a delay when the laboratory informed the obstetrician that the time to obtaining crossmatched blood would be 30 minutes but it took 90 minutes by which time the mother had both hypovolaemia and a coagulopathy.

Wrong sample:

Blood was requested for emergency transfusion but provision of red cells was delayed because a previously sent sample already in the laboratory was labelled with the wrong patient details.

No provision of plan for emergencies during a fire alarm

Case 8

Obstetric major haemorrhage with delay in transfusion caused by a fire alarm.

A 40 year old woman was undergoing elective caesarean section and started to bleed excessively. At the same time, the fire alarm sounded. The obstetrician and theatre staff were aware of the alarm, but management of the bleeding continued. Urgent bloods were sent to haematology via the tube system and the laboratory was telephoned to alert them to the need for urgent analysis and a need for blood components. However, there was no answer so an assumption was made that the laboratory had been evacuated. The general manager (outside the building with evacuated staff) was contacted and located haematology staff who were cleared to return to the laboratory. Blood samples were analysed and major haemorrhage pack was requested. Once samples had been received in the laboratory there was a delay in sending blood products to theatre as additional paperwork was requested for use by porters.

The root cause analysis of this case was very useful with several learning points which led to changes in practice.

a) There was a lack of communication between the fire co-ordinators and the pathology services, with no understanding of the impact of evacuating the laboratory. Senior laboratory staff were unable to obtain information or updates about what was happening.

b) The maternity staff could have used the bleep system to update laboratory staff, as they knew that pathology had been evacuated.

c) The review also demonstrated that the medical staff asking for the major haemorrhage pack had little understanding of how it should be used or collected indicating a need for training.

A new policy is now in place in blood transfusion for actions on hearing a fire alarm, particularly that the transfusion section was not to be evacuated unless absolutely necessary.

Delay associated with new working practices

Case 9

Delay due to main laboratory being offsite

*A 61 year old woman suffered a post-operative haemorrhage. Blood was requested but the BMS found a mixed field (and could not determine the correct group) and was unable to authorise electronic release of red cells. A blood sample was sent out to a hub laboratory and red cells were provided after 2 hours. There was poor communication from the BMS to the surgical team. Emergency O RhD negative units were available***.**

This case illustrates three problems, lack of understanding of the BMS in the local laboratory, failure to keep the clinicians informed, and delay caused by the main laboratory being off site. This is further discussed in the Errors Related to Laboratory Practice chapter (Chapter 7).

Transfusions based on erroneous results

Table 9.2
Transfusion based on incorrect haemoglobin result n=53

Clinical causes of falsely low Hb value	No
Falsely low Hb due to phlebotomy from drip arm, or "diluted sample"	16
Unexplained low Hb result not queried prior to transfusion	11
Substitution of white cell count for Hb (transcription error)	4
Wrong results from point of care testing	
Blood gas machine Hb used	7
Erroneous result from POCT Hb estimation device	2
Incorrect POCT device used (measured glucose rather than Hb)	1
Faulty sample (clotted, short etc)	3
Result from an older pre-transfusion sample used after a transfusion had taken place	2
Sample tubes transposed in lab	2
Hb result belonged to another patient	2
Transfusion based on an old Hb result despite a more recent result being available	1
Hb transcription error	1
Verbal miscommunication of results	1
TOTAL	**53**

Table 9.3
Causes of false low platelet count n=8

Causes of a false low platelet count	No
Platelet clumping	3
Clot in sample	4
Analyser error	1

Case 10

Inaccurate platelet count leads to inappropriate transfusion

The analyser in the haematology laboratory gave inaccurate platelet counts over a period of 3 weeks due to a laser lens being coated in debris. A haematology patient was subsequently transfused 2 units of platelets based on an inaccurate platelet count reported as 9x10^9/l.

Transfusion of two adult doses of platelets for a count <10x10^9/l does not comply with British Committee for Standards in Haematology (BCSH) guidelines[43]. It is not clear how the problem with the analyser came to light, but this demonstrates a failure of appropriate quality management. A problem persisting for 3 weeks is likely to have impacted on the care of many other patients.

Table 9.4
Causes of incorrect coagulation results n=2

Causes of incorrect coagulation results	No
Sample from drip arm (also gave false Hb result)	1
Transcribed wrong results from another patient	1

Case 11

Wrong results for Hb and coagulation tests – sample from drip arm

A 33 year old man was admitted with collapse and hypotension. The first blood sample gave Hb 3.3g/dL and very abnormal coagulation results. The BMS queried the results suspecting a diluted sample but was told it was not. The man was transfused with red cells, FFP and cryoprecipitate. Repeat testing then gave dramatically different results and the conclusion was that the initial sample was from a 'drip' arm and was erroneous.

A repeat sample should have been sent before transfusion.

Learning points

- There are 53 reports shown in table 9.2 where a low Hb result was incorrect resulting in an inappropriate and unnecessary transfusion. SHOT has previously noted the problems associated with samples from 'drip' arms or dilution after sampling from central lines[24 27]. There were more instances of this reported this year than in each of the two previous years.
- There are 10 instances this year related to near patient testing. Seven of these relate to use of blood gas analysers which have been shown to be unreliable by UK National External Quality Assessment Service (UK NEQAS) Haematology. Again this year on one occasion a Hb result was taken from a blood glucose machine.
- All near patient testing equipment must be fully quality assured for any test undertaken and all staff who use it must be appropriately trained and competency assessed[27].

Table 9.5 Inadequate clinical knowledge or prescribing n=63

Categories of poor knowledge or prescribing (excluding use of erroneous Hb)	No
Excessive volume/rate of red cells transfused to infant or child	3
Excessive red cell transfusion resulting in Hb above the normal range	2
Transfusion of red cells for chronic iron deficiency	5
Hb result not monitored for patient with GI bleed	2
Hb result not checked between transfusion episodes	3
Incorrect component requested and given	1
Duplicate prescription	1
Components prescribed despite normal results	6
Use of emergency O RhD negative units when crossmatched units or valid group and screen were available	2
Use of neonatal emergency O RhD negative blood for adult patient	2
Red cells transfused which were not prescribed	1
Over-transfusion resulting in circulatory overload	2
Prescription unclear* (including misunderstanding over 'units' of cryoprecipitate)	4
Known unexplained erroneous/spurious result used despite repeat sample being taken	6
Unexplained erroneous/spurious result used – not queried prior to transfusion	4
Repeat sample taken but transfusion took place before result available	7
Inappropriate transfusion of FFP to patient with acquired haemophilia (2 episodes)	1
Inappropriate transfusion of platelets to patient with immune thrombocytopenia	3
Unnecessary transfusion of red cells to a patient in sickle crisis	1
Paediatric red cell prescription in 'units' not mL	1
Others	6
Total	**63**

**In 2 cases where the patient was intended to receive 1 litre of FFP, only 1 pack (approx 250mL) was given (one failure to follow the prescription and the other a failure to prescribe more than one pack after a verbal instruction to give 4 packs)*

Case 12

Consultant continues to sign regular prescription for transfusion without checking any Hb levels

An elderly male patient with myelodysplastic syndrome attended the outpatient department for monthly transfusion. A post-transfusion Hb was eventually found to be 17.4 g/dL. The consultant had continued to sign a regular prescription for 2 units of red cells at each visit without reference to Hb results. The last Hb result available was prior to treatment being commenced 8 months previously. The patient received 16 units during this period without any repeat Hb measurements despite samples being taken regularly for grouping.

Every patient should have a Hb check prior to transfusion. No doctor should sign a prescription without confirming that it is clinically indicated. This case demonstrates a breakdown in communication within the team and incorrect assumptions.

Case 13
Inappropriate treatment for iron deficiency
An 85 year old woman with iron deficiency anaemia received an unnecessary blood transfusion. She was prescribed 3 units of red blood cells by her general practitioner (GP); she only however received one of the units after the GP was contacted and the request challenged. Oral iron was started.

This was particularly inappropriate since a patient of this age is at risk of transfusion-associated circulatory overload. Oral or IV iron are preferred treatment.

Case 14
Inappropriate management of iron deficiency in pregnancy
A 27 year old lady had a Hb 8.1 g/dL at 39 weeks gestation. A junior doctor agreed a transfusion of 2 units of red cells with a consultant haematologist but this was outside the obstetric guideline threshold of 7.0 g/dL. The known iron deficiency had resulted in a prescription for iron tablets, but her Hb continued to fall (booking Hb 12.2 g/dL). It transpired that she had been taking folic acid instead of iron.

It is disappointing that 5 patients received transfusions to treat iron deficiency. Two of these were treated prior to elective surgery where they could not wait for a response to oral or intravenous iron. Intravenous iron preparations are now safe and a very good alternative for patients who cannot tolerate or adhere to oral iron therapy.

Patients with haematological disease (iron deficiency, immune thrombocytopenia and acquired haemophilia in 9/62 (14.5%) cases) could have been managed differently if advice had been sought from a haematologist.

A patient of low weight, <40kg, with Hb 5.1 g/dL was transfused in excess, with 5 units of red cells resulting in a post-transfusion Hb of 15 g/dL and respiratory compromise.

Learning points

- All patients receiving regular transfusions should have regular clinical review and assessment of their needs. Every clinician who signs a transfusion prescription should satisfy him/herself that the reason for every transfusion is known, evidence-based, and documented in the case notes.
- At the time of transfusion it is essential that the patient is properly identified, and that the component is verified as the one that has been prescribed for that patient.
- It is particularly important to assess patients carefully when an unexpected result is reported. The result may be erroneous for a variety of reasons. If the results do not fit the clinical situation the test should be repeated prior to transfusion.
- Blood transfusion is not an appropriate treatment for iron deficiency. Elderly patients are particularly at risk for transfusion-associated circulatory overload (TACO see Chapter 16).
- Patients with a low body mass index (BMI) will have a smaller blood volume and require a smaller transfusion to achieve the same increment in Hb, and are at risk of TACO.

Table 9.6 Avoidable use of emergency O RhD negative units n=8

Avoidable use of emergency O RhD negative blood	No
Emergency blood used when crossmatched available	1
Grouping sample taken but not sent to the laboratory	1
Sample lost	1
Wrong blood in tube	2
Hb 9.7g/dL with no active bleeding	1
No ID band in situ at sampling or transfusion	1
Antibody detected but elective patient already in theatre and bleeding	1

Case 15

Late request for blood to cover surgery leads to inappropriate use of emergency O RhD negative blood.

An elderly lady was admitted on the morning of surgery for major abdominal surgery and a sample was sent for grouping with request for a crossmatch. She was taken to theatre without waiting for results. The antibody screen was positive. The BMS phoned theatre, but surgery was already underway. Four units of O RhD negative emergency blood and 4 units of FFP were transfused. The antibody was anti-E and fortunately the O RhD negative units used were compatible.

This case demonstrates worrying lack of understanding concerning the use of O RhD negative units. These may not be safe in the face of possible unidentified irregular antibodies. A pre-transfusion screen should have been carried out in advance.

A root cause analysis was carried out and the outcome was to ensure that nursing staff in preassessment and surgical wards are trained to take transfusion samples so that patients can be sampled earlier than day of surgery.

Case 16

Wrong blood in tube

A 40 year old woman undergoing surgery required urgent transfusion. The sample received in the transfusion laboratory was labelled for Patient A. The sample was analysed and a group discrepancy was identified when compared to the historical record. The BMS contacted theatre staff who identified that Patient B was the one in theatre for whom urgent transfusion was required, but her samples had been labelled as Patient A (the previous patient in theatre). Patient B was given emergency O RhD negative blood due to a delay in receiving the correct sample.

Learning points

- As noted in the 2010 Annual Report[12] patients with gastrointestinal bleeding are sometimes inadequately monitored during transfusion, leading to excessively high haemoglobins.
- Several instances of delayed transfusion were due to communication breakdown.
- Careless practice, where results are misread, or short cuts are taken including the use of point of care machines not validated for the purpose, results in inappropriate or unnecessary transfusion.
- Emergency situations are particularly prone to error and miscommunications.

COMMENTARY

The 36% rise in reported inappropriate, unnecessary and delayed or under-transfused cases is likely to be due in part to increases in reporting such cases to SHOT. Last year only 2 delayed transfusions were reported. This year the number is 12, one of which resulted in a death. Many cases of inappropriate and unnecessary transfusion continue to occur due to poor communication, understanding and knowledge.

Major haemorrhage protocols are essential but are not always activated in a timely manner. Staff are often unaware of the protocol, who calls it, and how it should run.

The management of ruptured aortic aneurysm is fraught with difficulty and requires close collaboration between clinical and laboratory teams with good communication as already recommended in anaesthetic guidelines for this condition[42].

Appropriate component therapy, especially platelets, should be ordered immediately when the decision is made to operate. It is not yet clear whether point of care-directed component replacement (eg TEG/ROTEM) is superior to conventional protocols where red cells and clear fluids are employed until surgical blood loss ceases, followed by FFP/platelet replacement prior to closure.

Point of care machines, including blood gas analysers, must be quality-assured regularly, as recommended by SHOT in 2009[27]. Blood gas machines are not always reliable for Hb estimation and must be considered a rough guide at best. Dedicated devices such as the HemoCue® are more accurate but should be regularly compared to local laboratory results.

Blood gas machines must not be used for Hb estimation unless they are designed and calibrated to produce accurate, reproducible results with external quality assessment in place[27]. A NEQAS pilot survey has demonstrated significant variation in Hb results from blood gas analysers and an EQA scheme is proposed (B. De la Salle, Scheme Manager, UKNEQAS Haematology, personal communication, 2011).

Recommendations

- Hospital Transfusion Committees (HTCs) should review the arrangements for the management of aortic surgery in line with the Vascular Society Quality Improvement Programme http://www.aaaqip.com

  Action: Hospital Transfusion Committees (HTCs)

- Hospital laboratories should review their arrangements for fire and other alarms regarding emergency telephone calls and the delivery of results and blood products.

  Action: Transfusion Laboratory Managers, Pathology Directors

- Hospitals/Trusts/Health Boards should review the arrangements for management of massive blood transfusion and to ensure that practice drills take place.

- Hospitals/Trusts/Health Boards should develop practice drills for activation of major haemorrhage protocols to ensure that all staff know what to do in an emergency.

  Action: Transfusion Laboratory Managers. Clinical Risk Managers. Medical Directors

- Blood transfusion is not an appropriate treatment for iron deficiency. Elderly patients are particularly at risk for transfusion-associated circulatory overload (TACO see Chapter 16). Iron deficiency must be diagnosed and treated with iron supplements.

  Action: General practitioners, Hospital doctors, Medical Schools, Hospital Transfusion Teams (HTT)

Several recommendations from previous years have still not permeated into practice, particularly the need for education and training on the subject of transfusion safety and triggers.

For active recommendations from previous years and an update on their progress, please refer to the SHOT website

10.

Right Blood Right Patient (RBRP)

Author: Alexandra Gray

Definition:

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

As in previous years reporters have been given the opportunity to separately submit incidents where the right blood was transfused to the right patient despite an error or errors that may have led to the unit being rejected or an incomplete documentation trail being available for that transfusion episode. These errors do not fit into the definition of IBCT but have been included to inform practice. They are not included in the overall numbers of IBCT cases. There were 159 cases analysed in 2011, representing a slight increase from 137 in 2010 (16%). Table 10.1 describes the findings from 159 completed questionnaires.

Table 10.1
RBRP episodes
n=159

Elements that were wrong on blood packs, documentation, identity bands etc	2010	2011
Patient identification errors	**89**	**100**
Name alone or with other elements	27	37
DOB alone or with other elements	38	30
Gender	1	1
Wristband missing or wrong wristband in place at final bedside checking procedure	4	14
Hospital or NHS number	17	17
Address alone or with other elements	2	1
Labelling Errors	**31**	**55**
Transposed labels	25	38
Other labelling errors	6	17
Miscellaneous		
Access cards	-	2
Prescription error	-	2
No final patient ID check undertaken prior to administration of component	1	-
Incomplete issue procedures undertaken	2	-
Incomplete patient details on request form etc	12	-
Component issued on inappropriate flag entered in laboratory IT system	1	-
Incorrect component selected from controlled temperature storage (CTS)	1	-
TOTAL	**137**	**159**

In 2011 55 errors (35%) occurred during the labelling process; the types of errors reported included transposition of labels at issuing, printing errors resulting in the wrong pack/donation number being applied to the compatibility tag or the unit being issued with the previous patient details still attached. The Medicines and Healthcare products Regulatory Agency (MHRA) also received 73 component labelling errors, whilst a further 89 labelling errors were reported in the SHOT near miss chapter (Chapter 25). Component labelling errors are the most frequently reported procedural error in the laboratory this year; it is essential that staff are extra vigilant when labelling blood components prior to issue.

This year we have chosen to focus on patient identification. The RBRP events provide an insight into how, when and possibly why errors occur; in 2011 67% of errors (n=67/100) concerned either the incorrect patient name and/or date of birth. Errors occurred during admission (n=20/67), sampling and request (n=25/67) and in the laboratory (n=15/67); in 7 cases there was insufficient information to identify the primary cause of error. In 52% of cases (n=35/67) the requests were identified as either urgent or an emergency. The root causes identified included cases where the incorrect details were entered into the patient admission system (PAS), others where there were duplicate patient records available, and further cases where there was failure to check the patient details at sampling and there were others with transcription errors.

In total, SHOT received 474 'wrong blood in tube' reports of which 5 resulted in an incorrect blood component transfused, whilst 469 were reported as near misses. Lumadue et al (2004) demonstrated that inappropriately or mis-labelled sample tubes were forty times more likely to contain blood from the wrong patient[44].

There were a further 28 errors reported in the IBCT category, and 60 near miss (55 component collection/ administration errors and 5 requesting errors) which also involved a failure in the identification procedure at some point in the transfusion process.

It is imperative that all staff check the identification details with the patent or their relative, i.e. ask the patient to tell you their name and data of birth and that care is taken when transcribing information onto the relevant paperwork, IT system or sample tube label and request form.

Case 1

High workload results in wrong patient details on addressograph label

A patient was transferred requiring emergency vascular surgery with the correct demographic details on the documentation. During booking in at Accident and Emergency (A&E) reception the addressograph labels were printed with the incorrect date of birth. The initial transfusion with blood received from the transfer hospital had the correct details; however a further crossmatch was requested and issued with new details on the form, sample and units, i.e. wrong date of birth which was not picked up by the laboratory staff. The receptionist reported a high workload at the time the initial error occurred.

Case 2

Reliance on case note information results in patient ID error

A pre-transfusion sample taken from a baby transferred to the unit resulted in an incorrect spelling of the surname, and subsequent transfusion of two units of blood. The mother's name was spelled incorrectly on admission and the addressograph label with the incorrect spelling was placed on baby's notes. The baby's details were not checked and verified on admission. The nurses failed to check the patient's wristband when taking the sample and during the final checking procedure prior to administering the blood.

COMMENTARY

All these errors were preventable. All staff have a personal and professional responsibility to adhere to the correct patient identification procedures at admission, sampling, on receipt of the sample and entering the patient ID details into the IT system and collection and administration processes. The final patient identification check at the bedside prior to the administration is the last opportunity to pick up any errors.

Learning points

There are no new learning points

Recommendations – Back to Basics (Chapter 5)

- It is imperative that laboratory staff are extra vigilant when issuing multiple components for the same patient and that a final component/patient ID check is undertaken prior to issue. Hospital transfusion laboratories should consider purchasing label verification software or ensuring that a two-person check of units is undertaken prior to issue.
- Training and assessment in the laboratory must cover basic manual checking procedures.
- It is imperative that staff are vigilant at all times in the laboratory and clinical areas when participating in the patient ID process, especially when the patient is admitted.
- NO wristband (or alternative patient ID) – NO transfusion.
- Use of a transfusion checklist across the transfusion process will provide and extra level of safety.

Action: Hospital Transfusion Teams (HTTs), Trust/hospital/Health Board Chief Executive Officers (CEOs)

For active recommendations from previous years and an update on their progress, please refer to the SHOT website

11.

Handling and Storage Errors (HSE)

Author: Alexandra Gray

Definition:

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

DATA SUMMARY Total number of cases: 325*							
Implicated components				**Mortality/morbidity**			
Red cells			293	Deaths due to transfusion			0
FFP			9	Deaths *probably/likely* due to transfusion			0
Platelets			19	Deaths *possibly* due to transfusion			0
Cryoprecipitate			4	Major morbidity			0
Unknown			0				
Gender		**Age**		**Emergency vs. routine and core hours vs. out of core hours**		**Where transfusion took place**	
Male	120	≥ 18 years	301	Emergency	31	A&E	12
Female	195	16 years to <18 years	0	Routine	199	Theatre	12
Not known	10	1 year to <16 years	5	Urgent	62	ITU/NNU/HDU/Recovery	34
		>28 days to <1 year	5	Not known	33	Wards	202
		Birth to ≤28 days	4			Community	3
		Not known	10	In core hours	189	Outpatient / day unit	5
				Out of core hours	126	Hospice	3
				Not known	10	Medical Admissions Unit	38
						Not known	16

**This section describes the main findings from 322 completed questionnaires. Two questionnaires refer to multiple patients so the total number of cases analysed is actually 325. Three questionnaires only provide detail of the number of components implicated (21 fresh frozen plasma (FFP) / 62 Red Blood Cells (RBCs)); in a further 2 cases there is insufficient information available to determine either the number of patients or the number of components.*

There has been a 36% increase in reports submitted under the HSE category in 2011 (325 cases) compared with 2010 (239 cases). The categories as previous years remain the same with 62% (201/325) of the cases being reported under the 'excessive time to transfuse' section. Fourteen cases involved paediatric patients including 4 neonates and 5 children less than a year old. In 10 cases the age was not given. All other cases were in adults over 18 years of age. As reported in previous years, 61% (199/325) of the incidents occurred in a routine setting, 29% (93/325) were emergencies and 10% (33/325) were unknown. There were no transfusion-related cases of morbidity or mortality reported.

Technical administration errors n=23

There were 23 technical administration errors, an increase of 28% from 2010. In 74% of cases (n=17) the report resulted from the use of the wrong type of giving set. In 3 cases a transfusion device was used incorrectly and the transfer of a patient resulted in the partial transfusion of a clotted red cell unit (see case 1).

Case 1

Transfusion of a clotted unit

When attempting to transfuse a unit of red cells through a rapid infuser the anaesthetist observed the blood had clotted. When the unit was examined by the Blood Service they found a mix of the patient's and the donor's blood in the pack. This can occur when a unit is lowered below the arm of the patient; in this instance the infusion bags (including the blood component) were positioned on the patient's bed during transfer.

Transfusion of expired blood components n=30 (includes 1 multiple report)

There were 30 cases of expired units being transfused (1 case was reported as a multiple event), which is similar to that of 2010 where 29 cases were reported. Mirroring previous years, errors resulted from staff failure to note short expiry time/dates, the patient's condition leading to prolonged interruptions or delays in commencing the transfusion and failure to clear satellite refrigerators.

Excessive time to complete administration of blood components n=201

Currently the UK guidance recommends that a unit of red blood cells should be transfused within 4 hours of leaving controlled temperature storage[45]. At present SHOT accepts all report in this category where the time to complete the transfusion took greater than 4 hours from leaving controlled temperature storage (CTS) to completion of transfusion, (4 hours 30 minutes for neonates). There has been a significant number of cases reported to SHOT (n=201) in 2011; a 73% increase from 2010. Seventeen per cent (35/201) of cases were reported as having been identified during audits, or review of the blood-tracking system or compatibility tag report. In this report we will focus on those cases where the transfusion took longer than 5 hours from leaving CTS to completion of the transfusion.

Where times were reported, in 8 cases the error arose due to time out of CTS whilst in 143 cases it was due to excessive administration time. In 29 cases excessive times were reported in both categories. In 105 cases the transfusion overran by more than 1 hour, alarmingly more than 4 hours in 5 cases (range 8 – 12 hours). In over 40% of reports we identified that the transfusion took place out of core hours (see Table 11.1); however in 39 cases where the transfusion exceeded the 4 hour recommended time the reporter categorised the event as an 'emergency' or 'urgent' priority. In a number of cases the patient was transferred to another department mid-transfusion (see case 2). Staff should be mindful of the prescribed transfusion rate when observing the patient and in particular when a patient is transferred to or from another area.

Table 11.1 Breakdown of working hours during which transfusion times were excessive n=201 NB not given in 10 cases

Time Period	In core hours / out of core hours	Number
08:00 to 20:00	Core Hours	111
20:00 to 00:00	Out of core hours	47
00:00 to 08:00	Out of core hours	33

Case 2

Failed handover results in excessive time to transfuse

A patient was transferred from the intensive therapy unit (ITU) to the haematology ward with a red cell transfusion in progress (started at 05:41). The transfusion was not discussed during the patient handover and was not noticed until 10:55 when the transfusion was discontinued with 60mL still in the pack.

This case highlights the importance of a comprehensive handover either when transferring patients or during shift changes. The use of a transfusion record would have ensured the relevant information was made available to the staff looking after this patient. An example of a transfusion record can be found at Healthcare Improvement Scotland[46]. As recommended in last year's Annual SHOT Report[12] any handover communication must include information with respect to transfusion support where relevant.

The Oxford Systematic Reviews group has recently undertaken a 'transfusion practice' review of the '30 minute' and '4 hour rules'; the findings will be published in 2012 in Transfusion Medicine Reviews[47]. SHOT will reflect any changes to the current guidance in future publications. In the meantime we recommend that as well as reporting to SHOT, any deviations to the recommended transfusion times in the local hospital transfusion policy should also be investigated locally through internal reporting systems and that any lessons learnt are disseminated to all relevant staff groups.

Cold chain errors n=71 (includes 6 multiple cases)

Table 11.2
Summary of cold chain related errors

Type of error	No. of cases 2010	No. of cases 2011
Alarm related *(where staff failed to carry out the correct procedure following an alarm being set off on a refrigerator)*	9	7
Equipment failure *(As a result of either a power failure or suspected refrigerator failure which failed to activate the alarm)*	17	8
Transport or delivery of components	2	4
Inappropriate storage of components	45	52
Returned to: *a) stock when they should have been discarded* *b) satellite refrigerator when they should have been discarded*	*8* *4*	*16* *3*
No/incomplete/inaccurate cold chain documentation/traceability	*18*	*8*
Stored inappropriately in clinical area e.g. out-of-order refrigerator, transport box, non-validated transport box/storage, unknown	*15*	*8*
Failure to clear refrigerator, resulting in units being transfused in which interval between sampling and transfusion had exceeded British Committee for Standards in Haematology (BCSH) guideline recommendations[45]	*Not tabulated in 2010*	*17*
TOTAL	**73**	**71***

**Reports from 2011 include 6 cases of multiple reports:*

- *3 equipment failures, 1 of which related to 2 patients and 2 reports did not specify the number of patients affected.*
- *3 alarm-related, 1 of which related to 3 patients and 2 reports did not specify the number of patients affected.*

This year there was a significant decrease (42%) in the number of equipment-related incidents (26 cases in 2010, 15 cases in 2011), which subsequently resulted in red cell components that were stored at inappropriate temperatures being transfused to a number of patients, see Table 11.2.

Of the total number of errors, 49% (35/71) involved patients receiving 1 or more units of red cells, platelets (2 cases) and plasma (2 cryoprecipitate and 1 FFP), which had been either inappropriately transported or had been out of CTS for more than 30 minutes and then returned to CTS.

In 2011 16 cases were identified where a unit of red cells was transfused when it should have been cleared from the satellite refrigerator because the interval between sampling and transfusion had exceeded BCSH guideline recommendations[14].

Case 3
Despite a biomedical scientist (BMS) putting suitable warning sticker on, the unit was still transfused
Two units of red cells were crossmatched for a patient from a sample provided on 21/06/2011. As the patient had been transfused within the last 28 days, the crossmatched blood was only suitable for transfusion to this patient until 23/06/2011 at 16:00. The BMS informed the ward that the blood was in the issue refrigerator and that it must be used by this time and wrote on the issue record 'Do not transfuse after 4pm'. At 20:00 the refrigerator was cleared by the BMS but these 2 units were not removed. At 06:45 and 08:54 on 24/07/2011 the 2 units were removed from the issue refrigerator and transfused to the patient.

It is imperative that each member of laboratory, clinical and support staff is vigilant when undertaking their part in the transfusion process.

There were 5 individual reports of cold chain errors (CCE) in 2011 that describe staff overriding or ignoring warning signals when collecting or returning blood products from the electronic blood-tracking systems. These are described in more detail in the IT chapter (Chapter 8). The use of electronic blood-tracking systems does not prevent errors occurring, particularly when staff use the override facility or ignore warning signals. Protocols should dictate that all returned units are placed in a specific section/tray in the blood refrigerator, allowing the staff to re-check all units and the cold chain details prior to re-issue.

Case 4

Out of CTS unit returned transfused despite warning alert

A unit was collected from the delivery suite blood refrigerator at 20:44, and then returned at 21:33 (approximately 45 minutes after initial removal) and the blood-tracking system alerted the member of staff and the hospital transfusion laboratory that the unit was out of CTS. However, this alert was ignored and the unit was placed back into the refrigerator. At 22:39 the unit was removed from the blood refrigerator, without being scanned, and therefore the alert was not activated and this resulted in a transfusion that was completed after 5 hours and 20 minutes of being removed from the refrigerator.

Failure to maintain an adequate or complete cold chain record can result in transfusion of a unit that has been out of CTS for longer than the recommended period of time, or unnecessary wastage of blood components. Where staff have failed to sign in/out blood components when removing them from satellite refrigerators these reports will no longer be included in the HSE category, but should be reported through internal reporting systems and the lessons learnt disseminated at a local level. It is important for staff to ensure the necessary documentation is completed to verify storage, transportation and administration of blood through recorded identification. This forms part of an effective traceability matrix and aims to prevent unnecessary component losses or the transfusion of potentially unsafe components.

The use of a transfusion record could assist in improving documentation; an example of a transfusion record can be found at Healthcare Improvement Scotland[46] and a transfusion checklist can be found on the SHOT website (http://www.shotuk.org/resources/current-resources/).

COMMENTARY

There has been an overall increase in the number of reported cases of handling and storage errors in 2011 (36%) (n=239 vs 325) compared to 2010, mainly in the 'excessive time to transfuse' category. However, whilst there has been a similar number of cold chain errors reported in 2011 to 2010, there has been a notable increase in errors involving units that have been returned to stock when they should have been discarded, resulting in components that have been out of CTS subsequently being transfused to patients. In 2011 for the first time the HSE chapter includes the number of cases where a failure to clear the blood refrigerator has resulted in units being transfused in which the interval between sampling and transfusion has exceeded BCSH guideline recommendations[45]. Transfusion may stimulate the production of unexpected antibodies; it is crucial therefore that staff a) understand the importance of the timing of samples in relation to receiving a blood component and b) that laboratory staff ensure that they have an understandable policy for clearing their blood refrigerators. Further advice is available in the BCSH guideline on *Compatibility Procedures*[37].

Once again a number of reports have been made to SHOT in which multiple patients were included under one event. These reports make reference to events where patients were transfused with components that should have been discarded because of failures to follow standard operating procedures (SOPs) when a refrigerator alarm was activated. This type of batched reporting (7 multiple reports in 2011) results in underestimation of the number of actual errors affecting patients. SHOT encourages reports to be based on one patient, to allow accurate participation and benchmarking data to be obtained.

All staff should be reminded that they have a professional responsibility to practise safely, and to ensure that their knowledge and skills are kept up-to-date when participating in the transfusion process. It is important to ensure regular maintenance; checking and traceability procedures are in place and understood by all staff to prevent the unnecessary wastage of blood components. These errors could be due to a lack of training or understanding of the rationale behind the protocols and SOPs in use.

Learning points

- It is imperative that staff are vigilant at all times during the transfusion process; when monitoring a patient they should include observation of the prescribed transfusion rate.
- Where staff have deviated from their local transfusion policy, e.g. failed to sign in/out components from controlled temperature storage (CTS) or transfused a component over the recommended transfusion time and these digressions are identified during local audit or review, hospital transfusion teams should ensure they are systematically reviewed and that any lessons learnt are disseminated to all relevant staff groups.
- Red cell units CANNOT be returned to CTS or reissued if they have been out of CTS for more than 30 minutes. There should be a clearly designated area assigned in the blood refrigerator for units awaiting discard.
- The use of a transfusion record or checklist can improve the documentation and handover processes.[46] http://www.shotuk.org/resources/current-resources/
- Hospitals should have a robust policy in place for removing expired blood components and components past their suitability date from satellite refrigerators.

Recommendations

- It is the requirement of all staff involved in the storage and transportation of blood components to make sure they are trained and competent to their local transfusion policy; this will ensure the correct temperature of each blood component is maintained and a clear documentation trail is available should the component be returned to storage.

  Action: Blood Services, Hospital Transfusion Laboratory Managers

- Laboratory and clinical staff should be familiar with the capability and capacity of their cold chain storage and monitoring equipment. Containers and or devices used to store and transport blood should be mapped and validated for purpose.

  Action: Transfusion Practitioners, Hospital Transfusion Laboratory Managers, Hospital Transfusion Committees

For active recommendations from previous years and an update on their progress, please refer to the SHOT website

12. Adverse Events Related to Anti-D Immunoglobulin (Anti-D Ig)

Author: Tony Davies

Definition:

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

DATA SUMMARY Total number of cases: 249							
Implicated components				**Mortality/morbidity**			
Red cells			0	Deaths *probably/likely* due to transfusion			0
FFP			0	Deaths *possibly* due to transfusion			0
Platelets			0	Major morbidity			9
Anti-D Ig			249	Potential for major morbidity			155
Unknown			0				
Gender		**Age**		**Emergency vs. routine and core hours vs. out of core hours**		**Where transfusion took place**	
Male	1	≥ 18 years	244	Emergency	0	A&E	0
Female	248	16 years to <18 years	3	Routine	0	Theatre	0
Not known	0	1 year to <16 years	2	Not known	249	ITU/NNU/HDU/Recovery	0
		>28 days to <1 year	0			Wards	193
		Birth to ≤28 days	0	In core hours	222	Community	56
		Not known	0	Out of core hours	27	Outpatient / day unit	0
				Not known	0	Not known	0

This section describes the main findings from 236 completed questionnaires. Three questionnaires in the 'wrong dose administered' category refer to 16 separate events, so the total number of cases analysed is actually **249**.

The reports are broken down into the reporting categories shown in Table 12.1.

Under current legislation[48], adverse events related to the administration of anti-D Ig are reportable as 'SHOT-only'. Clinical reactions to anti-D Ig are reportable via the Medicines and Healthcare products Regulatory Agency (MHRA) 'Yellow Card' system.

Table 12.1 Reporting categories

Category of adverse event	Number of cases	
Omission or late administration of anti-D Ig	157	
Inappropriate administration of anti-D Ig	60	
to a RhD positive woman		*30*
to a woman with immune anti-D		*17*
to a mother of a RhD negative infant		*9*
given to the wrong woman		*4*
Wrong dose of anti-D Ig given according to local policy	24	
Handling and storage errors related to anti-D Ig	8	
TOTAL	**249**	

Deaths n=0

There was no reported fetal mortality following the omission or delay in administration of anti-D Ig, though one baby is reported to have died three days after an exchange transfusion given as a result of haemolytic disease of the fetus and newborn (HDFN) - see Case 15.

Major morbidity n=9

There were 2 cases where a mother developed an immune anti-D following delay or omission in prophylaxis during the pregnancy, and a further 7 cases where a positive antibody screen was erroneously assumed by the laboratory to be from prophylaxis, resulting in inadequate monitoring throughout the remaining term of the pregnancies. 6/7 of these cases resulted in babies being born with varying degrees of HDFN and 3/6 required urgent transfusion support.

Potential for major morbidity n=155

In a further 155 cases anti-D Ig was administered more than 72 hours following a potentially sensitising event, or omitted altogether, resulting in the potential for sensitisation of the woman to the D antigen. This satisfies the current SHOT definition of potential major morbidity.

Clinical versus laboratory errors

For the reporting year 2011, 249 events related to anti-D Ig administration are summarised in table 12.2 below, with a breakdown of the proportion of clinical and laboratory errors that were primarily responsible.

The distribution of cases has in past years reflected general SHOT findings that around 2/3 of reports involve errors by clinical staff and 1/3 laboratory staff. This year follows the pattern of 2009 and 2010 with clinical errors accounting for 76% and laboratory errors 24% of the total reports related to administration of anti-D Ig.

Table 12.2 Adverse incidents involving anti-D Ig administration, with site of primary error

Type of event	Cases	Number of primary errors		
		Nurse / midwife	Laboratory	Doctor
Omission or late administration of anti-D Ig	**157**	134	10	13
Anti-D Ig given to RhD positive woman	**30**	18	11	1
Anti-D Ig given to woman with immune anti-D	**17**	6	11	0
Anti-D Ig given to mother of RhD negative infant	**9**	3	6	0
Anti-D Ig given to wrong woman	**4**	4	0	0
Wrong dose of anti-D Ig given	**24**	6	18	0
Anti-D Ig handling & storage errors	**8**	5	3	0
Totals	**249**	**176**	**59**	**14**

Omission or late administration of anti-D Ig n=157

In 134/157 cases the primary error was made by a nurse or midwife, and in 13/157 cases by a doctor. 10/157 errors originated from failures in the laboratory.

37 cases occurred in the community, and 120 in a hospital setting.

As in last year's report, there are multiple examples where anti-D Ig has been issued by the laboratory, only to be found days or weeks later in maternity refrigerators indicating a failure of the discharge checklist, and possibly a lack of understanding by some clinical staff of the time limits within which anti-D Ig must be administered.

Case 1

Anti-D Ig not given following self-referral for per vaginam (PV) bleed

A known RhD negative woman self-referred to the early pregnancy unit following a PV bleed at 14 weeks gestation. The midwife told her she did not need anti-D Ig and sent her home.

Case 2

Failure of communication leads to delay in administration of anti-D Ig

The post-natal ward was telephoned to inform them of maternal and cord results, and that anti-D Ig was available for the woman, details of the call were logged as per standard operating procedure (SOP) in the laboratory. Five days later the laboratory received a telephone call from the community midwife asking if anti-D Ig was required for the woman.

Case 3

Incorrect information given to woman by a junior doctor results in delayed administration of anti-D Ig

A woman presented with a PV bleed at 16 weeks gestation. She was reviewed by the junior doctor, who informed her that she was RhD positive and discharged her. The woman telephoned the early pregnancy unit 4 days later as she had received a leaflet through the post informing her that she was RhD negative.

Case 4

Failure of communication between midwifery teams results in omission of anti-D Ig

There was a failure to record the woman's booking blood results in the notes, and a lack of communication between the Trust midwifery team and the community midwives, resulting in routine antenatal anti-D Ig prophylaxis (RAADP) being omitted completely. The woman presented at delivery having developed an immune anti-D in late pregnancy.

Case 5

Mis-reporting of RhD status leads to omission of RAADP

A laboratory reported equivocal RhD typing results as RhD positive, even though a reference laboratory had confirmed that the woman was a novel D-variant to be treated as RhD negative. As a result, the woman did not receive RAADP or anti-D Ig in response to potentially sensitising events (PSEs) during her pregnancy.

Case 6

Laboratory misunderstands need for anti-D Ig for all PSEs and refuses to issue anti-D Ig

A laboratory refused to issue anti-D Ig following an intrauterine death on the basis that prophylaxis had been given for a potentially sensitising event less than 6 weeks earlier.

Case 7

Lack of knowledge results in delay in administration of anti-D Ig

A woman presented with a PV bleed at 19 weeks gestation, but was discharged without anti-D Ig by a doctor who stated that anti-D Ig should only be given if a Kleihauer test was positive. The woman was recalled and given her anti-D Ig 4 days later.

Case 8

Lack of understanding results in omission of RAADP

Community midwives at a GP surgery returned a dose of anti-D Ig intended for RAADP with the message "already given in hospital". The woman had received prophylaxis in response to a PSE earlier in her pregnancy.

Learning point (repeated from 2010)

- Anti-D Ig must still be administered in response to a PSE* even if the woman has received, or is due to receive, routine antenatal anti-D prophylaxis. RAADP must still be administered at the appropriate time, even if the woman has recently received anti-D prophylaxis for a PSE.

  * PSE = Potentially sensitising event

Inappropriate administration of anti-D Ig n=60

This group is further subdivided into four categories.

Anti-D Ig given to RhD positive women n=30

Overall 19/30 errors were clinical, 18 made by a nurse or midwife and 1 by a doctor, and 11/30 primary errors arose in the laboratory.

26/30 errors were made in the hospital setting, with 4 in the community.

Case 9
Anti-D Ig issued to a RhD positive woman after grouping results were mis-transcribed into her notes
Blood grouping results from booking were incorrectly transcribed into a woman's notes and anti-D Ig was issued in response to a sensitising event from stock held in the clinical area.

Case 10
RhD positive woman administered RAADP after results were incorrectly entered onto IT system
Blood grouping results from booking had been incorrectly entered (manually) onto the maternity computer system. As a result, the woman was given 1500 iu anti-D Ig from clinical stock as RAADP.

Case 11
Laboratory telephone incorrect result to the clinical area
A biomedical scientist telephoned an incorrect grouping result to the ward, then failed to notice the discrepancy on the laboratory computer system when requested to issue anti-D Ig for the woman.

Case 12
Misinterpretation of blood grouping report results in inappropriate administration of anti-D Ig
A junior doctor misread a woman's grouping report, and interpreted the negative antibody screen as the RhD-type. Anti-D Ig was erroneously issued to the woman from stock held in the clinical area.

Case 13
Anti-D Ig requested from Pharmacy
The clinical area requested anti-D Ig directly from Pharmacy, bypassing any grouping checks, and administered it to a RhD positive woman.

Anti-D Ig given to women with immune anti-D n=17

Of these 17 reported cases 6 resulted from a primary clinical error and 11 from a laboratory error.

15/17 occurred in the hospital setting, with 2/17 in the community.

7/11 of the laboratory errors involved failure to consider that a strongly positive antibody screen could have been from immune anti-D rather than assuming that it must be a result of prophylactic anti-D.

4/11 of the laboratory errors involved failure to take heed of the laboratory computer record that clearly showed the woman to have immune anti-D.

5 clinical errors involved issue of anti-D Ig from stocks held in the clinical area, outside laboratory control.

One clinical error was due to failure to send repeat samples to the laboratory who had reported equivocal results in an antibody screen.

Case 14
Misinterpretation of antibody screen results in lack of monitoring
The laboratory misinterpreted a positive antibody screen as due to prophylaxis, even though there was no record of any being issued or administered. As a result further anti-D Ig was issued, the pregnancy was not closely monitored, and the baby was born suffering from HDFN, requiring 3 blood transfusions to correct severe anaemia.

Case 15

Failure to follow up a weak positive antibody screen results in lack of monitoring

The laboratory staff were unsure whether a weak positive antibody screen was due to prophylaxis. Repeat samples were requested but were not received. As a result further anti-D Ig was issued (correctly, according to guideline), the pregnancy was not closely monitored, mother was reported to have a strong anti-C+D at delivery and the baby was born suffering from HDFN, requiring an exchange transfusion. The baby died three days later.

Case 16

Lack of knowledge results in inappropriate administration of anti-D Ig

A woman was known to have a strong immune anti-D, and there were clear instructions that she did not require prophylaxis. Following an emergency caesarean section, a midwife administered the standard post-natal dose of anti-D Ig from clinical stock.

Anti-D Ig given to mothers of RhD negative infants n=9

3/9 of these errors originated in the clinical area, and 6/9 in the laboratory. All 9 occurred in the hospital setting.

- 3/6 laboratory errors involved inappropriate issue of anti-D Ig by a lone worker biomedical scientist (BMS) out of core hours without referring to the cord grouping results.
- 3/6 laboratory errors involved inappropriate issue when results clearly showed the baby to be RhD negative.
- 3/3 clinical errors involved failure of the checking process during administration.

Case 17

Failure to follow laboratory procedure leads to inappropriate administration of anti-D Ig

A BMS not normally working in transfusion issued anti-D Ig before the baby's group had been fully interpreted. The group was incorrectly recorded manually as RhD positive.

Case 18

Anti-D Ig issued for a PSE, kept on ward then inappropriately administered post delivery

500 iu anti-D Ig had been issued to cover an external cephalic version at 39 weeks. However, it was not given at the time, and kept in a ward refrigerator. It was administered 3 days later following delivery, even though cord results had been telephoned through to the ward as RhD negative.

Anti-D Ig given to the wrong woman n=4

These were exclusively clinical errors, involving failure by nurses or midwives to identify the correct woman.

3/4 cases occurred in the hospital setting, and 1/4 in the community.

Case 19

No identification checks performed

A nurse did not perform any identification checks at all, and administered 250 iu anti-D Ig to the wrong woman following a gynaecological procedure. The woman who received the anti-D Ig was RhD positive.

Case 20

Wrong woman and wrong notes

Anti-D Ig clearly labelled for one woman in a RAADP clinic was administered to a different woman as the midwife failed to carry out basic identification checks. Moreover, the administration was recorded in the intended woman's notes.

Wrong dose of anti-D Ig given n=24

6/24 errors were made by nurses or midwives and 18/24 errors occurred in the laboratory.

14/24 cases occurred in hospital and 10/24 in the community.

Case 21
Incorrect dose of anti-D Ig issued for ten women for RAADP
A trainee BMS issued 10 doses of 1250 iu anti-D Ig instead of 1500 iu doses to cover a RAADP clinic. All doses were administered without question by the clinical staff.

Case 22
Misreading of a Kleihauer film results in administration of 10 times the correct dose of anti-D Ig
A BMS reported a transplacental haemorrhage (TPH) of 40mL, for which a 5000 iu dose of anti-D Ig was issued and administered.
The film was reviewed by a senior member of staff the following day - no fetal cells were detected at all, and a 500 iu standard post-natal dose would have been sufficient.

Case 23
Misreading of a Kleihauer film results in significant under-dosing with anti-D Ig
A BMS reported a 6.5mL TPH, and issued 1000 iu anti-D Ig, but did not refer to the Blood Service Laboratory for flow cytometry as it was a weekend. The flow cytometry result showed a TPH of 21.5mL, while another BMS rechecked the Kleihauer film and confirmed this magnitude of bleed. Further anti-D Ig was issued, but later than the 72 hour window.

Case 24
Verbal request leads to inadequate RAADP
Four request forms for anti-D Ig were sent to the laboratory, but contained no clinical details. A midwife gave verbal confirmation that these were all for 500 iu anti-D Ig to cover sensitising events. In fact they were for a RAADP clinic and should have been for 1500 iu each. The discrepancy was not noticed until case notes were reviewed at delivery.

Handling and storage errors related to anti-D Ig n=8

5/8 errors occurred in the clinical area and 3/8 were laboratory errors.

6 errors occurred within a hospital, and 2 in the community.

Case 25
Poor advice from the laboratory results in incorrect route of administration
A BMS advised administering a 1500 iu dose of anti-D Ig intravenously when the product issued was licensed only for intramuscular injection.

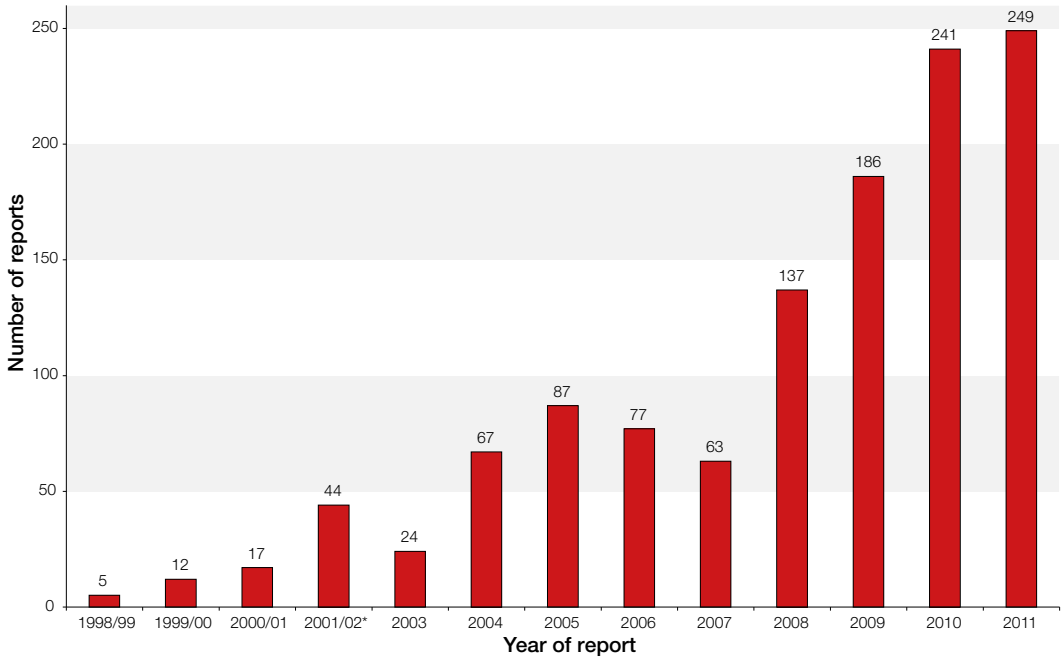
Case 26
Woman administered incorrect globulin
A woman was given 250 iu anti-tetanus globulin by a nurse in the Accident and Emergency (A&E) department, instead of 250 iu anti-D Ig. Both immunoglobulin preparations were kept as stock in the clinical department.

Case 27
Expired anti-D Ig issued from clinical stock
A retrospective review of traceability sheets revealed that expired anti-D Ig had been administered on 3 occasions from remotely held clinical stock.

COMMENTARY

The number of reports reviewed this year was 236, representing 249 individual patients. This represents the maintenance of an upward trend in reporting since SHOT reporting commenced in 1996 (see figure 12.1 below), and is a reflection of an increasing awareness of the need to report rather than a decline in standards of practice.

Figure 12.1
Cumulative data



** 2001–2002 figures covered a 15 month period*

Recurring themes throughout the reports include;

- Communication failures between hospital-based and community-based midwifery teams were cited in 26 cases involving late or omitted anti-D Ig this year.
- The lack of a robust system for receiving and recording anti-D Ig for use at RAADP clinics in the community.
- Failure of the post-natal discharge checklist was cited in 31 cases this year.
- Transcribing blood grouping results onto care plans or the front of notes is not a secure way of recording results, and errors were noted in 9 cases this year.
- Poor decision-making and advice regarding issue and administration of anti-D Ig by laboratory staff lacking relevant knowledge and experience.
- Inappropriate use of anti-D Ig kept in clinical stock (22 cases) or ordered directly from pharmacy (2 cases) outside the control of more robust laboratory procedures.
- Failure to consult the historical group and/or antibody results on the laboratory IT record before issue of anti-D Ig, including issue of anti-D Ig outside the relative security of the laboratory information management system (LIMS). 14 cases could probably have been avoided had available IT information and warning flags been heeded.
- Poor advice given by midwives to women regarding the need for anti-D Ig following sensitising events.
- Clinical staff not reading or misreading laboratory reports before making treatment decisions.
- The inappropriate use of the Kleihauer test by both clinicians and laboratory to decide whether or not anti-D Ig needs to be given in the first place.
- The misinterpretation of Kleihauer films in hospital laboratories leading to errors in dosing with anti-D Ig.
- Failure by both laboratory and clinical staff to follow up women with positive antibody screens detected during pregnancy and an assumption in 7 cases that the result reflected evidence of prophylactic anti-D Ig when none had in fact been administered.

Learning point

- The Kleihauer test provides an approximate measure of fetal red cells in maternal circulation, and is used to determine how much more anti-D Ig than the standard dose, if any, needs to be administered. It is NOT used to determine whether anti-D Ig should be administered in the first place and should not be performed at less than 20 weeks gestation.

2011 is by far the worst year in the history of SHOT with regard to adverse clinical outcome due to errors associated with anti-D Ig. It is disturbing to note 7 cases where the laboratory assumed a positive antibody screen to be due to prophylactic anti-D Ig where in 6 cases there was no record of any prophylactic anti-D Ig being issued, and in 1 case there was a report from a reference laboratory that the woman had immune anti-D. Due to this erroneous reporting there was a lack of clinical follow-up. Six babies were born suffering varying degrees of HDFN, the severity of which may have been mitigated by close monitoring and early intervention. One baby died three days after an exchange transfusion – in this case the clinical area did not respond to requests for repeat samples in order to clarify whether a positive antibody screen was likely to be due to prophylactic or immune anti-D.

Learning points

- Interpretation and reporting of positive antibody screens during pregnancy must be the responsibility of senior laboratory staff, and must take into account an accurate patient history and accurate records of administration of anti-D Ig.
- Effective provision of anti-D Ig prophylaxis is a partnership between the laboratory and the clinical area – the clinical area must be more responsive to requests from the laboratory for follow-up samples and the laboratory must not assume that actions have been taken purely on the basis that a report has been issued.

This year's Annual SHOT Report again highlights a number of key issues in the provision of anti-D Ig, including poor knowledge and understanding in both the laboratory and the clinical area about the use of anti-D Ig, failure to utilise IT to increase the security of the process, and a lack of robust systems for the issue, receipt and recording of anti-D Ig.

Organisations must not be complacent in their arrangements, but should regularly audit the systems in place with a view to improving them, and to this end SHOT has produced a checklist covering key points in the process that may be used as an aide memoire, poster or as an audit tool, and this may be found at http://www.shotuk.org/resources/current-resources/.

While this chapter inevitably concentrates on process failures in the provision of care to a particular group of women, it is apparent that patient choice also plays a role in failures of prophylaxis.

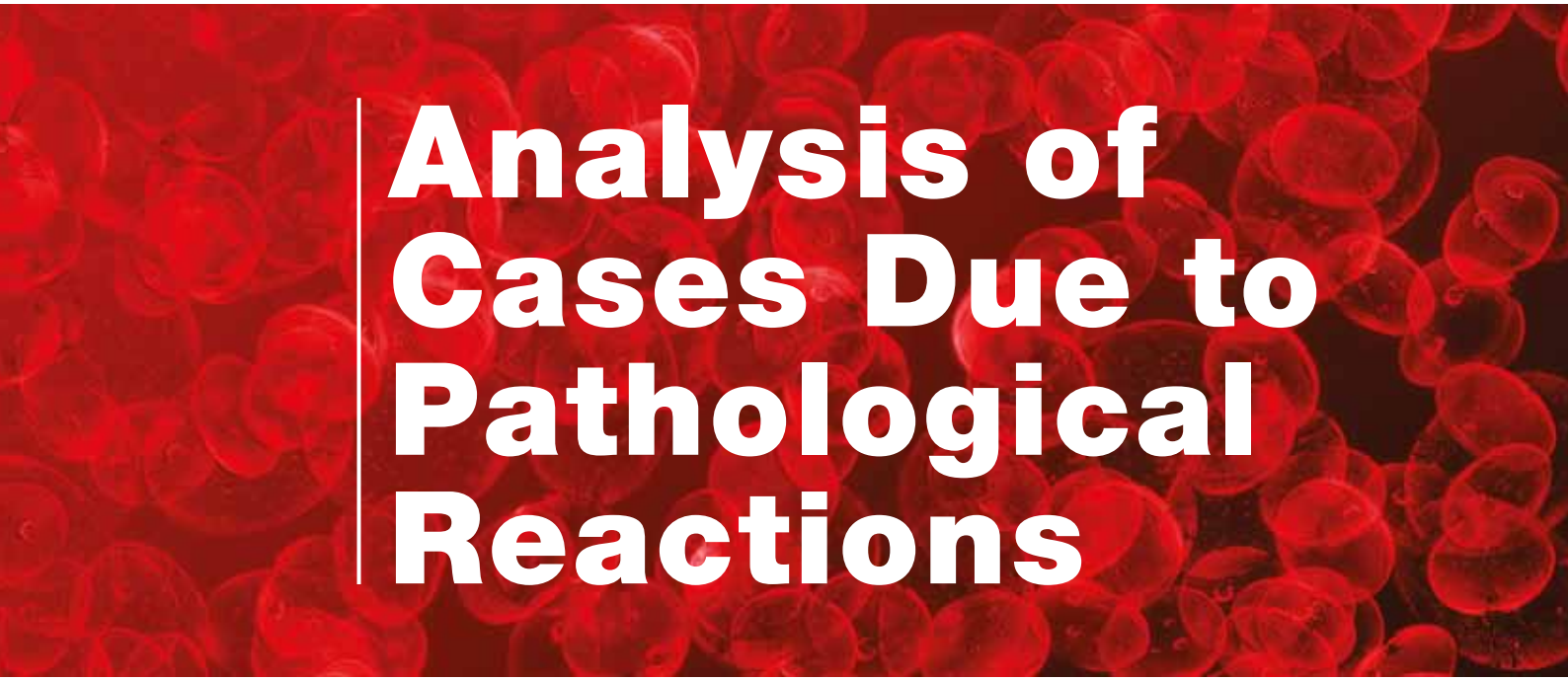
Cases related to patient choice are withdrawn from the final analysis of the Annual SHOT Report as they are outside the control of the transfusion process, but include failure to attend clinic appointments, or refusal to return for administration of anti-D Ig when requested, declining to wait for test results before discharging themselves, and refusal to accept anti-D Ig prophylaxis when offered. One such case of refusal to accept any anti-D Ig during pregnancy resulted in the woman developing a strong immune anti-D and serves as an unfortunate but timely illustration of just how important effective anti-D Ig prophylaxis is.

Recommendations

- All organisations involved in the issue and administration of anti-D Ig must ensure that their systems are robust with respect to issue, receipt and recording, and should audit their systems with a view to increasing the safety and security of the process.
- Kleihauer tests that suggest a transplacental haemorrhage of >2mL, or that give equivocal results, should be referred for flow cytometry at the earliest opportunity.
- Laboratories performing Kleihauer screening must participate in external quality assessment schemes.

Action: Hospital Transfusion Laboratories, Hospital Transfusion Committees, Trust/ Hospital/Health Board Chief Executive Officers (CEOs)

For active recommendations from previous years and an update on their progress, please refer to the SHOT website



Analysis of Cases Due to Pathological Reactions

Page	Chapter
92	**13.** Acute Transfusion Reactions (ATR) - *Hazel Tinegate and Fiona Regan*
101	**14.** Haemolytic Transfusion Reactions (HTR) and Alloimmunisation - *Clare Milkins*
	Pulmonary complications:
110	**15.** Transfusion-Related Acute Lung Injury (TRALI) - *Catherine Chapman*
114	**16.** Transfusion-Associated Circulatory Overload (TACO) - *Hannah Cohen*
119	**17.** Transfusion-Associated Dyspnoea (TAD) - *Hannah Cohen*
123	**18.** Post-Transfusion Purpura (PTP) - *Catherine Chapman*
126	**19.** Transfusion-Associated Graft Versus Host Disease (TA-GvHD) - *Catherine Chapman*
128	**20.** Transfusion-Transmitted Infection (TTI) - *Claire Reynolds*
133	**21.** Cell Salvage and Autologous Transfusion (CS) - *Joan Jones*

13.

Acute Transfusion Reactions (ATR)

Authors: Hazel Tinegate and Fiona Regan

Definition

Acute transfusion reactions are defined in this report as those occurring at any time up to 24 hours following a transfusion of blood or components excluding cases of acute reactions due to incorrect component being transfused, haemolytic reactions, transfusion related acute lung injury (TRALI), transfusion-associated circulatory overload (TACO), transfusion-associated dyspnoea (TAD) or those due to bacterial contamination of the component.

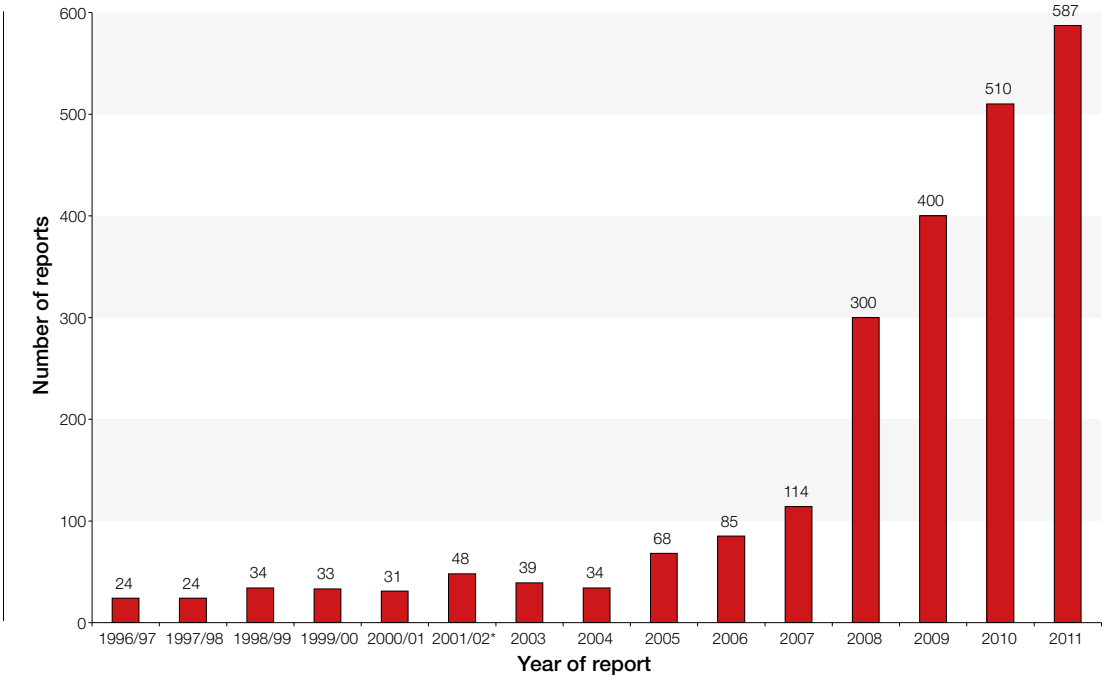
DATA SUMMARY
Total number of cases: 587

Implicated components		Mortality/morbidity	
Red cells	388	Deaths *probably/likely* due to transfusion	0
FFP	46	Deaths *possibly* due to transfusion	2
Platelets	145	Major morbidity	53
Other (cryo)	1		
Multiple components	7		
Unknown	0		

Gender		Age		Emergency vs. routine and core hours vs. out of core hours		Where transfusion took place	
Male	300	≥ 18 years	536	Emergency	59	A&E	6
Female	282	16 years to <18 years	6	Urgent	86	Theatre	23
Not known	5	1 year to <16 years	37	Routine	413	ITU/NNU/HDU/Recovery	58
		>28 days to <1 year	2	Not known	29	Delivery/Postnatal	16
		Birth to ≤28 days	3			Wards	396
		Not known	3	In core hours	426	Community	6
				Out of core hours	157	Outpatient/day unit	74
				Not known	4	Not known	8

587 cases have been included in the analysis. This includes 4 cases transferred from haemolytic transfusion reaction (HTR), 4 from previously uncategorised complication of transfusion (PUCT) and 1 from right blood right patient (RBRP). A further 20 cases with predominantly respiratory features were transferred to TAD and 12 to TACO. 5 cases were withdrawn as the reporters subsequently attributed the clinical features to other causes.

Figure 13.1
Cases of ATR since 1996



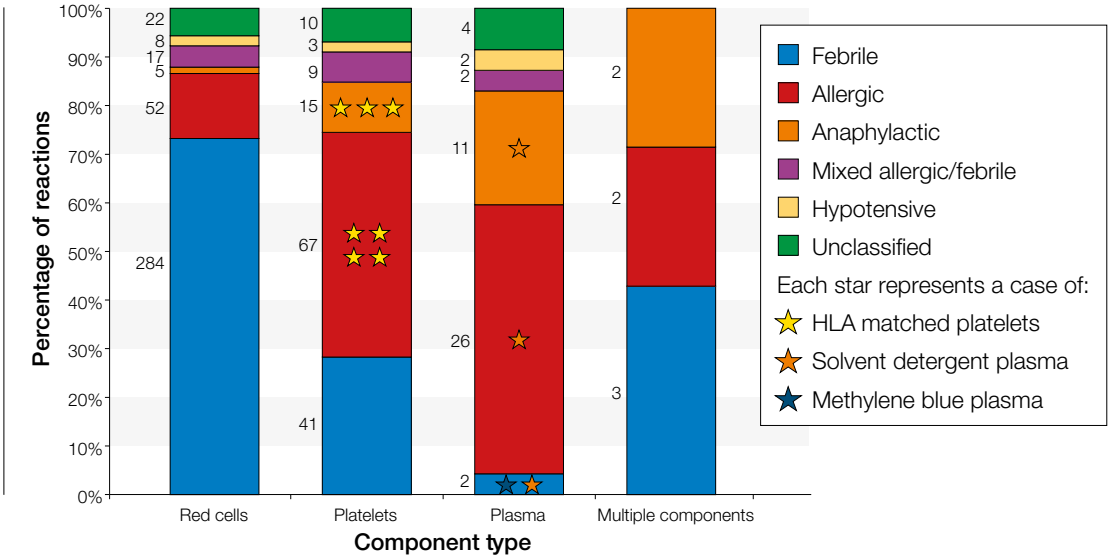
Introduction

Although the total number of reports has increased from 510 in 2010 to 587 this year, the pattern of reactions remains similar (see Figure 13.2, reactions by component type) and figures for anaphylaxis and major morbidity are similar. Where possible, reactions have been classified according to the International Haemovigilance Network/International Society of Blood Transfusion (IHN/ISBT) draft definitions which have recently been published[15], (see Table 13.1, IHN/ISBT classification of ATRs) but, as in previous years, many reactions are difficult to classify. In many cases, symptoms and signs may be due to either the patient's underlying condition or to transfusion.

Table 13.1
Current IHN/SHOT/BCSH classification of acute transfusion reactions

	1 = Mild	2 = Moderate	3 = Severe
Febrile type reaction	A temperature ≥ 38°C and a rise between 1and 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 mm or more occurring during or within one hour of completing transfusion **and** a systolic blood pressure 80mm 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

Figure 13.2
Reaction by component type



Types of reactions

As far as possible, reactions have been classified and the following figures obtained:

- 330 febrile (115 mild, 201 moderate, 14 severe)
- 180 allergic (83 mild, 64 moderate and 33 anaphylactic or severe allergic)
- 28 mixed allergic/febrile
- 13 hypotensive
- 36 blank or unclassifiable

Imputability

- 22 were stated by reporters to be certain (imputability 3)
- 162 were likely/probable (imputability 2) including 4 in which a possible alternative cause was identified
- 293 possible (imputability 1)
- 71 were excluded by reporters, usually because an alternative cause was considered more likely, but these have been kept in this chapter as it is often difficult to determine the cause of adverse symptoms/signs associated with transfusions
- 5 not assessable
- 34 blank

Deaths n=2

There were two deaths in which a transfusion was possibly implicated (imputability 1), and 13 which were considered to be unrelated to any transfusion reaction.

Case 1

Possible fatal transfusion reaction in a patient with multiple problems

An elderly male patient with multiple co-morbidities including pneumonia and a pulmonary embolus was transfused with fresh frozen plasma (FFP) prior to endoscopy. 15 minutes into transfusion of the first unit, he developed dyspnoea and suffered a fatal cardiac arrest. During attempted resuscitation he was noted to be developing a florid coalescing rash. Post mortem examination was inconclusive. Serum IgA was normal. A pre-transfusion mast cell tryptase was normal but a post transfusion sample was unsuitable for analysis as it was grossly haemolysed.

It was concluded that the clinical picture may represent an anaphylactic reaction to plasma, although other potential causes such as DIC or sepsis could not be ruled out, and the rash was not suggestive of urticaria. The patient's frail condition may have contributed to the severity of any reaction.

Case 2

Febrile reaction may have contributed to death

An adult male with metastatic gastric cancer and thrombocytopenia had haematemesis and septicaemia. One hour after the start of a red cell transfusion, his temperature rose 2.5°C to 39.5°C. He developed anxiety, tachycardia and respiratory distress. His oxygen saturation dropped to 80% but responded to oxygen therapy. His blood pressure remained satisfactory but he died four hours later.

Major morbidity n=53

Although only 7 cases were reported as being associated with major morbidity, a further 33 were reported as experiencing severe or life-threatening reactions. Thirteen of these cases had a clinical picture suggestive of anaphylaxis, 2 had features of moderate allergic reactions, 2 had severe febrile reactions and 7 had moderate febrile reactions.

In addition, a further 13 cases, not reported as having a severe or life-threatening reaction, had features leading to a classification of anaphylaxis, and 10 were classified as having severe febrile reactions either because of hypoxia, hypotension, or admission of a day case to a ward or high dependency unit.

Ascribing major morbidity can be difficult in acute transfusion reactions, as, although signs and symptoms can be severe, they are often transient. The IHN describes reactions as life-threatening if major intervention such as use of vasopressors or admission to intensive care is required to prevent death, or severe if the reaction requires, or prolongs, hospitalisation[15].

Specific types of reactions

Anaphylactic reactions n=33

Anaphylaxis is defined by the UK Resuscitation Council (UKRC)[49] and National Institute for Health and Clinical Excellence (NICE)[50] as: "…a severe, life-threatening, generalised or systemic hypersensitivity reaction… characterised by rapidly developing life-threatening airway and/or breathing and/or circulation problems usually associated with skin and mucosal changes."

33 reactions were consistent with anaphylaxis or severe allergy. Seven of these were in paediatric patients, including one neonate. Six reactions occurred in either a hospice or outpatient setting. Twelve reactions occurred in haematology patients. Only 18 patients were recorded as being given adrenaline (or noradrenaline), the former stated as being the first line drug in anaphylaxis by the UKRC[49].

Case 3

Reaction to cryoprecipitate

A young female patient undergoing spinal surgery was given a pool of standard cryoprecipitate as part of a massive transfusion. Within half an hour she developed urticaria and a sudden drop in cardiac output. She was treated with adrenaline, antihistamine and hydrocortisone. No investigations were reported.

Hypotensive reactions n=13

Thirteen reactions were classified as being hypotensive. 7/13 (54%) reports originated from cardiothoracic surgery, a specialty which accounted for 20/586 (3.4%) of reports in total. Three of the 7 patients were in ITU, 2 in theatre, 1 in recovery, and 1 had no information about location. The diagnosis of a hypotensive reaction can be difficult, especially in a patient in whom haemorrhage is suspected. However, in these cases, there was no evidence of continuing bleeding. Hypotensive reactions are stated to be more common in patients on ACE-inhibitors and in patients with abnormal bradykinin metabolism. These reactions merit further study.

Severe febrile reactions n=14

Fourteen febrile reactions were classifiable as severe: 9/14 cases were associated with red cell transfusion. Five patients had temperatures of 39°C or higher (in one case 41.3°C) The additional factors which led to a severe classification were hypotension (6 cases), hypoxia (3 cases), shock (1 case) and transient loss of consciousness in 1 case. In addition to managing hypotension and/or hypoxia, recognition of these severe reactions is important as the presentation may suggest possible bacterial transfusion-transmitted infection.

Case 4

Severe febrile reaction following post partum haemorrhage (PPH)

A young female experienced a 2L PPH. During the second unit of red cells transfused her temperature rose 2.3°C, and she had rigors, tachycardia, hypertension, tachypnoea and vomiting. She also had cold cyanosed peripheries. The red cell unit was investigated for possible bacterial contamination but cultures were negative. The patient made a good recovery.

Speed of onset

The time of symptoms from the start of transfusion was recorded in 252 cases. The median time was 30 minutes (range 1-240 minutes).

Management of transfusion reactions

Stopping the transfusion

It is important to temporarily stop the transfusion and confirm the identity of the component and the patient, and check for obvious contamination. In severe reactions, the component should be taken down and retained for further investigation if necessary, and venous access maintained by physiological saline. (However, clinical judgement is required in the case of hypotension in a bleeding patient, where continuation of the transfusion may be life-saving). There is no published evidence which will guide clinicians as to whether continuation of transfusions in milder reactions would be of harm. In 2011, the following actions were recorded:

- 391 reports mentioned stopping the transfusion, including 122 mild reactions
- 8 transfusions were continued then stopped as symptoms recurred or worsened
- 4 continued at same rate
- 8 continued at slower rate
- 61 reports stated that the transfusion had been completed already
- 115 did not mention the fate of transfusion

Treatment

69 reports stated that no medication was given to treat the reaction, 340 stated that medication was given and 178 reports were left blank.

Many of the 340 cases were treated with several drugs.

- 33 received antihistamine alone
- 7 received steroid alone
- 111 paracetamol alone
- 4 salbutamol alone
- 1 adrenaline alone
- 184 received combinations, mostly involving the above four drugs. Of these, 82 received antihistamine and hydrocortisone

Adrenaline was mentioned as being given, in combination with other drugs, in 34 reports, and noradrenaline in nine.

Fifteen patients were given oxygen, and three reports mention that patients who were on already on oxygen therapy at the time of the reaction, had their flow increased.

The forthcoming BCSH guidelines on acute transfusion reactions[13] will cover treatment. Paracetamol may provide symptomatic relief in moderate or severe febrile reactions, and antihistamine, either topical or systemic, may have a role in allergic reactions. The role of steroids is unclear. Adrenaline is the first line drug in anaphylaxis, and antihistamine and hydrocortisone may have a role in shortening the anaphylactic reaction and preventing recurrence[49].

Investigations

The purpose of investigations should be to contribute to patient management, for example, by excluding other causes for the patient's symptoms/signs, or by guiding management of further transfusions by identifying a likely cause for the present reaction. There are only two examples in the 2011 data of an investigation identifying a likely cause: two case of anaphylaxis associated with IgA deficiency (IgAD), discussed below.

Respiratory investigations

77 patients were reported as having oxygen saturations measured: 28 provided results, only 1 case was mentioned as having falling saturation.

19 cases were reported as having a chest X-ray: none reported changes. 2 patients had evidence of chest infection, 1 case was consistent with pulmonary embolus and 1 case had cardiac enlargement.

Investigations for IgA deficiency

IgA deficiency, defined as serum IgA level < 0.07 g/L with normal levels of other immunoglobulins, forms part of the spectrum of common variable immunodeficiency[51]. It was historically considered an important cause of severe transfusion reactions, although results from cumulative haemovigilance data show that such cases are very rare. IgA was reported as having been measured in 67 patients but only 15 cases which had anaphylaxis or severe allergy. The two vignettes below (the second one occurring in 2010 and describing an atypical reaction), indicate that occasional cases do arise. In both these cases, there was a high titre of IgA antibodies, a feature which is reported to be a predictor of severe reactions. A low IgA in the setting of generalised hypogammaglobulinaemia is not considered a risk factor for severe reactions (see Case 7, below).

Case 5

Severe reaction associated with IgA deficiency

An adult female with an undetermined bleeding disorder was given plasma prior to a dental procedure. Shortly after the start of the transfusion, she complained of an itch in her arm, followed by flushing, chest tightness, a strange sensation in her neck and pain in her head and back. She transiently lost consciousness. Serum IgA was measured at < 0.06 g/L, and her IgA antibodies were very high at 1 in 8,198. The reporting clinical team were seeking a management plan for further transfusions.

Case 6

Atypical reaction associated with IgA deficiency

A male patient experienced two similar moderate to severe febrile reactions two days apart. On each occasion he complained of back pain and rigors within a few minutes of starting the transfusion. On investigation, his IgA level was undetectable and he had anti IgA titre of 512. The advice was given that, although febrile reactions are not typical of IgA deficiency, the findings should not be ignored. A careful management plan should be developed and subsequent components should be IgA deficient if possible. The team were also advised to refer the patient to an immunologist for assessment of his immunodeficiency.

Case 7

Generalised hypogammaglobulinaemia

An elderly male patient with chronic lymphocytic leukaemia experienced a severe febrile reaction to red cells. Investigations included immunoglobulins. IgA was on the low side at 0.09 g/L, but IgG was also low.

Learning point

- A patient who has experienced a severe reaction and shown to have IgA deficiency should have a management plan for future transfusions. In addition, discussion with an immunologist, regarding management of common variable immunodeficiency, is important.

Mast cell tryptase

Mast cell tryptase (MCT) is a measure of mast cell degranulation. A typical "rise and fall" pattern, with the peak 1-3 hours post-reaction, is characteristic of anaphylaxis, but as the first vignette below shows, may also occur in less serious cases. Persistently raised MCT is seen in a range of haematological disorders (see second case below), as well as systemic mastocytosis, renal failure, and indeed any condition causing chronic pruritus[52]. The test does not identify the cause of anaphylaxis.

MCT was measured on 14 occasions. In two episodes, a "rise and fall" was seen, in the first vignette below and in a second case.

Case 8

"Typical" mast cell tryptase pattern in a moderate to severe allergic reaction.

A young male received standard plasma during plasma exchange. Within 15 minutes he developed urticaria, dyspnoea and angioedema, but hypotension was not described. He was treated with adrenaline, hydrocortisone and an antihistamine. A mast cell tryptase was raised at over 30 microg/L shortly after the reaction, but fell to 6.8 microg/L 24 hours later (normal level <13 microg/L).

Case 9

A raised MCT is not always due to anaphylaxis

An adult male with newly-diagnosed acute myeloid leukaemia experienced what appeared to be a minor febrile reaction shortly after transfusion of plasma and platelets. A single mast cell tryptase was very high at 100 microg/L.

A repeat sample should be performed: a return to baseline would suggest anaphylaxis, which would be unlikely in this case. Persistently raised MCT could be compatible with this underlying diagnosis.

Investigations to exclude bacterial contamination

Bacterial contamination is part of the differential diagnosis to consider when a patient presents with marked rise in temperature or severe rigors, especially when there is evidence of hypoxia, hypotension or shock. It is extremely unlikely in mild or moderate febrile reactions. 234 cases were reported as having blood cultures performed, including 159 febrile reactions, 48 allergic, 10 mixed allergic/febrile, 3 hypotensive and 14 unclassifiable reactions. The blood components involved were red cells (170 reports) platelets (46) plasma (15) and multiple components (3). 27 positive patient blood cultures were reported, but, in many cases, the positive finding appeared to be due to intercurrent septicaemia. In severe febrile reactions, the most important action is to contact a blood service consultant, for consideration of recall of any associated components from this donation, and discussion of further investigations of the implicated component. (Ten reports specifically mention that the implicated units were referred to blood service bacteriology laboratories for culture.) The vignette below describes contact with the Blood Service. The reaction may not have been sufficiently severe to necessitate an immediate recall, but concern was raised as the patient had a positive blood culture.

Case 10

ATR mimics bacterial infection, but transfusion-transmitted infection is excluded

An adult female with cancer was receiving a red cell transfusion as an outpatient. Near the end of the first unit, she developed a temperature rise of 1.5°C with rigors and a rise in blood pressure (a common feature in febrile reactions). She later vomited. The transfusion was discontinued and the unit was quarantined. Hospital blood culture showed a coagulase-positive staphylococcus. A Blood Service consultant was then contacted, and a recall was performed. The unit was sent for culture which was negative, and bacterial transfusion-transmitted infection was excluded.

Learning point

- If there is reason to suspect bacterial contamination, it is important to contact the Blood Service, even if the hospital is performing their own cultures of the unit, in order that the need for a recall of associated components can be considered promptly.

Human leucocyte antigen (HLA), human platelet antigen (HPA) and human neutrophil antigen (HNA) investigations

These were recorded as being performed in 27 cases, 8 with abnormal results. From the clinical information provided, this did not appear to be an appropriate investigation in any of the cases as none mentioned platelet refractoriness or new cytopenia[53].

Appropriateness of transfusion

This is difficult to assess. However, 18 reporters stated that transfusion had not been clinically indicated according to current BCSH guidelines. These reports included 9 red cell transfusions, 6 platelet and 3 plasma transfusions. No details are available except for one case of inappropriate use of plasma for warfarin reversal, which has led to a change in hospital policy on FFP use.

Reactions to methylene blue (MB-FFP) or solvent detergent treated plasma (SD-FFP)

This year, there have been three reactions in which *solvent detergent plasma* was implicated: severe reaction in an infant, described in detail (Case 5) in the paediatric chapter (Chapter 22), a mild allergic reaction, and one undefined reaction of low imputability. *Methylene Blue (MB)* treated plasma was initially implicated in the severe reaction, but has since been transfused to this individual without problems. MB plasma was also implicated in a mild febrile reaction of low imputability in a neonate.

Another European Union (EU) country has reported a higher rate of anaphylaxis with MB versus standard plasma, and there are case reports of patients whose allergy skin testing for methylene blue and related compounds was positive[54]. In 2011 only 1 reaction, a mild febrile reaction, was related to MB-FFP and from 2007-2011 there has been a total of 8 MB-FFP ATR reports (1 including multiple components), of which 5 were severe reactions (3 anaphylactic and 2 hypotensive).

COMMENTARY

Since 2007, the number of SHOT ATR cases has shown a steady increase. However, the number of cases of anaphylaxis has stayed relatively constant, ranging from 27 cases in 2007 to 33 in 2011. This suggests that more serious reactions have been reported in the past, but the increase in numbers probably reflects more comprehensive reporting of less serious events. The chart of reactions by component (Figure 13.2) shows a similar pattern to the charts of 2009 and 2010.

Now that the ATR reports could be considered to be in a “steady state”, it is timely to consider their value. Through comprehensive reporting, SHOT is able to monitor any change in reactions associated with new components or processes, and to compare our data with other countries’ haemovigilance schemes. The data on methylene-blue plasma is an example of this. The investigation of ATRs is a very interesting area: some investigations can help in the immediate management of the patient (e.g. oxygen saturation, full blood count and chest X-ray where appropriate), but one of the main purposes of investigations should be to exclude other serious adverse reactions e.g. transfusion-transmitted infection (TTI), TRALI and HTR where the clinical picture is not clear cut. However, performing all tests indiscriminately, in all cases, is not appropriate. Occasionally, investigations can guide selection of components for future transfusions, for example identification of IgA deficiency associated with severe allergic reactions.

Recommendations

- If a transfusion reaction is considered sufficiently severe that bacterial contamination is considered as a possible diagnosis, clinicians must contact the Blood Service to discuss whether a recall of associated components from the donation is necessary. This applies even when the hospital performs its own bacterial testing of the component.

  Action: Hospital Transfusion Teams (HTTs)

- Any reactions to fresh frozen plasma (FFP) (all types) should be reported to SHOT and investigated in detail.

  Action: Hospital Transfusion Committees (HTCs)

- Patients who have experienced an anaphylactic transfusion reaction should be discussed with an immunologist regarding further investigation and management.

  Action: Haematologists

For active recommendations from previous years and an update on their progress, please refer to the SHOT website

14. Haemolytic Transfusion Reactions (HTR) and Alloimmunisation

Author: Clare Milkins

Definitions

Haemolytic transfusion reactions are split into two categories: acute and delayed.

Acute reactions are defined as fever and other symptoms/signs of haemolysis within 24 hours of transfusion, confirmed by one or more of: a fall in Hb, rise in lactate dehydrogenase (LDH), positive direct antiglobulin test (DAT) and positive crossmatch.

Delayed reactions are defined as fever and other symptoms/signs of haemolysis more than 24 hours after transfusion; confirmed by one or more of: a fall in Hb or failure of increment, rise in bilirubin, positive DAT and positive crossmatch which was not detectable pre-transfusion.

Alloimmunisation (optional reporting) is defined as demonstration of clinically significant antibodies post transfusion which were previously absent (as far as is known) and when there are no clinical or laboratory signs of haemolysis.

DATA SUMMARY
Total number of cases: 94

Implicated components		Mortality/morbidity	
Red cells	92	Deaths *probably/likely* due to transfusion	0
FFP	0	Deaths *possibly* due to transfusion	0
Platelets	1	Major morbidity	11
Other (IVIg)	1		
Unknown	0		

Gender		Age		Emergency vs. routine and core hours vs. out of core hours		Where transfusion took place	
Male	35	≥ 18 years	92	Emergency	9	ED	2
Female	59	16 years to <18 years	0	Routine	57	Theatre	6
Not known	0	1 year to <16 years	2	Urgent	22	ITU/NNU/HDU/Recovery	15
		>28 days to <1 year	0	Not known	6	Wards	57
		Birth to ≤28 days	0			Community	2
		Not known	0	In core hours	0	Outpatient / day unit	8
				Out of core hours	0	Not known	4
				Not known/ applicable	94		

Change in definitions for 2012

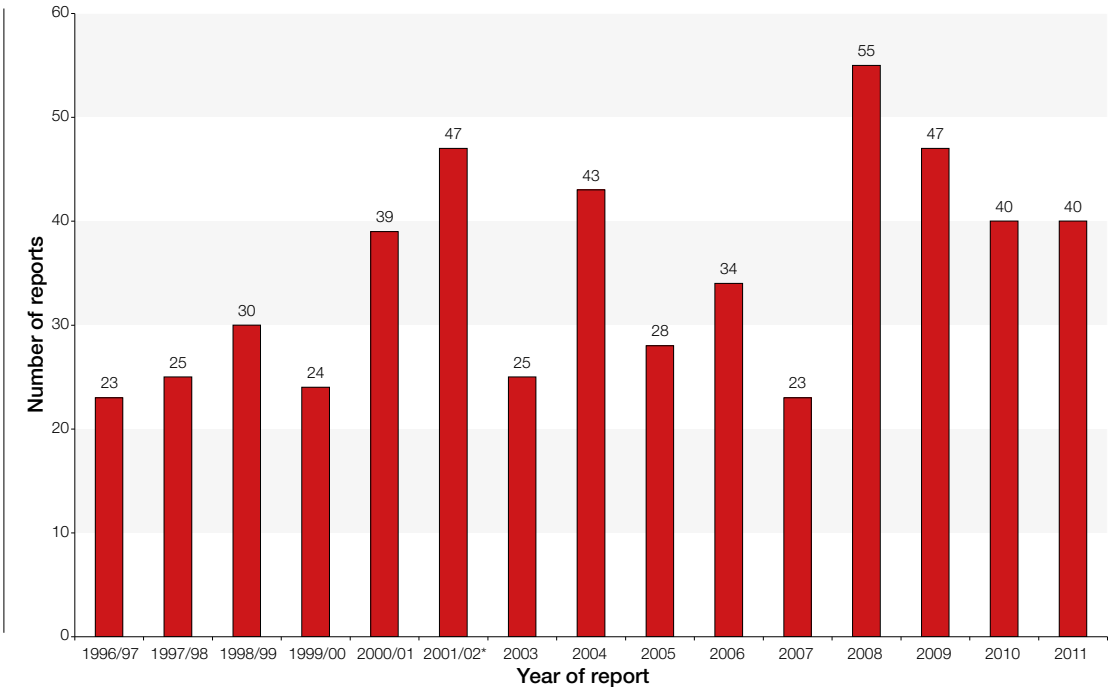
Alloimmunisation is an optional reporting category and a minimum data set is collected. It has become clear from the descriptions given that at least some of the cases had positive DATs and would fall into the current SHOT definition of Delayed Haemolytic Transfusion Reaction (DHTR), and for this reason the 2 categories are being reported in a combined chapter again this year. However, a positive DAT alone without supporting biochemical or clinical signs is not indicative of haemolysis, and therefore, the definition of HTR and alloimmunisation will change in 2012; development of an antibody with or without a positive DAT, but without clinical or biochemical signs of haemolysis will be classed as alloimmunisation.

Number of cases

There were 94 cases reported in this chapter, 54 reports of alloimmunisation and 40 reports of HTR.

Of the 40 HTR, there were 6 reports of DHTR with no clinical or laboratory signs of haemolysis, and these are summarised in Table 14.3. The remaining 34 cases of HTR included 10 reported as acute and 24 as delayed, although in at least 2 cases, the patient suffered both acute and delayed reactions.

Figure 14.1 Number of cases of HTR reviewed since 1996



** 2001–2002 figures covered a 15 month period*

Acute haemolytic transfusion reactions (AHTR) n=10 (including 1 that was also DHTR)

Major morbidity n=2

There were 2 cases of major morbidity, both with impaired renal function; one required intensive therapy unit (ITU) admission but recovered, whilst the other died of underlying illness.

Case 1

ITU admission following an acute and delayed HTR

A young female patient with a history of multiple transfusions was admitted with menorrhagia and an Hb of 7.8g/dL, having been transfused 7 days earlier. The bilirubin and creatinine were both raised and the DAT was positive. Anti-Fy^b was identified in addition to a historically known anti-s. Two units of s-, Fy(b-) red cells were transfused. During the 2nd unit, the patient had rigors and difficulty breathing, and the transfusion was stopped. The creatinine continued to rise and the patient was admitted to ITU. The Blood Service reference laboratory confirmed the presence of anti-Fy^b in the plasma and in an eluate. A weak anti-Jk^a was also identified in the plasma by enzyme techniques only. Both units implicated in the acute reaction were Jk(a+), as were at least 2 of the 4 transfused 7 days earlier. The patient remained in ITU for a week, and was discharged with a creatinine of 158 micromol/L.

This appears to be a combination of an acute haemolytic transfusion reaction due to anti-Jk^a, and a delayed reaction due to anti-Fy^b and probably also anti-Jk^a.

Case 2

Patient with an antibody to high frequency antigen requires incompatible red cells in an emergency

An elderly male patient with carcinoma (Ca) colon was admitted with gastrointestinal (GI) bleeding. He was known to have the rare Rh phenotype D--, and anti-Rh17 (anti-Hr_o) in his plasma. He was transfused with 3 units frozen/thawed compatible units but continued to bleed down to a Hb of 5.0g/dL. The decision was taken to transfuse 2 units of incompatible rr K negative red cells, with IVIg and prednisolone cover. The transfusion was uneventful, but signs of haemolysis, including renal impairment, developed a few hours post transfusion and progressed over the next 3 days. The patient was already very unwell and died of his underlying illness.

Learning point

- Additional sensitive techniques are important in elucidating all antibodies present when investigating a haemolytic transfusion reaction.

Delayed haemolytic transfusion reactions (DHTR), n=24

Major morbidity n=9

There were 9 cases of major morbidity, including 5 in patients with sickle cell disease, which were all complicated by hyperhaemolysis and shared care; these are further discussed in the new chapter on haemoglobin disorders (Chapter 23).

In another case a patient's Hb dropped to 3.5 g/dL 11 days post transfusion, although it is not clear how much the patient's underlying condition contributed to this. Another 3 cases resulted in renal impairment, with one patient being admitted to ITU and another dying from their underlying illness.

The case numbers in brackets in some of the vignettes below correlate with those in Table 14.1.

Case 3 (D1)

Delayed and acute reaction to different antibodies

An elderly male patient, with known anti-E+Fy^b was admitted with acute blood loss and transfused on several occasions over a 10 day period. 15 days after admission, the patient was on ITU and bleeding heavily; several units of E-Fy(b-) red cells were incompatible, and patient was transfused with E- K-, Fy^b untyped, serologically compatible red cells. Further samples were sent to the Blood Service reference laboratory, where anti-Fy^b was detected in an eluate, and 6 units of crossmatch compatible, E- K-, Fy(b-) red cells were issued. 4 days later anti-Jk^a was also identified in the plasma. Bilirubin peaked at 80 micromol/L one day later. Creatinine was rising and peaked at 238 micromol/L one day after the transfusion of Fy(b+) red cells. The patient was probably having a delayed HTR due to anti-Jk^a, and possibly an acute HTR due to anti-Fy^b, but given the significant co-morbidities, the clinical team thought it unlikely that the transfusion reaction contributed to the death of the patient a week later.

Case 4 (D11)

Delayed haemolysis with possible autohaemolysis

Patient with Ca colon and chronic anaemia who presented with Hb 6.7 g/dL was transfused 5 units of red cells over 3 days and discharged with an Hb of 10.3 g/dL. 11 days later the patient represented in A&E with Hb of 3.5 g/dL, positive DAT, raised bilirubin and haemoglobinuria. Samples were sent to the Blood Service reference laboratory and anti-K plus an autoantibody were identified. Four of the 5 units transfused were K positive. The post-reaction Hb was considerably lower than the pre-transfusion Hb, however the initial Hb of 6.7 g/dL was recorded on a point of care testing (POCT) device and was not checked in the laboratory, suggesting that this could have been falsely high, or that there was an element of autohaemolysis involved in addition to immune red cell destruction due to the anti-K.

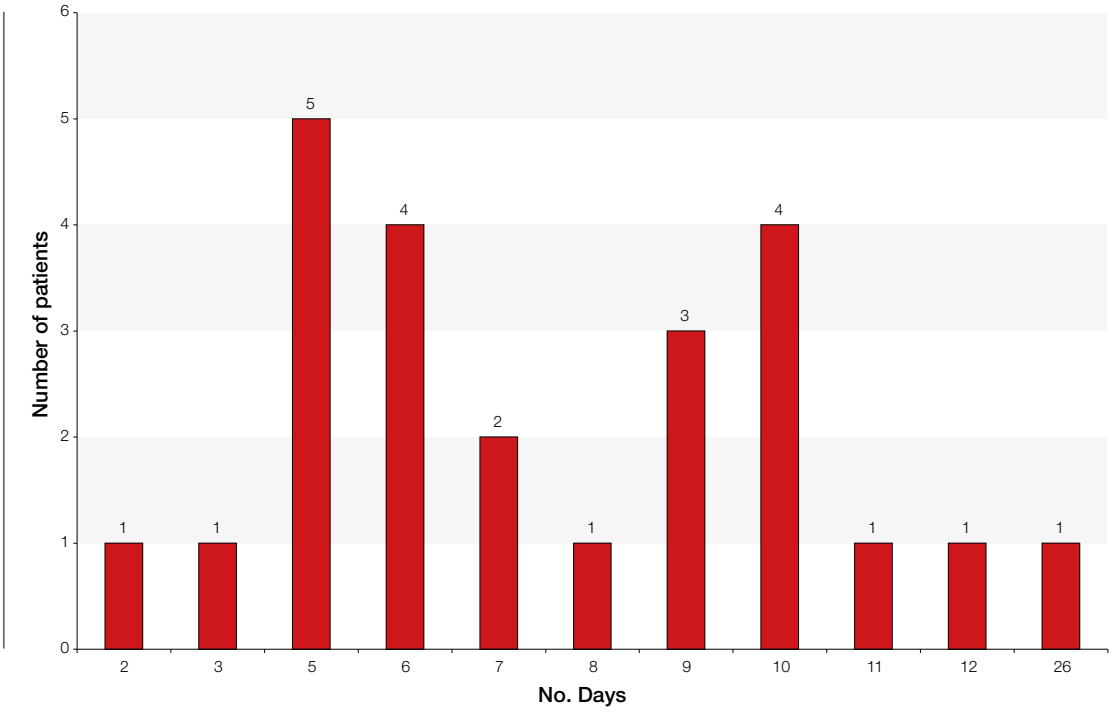
Timing of reaction in relation to the transfusion

AHTR

Eight of the 10 reactions occurred during the transfusion, with a range of 37 to 200mL of red cells being transfused. The other two occurred within 24 hours of the transfusion.

DHTR

Figure 14.2 Interval in days between administration of the implicated transfusion and signs or symptoms of a DHTR



Signs of haemolysis were recorded between 2 and 26 days post transfusion, with a median of 7 days.

Alloimmunisation

Newly detected antibodies were reported between 3 and 410 days following transfusion of between 1 and 6 units of red cells.

Serological findings – AHTR n=10

Nine patients reacted to red cells and 1 probably reacted to platelets.

No causative antibodies were detected in 4 cases and there was no clear explanation for the reaction. Two cases were of low imputability: in one case (Case 5 below), anti-Jk^a had been previously detected in a different hospital and the units transfused were Jk(a+), but there was no evidence that it caused the reaction; in another, the only sign of reaction was jaundice the day after transfusion.

Case 5

Possible reaction due to undetectable anti-Jk^a known at a previous hospital

A patient with chronic anaemia required urgent transfusion prior to liver surgery. Anti-K,anti-S, and anti-Kp^a were identified. Antigen-negative units were given, but the transfusion was stopped when the patient developed a fever during the 2nd unit. A transfusion history was then obtained from another hospital, where the patient had a record of anti-Jk^a. The bilirubin rose transiently from 23 to 88 micromol/L and the Hb dropped by 2 g/dL. The 2 transfused units were both Jk(a+), but anti-Jk^a was not detectable in a post transfusion sample (confirmed by a reference centre) and the DAT was negative.

It is not clear whether this was a reaction due to undetectable anti-Jk^a or whether the symptoms were due to the patient's underlying liver disorder.

There was one case of an antibody to a high frequency antigen, where incompatible blood was transfused in an emergency, and another of an antibody to a low frequency antigen of undetermined specificity. In one case a cold autoantibody with a high thermal range caused a reaction in the same patient on 2 separate occasions (Case 7 below). One patient with known anti-Fy^{b} received Fy(b+) red cells in an emergency and also had a newly developed but unidentified anti-Jk^{a}.

The 10th patient (see Case 6 below) was group A, post group O/A double cord haemopoietic stem cell transplant (HSCT), who received both group O red cells and platelets, and the reaction was probably due to anti-A from the platelets.

Case 6

Probable anti-A from group O platelets

A patient with acute myeloid leukaemia (AML), blood group A RhD positive, received 2 pools of group O high-titre negative platelets, followed by group O red cells, one year post double cord allograft (one group O and one group A). Within 30 minutes of commencing the red cell transfusion, he developed rigors and fever. The rigors resolved with hydrocortisone and chlorphenamine. His Hb dropped from 9.6 to 4.8 g/dL after transfusion, but was 7.3 g/dL on a sample taken a few hours later, casting some doubt on the validity of the result of 4.8. The bilirubin rose from 2 to 28 micromol/L. The reference laboratory confirmed the ABO group as mixed field A/O, with anti-A detectable in the reverse group, DAT positive (IgG and C3d coating), and no atypical antibodies in the plasma or eluate; however the eluate was not tested against group A cells, as the reference laboratory was unaware of the group O platelet transfusion. The patient was transfused again uneventfully, and was discharged two days later. At the time this was considered to be an acute haemolytic transfusion reaction with no obvious cause; however, retrospective review suggests that this was probably due to passive anti-A from the group O platelets.

Learning points

- Where possible, non-group O plasma components should be selected for recipients of ABO mismatched or mixed haemopoietic stem cell transplant (HSCT) whilst there are circulating group A or B cells.
- Plasma components should be considered as the potential cause of an acute haemolytic transfusion reaction (AHTR) even if the reaction occurs during a subsequent red cell transfusion.

Case 7

Haemolysis due to cold auto-antibody with wide thermal range

A patient with chronic lymphocytic leukaemia (CLL) and anti-C was transfused group A, crossmatch-compatible, antigen-negative units, but the patient had rigors and fever, and haemoglobinuria, and the transfusion was stopped after 150mL. The Blood Service reference laboratory found a cold antibody with undetermined specificity and a positive DAT (complement coating only). Four days later the patient suffered a similar reaction to a unit of group O crossmatch compatible red cells issued by the reference laboratory. Further samples confirmed a cold auto-antibody with a high thermal range. It was recommended that future transfusions should be group A1 and given through a blood warmer.

Learning point

- Cold antibodies with a high thermal range can cause haemolytic transfusion reactions (HTRs) and if the patient is group A or B and has already had an acute HTR, group O blood should be avoided. Consideration should also be given to transfusing blood through a blood warmer in these circumstances.

Serological findings – DHTR

The serology, signs of haemolysis and time intervals are detailed in Table 14.1. The causative antibodies are summarised in Table 14.2.

Case 8 (D17)

Anti-Jk^a detected by more sensitive techniques

An elderly male patient with myelodysplastic syndrome (MDS) was seen at a routine outpatient appointment with Hb 5.3 g/dL. Patient was D negative with anti-D and positive DAT. Samples were sent to the Blood Service reference laboratory where anti-Jk^a was also identified by enzyme indirect antiglobulin test (IAT) only. Anti-D and anti-Jk^a were both detected in an eluate. The patient had been transfused at a different hospital 26 days earlier where he had undergone surgery for an aortic aneurysm repair, without the laboratory being informed that the patient had MDS, and should therefore have received RhD negative red cells.

Learning points

- More sensitive techniques might be required to detect all causative antibodies following an haemolytic transfusion reaction (HTR).
- An eluate is an essential part of an investigation into a haemolytic transfusion reaction, at least when the direct antiglobulin test (DAT) is positive.
- Full clinical details should be provided so that the laboratory can provide the most appropriate components.

Case 9 (D20)

Haemolysis due to anti-A from IVIg

A patient with a severe autoimmune inflammatory skin condition, blood group A, was treated over 4 days in outpatients with high-dose IVIg. He was admitted 5 days later with signs of severe haemolysis, including haemoglobinuria, a raised bilirubin and a massive fall in Hb, from 15.3 to 8.5 g/dL, requiring transfusion of 2 units of group O red cells. The DAT was positive, but no anti-A was detected in the eluate. The titre of anti-A in the batch of IVIg was 4 by direct agglutination at room temperature, but 1024 by IAT at 37°C. This was reported as major morbidity, presumably due to the huge fall in Hb; however, even though the haemolysis was due to anti-A, the time-frame suggests that this was relatively slow extravascular haemolysis, rather than acute intravascular haemolysis, and it does not therefore meet the SHOT definition of major morbidity.

Strictly speaking, this case is not reportable to SHOT, as IVIg is classed as a medicinal product, and reactions are reportable to the Medicines and Healthcare products Regulatory Agency (MHRA) under the 'Yellow Card Scheme'. However, because the product caused such a severe haemolytic reaction due to anti-A, it fits well with this chapter and provides a good opportunity to make some learning points.

Learning points

- Large volume transfusion of IVIg can cause significant haemolysis in non-group O recipients, particularly where the patient has an underlying inflammatory condition.
- When severe haemolysis occurs in group A, B, or AB patients, it may be necessary to stop the IVIg therapy and transfuse group O red cells. A different batch of IVIg should be considered for subsequent therapy.
- A mechanism should be put in place to monitor patients for signs of haemolysis post high-dose IVIg therapy.

Table 14.1 Serology, laboratory signs and timing of reaction DHTR

Case number	New antibody (ies) in plasma	Antibodies in eluate	Comments	Days post transfusion
D1	Jk^a	Fy^b	Hb↓; bilirubin↑; creatinine↑. Known anti-E+Fy^b - ; Also acute HTR - non-typed red cells issued in emergency; died unrelated.	5
D2	c	Not done	Hb↓; bilirubin↑; fever, back pain, chills.	5
D3	Fy^a	Fy^a	bilirubin↑; renal impairment; dark urine.	11
D4	Jk^a	Not done	bilirubin↑; Hburia; chills & rigors; DAT C3d coating only.	10
D5	(E, C^w)	No specificity	Fever, Hb↓; bilirubin↑. Anti-E+C^w present pre-transfusion but not detected. Units E neg, C^w untyped.	6
D6	Auto anti-D, (C, Fy^a)	Non reactive	Hb↓; bilirubin↑; Hburia; creatinine↑. SCD - ? hyperhaemolysis	8
D7	K, Jk^b	Not done	bilirubin↑; dark urine; creatinine↑.	10
D8	Jk^b, S	Jk^b, S	SCD Hb↓↓↓; bilirubin↑; known anti-E; also historical anti-Jk^b + S.	9
D9	K, auto	Not done	Hb↓; bilirubin↑.	12
D10	E, c, K	E	Hb↓; bilirubin↑; Hburia	
D11	K	Non reactive	Hb↓↓↓; bilirubin↑.	10
D12	None	Not done	SCD; hyperhaemolysis; DAT negative.	6
D13	Fy^a	Non reactive	SCD; hyperhaemolysis; DAT negative.	6 + acute
D14	Jk^a	Not done	Hb↓.	1-2 days
D15	Jk^a	Jk^a	Hb↓; bilirubin↑.	5
D16	Jk^a	Not done	Hb↓; bilirubin↑; DAT negative	3
D17	D, Jk^a	D Jk^a	Hb↓.	26
D18	E, C^w, Jk^b, Lu^a, C	Not done	SCD; Hb↓; bilirubin↑; creatinine↑; DAT negative.	7
D19	E	Not done	Hb↓; DAT not done.	7
D20	Passive anti-A	Non reactive against O cells	Hb↓↓↓; bilirubin↑; dark urine; IVIg.	5
D21	Jk^b, C	Jk^b	Hb↓; LDH↑; Known anti-Fy^a.	6
D22	Jk^b	Not done	Hb↓; bilirubin↑; dark urine.	10
D23	Fy^a	Fy^a	Hb↓; bilirubin↑.	9
D24	Anti-c (enzyme only)	Not done	Hb↓; bilirubin↑; dark urine. Chest pain soon after transfusion but AHTR not considered. DAT negative.	9

Table 14.2 Summary of cases by antibody specificity

Antibody specificity by blood group system	No. cases	Sole new antibody
Kidd		
Jk^a	6	5
Jk^b	5	1
Rh		
D	2	1
C	3	0
E	4	1
C	3	0
C^w	2	0
Kell		
K	4	2
Duffy		
Fy^a	4	3
MNSs		
S	1	0
Other		
Lu^a	1	0
Total	**35**	**13**

Table 14.3 New antibodies with or without positive Direct Antiglobulin Test but with no clinical or laboratory signs of haemolysis (alloimmunisation)

Specificity	No. cases
Jk^a	14
E	8
Mixture including Rh	7
c+/- E	6
K	5
Fy^a	5
e+/-C	4
Jk^b	2
Lu^a	2
Mixture Rh and Kidd	2
M	1
C^w	1
Kp^a	1
Mixture including Kidd	1
Mixture other	1
TOTAL	**60**

Direct antiglobulin tests, use of eluates and referral to a Blood Service reference laboratory

The DAT was positive in 19/24 (79%) cases of DHTR, negative in 4 cases, and not undertaken in one case. The DAT was positive in 7/10 (70%) cases of AHTR.

Eluates were undertaken in 12/24 (50%) cases, including 2 cases where the DAT was reported to be positive with C3d coating only. Of the cases where an eluate was not tested, 4 of these had a negative DAT, and one was positive due to C3d coating only. In another case, the reference laboratory did not prepare an eluate because the DAT was also positive pre-transfusion and the hospital did not mention that the referral was part of an investigation into an HTR.

The serology was confirmed by a reference laboratory in 16/24 (67%) cases of DHTR and in 9/10 cases (90%) of AHTR.

COMMENTARY

Anti-Jk^a is the single most common specificity implicated in both acute and delayed reactions and in the alloimmunisation group.

Eluates were only undertaken in 50% of DHTR cases, which is the same as last year; however, the reference laboratories generally do not prepare eluates unless the DAT is positive with IgG coating. Reference laboratories also need to be made aware that they are investigating a transfusion reaction.

Patients with sickle cell disease were, once again, overrepresented in the DHTR cohort, and all suffered major morbidity. These cases have also been discussed in a separate chapter on haemoglobin disorders (Chapter 23).

The severe haemolytic episode following treatment with IVIg is an interesting case. Most episodes of haemolysis due to IVIg are mild and probably often go unnoticed. Rare cases of severe haemolysis have been reported with high doses of IVIg (more than 100g over 2-4 days or 1 to 2 g/Kg), and are more likely where the ABO haemagglutinin titre is >16[55]. It has also been suggested that the newer liquid products have higher titres of anti-A/B than the lyophilised products[56]. Patients with an underlying inflammatory state appear to be at greater risk[57]. ABO haemagglutinins are not removed during manufacture of IVIg, but the European Pharmacopoeia recommends that they should not be detectable at a titre of 64[58]. It is recommended that IVIg recipients be monitored for clinical signs and symptoms of haemolysis[59]. Several strategies have been suggested by the above authors for managing patients who have severe HTRs: if transfusion is required, use group O red cells; titre the causative batch of IVIg and select a different batch with a lower titre.

Recommendations

- Plasma components should be considered as the potential cause of an acute haemolytic transfusion reaction (AHTR) even if the reaction occurs during a subsequent red cell transfusion.

  Action: Hospital Transfusion Teams (HTTs)

- If platelets are thought to be the cause of an AHTR, this must be reported to the Blood Service for further investigation, whether or not they are labelled as high-titre negative.

  Action: HTTs

For active recommendations from previous years and an update on their progress, please refer to the SHOT website

15. Transfusion-Related Acute Lung Injury (TRALI)

Author: Catherine Chapman

Definition

Transfusion-related acute lung injury (TRALI) is defined as acute dyspnoea with hypoxia and bilateral pulmonary infiltrates during or within 6 hours of transfusion, not due to circulatory overload or other likely causes.

DATA SUMMARY Total number of cases: 12							
Implicated components with confirmed antibody concordance				**Mortality/morbidity**			
Red cells			1	Deaths due to transfusion			0
FFP			0	Deaths in which reaction was possibly implicated			1
Platelets			0	Major morbidity			8
Other			0	Potential for major morbidity			1
Gender		**Age**		**Emergency vs. routine and core hours vs. out of core hours**		**Where transfusion took place**	
Male	5	≥ 18 years	11	Emergency	3	ED	0
Female	7	16 years to <18 years	1	Urgent	4	Theatre	0
		1 year to <16 years	0	Routine	5	ITU/NNU/HDU/Recovery	0
		>28 days to <1 year	0			Wards	0
		Birth to ≤28 days	0	In core hours	1	Community	0
		Not known	0	Out of core hours	3	Outpatient/day unit	0
				Not reported	8	Not known	12

Twelve cases of suspected TRALI have been included this year. Ten other reports were either transferred to another SHOT category (5 to transfusion-associated circulatory overload (TACO), 1 to transfusion-associated dyspnoea (TAD)) or were withdrawn because the case had subsequently been attributed to a cause unrelated to transfusion (4).

Table 15.2 shows the assessed probability of TRALI in these twelve cases. Four patients died; one death was possibly related to TRALI (Case 2) and three were categorised as unrelated to TRALI. All other patients made a full recovery from their respiratory event.

Three of the reported cases had occurred in 2010 but reports had been completed in 2011.

Assessment of TRALI Cases

There is no diagnostic test for TRALI and it is difficult to distinguish from other causes of acute lung injury, circulatory overload or infection. Most reported cases are complex with several possible contributory factors. The probability of TRALI has been assessed in each case (Table 15.2). Clinical factors which influence this assessment include: timing; radiological features; possibility of infection; other risk factors for acute lung injury (ALI)/acute respiratory distress syndrome (ARDS); evidence of circulatory overload and/or impairment of cardiac function; pre-existing cardiac, pulmonary, renal, hepatic or other disease and response to diuretics. Serological results are also considered.

Two intensive care specialists and a transfusion medicine expert (TRALI expert panel) assessed all NHSBT cases (10 of 12 cases) before laboratory investigation. Cases are subsequently categorised to take account of the laboratory results. As in previous years, cases have been divided into four groups (as shown in Table 15.1):

Figure 15.1 Number of suspected TRALI cases and deaths at least possibly related to TRALI by year of report

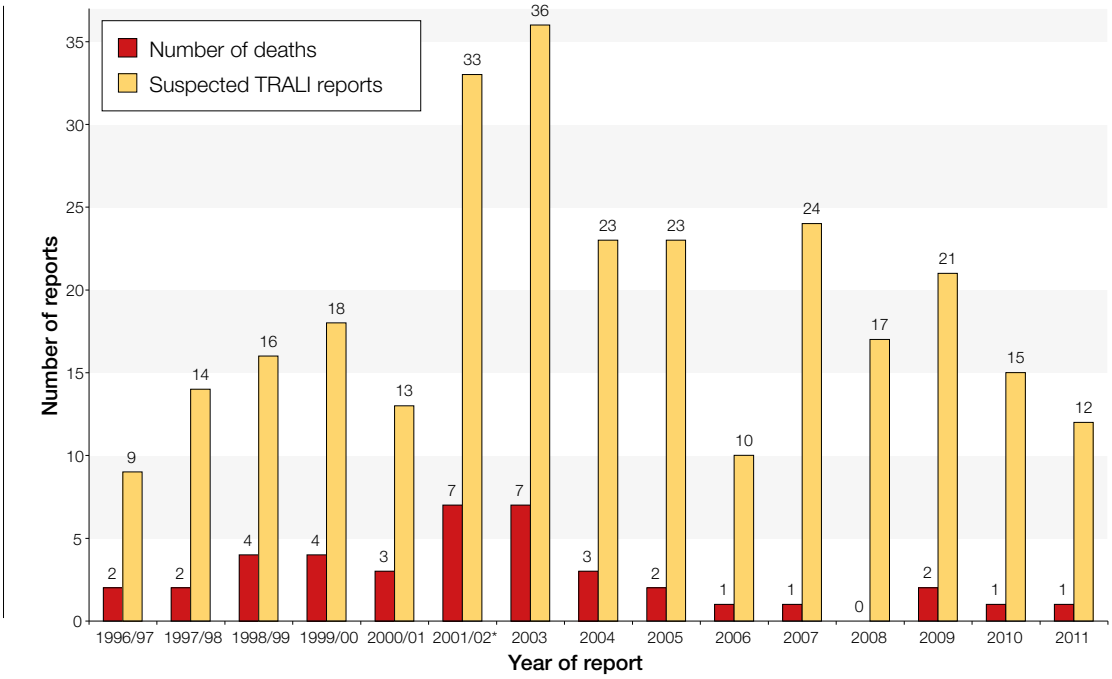


Table 15.1 Imputability levels for the diagnosis of TRALI

Imputability levels for the diagnosis of TRALI	
Highly likely	where there was a convincing clinical picture and positive serology
Probable	where there was either a less convincing history and positive serology or a good history and less convincing or absent serology
Possible	where either the clinical picture or serology was compatible with TRALI, but other causes could not be excluded
Unlikely	where the picture and serology were not supportive of the diagnosis

Table 15.2 TRALI cases imputability levels (SHOT Criteria)

TRALI case imputability (SHOT criteria)	Number of cases
Highly likely	0
Probable	1
Possible	2
Unlikely	9
TOTAL	**12**

Patients

Age

Patient ages ranged from 16 days to 87 years. Only one patient was aged less than 18 years; this case was classified as unlikely to have been TRALI.

Clinical specialty

This year the most frequent case specialties were haematology (5 cases) and surgery (5 cases), the other two patients were medical. Analysis of cumulative figures since 1996 from 284 reports of suspected TRALI has shown that haematology/oncology combined has provided the highest number of reports of suspected TRALI (97/284, 34%) and surgery the second highest (94/284, 33%). General medicine was reported as the specialty in 35/284 cases (12%). Denominator data are not available.

Clinical presentation

All cases, by definition, had been hypoxic. All except one had bilateral pulmonary infiltrates on chest X-ray (CXR); the exception had bilateral changes on CT pulmonary angiogram. Seven patients were treated in intensive therapy unit (ITU), of these, 3 were already on ITU before the event. Five patients required invasive mechanical ventilation, in 3 cases this continued between 1 and 4 days, in the other 2 cases the duration was not specified.

Fever was present in 4 patients, absent in 4 and unreported in 4. Hypotension was present in 6, absent in 4 and unreported in 2. Signs of heart failure were reported as present in 2, absent in 5 and unreported in 5.

Patient outcomes

Four patients died; 1 death was possibly related to TRALI (Case 2), 2 deaths were due to an unrelated cause (1 liver failure, 1 intracranial haemorrhage) and 1 death occurred in a case which was assessed as unlikely to be TRALI based on the clinical history and the absence of human leucocyte antigen (HLA) and granulocyte antibodies in the single donor concerned. All other patients recovered fully from their respiratory event.

Laboratory investigations

Complete TRALI investigation results were available in 7 cases, results were incomplete in 2 cases and investigations had not been undertaken following expert advice in 3 cases. It had been advised that these 3 events were much more likely to have been due to alternative causes.

Donor antibodies

Concordant donor leucocyte antibodies were found in a single donor (Case 1). The male donor of the implicated red cells had a previous history of having been transfused in 1975. The concordant antibody had HLA class II specificity (HLA-DR7).

Patient antibodies

Patients are no longer routinely tested for leucocyte antibodies because all components except granulocytes are now leucodepleted in the UK. Such testing is confined to recipients of granulocytes (apheresis or buffy coat).

Components

The only implicated component with proven donor-patient concordance was a unit of red blood cells in optimal additive solution (RBCOA) (Case 1)

Classification of cases according to Canadian Consensus Criteria[60 61]

All 12 reports have also been separately classified using the Canadian Consensus criteria to allow international comparison (Table 15.3).

Table 15.3 TRALI case probability (Canadian Consensus Criteria)

TRALI probability (Consensus Panel criteria)	Number of cases
TRALI	1
Possible TRALI	11
Total	**12**

Case 1

Probable TRALI

A 70 year old patient with acute myeloid leukaemia (AML) had been treated with antibiotics for neutropenic sepsis (WBC 0.2 x 10^9/L) for 24 hours and her temperature was settling. She was transfused with three units of blood followed by a unit of platelets. She became short of breath (SOB), hypoxic and developed rigors and increased blood pressure (BP) 30 minutes after platelets and about 6 hours after RBCOA. CXR showed no change but CT pulmonary angiogram was reported as showing bilateral ground glass shadowing throughout lung parenchyma. She was treated with 40mg furosemide with no immediate improvement and recovered over 48 hours to normal oxygen saturation with no additional treatment.

Investigation showed that the male donor of the 3rd red cell unit had HLA class II antibodies (specificity HLA-DR7) which were concordant with the patient. He had been transfused in 1975.

This case has been classified as probable rather than highly likely TRALI because: hypertension is atypical in TRALI; there was no CT examination before transfusion for comparison and TRALI is exceptional in severe neutropenia.

Case 2
Possible TRALI
A 73 year old patient with end stage CLL was transfused with two units of red cells to treat anaemia with breathlessness. The first unit was given with no complication. The second was commenced three hours later and, during transfusion of this unit, he developed increased dyspnoea, reduced pO2 and cough. He died later that day and did not have a post mortem examination. He had been on antibiotics before transfusion and had been treated with Campath® and rituximab in the recent past; he had also received recent treatment with rasburicase for possible tumour lysis. No pretransfusion CXR but a CT scan six days before transfusion had shown evidence of disease progression. Post transfusion CXR 16/04/11 was reported as "Bilateral perihilar alveolar pulmonary infiltrates demonstrated with consolidation in left mid and lower lung zones. Picture is in keeping with bronchopneumonic infiltrates, pulmonary oedema or leukemic infiltrates; clinical correlation is required".

Investigation identified that one donor had HLA Class 1 antibodies but it was not possible to test for concordance because a patient sample was not available. HLA antibodies occur commonly in donors and this result is not strong evidence to support a diagnosis of TRALI. Additionally, this patient was very ill before transfusion with advanced disease and several possible reasons for respiratory deterioration. This was classified as possible TRALI.

COMMENTARY

No case of highly likely TRALI and only one case of probable TRALI was reported this year.
The case of probable TRALI was associated with a transfused male blood donor who had concordant HLA class II antibodies. This is the first such case reported to SHOT.
One death occurred which was possibly related to TRALI but the patient had several other co-morbidities.
Reported rates of TRALI remain consistently lower than in 2003/2004 when TRALI risk reduction strategies were first initiated.
This is the first year that no serologically confirmed case of TRALI has been linked to transfusion of female plasma rich components.
All UK Blood Services currently use male donors to provide 100% fresh frozen plasma (FFP) and plasma for platelet pooling.

Recommendations

- If it has been concluded, following hospital case review, that a case reported to SHOT as transfusion related acute lung injury (TRALI) would be better categorised in an alternative category (e.g. transfusion-associated circulatory overload (TACO), transfusion-associated dyspnoea (TAD), acute transfusion reaction (ATR) please inform the SHOT office.

  Action: Hospital Transfusion Teams (HTTs)

For active recommendations from previous years and an update on their progress, please refer to the SHOT website

16. Transfusion-Associated Circulatory Overload (TACO)

Author: Hannah Cohen

Definition

TACO includes any 4 of the following that occur within 6 hours of transfusion:

- **Acute respiratory distress**
- **Tachycardia**
- **Increased blood pressure**
- **Acute or worsening pulmonary oedema**
- **Evidence of positive fluid balance**

DATA SUMMARY
Total number of cases: 71*

Implicated components		Mortality/morbidity	
Red cells	58	Deaths due to transfusion	0
FFP	3	Deaths *probably/likely* due to transfusion	0
Platelets	2	Deaths *possibly* due to transfusion	2
Multiple components	8	Major morbidity	24

Gender		Age		Emergency vs. routine and core hours vs. out of core hours		Where transfusion took place	
Male	26	≥ 18 years	66	Emergency	26	A&E	1
Female	44	16 years to <18 years	1	Routine	41	Theatre	7
Not known	0	1 year to <16 years	1	Not known	4	ITU/NNU/HDU/Recovery	11
		>28 days to <1 year	1			Wards	45
		Birth to ≤28 days	1	In core hours	34	Community	2
		Not known	0	Out of core hours	36	Outpatient/day unit	4
				Not known	1	Not known	1

**There were 71 cases in 70 patients*

A total of 49 questionnaires on TACO were received; 3 were transferred in from the transfusion-associated dyspnoea (TAD) category, 11 from acute transfusion reaction (ATR) (2 reports of which were in one patient), 5 from transfusion-related acute lung injury (TRALI), 1 from right blood right patient (RBRP), 1 from inappropriate, unnecessary or under/delayed (I&U) and 1 from previously uncategorised complication of transfusion (PUCT), resulting in a total of 71 cases which are analysed in this chapter. In addition, 1 patient is described in the I&U chapter (Chapter 9, Case 1).

Definition

Cases were assessed by the reviewer for probability of a diagnosis of TACO based on the International Society of Blood Transfusion (ISBT) definition[15], also available on the SHOT website (www.shotuk.org).

Patients

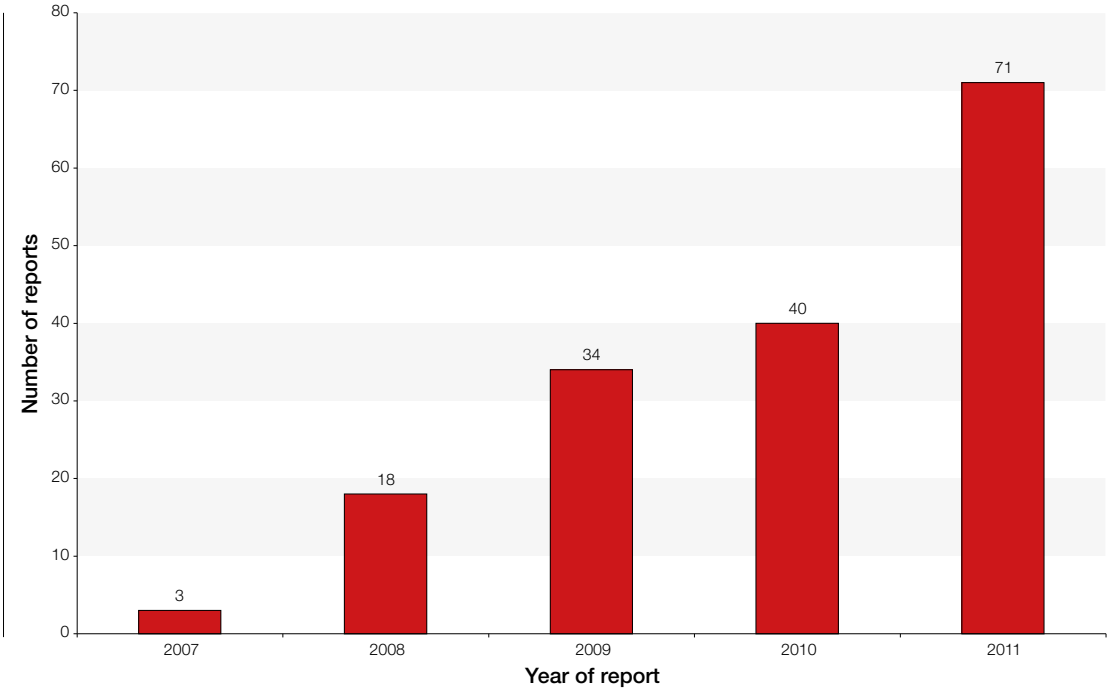
There were 26 males and 44 females. The age range was 15 days – 92 years, with 41/70 patients (58.6%) ≥70 years and 14/70 (20%) <50 years. There were 4 patients under 18 years (1 was a 17 year old male (2 reports), 1 was 7 years, 1 was 1 year; and 1, 15 days).

Table 16.1 TACO case probability

TACO case probability (ISBT criteria)*	Number of cases
Highly likely	16
Probable	14
Possible	41
TOTAL	**71**

** Cases where TACO was observed between 6 hours and 24 hours are also included*

Figure 16.1 Number of cases of TACO reported to SHOT each year



One further case of TACO this year is described in the I&U chapter (Case 1, Chapter 9).

Deaths n=2

TACO was possibly contributory to death (imputability 1), in two patients, both aged 72 years.

In addition, there was 1 fatal TACO case (imputability 3), described in the I&U chapter (Case 1, Chapter 9).

There were a further 4 deaths, where the reporter considered that the transfusion was possibly contributory to the reaction but unrelated to the death.

Major morbidity n=24

Twenty-four patients developed major morbidity; of these, 23 required intensive care or high dependency admission and/or ventilation, and 1 was admitted to the renal unit for emergency dialysis.

The remainder (n=45) experienced minor morbidity; of these, the majority were managed with oxygen and diuretic therapy.

Clinical details and transfused fluids in TACO cases

Thirty-two of the 70 patients (45.7%) were reported to have 1 or more concomitant medical conditions that increase the risk of TACO: cardiac failure, renal impairment, hypoalbuminaemia and fluid overload.

Complete details on fluid balance were supplied by the reporter in 10/71 (14.1%) of cases.

The median time between the transfusion and the onset of symptoms, where information was available, was 0-2 hours in 49.3% (35/71), 2-6 hours in 30.9% (22/71), and between 6-24 hours in 11.3% (8/71) of cases.

Case 1

TACO in an elderly patient with severe chronic iron deficiency anaemia

An 82 year old woman was admitted to hospital with chronic iron deficiency anaemia, Hb 4.5 g/dL. Four units of red cells were transfused, each over 2.5 hours. Following this she developed acute shortness of breath, her oxygen saturation dropped to 54% associated with pulmonary oedema. She had a tachycardia with a pulse rate of 110 bpm, and was hypertensive, blood pressure (BP) 200/99, with a subsequent fall in her BP the following day to 50/20. She was stated to be fluid overloaded. She required intubation and ventilation for 2 days in the intensive therapy unit (ITU). Her treatment post-transfusion included furosemide and noradrenaline. She made a full recovery.

Although this case was reported to have occurred within 12-24 hours of the transfusion (i.e. outside the standard definition), it was in other respects a typical and highly likely case of TACO.

Learning points

- The elderly are at high risk of transfusion-associated circulatory overload (TACO). Younger individuals are also at risk, particularly those with one or more concomitant risk factors for TACO: cardiac failure, renal impairment, hypoalbuminaemia and fluid overload. Pre-transfusion clinical assessment will identify patients at increased risk of TACO in whom measures can be taken to reduce the risk of developing this complication.
- Chronic iron deficiency anaemia should be identified before the Hb falls to critical levels and corrected with iron therapy, and the underlying cause established and treated.
- Cases of TACO are observed up to 24 hours after completion of transfusion. All patients having a blood transfusion should be monitored accordingly as advised in the British Committee for Standards in Haematology (BCSH) guidelines on blood administration[14].

Acute haemorrhage cases in which more than one component was transfused n=5

There were 5 cases of acute haemorrhage where more than 1 blood component was transfused. Red cells and fresh frozen plasma (FFP) were transfused in 2 cases of ruptured ectopic pregnancy; together with platelets in 1 case of massive obstetric haemorrhage; and in a fourth case, for massive haemorrhage following liver transplantation, when cryoprecipitate and platelets were also transfused. In the fifth case, FFP and cryoprecipitate were given for a second case of obstetric haemorrhage, detailed below.

Case 2

An unusual case of TACO - after cryoprecipitate and FFP for congenital hypodysfibrinogenaemia

A 36-year old woman with congenital hypodysfibrinogenaemia underwent emergency caesarean section because of failure to progress. The pre-operative fibrinogen was 1.4 g/dL. During the operation, she bled 1100mL; 295mL of this blood was salvaged, and returned to her. She was also given 2L of crystalloid, then 2 units of FFP (~500mL) and finally ~200mL of cryoprecipitate (1 adult dose). In recovery, she became hypoxic, pO2 84, and her blood pressure increased to 185/105. A chest X-ray showed bilateral pulmonary infiltrates. An echocardiogram showed normal cardiac function. She was then transferred to the ITU. She was noted to be oedematous and the central venous pressure (CVP) (post-furosemide) was 9cm H_2O.

This degree of fluid overload would not have been expected to have precipitated TACO in a fit 36 year old, however, it occurred in the presence of probable pre-eclampsia which is associated with pulmonary oedema. Her symptoms did not respond quickly to 100mg of furosemide, and she required ventilatory support for several days afterwards.

Learning point

- Individuals with congenital bleeding disorders undergoing procedures should be managed in a Haemophilia Centre[62].

Cases in which red cell transfusion was implicated n=58

Red cells were implicated in 58 cases and transfused in a further 7 cases where multiple components were transfused. In 48 cases red cells were transfused in the absence of suspected acute haemorrhage. In 46 of these 48 cases (i.e. in patients >18 years) TACO occurred after ≥3 units in 12 cases, after ≤2 units in 23, and after ≤1 unit in 11. In 71.7% (33/46) of these cases, patients were ≥70 years of age. The median duration of transfusion/RBC unit where red cells were transfused in the absence of suspected acute haemorrhage (in 33/46 cases where details were given) was 2.5 (range 1-6) hours. One patient developed possible TACO following red cell transfusion for obstetric haemorrhage.

Learning point

- Transfusion-associated circulatory overload (TACO) can occur after relatively small volumes of red cells, even 1 unit or less, particularly in patients at increased risk of developing TACO.

Cases in which FFP was transfused n=10 (some had multiple components)

There were 10 cases where FFP was transfused. Five are detailed above. In the remainder, 4 patients were given FFP to correct coagulopathy and 1 patient on warfarin was given FFP pre-procedure to correct a high International Normalised Ratio (INR).

Learning point

- Fresh frozen plasma (FFP) should not be used for warfarin reversal. The The British Committee for Standards in Haematology (BCSH) guidelines have, since 1990, recommended that prothrombin complex concentrate (PCC) is the treatment of choice for warfarin reversal when this is indicated[19].

Cases in which platelets were transfused n=6 (some had multiple components)

There were 6 cases where platelets were transfused, 2 pooled and 4 apheresis. Three platelet transfusions were given to patients with massive blood loss and 3 prophylactically: 1 in a patient with liver disease who had a platelet count of <20 x 10^9/L with additional risk factors for bleeding; 1 prior to an invasive procedure in a patient with pancytopenia; and 1 in a patient with post-transplant thrombocytopenia.

COMMENTARY

TACO remains an important cause of serious morbidity. This year TACO was implicated in 2 deaths (both imputability 1) and 24 cases of major morbidity, with these serious outcomes together comprising 36.6% (26/71) of cases analysed in the TACO chapter.

There was 1 further death related to TACO (imputability 3) described in the I&U chapter (Chapter 9).

Whilst the number of cases of TACO has increased from 40 in 2010 to 71 in 2011, TACO probably remains under-reported.

Elderly patients are particularly at risk of TACO with almost 60% of patients reported in 2011 ≥70 years. Younger individuals are also at risk of TACO particularly when there are 1 or more concomitant risk factors that increase the likelihood of TACO: cardiac failure, renal impairment, hypoalbuminaemia and fluid overload. Low body weight is also a risk for TACO and SHOT is now systematically collecting information on this.

It remains of concern that complete details on fluid balance were documented in only 10/71 (14.1%) of cases; and 9/57 (15.8%) of cases reported as TACO or transferred from the TAD or TRALI chapters where the questionnaires requested details of fluid balance.

Whilst the ‘4 hour rule’ for the duration of transfusion prevails[14 63], this is based on data relating to the ‘lag phase’ before bacteria begin to proliferate rather than clinical evidence. A recent systematic review concluded that available data make it difficult to draw significant conclusions, and that robust studies using multiple combinations of blood, anticoagulant, and additive solutions with defined temperatures

and times of exposure are required[47]. BCSH guidance on the clinical assessment of patients pre-transfusion and measures to reduce the risk of TACO, including the rate of transfusion in patients at high risk of TACO is awaited.

Notably, a small proportion of TACO cases (11.3%) continue to be observed between 6 and 24 hours emphasising the importance of vigilance to identify these cases so that affected patients can receive appropriate management.

In one case, FFP was given for warfarin reversal prior to a procedure. PCC is the product of choice for warfarin reversal and FFP[19] should not be used for this indication.
Five patients including Case 1, four of these aged ≥70 years, were given red cell transfusions for chronic iron deficiency anaemia. This has also been noted in the I&U chapter (Chapter 9). Chronic iron deficiency anaemia should be corrected with iron therapy and the underlying cause, almost always blood loss, established and treated.

One patient received FFP and cryoprecipitate for bleeding associated with congenital hypodysfibrinogenaemia. Patients with congenital bleeding disorders should be managed within a Haemophilia Centre[62].

Three further cases of TACO in patients with obstetric haemorrhage were reported this year, bringing these to a total of 10 cases reported since 2008, and highlighting that this complication does occur in these young individuals who are often regarded to be 'immune' to TACO. Contributory factors are difficulties in estimating actual blood loss, particularly because of the changing blood volume and circulatory capacity.

Of the 71 TACO cases analysed, 49 (69%) were reported as TACO, with the remainder transferred from several other categories. Data on these transferred TACO cases is inevitably incomplete due to the differences in the individual questionnaires. The new SHOT pulmonary questionnaire prompts collection of relevant information in all cases reported where respiratory distress is prominent. This will provide a common dataset, which will enable accurate categorization of pulmonary complications of transfusion.

Recommendations

- All measures must be taken to reduce the risk of transfusion-associated circulatory overload (TACO). These include pre-transfusion clinical assessment to identify patients at increased risk of TACO, in whom particular consideration should be given to the appropriateness of transfusion, the rate of transfusion and diuretic cover. Careful attention to fluid balance is essential and must be documented.

  Action: Transfusion practitioners, Hospital Transfusion Teams (HTTs), Hospital Transfusion Committees (HTCs)

- Prothrombin complex concentrate should be used for warfarin reversal in accordance with national guidelines[19], and should be immediately available in all Trusts/Hospitals/Health Boards.

  Action: HTTs, Hospital Transfusion Laboratory Managers

- Blood transfusion is not an appropriate treatment for iron deficiency and puts patients, particularly the elderly, at risk of TACO. Iron deficiency should be diagnosed and appropriately corrected with iron supplements, and the underlying cause established and treated.

  Action: General Practitioners, hospital doctors, Medical Schools, HTTs

For active recommendations from previous years and an update on their progress, please refer to the SHOT website

17. Transfusion-Associated Dyspnoea (TAD)

Author: Hannah Cohen

Definition

TAD is characterised by respiratory distress within 24 hours of transfusion that does not meet the criteria of transfusion related acute lung injury (TRALI), transfusion-associated circulatory overload (TACO) or allergic reaction. Respiratory distress should not be explained by the patient's underlying condition or any other known cause. This will allow haemovigilance systems to classify all reported pulmonary reactions without the need for exceptions or inappropriate assignment.

DATA SUMMARY
Total number of cases: 35

Implicated components		Mortality/morbidity	
Red cells	28	Deaths due to transfusion	0
FFP	2	Deaths *probably/likely* due to transfusion	0
Platelets	3	Deaths *possibly* due to transfusion	0
Multiple components	2	Major morbidity	3

Gender		Age		Emergency vs. routine and core hours vs. out of core hours		Where transfusion took place	
Male	12	≥ 18 years	34	Emergency	1	A&E	0
Female	23	16 years to <18 years	0	Urgent	7	Theatre	1
Not known	0	1 year to <16 years	1	Routine	27	ITU/NNU/HDU/Recovery	6
		>28 days to <1 year	0	Not known	0	Wards	27
		Birth to ≤28 days	0			Community	0
		Not known	0	In core hours	22	Outpatient/day unit	1
				Out of core hours	11	Not known	0
				Not known	2		

Thirteen reports of TAD were received; 2 more cases were transferred from the TACO section, 19 from the acute transfusion reaction (ATR) section and 1 from the TRALI section, resulting in a total of 35 cases, which are reported in this chapter.

Definition

Cases were assessed by the reviewer for probability of a diagnosis of TAD based on the International Society of Blood Transfusion (ISBT) definition[15]. A standardised definition, which is under review, will help haemovigilance organisations generate data that will be comparable at an international level.

Patients

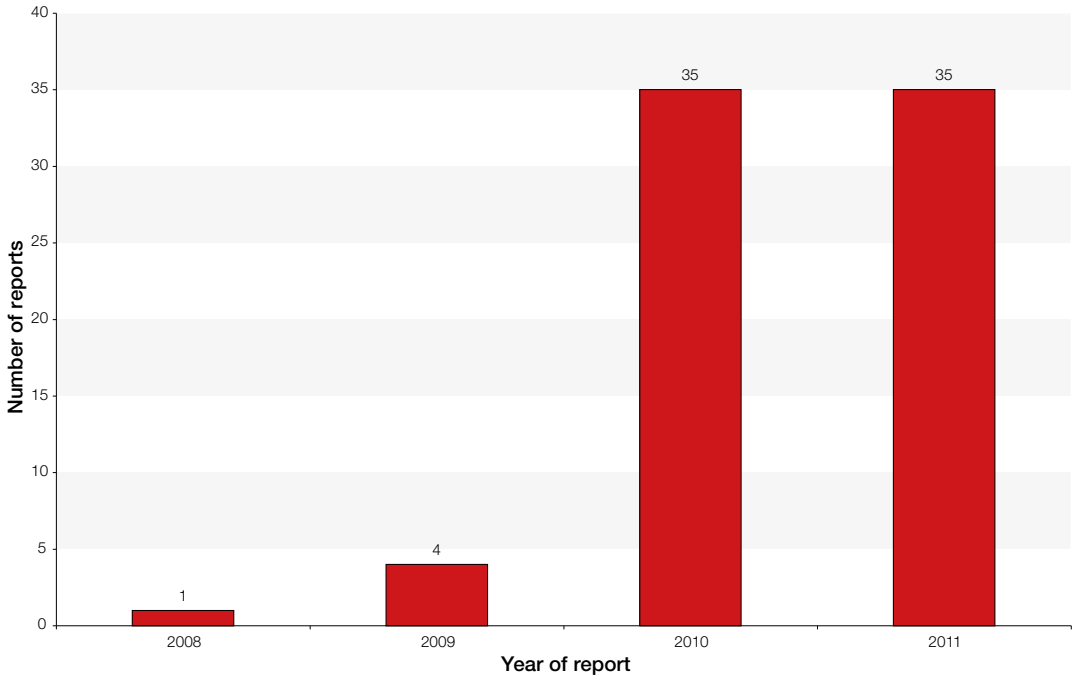
There were 12 males and 23 females. The age range was 6 years to 84 years. There was one patient <18 years, aged 6 years.

Table 17.1 TAD case probability based on ISBT criteria

TAD case probability (ISBT criteria)	Number of cases
Certain	0
Likely	6
Possible	24
Unlikely/excluded	3
Not assessable	2
TOTAL	**35**

Figure 17.1 Number of cases of TAD reported to SHOT each year*

* TAD was introduced as a SHOT reporting category in 2009.



The cases in this chapter are heterogeneous, with the unifying salient feature respiratory distress, although this condition is distinct from respiratory distress syndrome. TAD is a diagnosis of exclusion. Cases considered to be TAD may contain elements of TACO, TRALI or allergic reactions, but they do not meet the criteria for any of these. Cases designated as TAD should also not be explained by the patient's underlying condition or any other known cause, although these can be difficult to definitively exclude.

Deaths n=0

There were 7 deaths, all of which were considered to be unrelated to a transfusion reaction.

In 1 case the transfusion was likely to have been contributory to the reaction (Case 1 described below), in 4, the transfusion was possibly contributory to the reaction, in 1 unlikely and in the 7th, the contribution of the transfusion to the reaction was not assessable.

Case 1

A likely case of TAD

A 66-year old woman with connective tissue disease and under investigation for pyrexia of unknown origin developed respiratory distress 60 minutes (100mL) into a red blood cell (RBC) transfusion, with a drop in her oxygen saturation to the low 90%s. She had an associated transient bradycardia, pulse 56 beats per minute (bpm) with blood pressure (BP) 101/59, and hypothermia, nadir 33.6°C. The transfusion was stopped. A chest X-ray was clear and an electrocardiograph (ECG) showed sinus rhythm, pulse 89 bpm. The pO2 was low at 6.4 kPa with pCO2 4.5. She was given oxygen support and rewarmed with full resolution of her symptoms.

An initial diagnosis of TRALI was discounted, and there was no clinical evidence of haemolysis, fluid overload or allergic reaction. This reaction did not meet criteria for TRALI (absence of bilateral pulmonary infiltrates), TACO (absence of pulmonary oedema or fluid overload) or an immunological reaction, but did appear to be related to the transfusion, and therefore probably represents TAD, although her underlying condition could also have possibly been contributory to her signs and symptoms. The patient subsequently died and this was considered to be unrelated to the transfusion.

Major morbidity n=3

There were 3 cases of major morbidity related to TAD. One occurred following transfusion with multiple components for major obstetric haemorrhage. The second case was a patient with an inherited platelet function disorder who experienced a respiratory arrest following one of his regular platelet transfusions. He had previously collapsed following red cell transfusion and received chlorphenamine and hydrocortisone prior to red cells but not platelet transfusions. The advice from the Blood Service was to transfuse human leucocyte antigen (HLA)-matched platelets in platelet suspension media in the future. The third case of TAD (possible) associated with major morbidity is described below.

Case 2

A possible case of TAD

A 39-year old woman had an elective pancreatectomy and splenectomy for chronic pancreatitis. She was transfused red cells, platelets and fresh frozen plasma (FFP) intra-operatively for major haemorrhage. Packs were therefore left in situ and she was admitted to the intensive therapy unit (ITU). She was given FFP pre-operatively to correct coagulopathy prior to removal of the packs and wound closure. Sixteen hours post operatively she developed increased dyspnoea and wheezing, and was hypoxic, pO2 8 kPa, necessitating continuous positive airway pressure (CPAP). The chest X-ray appearances were in keeping with acute respiratory distress syndrome (ARDS), which can arise in the context of massive transfusion. Her respiratory symptoms resolved completely over 48 hours. The time course was not consistent with TRALI (defined as occurring within 6 hours of transfusion), so investigations for this were not instigated, and there was no evidence of TACO (absence of pulmonary oedema) or allergic reaction.

Learning point

Transfusion-associated respiratory distress can be related to transfusion-associated circulatory overload (TACO), transfusion related acute lung injury (TRALI), allergic reactions, the patients' underlying condition or other causes, with transfusion-associated dyspnoea (TAD) a diagnosis of exclusion. Assessment of cases of transfusion-associated respiratory distress should take this into account, and include assessment of oxygen saturation/arterial blood gases and chest X-ray appearances in all cases.

Implicated components

The majority of cases (85.7%; 30/35) were related to red cell transfusion. The platelets transfused were pooled in 2 cases and apheresis in 2 (1 HLA-matched to a patient with acute myeloid leukaemia). There was no preponderance of TAD associated with plasma-rich components.

Clinical features

All patients had respiratory distress. Twenty-four patients were reported to have developed one or more of the following: tachycardia (12), hypertension (7) and hypotension (8). Five patients were stated to have pyrexia with a temperature rise of >1.0°C and 1 had transient bradycardia and hypothermia (Case 1). Six patients were reported to have anxiety/agitation.

The reaction was stated to have occurred within 2 hours of the transfusion in 23/35 (65.7%) of cases and between 2-6 hours in 3 cases, during the transfusion in 4 cases and 12-24 hours after the transfusion in 1 case.

Information was supplied on oxygen saturation/arterial blood gases in 21/35 (60.0%) of cases and on chest X-ray appearances in 12/35 (34.3%).

COMMENTARY

This year the number of cases of TAD has remained static. Although 7 patients died, and in 5 of these cases the transfusion was considered to be contributory (likely in 1 and possibly in 4) to the reaction, the transfusion was not considered to be contributory to any of these 7 deaths. There were 3 cases of TAD-related major morbidity (8.6% of the total 35).

The majority of cases of TAD (approximately two-thirds) occurred within 2 hours after transfusion, however, as stated in the ISBT definition, TAD can occur up to 24 hours after transfusion and therefore patients require appropriate monitoring as recommended in the British Committee for Standards in Haematology (BCSH) guidelines on blood administration[14].

It is notable that of the 35 patients, all of whom had respiratory distress, information on oxygen saturation/blood gases was not supplied in approximately 40% of cases reported, and information on chest X-ray findings was not supplied in 65.7%.

Of the 35 cases of TAD analysed, only 13 were reported as TAD with the remainder transferred from other categories, mainly from ATR. A new SHOT pulmonary questionnaire was implemented in January 2011, to which reporters are directed if the predominant clinical feature is respiratory distress. Particularly as TAD is a diagnosis of exclusion, this questionnaire will provide relevant information, which will enable a more systematic delineation of the clinical and diagnostic characteristics of TAD, as well as other transfusion-related pulmonary complications. This in turn will provide a basis for a systematic approach toward the recognition, investigation and management of TAD.

One patient was given FFP to correct an International Normalised Ratio (INR) of I.4 in the out-patient department for a CT-guided lung biopsy. The need for plasma product for warfarin reversal in this situation is questionable and, in any case, prothrombin complex concentrate (PCC) is the treatment of choice for warfarin reversal[19] (see recommendations in the TACO chapter (Chapter 16)), with cessation of warfarin (with bridging anticoagulation with low molecular weight heparin if indicated) or vitamin K administration alone appropriate for non-emergency procedures.

Recommendations

- Reporters should continue to report all cases of transfusion-associated respiratory distress via the new SHOT pulmonary questionnaire. The information provided will enable accurate categorisation of transfusion-associated dyspnoea (TAD), which in turn will enable better recognition of this entity, and its appropriate investigation and management.

  Action: Hospital Transfusion Teams (HTTs)

Recommendations still active from previous years:

2010 – Assessment of all cases of respiratory distress associated with transfusion should include assessment of oxygen saturation/arterial blood gases and chest X-ray appearances.

For active recommendations from previous years and an update on their progress, please refer to the SHOT website

18.

Post-Transfusion Purpura (PTP)

Author: Catherine Chapman

Definition:

Post-transfusion purpura is defined as thrombocytopenia arising 5-12 days following transfusion of red cells associated with the presence in the patient of antibodies directed against the human platelet antigen (HPA) systems.

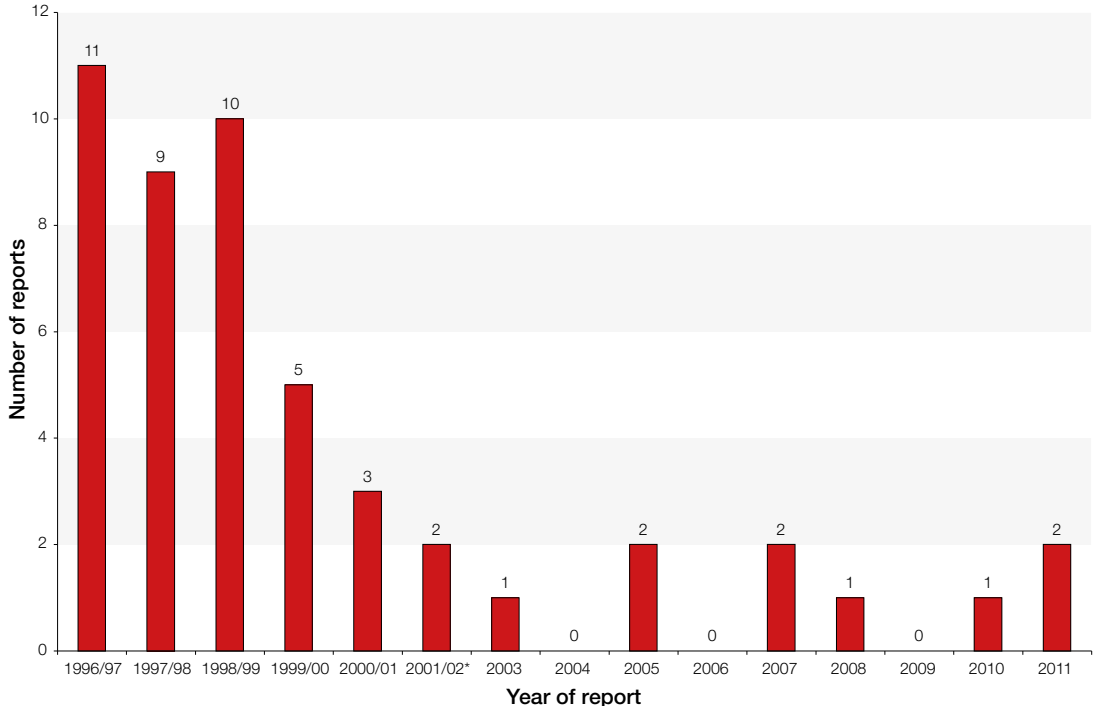
DATA SUMMARY Total number of cases: 2							
Implicated components				**Mortality/morbidity**			
Red cells			1	Deaths due to transfusion			0
FFP			0	Deaths in which reaction was implicated			0
Platelets			1	Major morbidity			1
				Potential for major morbidity			1
Gender		**Age**		**Emergency vs. routine and core hours vs. out of core hours**		**Where transfusion took place**	
Male	0	≥ 18 years	2	Emergency	0	ED	0
Female	2	16 years to <18 years	0	Urgent	2	Theatre	1
		1 year to <16 years	0	Routine	0	ITU/NNU/HDU/Recovery	0
		>28 days to <1 year	0			Wards	1
		Birth to ≤28 days	0	In core hours	0	Community	0
		Not known	0	Out of core hours	0	Outpatient/day unit	0
				Not known/applicable	2	Not known	0

Two cases have been included in this report and individual case reports are provided for these. Reports of five suspected cases were initially submitted this year but three were withdrawn; one was withdrawn because the clinical features were not consistent with a diagnosis of PTP and two were withdrawn because they had no evidence of HPA antibodies.

Cumulative data 1996 to 2011

Figure 18.1 shows the annual number of cases of PTP reported to SHOT with confirmed HPA alloantibodies since 1996, a total of 49 reports.

Figure 18.1 Number of cases of PTP reported to SHOT each year (HPA antibody positive)



Case 1

PTP followed by acute transfusion reaction (ATR)

A woman aged 68 had a coronary artery bypass graft (CABG) and was transfused with 4 red blood cell (RBC) units, 2 adult therapeutic doses (ATD) of platelets and fresh frozen plasma (FFP) in theatre. Her platelet count was 209x10^9/L preoperatively but began to drop soon after transfusion. On the third postoperative day her count was 46x10^9/L and she was transfused with platelets. On the 8th postoperative day her platelet count was 2x10^9/L; bruising was reported but no overt bleeding. She then received 2 pools of random donor platelets and developed symptoms of ATR (sweating, tachycardia and bronchospasm) which was treated with hydrocortisone and chlorphenamine; she was transferred to the high-dependency unit (HDU) as a precautionary measure. She was treated with intravenous immunoglobulin (IVIg) and prednisolone and made a full recovery. Her platelet count took 14 days to recover to >50x10^9/L and 18 days to >100x10^9/L. Platelet investigations identified HPA-1a alloantibodies. She had had two pregnancies with no history of neonatal thrombocytopenia and had not been previously transfused.

Case 2

Possible PTP

A fifty year old woman with alcoholic liver disease, cirrhosis and oesophageal varices was admitted with pneumonia and septic shock. Her platelet count was 25x10^9/L on admission and she was anaemic. She was treated with antibiotics including vancomycin and was transfused with 1 unit of red cells and 3 FFP on 11th and 2 ATD platelets on 13th. Her platelet count rose to 91x10^9/L by the 17th but on the following day her platelet count had dropped to 24x10^9/L and 1 ATD random donor platelets was transfused without increment. By the 19th her platelet count had dropped to 2x10^9/L and she developed skin bruising, epistaxis and oral blood blisters. Vancomycin was discontinued. She was treated with IVIg and HPA-matched platelets following which her platelet count rose to 27x10^9/L and it remained in the mid 20s for the rest of her admission. She had had 3 pregnancies 5-20 years previously; it was not known if any were affected by alloimmune thrombocytopenia. Platelet investigations identified HPA-5a alloantibody and multiple human leucocyte antigen (HLA) class I antibodies. A validated assay was not available to investigate the possibility of vancomycin-induced thrombocytopenia. A diagnosis of possible PTP was made but vancomycin-induced thrombocytopenia could not be excluded. She also had underlying thrombocytopenia relating to portal hypertension.

COMMENTARY

A sustained decrease in annual PTP case reports has been seen since the introduction of leucodepletion in late 1999. This is thought to relate to the removal of most platelets as well as leucocytes by leucodepletion filters. Both reports in this chapter followed transfusion of both red cells and platelets.

Analysis of cumulative data since 1996 has shown a total of 49 PTP cases.

Table 18.1 Cumulative PTP cases 1996 - 2011

Causative antibody	Number of cases
HPA-1a	32
HPA-1a in combination with other antibodies	5
Other antibodies (HPA-1b; -2b; -3a; 3b; -5a; -5b and 15a.)	12
Total	**49**

As shown in table 18.1, antibodies against HPA-1a are the most common cause of PTP, found in 75% either alone or in combination with other antibodies. Other HPA antibodies are shown above. Of these, HPA-1b and HPA-3a antibodies were found most frequently (5 cases each). HPA-5a and HPA-5b antibodies have each been associated with only 2 cases of PTP reported to SHOT.

Most cases occurred before the introduction of universal leucodepletion. Since then, 11 cases have been caused by HPA-1a antibodies alone, one case has been caused by HPA-1b, one by HPA-5b and this year's case implicating anti-HPA-5a antibodies.

Further information about PTP is available in Practical Transfusion Medicine[64].

Recommendations

There are no new recommendations.

Recommendations still active from previous years

- Clinicians are encouraged to contact Blood Services if they suspect PTP (for advice and to arrange for patient investigation at platelet reference laboratory as required).
- Clinicians need to maintain awareness of this rare but treatable complication of transfusion.

For active recommendations from previous years and an update on their progress, please refer to the SHOT website

19. Transfusion-Associated Graft Versus Host Disease (TA-GvHD)

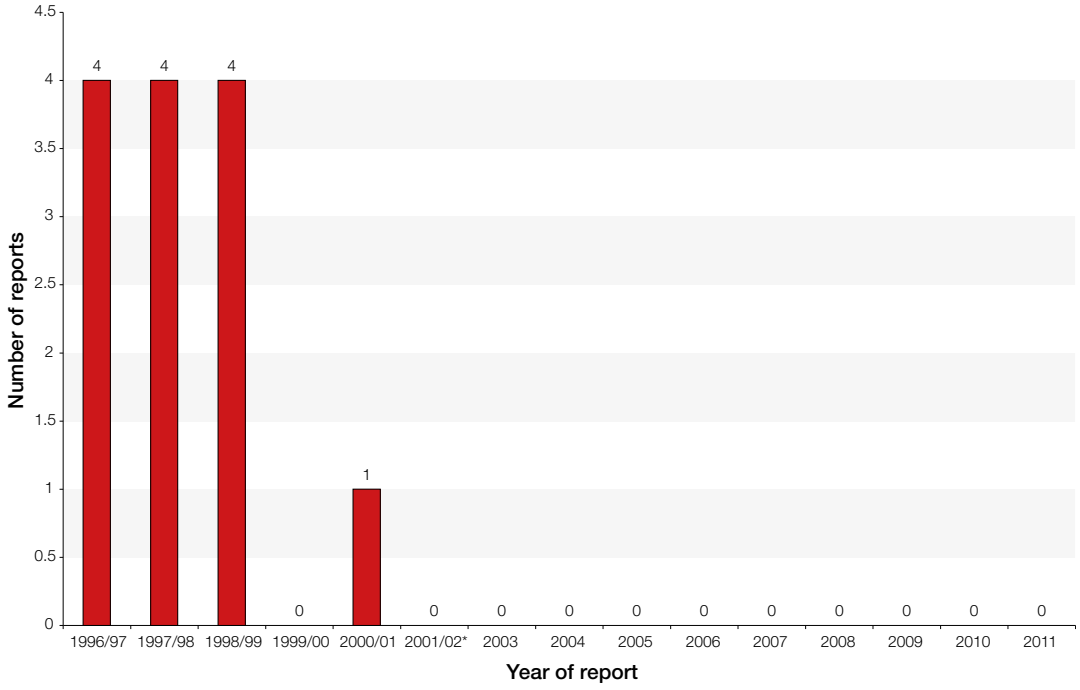
Author: Catherine Chapman

Definition:

Transfusion-associated graft versus host disease is a generally fatal immunological complication of transfusion practice, involving the engraftment and clonal expansion of viable donor lymphocytes, contained in blood components in a susceptible host. TA-GvHD is characterised by fever, rash, liver dysfunction, diarrhoea, pancytopenia and bone marrow hypoplasia occurring less than 30 days following transfusion. The diagnosis is usually supported by skin/bone marrow biopsy appearance and/or the identification of donor-derived cells, chromosomes or deoxyribonucleic acid (DNA) in the patient's blood and/or affected tissues.

No new case of TA-GvHD was reported in 2011.

Figure 19.1
Number of cases of TA-GvHD reported to SHOT each year



COMMENTARY

No report of TA-GvHD has been received during the last 10 years, despite reports of transfusion of non-irradiated blood to 780 patients at risk of TA-GvHD in the same period.

A total of 13 cases of TA-GvHD has been reported to SHOT since 1996 all of which were fatal. Only one case has occurred since the introduction of leucodepletion of all components except granulocytes/ buffy coats in late 1999. Two cases have occurred following transfusion of leucodepleted components (reported in years 1998-1999 and 2000-2001).

Although the risk of TA-GvHD is small it remains essential to comply with current British Committee for Standards in Haematology (BCSH) guidelines on the use of irradiated blood components and to irradiate blood components for all recipients who are at risk of this lethal complication[26].

Recommendations

There are no new recommendations.

For active recommendations from previous years and an update on their progress, please refer to the SHOT website

20. Transfusion-Transmitted Infection (TTI)

Author: Claire Reynolds

Definition

A report was classified as a transfusion-transmitted infection if, following investigation:

- **the recipient had evidence of infection following transfusion with blood components and there was no evidence of infection prior to transfusion and no evidence of an alternative source of infection;**

and, *either:*

- **at least one component received by the infected recipient was donated by a donor who had evidence of the same transmissible infection**

or:

- **at least one component received by the infected recipient was shown to contain the agent of infection.**

DATA SUMMARY Total number of cases: 0
There were no proven cases of TTIs reported in 2011

Reports of suspected TTIs

Most reports of suspected viral and bacterial TTIs are received and investigated by the UK Blood Services and then reported to the NHS Blood and Transplant (NHSBT)/Health Protection Agency (HPA) Epidemiology Unit. From here, data are included in the SHOT report. A number of reports are also received from the SHOT online reporting system and the Medicines and Healthcare products Regulatory Agency (MHRA)'s online reporting system for Serious Adverse Blood Reactions and Events (SABRE). Incidents are included for the year in which they were reported, even if the investigation is not yet complete, as the investigation into suspected viral TTIs can take several months.

During 2011, 41 suspected TTI incidents were reported by Blood Services and hospitals throughout the UK. Zero incidents were confirmed as TTIs according to the above definition. Twenty-eight bacterial incidents were concluded as not TTI (a further 77 investigations into reports of suspected bacterial incidents found no evidence of bacteria in either the recipient or the pack and were reclassified as possible transfusion reactions). Eleven investigations of viral infections concluded as not TTI, included 1 cytomegalovirus (CMV) incident, 1 hepatitis B virus (HBV), 6 hepatitis C virus (HCV), 1 hepatitis E virus (HEV) and 2 human immunodeficiency virus (HIV) incidents. One HBV incident reported in December 2011 is pending complete investigation.

There was 1 undetermined bacterial TTI investigation in 2011. A child was receiving an apheresis platelet transfusion due to a low platelet count. Towards the end of the transfusion the patient's blood pressure, pulse and temperature all dropped. Symptoms of breathlessness, nausea/vomiting and a rash also developed. The patient was not on any antibiotics at the time of the transfusion and was not given any as a result of the reaction. Patient blood cultures were not taken. The empty pack was returned to the Blood Service with one open unsealed port causing some leaking of the pack remnants. Nevertheless the pack was washed out with saline and *Lactococcus lactis ssp.lactis* was isolated. This organism, formerly known as *Streptococcus lactis*, is primarily associated with food and vegetation, although

it has been isolated from clinical specimens and blood cultures. It is also thought to form part of the normal flora of the alimentary tract. This case was difficult to conclude as although the recipient had had previous minor reactions following transfusions no confirmatory tests could be carried out due to lack of sample. However, it was unlikely to be a TTI. A second pack from this donation was transfused with no adverse reaction to a patient who was on antibiotics at the time of the transfusion.

Confirmed incidents

There were no confirmed TTIs reported in 2011.

Other incidents

Near miss

There were no near miss incidents reported in 2011.

Investigations reported as pending or undetermined in 2010

There were 6 investigations reported as pending in 2010 (1 CMV, 1 HBV, 2 HCV, 1 HIV and 1 bacterial case). All have been confirmed as not TTIs.

Cumulative data

Bacterial TTIs

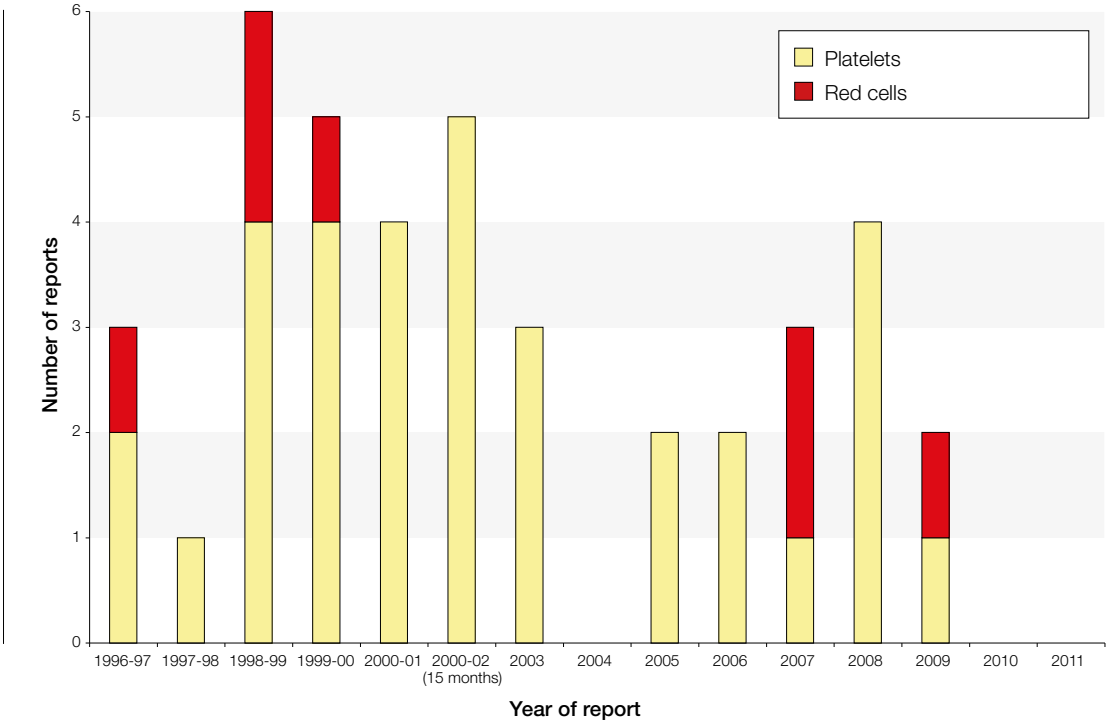
Since 1996, 40 bacterial TTI incidents have been confirmed, involving a total of 43 recipients (see Figure 20.1 and Table 20.1), 11 of whom died (death due to infection or in which transfusion reaction was implicated). A total of 33 incidents have related to the transfusion of platelets, whereas only 7 have related to the transfusion of red cells.

In Figure 20.1:

The histogram shows the number of incidents, not infected recipients identified. A total of 6 recipients were infected in 2008 and 3 in 2009.

In 2004 there was a further incident (not included in Figure 20.1) involving the contamination of a pooled platelet pack with *S. epidermidis*. This incident did not meet the TTI definition as transmission to the recipient, although likely, could not be confirmed.

Figure 20.1 Number of bacterial TTI incidents, by year of report and type of unit transfused (Scotland included from 10/1998)



Viral and parasitic TTIs

Since 1996, 22 confirmed incidents of transfusion-transmitted viral and parasitic infections have been reported, involving a total of 25 recipients (see Figure 20.2 and Table 20.1); 1 incident resulted in a fatal transfusion reaction (malarial transmission). There have been no confirmed transfusion-transmitted viral or parasitic infections in recent years – the last confirmed incident was in 2005. Three of the incidents were related to the transfusion of platelets, including the 2005 hepatitis A virus (HAV) incident, while the remaining 19 incidents were related to the transfusion of red cells.

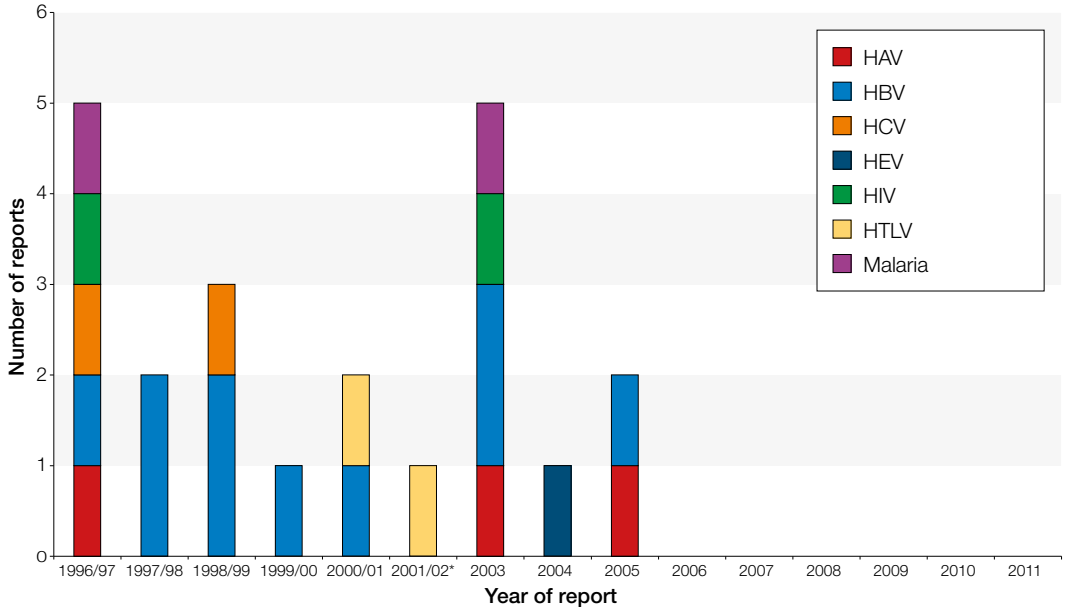
In Figure 20.2:

The year of transfusion may have been many years prior to the year in which the case is investigated and reported in SHOT because of the chronic nature of some viral infections. The figure shows the number of incidents, not infected recipients identified. For 1 incident in 1996–97 (HIV) and 1 in 1999–2000 (HBV), 3 and 2 recipients were identified, respectively.

The 2 HIV incidents were associated with anti-HIV negative/HIV ribonucleic acid (RNA) positive donations, i.e. window period donations. 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 Figure 20.2.

No screening was in place for the following TTIs at the time of transfusion: HAV, HEV and Human T-cell Lymphotropic Virus (HTLV).

Figure 20.2 Number of viral and parasitic TTI incidents, by year of report and infection type (Scotland included from 10/1998)



Variant Creutzfeld-Jakob Disease (vCJD)

There were no vCJD investigations in 2011.

To date there have been 4 transmissions of vCJD/prion infection via red cell transfusion from 3 donors. These donors later developed vCJD. Three of the 4 recipients developed clinical vCJD some years after transfusion; one donor was common to the second and third of these cases. In the fourth case, relating to a different donor, the recipient was found to have abnormal prion in tissues at post-mortem after dying of an unconnected condition. The cases reported were among a small group of recipients who were under active surveillance because they had received non-leucodepleted red blood cells (RBCs) between 1996 and 1999 from blood donors later diagnosed with vCJD. A small number of other cases have been investigated, where a blood transfusion recipient has developed clinical vCJD, but where none of the relevant donors has developed the disease. In these cases, it remains possible that one of the donors is a carrier, but unaffected, and would not be detected as infected in the absence of a blood screening test. These known "at risk" donors have been removed from the donor pool. Work to develop a test for vCJD is at a very early stage of development. The UK Blood Services are involved in the work to develop further a possible test. However, there is currently no screening test for vCJD available for use in blood donors.

Since 1997, the UK Blood Services have introduced a number of precautionary measures[65]:

- Leucodepletion of all blood components (1999).
- Use of methylene-blue virally inactivated fresh frozen plasma (FFP) (MB-FFP) obtained outside the UK for children born on or after 01/01/1996 (2002).
- Importation of plasma for fractionation (1998).
- Imported solvent detergent treated FFP (SD-FFP) for adult patients with TTP (2006).
- Exclusion of donors who have received a blood transfusion in the UK since 1980 (2004).

Table 20.1 Number of confirmed TTI incidents, infected recipients and outcomes (death, major morbidity, minor morbidity) in the UK between October 1996 and December 2011 (Scotland included from October 1998) NB No screening in place for the following TTIs at the time of transfusion: HAV, HEV, HTLV, vCJD/prion

Infection	Number of incidents	Number of infected recipients	Death due to, or contributed to, by TTI	Major morbidity	Minor morbidity
Bacteria	40	43	11	28	4
HAV	3	3	0	2	1
HBV	10	11	0	11	0
HCV	2	2	0	2	0
HEV	1	1	0	0	1
HIV	2	4	0	4	0
HTLV I	2	2	0	2	0
Malaria	2	2	1	1	0
Prion	1	1	0	1	0
vCJD	3	4	3	0	0
Total	**66**	**73**	**15**	**51**	**6**

COMMENTARY

2011 was the second consecutive year with no proven reports of TTI. This reflects the continuing high working standards and improvements based on the learning outcomes from previous investigations into contamination incidents. The investigation of possible TTIs forms part of the quality and governance framework.

There were no near miss incidents reported in 2011. In recent years near miss incidents, where staff noted visual abnormalities in the packs (usually platelets) and prevented their use, have occasionally occurred. It is thought that bacterial screening quickly detects fast-growing organisms thus pre-empting such near misses.

Bacterial screening for platelet donations was rolled out in NHSBT during 2011. The other UK Blood Services were already screening platelet donations for bacterial contamination. Bacterial screening is proving to be an additional effective risk reduction measure.

It should be noted that bacterial screening is unlikely to prevent all transmissions and the current high standards of collection, processing and vigilance should be maintained[66]. Strategies to reduce the bacterial contamination of blood components are under continual review.

One bacterial case in 2011 was undetermined partly because the pack had not been sealed before being sent to the Blood Services for testing therefore environmental contamination could not be ruled out. There was also insufficient material for confirmatory testing. Other investigations not described here were compromised because of possible contamination during local sampling of the pack post-transfusion. Attention should be paid to the sampling and storage of implicated units or their residues to avoid contamination of the pack.

The numbers of suspected and proven viral TTIs are much smaller than for bacterial TTIs. The current estimated risks of transmission of HBV, HCV, and HIV via blood transfusion are low (0.94 per million donations for HBV, 0.01 per million for HCV, and 0.16 for HIV)[67].

One report in 2011 involved a multi-transfused immunosuppressed recipient who developed chronic HEV infection. Investigation of implicated blood donors revealed no evidence that any donor could have been the source of infection. There has been one proven case of HEV transmission by red cells in 2004, which was detected by lookback when the donor reported hepatitis following blood donation. The platelet recipient did not become infected. Although more work is required, it is becoming apparent that HEV infection is more common in the UK than previously believed[68], and that HEV infection can lead to chronic liver disease in immunosuppressed individuals, therefore HEV could be more important as a TTI than previously thought.

Box 20.1: Initiating an investigation into a suspected TTI

Guidance on initiating an investigation and the required reporting forms for suspected transfusion-transmitted infections (TTIs) for hospitals served by NHSBT can be found on the Requests for Investigation of Adverse Events & Reactions page at http://www.blood.co.uk/hospitals/library/request_forms/aer/

For other Blood Services please contact the local blood supply centre.

Reporting a suspected bacterial TTI

If bacterial contamination is suspected, please report the incident to the Blood Service as soon as possible in order to facilitate the return of implicated packs and the recall of any associated units.

Do not sample the pack locally unless clinically indicated. The Blood Services provide comprehensive bacterial testing and where isolates are available from the recipient will arrange typing of strains.

If no bacteria are detected in recipient or pack, the reporter should either amend or place an initial report to SHOT based on findings of the investigations so that the transfusion reaction can be classified in another hazard category eg ATR.

Reporting a suspected viral or non-bacterial TTI

If viral or non-bacterial contamination is suspected please report to the Blood Service. Investigations by NHSBT will not be initiated without completed notification forms.

Before reporting, staff should attempt to ensure that the infection is confirmed and was not present prior to the transfusion.

As the number of TTIs is so low, other identified possible sources of infection should be investigated without waiting for the outcome of the Blood Service investigation.

Recommendations

There are no new recommendations. The 2010 recommendations are still active.

For active recommendations from previous years and an update on their progress, please refer to the SHOT website

21. Cell Salvage and Autologous Transfusion (CS)

Author: Joan Jones

Definition:

Any adverse event or reaction associated with autologous transfusion including intraoperative and postoperative cell salvage (washed or unwashed), acute normovolaemic haemodilution or pre-operative autologous donation.

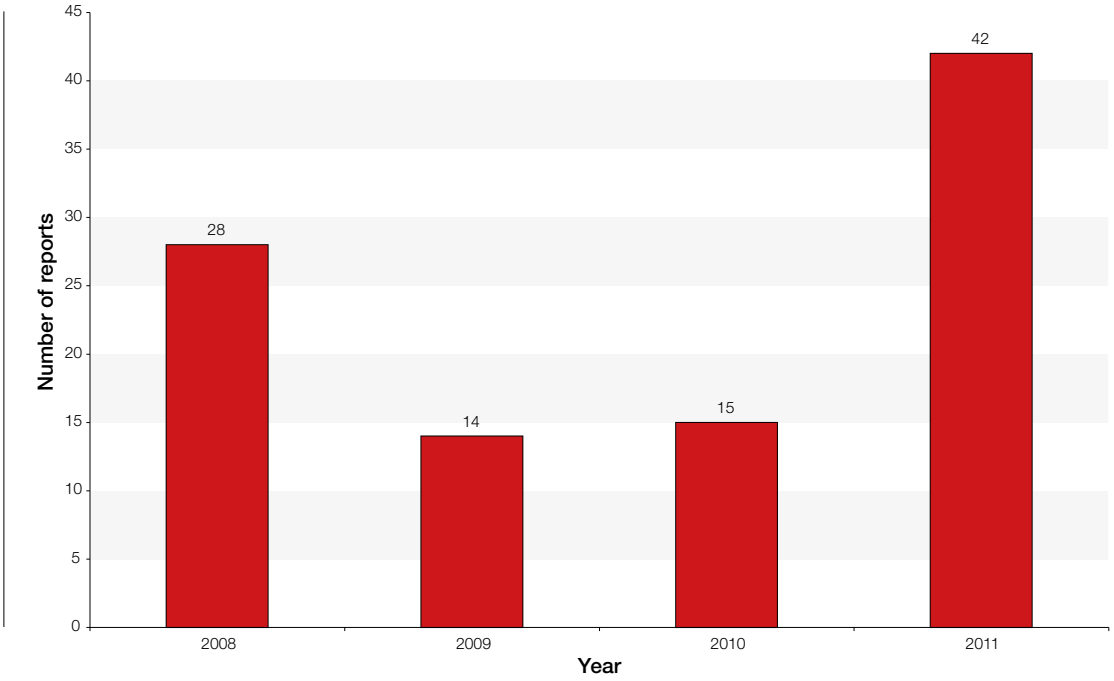
DATA SUMMARY - CELL SALVAGE
Total number of cases: 42

Implicated components		Mortality/morbidity	
Red cells	42	Deaths *probably/likely* due to transfusion	0
FFP	0	Deaths *possibly* due to transfusion	0
Platelets	0	Major morbidity	0
Other (granulocyte)	0		
Unknown	0		

Gender		Age		Emergency vs. routine and core hours vs. out of core hours		Where transfusion took place	
Male	24	≥ 18 years	40	Emergency	5	A&E	0
Female	16	16 years to <18 years	0	Routine	37	Theatre	0
Not known	2	1 year to <16 years	0	Not known	0	ITU/NNU/HDU/Recovery	0
		>28 days to <1 year	0			Wards	0
		Birth to ≤28 days	0	In core hours	29	Community	0
		Not known	2	Out of core hours	11	Outpatient/day unit	0
				Not known	2	Not known	42

There were 42 cell salvage reports (intraoperative and postoperative) submitted this year. There were none submitted related to adverse events whilst undertaking acute normovolaemic haemodilution (ANH) or preoperative autologous donation (PAD). Both these techniques are rarely undertaken and their use not routinely recommended. The 42 reports were submitted by 22 different Trusts/Health Boards. The increased numbers submitted this year probably reflect the increased awareness of the requirement to report to SHOT.

Figure 21.1
Autologous adverse events



Adverse events by type of autologous transfusion

Post operative cell salvage (PCS) – 25, intraoperative cell salvage (ICS) - 17, Combined - 0

Adverse events by specialty

Orthopaedic - 28, Obstetrics – 5, Urology – 2, Cardiac – 2, Gynaecology -1, General surgery – 2 and Vascular surgery – 2

Incidents

Postoperative Cell Salvage (PCS) n=25

In this category the following reports were filed:

- 8 reactions with varying reports of rigors, dyspnoea, hypertensive episodes and feeling unwell.
- 8 equipment not assembled correctly
- 7 paperwork not completed correctly - this included information on patient identification and/or time of collection
- 2 other

Case 1

Air in the reinfusion line

A patient was admitted for total knee replacement. Following the procedure the patient went to the intensive therapy unit (ITU). The patient had a cell salvage autologous drain in-situ. The nurse in ITU had received no training in the use of these drains or how to reinfuse red cells from them. The nurse continued and reinfused the blood from the drain but did not retro-prime the line. He/she then decided to put the salvaged blood through a pressure bag which is contra-indicated. At the end of the infusion the member of staff noticed air had been infused into the patient. The patient became very unwell and subsequently had a cerebrovascular accident (CVA).

Based on the report, this is probably not a major morbidity due to cell salvage and the CVA was not related to the transfusion.

Learning points

- Only staff who have been trained and shown to be competent in using cell salvage equipment should administer red cells collected by autologous equipment.
- Regardless of the component being transfused staff need to be vigilant to avoid air in the giving set.

Intraoperative cell salvage (ICS)

Events of varying clinical severity were reported. These included 2 febrile reactions and 6 adverse events, all of which had an element of hypotension, but only one that had a serious adverse reaction. The remainder were classed as minor morbidity. There were 9 events reported to be related to equipment or operator error.

Table 21.1 Hypotensive reactions and use of leucodepletion filter (LDF)

Cases	Gender	Age	Clinical specialty	Anticoagulant
1	F	28	Gynaecology	ACD
2	F	32	Obstetrics	ACD
3	F	24	Obstetrics	Heparin
4	F	NS	Urology	NS
5	F	38	Obstetrics	ACD
6	F	39	Obstetrics	ACD

This report again identifies hypotensive reactions associated with LDF when re-infusing cell-salvaged red cells. However for the first time this year there is a hypotensive reaction involving ICS use with LDF when heparin was used as the anticoagulant. Only one of these hypotensive events resulted in a clinical reaction requiring ITU admission. Anaphylaxis was suspected at the time but serum mast cell tryptase was negative suggesting the hypotension may have been secondary to the infusion of cell-saved blood again via a LDF. In one of the other cases the hypotension was reported but on removal of the filter a further 1.5 litres of cell saved blood was infused without problem. In all cases a full recovery was made with no long-term morbidity.

This phenomenon had been acknowledged and noted in the Association of Anaesthetists Great Britain and Ireland (AAGBI) cell salvage guideline and in the Medicines and Healthcare products Regulatory Agency (MHRA) “one liner”[69]. (This is a news sheet aimed at healthcare professionals, which highlights problems with the use of medical devices[70]). There is as yet no further evidence to show whether these events are actually related to the use of the filter.

It is important that hypotension with the use of a leucodepletion filter is recognised as a possible adverse event and may be treated by discontinuation of the infusion of the salvaged red cells and appropriate vasopressors.

Learning point

- Monitoring of patients is as important for the reinfusion of red cells collected by intraoperative cell salvage (ICS) or postoperative cell salvage (PCS) as it is for allogeneic red cells.

A case involving ICS is commented on in the Inappropriate, Unnecessary or Under/Delayed Transfusion (I&U) chapter (Case 2 Chapter 9). During the operation 3279mL of salvaged blood were reinfused (equivalent to approximately 13 units) to the patient, in addition to 18 units of allogeneic blood, 8 units of fresh frozen plasma, 3 units of platelets and 2 units (one therapeutic dose) of cryoprecipitate were given. The post-operative Hb showed a haemoglobin result of 19.1g/dL and deranged coagulation results.

Learning point

- Intraoperative cell salvaged red cells and allogeneic red cells have no associated coagulation factors and it is absolutely essential to monitor haemoglobin and coagulation tests and to replace coagulation factors in these massive blood loss cases.

COMMENTARY

There have been several cases reported this year where the autologous blood has not been labelled with the correct patient identification. In some cases this has been noted by staff in the clinical area prior to reinfusion but not always. Patient identification is critical step in any clinical intervention and patients undergoing autologous transfusion must have the red cells for reinfusion fully labelled with the appropriate patient identification and other necessary information.

Learning point

- Maintaining the correct patient identification is a critical point in the process.

Recommendations

- All intraoperative cell salvage (ICS) and postoperative cell salvage (PCS) related adverse events and reactions should be reported to SHOT. Hospital Transfusion Teams (HTT) should develop a process to ensure all these events are reported to SHOT.
- Training and competency for cell salvage operators should be in place in all organisations where cell salvage is undertaken.
- Replacement of coagulation factors is essential when reinfusing large volumes of salvaged red cells.
- The use of the UK Cell Salvage Action Group label is recommended for both ICS and PCS red cells for reinfusion allowing all necessary patient information and collection information to be documented[71] (These labels are supplied by the manufacturers of both intra and postoperative systems).

  Action: HTTs, Cell Salvage Teams; Anaesthetists

For active recommendations from previous years and an update on their progress, please refer to the SHOT website

Special Clinical Groups

Page	Chapter
138	**22.** Paediatric Cases - *Helen New*
147	**23.** Transfusion Complications in Patients with Haemoglobin Disorders - *Paula Bolton-Maggs*

22.

Paediatric Cases

Author: Helen New

Definition

Paediatric cases comprise all those occurring in patients under 18 years of age.

Paediatric cases 2011

This chapter analyses the data on paediatric cases from the other chapters in this annual report. All the cases are also included in the data in their respective chapters apart from the two reports of 'previously uncategorised complication of transfusion' (PUCT). All children < 18 years of age are included and have been subdivided by age groups: neonates ≤ 28 days; infants > 4 weeks and < 1 year old; and children < 16 years - because each of these has recommendations regarding blood components.

Table 22.1 Summary of paediatric cases 2011

Category of case	No ≤28 days	No >28 days to <1 year	No 1 to <16 years	No 16 to <18 years	Total paediatric cases
IBCT (total)	**7**	**4**	**17**	**2**	**30**
IBCT WCT	6	2	6	1	15
IBCT WCT Clinical	*2*	*0*	*2*	*0*	*4*
IBCT WCT Laboratory	*4*	*2*	*4*	*1*	*11*
SRNM (total)	1	2	11	1	15
Irradiated	*1*	*1*	*4*		*6*
CMV negative			*3*		*3*
Irradiated and CMV negative			*1*		*1*
MB-FFP		*1*	*2*		*3*
Others			*1*	*1*	*2*
I&U	**2**	**3**	**3**	**3**	**11**
HSE	**4**	**5**	**5**	**0**	**14**
Anti-D related	**0**	**0**	**2**	**3**	**5**
ATR	**3**	**2**	**37**	**6**	**48**
HTR/DSTR	**0**	**0**	**2**	**0**	**2**
TRALI	**0**	**0**	**0**	**1**	**1**
TACO	**1**	**0**	**2**	**2**	**5**
TAD	**0**	**0**	**1**	**0**	**1**
PUCT	**0**	**2**	**0**	**0**	**2**
TOTAL	**17**	**16**	**69**	**17**	**119**
NM	**29**	**11**	**39**	**10**	**89**
RBRP	**4**	**4**	**3**	**0**	**11**

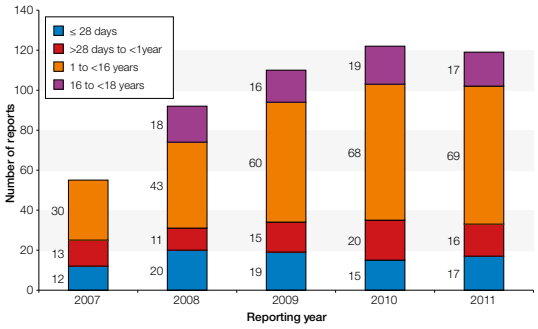
Note: There were no paediatric cases of IBCT-WBIT, PTP, TA-GVHD, TTI or CS, so these are omitted from table. Near Miss and RBRP numbers are shown separately as they are not included in the overall reporting figures. MB: Methylene-blue treated

Introduction and overall trends

This year histograms are included to demonstrate some of the trends in paediatric reports from 2007-11 (Figure 22.1 a to d). Overall numbers of reports steadily increased from 2007-2010 but have reached a plateau since then. The increase in reports was largely due to a sharp rise in the number of acute transfusion reaction (ATR) reports, in parallel with the rise in total ATR reports. Paediatric ATRs are largely due to red cells and platelets, and there has been a steady increase in the number of febrile reactions since 2007. There has been less variation in numbers in other reporting categories and the number of special requirements not met (SRNM), a significant category of paediatric reports, has slightly decreased for irradiation/cytomegalovirus (CMV) negative reports. It is difficult to relate the reports to numbers of transfusions as there is little specific paediatric issues data. However, the stabilisation of overall numbers may indicate that current reporting rates are more representative of actual significant errors and events related to paediatric transfusion than in the past.

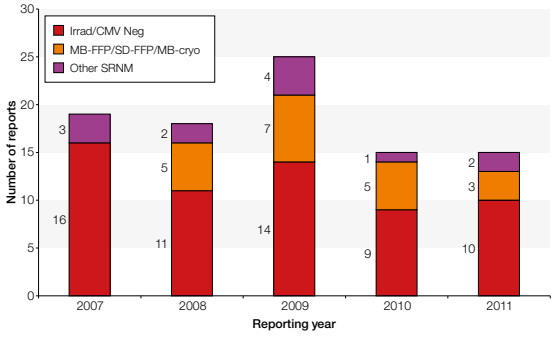
Figure 22.1 Trends in paediatric reports 2007-2011

a. Total numbers of paediatric reports

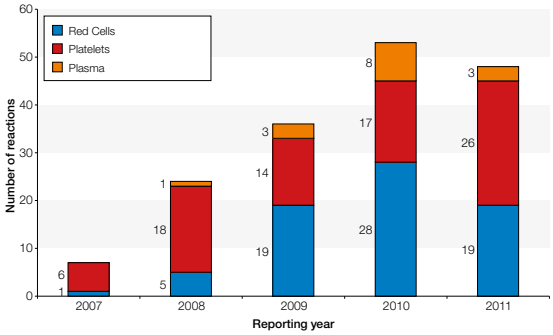


Note: in 2007 only cases < 16 years were included

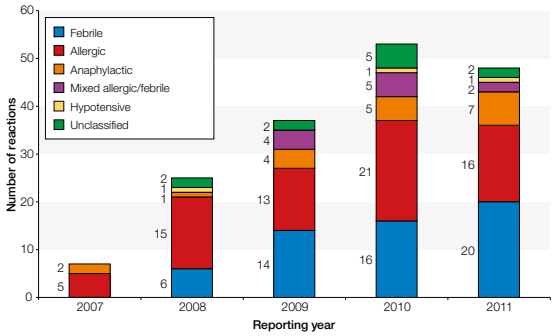
b. Paediatric SRNM reports



c. Paediatric ATR reports by component type



d. Paediatric ATR reports by reaction type

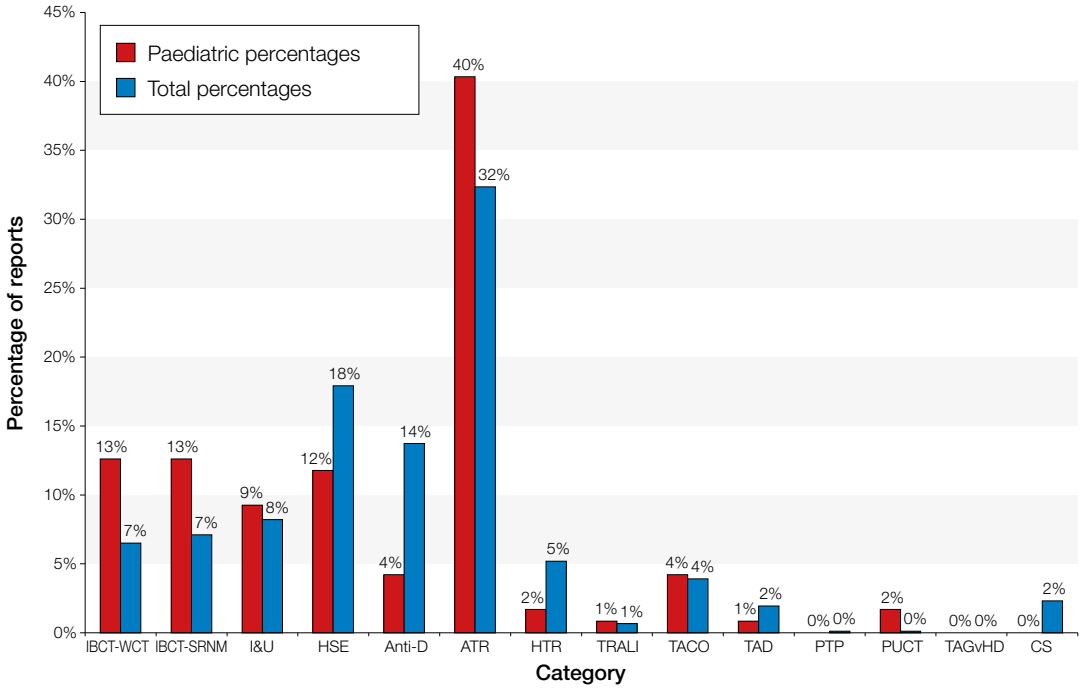


Note: 2008 anaphylactic reaction previously described as severe allergic

For 2011, paediatric reports were 119/1815(6.6%) of total SHOT reports, down compared to the last 3 years, from 8.8% in 2008, 8.6% in 2009 and 8.3% in 2010. If near miss (NM) and right blood right patient (RBRP) cases are included, paediatric reports were 219/3054 (7.2%). The number of paediatric reports is almost identical to last year, with a similar pattern of reports from different categories and age groups (Table 22.1, Figure 22.2). 50% (60/119) of paediatric reports were error-related (incorrect blood component transfused (IBCT), handling and storage errors (HSE), inappropriate, unnecessary or under/delayed (I&U) and anti-D), and errors were 73% (24/33) of reports in infants < 1 year. A total of 25/60 (42%) of paediatric errors originated primarily from the laboratory (21 IBCT, 2 HSE, 1 I&U, 1 anti-D), down from 32 in 2010. Laboratory errors were 21% (25/119) of all paediatric reports, compared to 26% in 2010. IBCT reports are twice the proportion of paediatric reports compared to SHOT reports as a whole (25% vs 14%), emphasising the importance of this category of errors in paediatric transfusion. ATR numbers were slightly down but reports of reactions to platelets had increased and were 55% of paediatric ATR (32% in 2010). Paediatric 'near miss' reports were significantly increased compared with 2010, probably due to changes in reporting patterns.

There were four paediatric deaths following transfusion, but only one was thought by the reporter to be possibly related to the transfusion, a neonate who developed necrotising enterocolitis (NEC), and causality is uncertain. There were 15 paediatric cases of major morbidity following transfusion, (10 ATR, 3 transfusion-associated circulatory overload (TACO), 1 transfusion related acute lung injury (TRALI), 1 PUCT).

Figure 22.2 Percentages of paediatric and total reports in each category (% numbers have been corrected to the nearest whole number)



Error-related reports n=60

Incorrect blood component transfused (IBCT) n=30

IBCT – Wrong component transfused (WCT) n=15

IBCT WCT – clinical n=4

There were 4 WCT reports resulting from predominantly clinical error. Two were for neonates of which one was transfused with adult emergency O RhD negative blood and another was given platelets when the staff had been intending to transfuse fresh frozen plasma (FFP).

Case 1

Baby given adult emergency O RhD negative blood

A preterm baby with hydrops fetalis required emergency transfusion following delivery. The baby was given adult emergency O RhD negative blood despite crossmatched blood being available within the maternity unit refrigerator following prior request by the obstetricians. The staff member who removed the emergency O RhD negative unit did this despite being told by a midwife that crossmatched blood was available. The baby died, unrelated to the transfusion.

A 2 year old who subsequently died was given red cells intended for her mother due to an error over identification of the different 'unknown females' in Accident and Emergency (A&E) following a major road traffic accident. A 14 year old after haemopoietic stem cell transplant (HSCT) was given RhD positive platelets despite having become RhD negative post-transplant when seen on a non-haematology ward and a new, incomplete, special requirements form was sent to the laboratory.

IBCT WCT - laboratory error n=11

There were 4 neonatal reports, three related to errors in neonatal and maternal grouping and antibody screening. For one, the mother had immune anti-D and a set of paedipacks was crossmatched against the mother, but a non-crossmatched set was issued. For 2 others, blood was issued with inadequate checking of maternal samples. Finally, there was incorrect recording of which packs of platelets were transfused to twins with neonatal alloimmune thrombocytopenia (NAITP). In the older age group, there were two reports where blood was inappropriately issued by electronic issue (EI): to an 8 month old following editing of a control well result on ABO grouping, and to a 9 year-old where it was overlooked that the patient had received a HSCT. There were 5 reports of RhD positive red cells being given to RhD negative recipients; 2 were females who were subsequently given anti-D Ig, with one of these having been incorrectly grouped using manual techniques. The other 3 were to male haematology/oncology patients.

IBCT- special requirements not met (SRNM) n=15

The number of SRNM reports was identical to 2010. Five were categorised as clinical error and 10 as laboratory. Non-irradiated components were erroneously given to 7 patients although there were no adverse consequences, and CMV negative to 4 (one with additional failure to irradiate). Two were given non-irradiated red cells post intrauterine transfusion (IUT) at approximately 3-4 weeks of age, one due to failure to notify the laboratory of an IUT at another hospital, and the other due to a laboratory failure to flag the requirement for irradiated blood post IUT. There were 4 other reports where clinicians either mistakenly informed the laboratory that irradiated or CMV negative components were no longer required or failed initially to request it, and 4 where the laboratory issued the incorrect component.

There were 3 cases where the laboratory did not issue MB-FFP to children <16 years, (from 2012 to be defined as those born after 1 January 1996) and 2 where the blood of an inappropriate phenotype was given including a K positive unit to a 17 year old female.

Inappropriate, unnecessary or under/delayed transfusion (I&U) n=11

The majority of paediatric I&U reports were not related to the recipients being paediatric. However, there were 3 cases of over-transfusion demonstrating poor paediatric prescription or administration. A neonate with bleeding was prescribed an incorrect volume of platelets, and two infants were overtransfused with red cells. For one infant the pump was set at too fast a rate for the first hour due an incorrect prescription of '1 unit'. For the other, a nurse gave the entire 200 mL volume of the red cell bag rather than the 100 mL prescribed due to thinking that red cell units are issued containing the requested transfusion volume.

There were 2 cases of delayed or under-transfusion. One was an under-transfusion of platelets to a 3 year old due to the issue of the incorrect volume. The second was a delayed urgent red cell transfusion for a symptomatic 16 year old with liver failure due to a misunderstanding by the night staff who left the transfusion for the morning shift.

Case 2

Confusion over platelet components

Platelets were requested for 3 year old child with thrombocytopenia post HSCT. Laboratory staff mistakenly ordered neonatal platelets and the bag supplied contained only 40mL despite the child having been prescribed 300mL. Platelets were transfused to the child and further platelets were ordered and administered the following day.

There were 6 cases where transfusions were given unnecessarily, due to poor communication or a lack of haematological advice. For 4, transfusions were given on the basis of the wrong result or where the transfusion had already been given. An 8 year old undergoing a laparotomy in theatre was transfused on the basis of an oxygen saturation result of '90' on a blood gas sample being misread as the Hb result (in fact '140'). An infant received a second transfusion of platelets because they were prescribed without checking first.

Case 3

Failure to check before prescribing that transfusion was indicated

A 2 month old baby on the neonatal intensive care unit (NICU) required platelets prior to surgery and the order for platelets was made twice. Following the first transfusion transfusion laboratory staff noticed the next day that platelets were still available but due to expire at midnight so informed the ward. This triggered staff to get the platelets to the ward on the assumption that they were required. On arrival the junior doctor was asked to prescribe the platelets. The infusion was discontinued when a senior doctor subsequently noticed that the baby was receiving platelets that were not required.

For 2 cases, the decision to transfuse was subsequently considered incorrect. Despite a local trigger of 11g/dL, a 16 year old with Diamond Blackfan Anaemia (congenital red cell aplasia) was transfused at a Hb of 12.2 g/dL in order not to waste the unit. A 17 year old with platelets of $66x10^9$/L and menorrhagia but no major bleeding was admitted and transfused platelets on the medical admissions unit, highlighted as inappropriate by haematological review for possible ITP the next day.

Handling and storage errors (HSE) n=14

The majority of HSE reports (10) were due to cold chain errors, 1 where the neonatal refrigerator was out of temperature range, and 9 where blood was out of controlled storage for longer than recommended in the British Committee for Standards in Haematology (BCSH) guidelines. 7 of these were due to slow red cell administration and 2 were due to a delay in setting up the transfusion. In one case a unit red cells was transfused to a child despite having been out of the blood refrigerator for 6 hours and having been set aside and marked as “out of cold chain” on the ward.

The other 4 cases were as follows:

Case 4

Slow transfusion due to incorrect administration set

Two hours after commencing a transfusion for a baby it was noted that only 2mL had been administered via the pump instead of the expected 14mL. The pump was replaced and the transfusion was recommenced. The transfusion finally finished after a total of 6.25 hrs. Later it was discovered that the pump malfunction was caused by using the wrong administration set.

There was 1 report of excessively rapid transfusion where a 6 month infant was transfused 41 mL over 20 minutes instead of 2 hrs due to an error setting the pump rate on a ward busy with many emergency admissions. In 2 reports expired units were transfused in theatre. 1 was of an infant undergoing cardiac surgery given FFP thawed for another patient 4 days earlier, and the other was of expired red cells transfused to 1 year old undergoing urgent neurosurgery; the red cells had not been recalled by the laboratory.

Anti-D Ig-related events n=5

The 5 cases were aged 15-17 where either the anti-D Ig was omitted or was given outside the 72 hr time limit. There was no clear indication that missing the anti-D Ig was related to young age.

Transfusion reactions n=59

Acute transfusion reactions (ATR) n=48

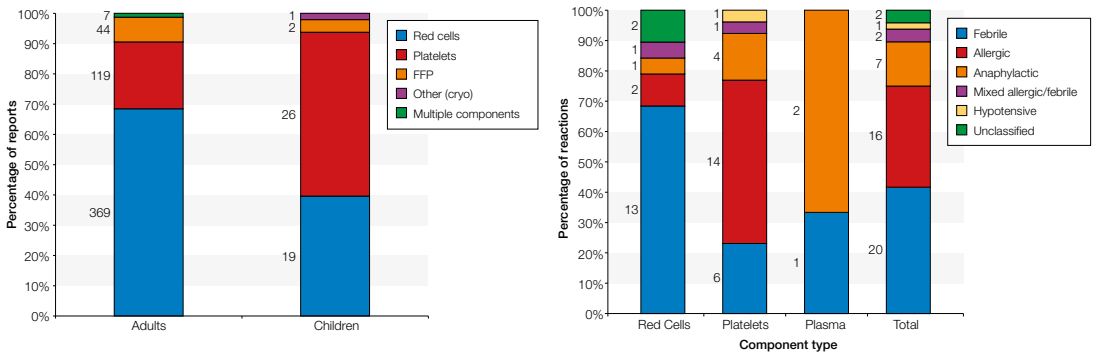
The number of paediatric ATR reports has fallen slightly to 48 from 53 in 2010. This is due to a reduction in the number of reactions to red cells and plasma (see Figure 22.1c). The number of platelet reactions increased from 17 to 26, which is 54% of paediatric ATRs (mostly to apheresis platelets) but although numbers of platelet reactions have fluctuated since 2007, they have represented a significant proportion of paediatric ATRs in all Annual SHOT Reports since 2007 when paediatric cases were first analysed separately. In 2011 only 1 reaction, a mild febrile reaction, was to MB-FFP, and there was an anaphylactic reaction to solvent-detergent FFP.

Paediatric ATRs are 8% (48/587) of all ATRs, but the pattern of reports to different components differs from that in adults (see Figure 22.3), with paediatric platelet ATR comprising 18% of all ATR to platelets, and a higher proportion of adult ATRs being to red cells.

Figure 22.3 Paediatric ATR reports

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

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



As in previous years, most paediatric ATR were in the age group ≥ 1 year, with only 5/48 (10%) in infants <1 year, including 3 neonates. Neonatal reactions may be more difficult to recognise; one became febrile following FFP, another had an anaphylactic reaction to red cells following cardiac surgery with a rash and hypotension, and a third developed cardiorespiratory failure during red cell transfusion although the imputability was low.

The ATRs were classified as described in Chapter 13. Of the 46 that could be classified, 10 (22%) were severe, 21 (46%) were moderate, and 15 (33%) were mild. In all cases the patients recovered. There were 7 anaphylactic reactions in total (15% paediatric ATR), 1 following red cells to a neonate, 4 following platelets (1 pooled, 3 apheresis) to haematology/oncology patients aged 1-16 years, 1 following SD-FFP to an infant with a coagulation factor deficiency, and 1 following non-MB pooled cryoprecipitate transfused to a 14 year-old undergoing a spinal fusion. Anaphylaxis was reported in a higher proportion of events for paediatrics than for total ATR (33/587, 6%). The majority of paediatric red cell reports were febrile reactions, although febrile reactions occurred for all component types, whereas the majority of platelet reports were allergic.

Case 5

Severe reaction to solvent detergent-treated plasma (SD-FFP)

A male infant with a congenital coagulation deficiency received SD-FFP to treat a cerebral bleed, and experienced a severe anaphylactic reaction within 30 minutes of starting the transfusion, with tachycardia, hypoxia and hypotension. He required intubation and was given adrenaline. He was subsequently given MB-FFP to treat the continuing bleeding problems. On one occasion, his oxygen saturation dropped again, but otherwise he experienced no problems and he continues to receive MB-FFP without problems. Investigations for the cause of anaphylaxis proved negative.

From the reasons given by reporters at least 22/26 of the platelet transfusions, including all those with severe reactions, were given as prophylaxis for low counts rather than treatment of bleeding. Twelve of these were stated to be transfused to keep platelets >20 rather than >10 so these may have been patients with higher levels of intercurrent illness. Most ATRs related to platelet transfusions (23/26 recipients) occurred in patients under haematology/oncology care.

Table 22.2 Type of reaction for each component for paediatric reports (classified as in ATR Chapter 13)

Reaction	Red cells	Platelets	Plasma	Total
Febrile	13	6	1 (FFP)	20
Allergic	2	14	0	16
Anaphylactic	1	4	2 (1 SD-FFP, 1 Cryo)	7
Mixed febrile and allergic	1	1	0	2
Hypotensive	0	1	0	1
Unclassified	2	0	0	2
Total	**19**	**26**	**3**	**48**

HTR and alloimmunisation n=2

There no reports of paediatric HTR but there were 2 reports of alloimmunisation alone from patients aged 6 and 7 years with no evidence of haemolysis (see HTR Chapter 14). In one case Kp^a antibodies were detected 15 days post transfusion, and for the other, anti-Cw, anti-e, and anti-C were detected at 46 days. Neither were patients with haemoglobinopathies: one had chronic anaemia with 'pancytopenia' and one was transfused post chemotherapy for a glioma.

TRALI n=1

There was one report in a 16 year-old with respiratory deterioration post FFP. However, following investigation it was felt unlikely to be TRALI (see Chapter 15).

TACO n=5

There were 5 paediatric reports classed as TACO for the first time in 2011, with ages ranging from a neonate to 17 years. These involved 4 patients as one suffered two separate episodes.

Case 6

Transfusion given too fast

A 15 day old neonate on PICU was erroneously transfused with 53 mL red cells over 15 minutes rather than 4 hrs due to setting the infusion pump at an incorrect rate following an incorrect prescription. The baby required furosemide for mild circulatory overload.

A 1 year-old child became hypoxic after HSCT with evidence of pulmonary oedema on a chest x-ray during the first 2 hours post transfusion of '1 unit' of platelets over 1 hr and 156 mL blood over 2-3 hrs. A 7 year old transfused with a unit of red cells following major orthopaedic surgery desaturated 20 hrs later, requiring intubation and ventilation. A chest x-ray was suggestive of pulmonary oedema but the patient was hypotensive and also treated with fluids and inotropes, illustrating the difficulty in diagnosing TACO in complex cases. There were two separate reports from a 17 year old ventilated with acute renal failure. In the first episode acute respiratory deterioration followed crystalloid infusion followed by a cardiac arrest after transfusion of FFP. On the second occasion there was sudden respiratory deterioration following a 2 unit red cell transfusion and during a 1 unit platelet transfusion.

The last 2 reports illustrate how transfusion can destabilise patients who are already extremely unwell, and the event in the 1 year old illustrates the need for care over prescribing large volumes of blood components to small children.

TAD n=1

There was one report classified as TAD in a 6 year old with sickle cell disease whose oxygen saturation dropped from 99% to 93% 35 minutes into a red cell transfusion, although the child remained clinically well.

Post-transfusion purpura (PTP), transfusion-associated graft vs host disease (TA-GvHD), transfusion-transmitted infection (TTI), cell salvage and autologous transfusion (CS) n=0

There were no paediatric cases in these categories.

Previously Uncategorised Complications of Transfusion (PUCT) n=2

This year for the first time there were 2 cases with necrotising enterocolitis (NEC) possibly associated with red cell transfusion in 5-6 week old preterm infants. One died, and the other had major morbidity, requiring ventilation and bowel surgery. In one case, the abdominal symptoms commenced during the transfusion, and in the other several hours post-transfusion.

Case 7

Necrotising enterocolitis post transfusion

A clinically stable non-ventilated 6 week old preterm infant, born at 26 weeks gestation, was given a red cell transfusion for symptomatic anaemia of prematurity (Hb 9.3 g/dL). There were no adverse events during the transfusion, and the post Hb was 16.7 g/dL. 4.5 hrs post transfusion the baby developed tachycardia, and over the next 12 hours deteriorated and developed a distended abdomen. An X-ray was consistent with NEC, the baby continued to deteriorate and died at approximately 36 hrs post-transfusion.

This is an area of interest and concern for neonatologists. Several retrospective studies have reported an association between red blood cell transfusions and subsequent necrotising enterocolitis (NEC) in neonates occurring up to 48 hrs post transfusion, particularly in preterm babies who develop NEC at around 3-5 weeks of age[72]. It has been suggested that transfusion-associated NEC could have parallels with TRALI[73]. However, the pathogenesis of transfusion-associated NEC is not clear, and prospective studies are required to further investigate a causal relationship.

Near miss events n=89

Near miss reports increased significantly from 41 in 2010 to 89 in 2011. Forty events occurred in infants < 1 year, and included 5 where there was WBIT or incorrect labelling due to confusion between twins. Three neonates had maternal details on the sample tube, and in other 2 cases correct procedures for neonatal blood grouping and antibody screens were not followed in the laboratory. Most of the other cases were not specifically paediatric related (see Chapter 25 for further discussion).

Right Blood Right Patient events n=11

Two of the RBRP cases affecting infants <1 year old involved misallocation/mislabelling of multiple split packs, FFP in one case and red cells in the other.

COMMENTARY AND LEARNING POINTS

- The number of paediatric reports is stable since 2010, and the number of laboratory errors has shown a slight decrease.
- Many of the paediatric reports highlight the same issues as in previous years, including use of adult emergency O RhD negative blood for neonates, laboratory errors in neonatal and maternal grouping and antibody screening, failure to recognise the need for irradiated components post IUT, and prescription and administration errors leading to either overtransfusion or the incorrect rate of transfusion.
- Poor communication and lack of checking were significant features of the I&U cases with poor clinical understanding of the transfusion process in paediatrics, including the need to administer a specific volume in mL based on body weight rather than in ‘units’.
- Neonatal components were associated with errors either from confusion over the volume being incorrect for the age/weight of the child, or with different split units being mislabelled or assigned to the wrong patient.
- Children were reported to have suffered transfusion-associated circulatory overload for the first time, illustrating the importance of prescribing the correct volume and rate for small infants and children.
- There were two reports of NEC associated with transfusion, but without further evidence of a causal association it is difficult to assign imputability beyond ‘possible’ for these. Prospective studies are needed to further investigate this association. SHOT requests that hospitals continue to report cases of possible transfusion-associated NEC in order to provide more representative information on the nature and extent of this possible reaction in the UK. There has been some suggestion that the age of red cells transfused may be important, and it would be helpful to have this information in any reports.
- There continue to be a significant proportion of ATRs following paediatric platelet transfusion, including 4 anaphylactic reactions. As the majority of the platelet transfusions were reported as given for prophylaxis rather than bleeding, this emphasises the need to ensure that prophylactic platelet transfusions are given according to guidelines, particularly as the recent National Comparative audit of platelet transfusions in haematology[74] found that many prophylactic platelet transfusions were inappropriate.

Recommendations

- A significant number of paediatric acute transfusion reactions (ATRs) followed prophylactic platelet transfusions; this underlines that it is important to ensure that prophylactic platelets are given according to guidelines[43].

  Action: Hospital Transfusion Teams (HTTs), clinical users of blood

- Paediatric ATRs where there are severe allergic reactions should be investigated in conjunction with allergy specialists (British Committee for Standards in Haematology (BCSH) ATR guidelines in preparation)[13].

  Action HTTs and haematologists

- SHOT requests that hospitals continue to report cases of possible transfusion-associated necrotising enterocolitis (NEC) in order to provide more representative information on the nature and extent of this possible reaction in the UK.

  Action: HTTs and clinical users of blood

For active recommendations from previous years and an update on their progress, please refer to the SHOT website

23. Transfusion Complications in Patients with Haemoglobin Disorders

Author: Paula Bolton-Maggs

This year we have decided to include a section focussing on reported events in patients with haemoglobinopathies. These conditions present particular issues for patients and both clinical and laboratory staff. The role of transfusion in sickle cell disease (SCD) is increasing[75] particularly in the management or prevention of stroke[76] but is not without problems. People with haemoglobin disorders are at risk of death or serious harm in relation to transfusion, from transfusion reactions and in the long-term from iron overload.

There were 26 reports of adverse events (or near miss events) in patients with haemoglobin disorders in 2011 and 19 (70%) relate to patients with sickling disorders (Table 23.1). The patient numbers reported here have all been included in the relevant chapters by category.

The median age of this group of patients is 28 years, (range 1 to 50, only 4 over 40 and 4 under 10 years of age) considerably younger than the median (61 years) of all patients reported to SHOT in 2011.

As with other complications of transfusion reported to SHOT, some are potentially preventable by better communication while others are unpredictable. Multi-transfused individuals are at increased risk of both acute transfusion reactions and alloimmunisation which can make repeated transfusion increasingly difficult. Patients with SCD have a particularly high risk of alloimmunisation which is inadvertently increased when clinical teams fail to inform the laboratory of the diagnosis, and in the absence of historical records the patients may not receive appropriately selected phenotyped red cells.

Alloimmunisation and unexpected falls in haemoglobin, possibly associated with hyperhaemolytic transfusion reactions (HHTR) in SCD are recurring problems in SHOT reports.

Table 23.1 Adverse events for patients with haemoglobin disorders 2010 and 2011 by category of report (numbers for 2011 included in the appropriate chapters of this report)

Adverse event category	Sickle cell disease		Beta thalassaemia		Outcomes
	2010	2011	2010	2011	
ATR	4	3	6	3	Minor morbidity
HTR*	4	5	0	0	1 death, 5 major morbidity
TACO	0	1	0	0	Major morbidity
TAD	0	1	0	0	
I and U	0	1	0	0	
SRNM	3	6	0	2	Alloimmunisation
HSE	0	0	1	2	
NM	2	2	0	0	
Total	**13**	**19**	**7**	**7**	

**There was also one adult with HbH disease who was admitted 10 days after transfusion (2010) with signs of delayed haemolysis in whom 2 new antibodies were identified, anti-E and anti-Lu^b.*

One additional patient with beta thalassaemia major is included in right blood right patient (RBRP) (but not added to this table) because crossmatch labels were transposed on two blood bags.

The majority of events (excluding near miss and RBRP) are acute or haemolytic transfusion reactions in SCD (62% events in SCD), with fewer events in regularly transfused patients with beta thalassaemia major. Failure to provide red cells with appropriate requirements is responsible for another 27% of cases (7/26) in SCD.

Transfusion reactions are relatively common in this group of patients with haemoglobinopathies, and all patients should be carefully monitored during transfusion. The UK Thalassaemia Society recommend that a nurse is in continuous attendance throughout the transfusion whether during the day or night for thalassaemia patients[77].

Alloimmunisation is common in SCD and less common in thalassaemia. The risk can be reduced by avoiding unnecessary transfusions in SCD patients.

Delayed Transfusion Reactions

Case 1

Immune haemolysis in a shared care patient with sickle cell disease

A patient with known sickle cell disease was admitted to the Acute Stroke Unit, and an exchange transfusion was arranged for the next morning at the nearest specialist centre. A crossmatch sample was taken at the first hospital using the NHS number and dispatched urgently for testing and crossmatching at the specialist centre. The admitting hospital had a record of anti-E, which was confirmed by the specialist centre on testing. The patient was discharged 3 days later, but was admitted to a third hospital 9 days after the transfusion with falling Hb and increased bilirubin. The new crossmatch was incompatible and samples were referred to the Blood Service reference laboratory. The patient had an historical record at the 3rd hospital on an old hospital number that needed merging. The historical record confirmed the anti-E but also listed an anti-Jk^b and anti-S. The patient's Hb fell to 3.8g/dL from 11.0g/dL at discharge, suggesting that all of the transfused blood was destroyed and/or there was an element of hyperhaemolysis.

The reference laboratory confirmed the presence of the anti-Jk^b and anti-S in the eluate from the patient confirming the clinical picture of a delayed transfusion reaction.

Case 2

Transfusion reaction – with possible HHTR

A patient with sickle cell disease presented with shortness of breath, tachycardia, back pain, nausea and vomiting, and haemoglobinuria, 7 days post an 8-unit exchange transfusion. The bilirubin peaked at 216 micromol/L, and the creatinine rose to 181 micromol/L. Samples were referred to a red cell reference laboratory, where weak auto anti-D, and weak allo anti-C and anti-Fy^a were identified in the plasma using a gel card technique. All transfused units were RhC-, Fy(a-), and although the direct antiglobulin test (DAT) was positive, the eluate was non-reactive. The cause of this reaction is unclear, but the patient subsequently suffered another similar episode following transfusion and this may be another case of hyperhaemolysis.

Case 3

Hyperhaemolytic transfusion reaction

A patient with sickle cell disease presented 2 days post-exchange transfusion with a drop in haemoglobin from 7.2 to 5.2 g/dL as well as pain, dark urine, dysuria, scleral jaundice and an increased bilirubin. No antibodies were detected and the DAT was negative. The patient was diagnosed with hyperhaemolysis and treated with immunoglobulin and methylprednisolone. However the Hb was reported to have fallen to 2.8 g/dL 6 days later and 3 further units of red cells were transfused.

HHTR is an uncommon but important complication of transfusion where both donor and recipient red cells are haemolysed resulting in severe and sometimes life-threatening anaemia. The pathophysiology is not well defined and under debate[78]. This complication resulted in the death of a child aged 10 years in 2010[12], and for 3 cases of major morbidity in 2011. The following cases demonstrate that it may complicate other transfusion reactions.

Case 4

Possible immune haemolysis

A patient with sickle cell disease and known anti-E plus a very rare CR1 (Knops) related antibody with Hb of 6.8 g/dL was transfused 4 units red cells over 2 days, having previously been transfused 12 days earlier. She was discharged with an Hb of 10.0 g/dL. She was readmitted 6 days later with fever, nausea, haemoglobinuria and an Hb of 3.3 g/dL. Samples were sent to the reference laboratory, where the DAT was found to be negative but anti-Fy^a was identified in the plasma. The patient

received 3 units of red cells but became more pyrexial during the third unit and the transfusion was stopped. The DAT was now weakly positive but no antibodies were detected in the eluate. The patient was subsequently diagnosed with parvovirus.

The fall in Hb is likely to be due to a mixture of hyperhaemolysis exacerbated by parvovirus-induced reduction in red cell production, but additional immune haemolysis due to anti-Fy^a cannot be ruled out.

Identification of special requirements to prevent adverse events

It is important that patients with haemoglobinopathies are properly identified to the laboratory so that their special requirements can be met. Mistakes occur when clinicians fail to include the correct diagnosis on the request form, and where patients present to a different hospital, or where patients have been transferred without access to important historical records. Antibodies may be undetectable but recur after stimulation by transfusion of inappropriate units leading to delayed transfusion reactions which can be severe.

Case 5

Failure to provide phenotyped red cells results in HTR

A patient with SCD was admitted 7 days after transfusion with symptoms suggestive of HTR. The antibody screen showed 5 different alloantibodies. She had been transfused at a different hospital where the diagnosis of SCD was not communicated to the laboratory, so that the 3 units transfused were not phenotyped.

Case 6

Preventable alloimmunisation

A young woman was transfused with two units in January on the basis of a verbal request. She was usually seen at another hospital for her SCD which was not communicated to the laboratory. In May she required further transfusion and this time the diagnosis was included on the request form. She had developed anti-E; retrospective assessment confirmed that one of the units transfused in January was RhE positive.

Case 7

Risk (preventable) of alloimmunisation

A young woman of childbearing age with SCD was admitted to a general medical ward with anaemia, Hb 6.0 g/dL. She was transfused without the laboratory being informed that she had SCD and therefore she did not receive appropriately phenotyped red cells.

Case 8

Care transferred between hospitals without information about historical transfusion records.

A young woman with SCD was transferred between hospitals. At the previous hospital there was a historical record of anti-Fy3 which was not noted in the transfer information. This antibody was not detected in a new sample. In addition, flags were not put on her record to prevent electronic issue.

One case of transfusion-associated cardiac overload was reported; a woman aged 50 years which is below the median age for transfusion-associated circulatory overload (TACO) where the majority of patients are over 70 years of age.

Case 9

TACO

A 50 year old woman with sickle cell disease was admitted in sickle crisis with Hb 2.8 g/dL. She was transfused at a rate of 140 mL/hr. During the 2nd unit she developed chest pain and respiratory distress with SaO_2 of 56% in air with gross pulmonary oedema on the chest X ray. She was transferred from a haematology ward to the intensive therapy unit (ITU) and ventilated, and made a full recovery. There was no history of cardiac disease.

The cases presented above illustrate the many hazards associated with transfusion in people with haemoglobin disorders. It is important that transfusions are only given when really indicated, and that a haematologist is involved with all transfusion decisions.

Case 10

Inappropriate and unnecessary transfusion

An 18 year old man with SCD was admitted with a sickling crisis and was unnecessarily transfused a unit of red cells. The Accident and Emergency (A&E) clinicians and the biomedical scientist (BMS) were not aware of the guidance that all potential transfusions in SCD should be referred to a haematologist.

COMMENTARY

There is a need for better training and awareness about medical issues associated with sickle cell disease. The reported alloimmunisation rate in SCD is 18-36% and rises with the number of red cell exposures, to 57% of those who have received more than 200 transfusions. This risk is considerably reduced by using full phenotyping. K, C and E antigen matching should be the minimum standard.[79] Recent molecular work has identified a significant incidence of RhC and RhE variants in people of African origin which may contribute to the risks of immunisation[80]. Alloimmunisation seems to predispose to the development of further antibodies including autoantibodies, so it is important that due care is taken to prevent this occurring. People with SCD are at increased risk of alloimmunisation and the reasons are not understood[81]. Patients with SCD who have been multiply transfused often have several irregular antibodies and it may be difficult to find compatible units. Haemolytic transfusion reactions are unpleasant and dangerous; some are preventable by appropriate choice of red cells but others are not. In a small study from France, 8 children who experienced delayed haemolytic transfusion reactions experienced serious symptoms requiring admission to intensive care, but alloantibodies were only identified in 2 of the children[82].

As noted in previous SHOT reports it is important to consider a diagnosis of a delayed haemolytic transfusion reaction, and possibly also HHTR when a patient presents about 1 to 2 weeks after transfusion. Further transfusion in a patient with HHTR may lead to increased haemolysis and even death as in the case described in the 2010 report whose initial event was a 1-unit transfusion prior to tonsillectomy[12]. The differential diagnosis for HHTR is delayed antibody-induced haemolysis (DHTR), and both may be present, but in HHTR alloantibodies are not found. The pathology of this condition is debated[78 83]. There is some evidence that haemolysis may be related to macrophage activity[84]. Recently this syndrome has been reported in people with other underlying haematological disorders[83 85 86]. Treatment is with steroids and intravenous immunoglobulin[87]. Patients who present with increased haemolysis and symptoms may also be misdiagnosed as having a sickle crisis (case 8 in the HTR chapter, 2010 report[12]). Both HHTR and DHTR must be considered in patients with SCD who present with a 'crisis' within 14 days of transfusion[12]. Patients may have more than a single pathology at a time such as a combination of HHTR and immune haemolysis (case 1 above).

Standards and guidelines from other organisations:

Standards have been published for adults with Sickle Cell Disease (SCD) in the UK[88] and also for children[89]. These standards should be followed. More individuals with sickle cell disease are now being started on long-term transfusion regimens for primary and secondary stroke prevention[90]. Patients started on long-term transfusion regimens in SCD should be monitored for iron overload. Recommendations have also been made for thalassaemia care[77]. These and the British Committee for Standards in Haematology (BCSH) compatibility testing guidelines[37] include the following recommendations:

a) All SCD patients must have their ABO group and full red cell phenotype at the first opportunity regardless of the severity of their SCD. This should include C, c, E, e, K, k, Jk^a, Jk^b, Fy^a, Fy^b, S, s. If S-negative and s-negative, then U typing should be performed. Full phenotyping should be performed prior to transfusion in patients with thalassaemia.

b) Red cell units should be ABO compatible and also matched for RhD, C, E, c, e, and K to minimise alloimmunisation. R_o blood should be selected for patients who are R_o if available, otherwise rr. Units for patients with thalassaemia should be similarly matched and units should be at least Rh and K compatible.

c) Donor red cells should be HbS negative* and preferably <14 days old for top-up transfusions, and less than 7 days old for exchange transfusion. There is recently published evidence that the use of red

cells less than 14 days old for regular transfusion in thalassaemia increases the transfusion interval and may have longer term benefits with reduced iron loading[91].

d) The transfusion laboratory [blood bank] must keep an accurate and detailed transfusion history of every SCD patient that has contact with the hospital. The transfusion laboratory must always carry out its own test on patients who have transferred their care from another hospital if there is any doubt about the validity of the results from the other hospital.

e) A card bearing details of the full red cell phenotype and all previously detected alloantibodies must be issued to the patient.

**Although these are national guidelines, at present Wales and Scotland blood services do not screen for HbS, because the incidence of HbS positive is considered so rare in those regions that screening is deemed unnecessary*.

Antibody cards

Antibody cards can be an important source of information for these and other patients who develop irregular antibodies, and should be carried by the patients and shown to medical staff. Antibody cards should be presented to patients at a face to face meeting (and not simply by mail) where a full explanation can be made, supported by written information, ensuring that the patient understands the importance of showing the card to medical staff in future so that this information can be transmitted to the transfusion laboratory, especially important where patients visit different hospitals. This patient education role is best undertaken by haematologists or transfusion practitioners. However people with haemoglobin disorders may have several cards, one for the haemoglobin disorder, one giving details of their red cell phenotype, and a third detailing any alloantibodies. Clearly this needs some rationalisation.

A further issue is that many medical and nursing staff do not understand what the cards signify nor their importance. With the lack of understanding there is a risk that the red cell phenotype and antibody specificity could be copied incorrectly. Since these patients can present to any area of a hospital, education of medical and nursing staff needs to be improved.

A national register of patients with antibodies has been previously suggested by SHOT and would be very helpful in managing such patients[24]. New BCSH guidelines for transfusion in haemoglobinopathy are in preparation.

Shared care is common in haemoglobinopathy patients, and every effort should be made to ensure that all hospitals involved in their care are kept fully informed of their special transfusion requirements. Patients should be encouraged to alert clinical staff to their special transfusion needs.

Recommendations:

- Clinicians must ensure that a haemoglobinopathy diagnosis is transmitted to the transfusion laboratory every time a patient is admitted and from every speciality area. There should be a mandatory field on the transfusion request whether paper or electronic to ask about haemoglobin disorders.

  Action: Manufacturers of hospital IT systems, Trusts/Health Boards/Hospitals, Hospital Transfusion Teams (HTTs)

- The warning card system for patients needs to be simplified so that people with haemoglobin disorders carry a single source of information about their diagnosis, red cell phenotype and any irregular antibodies. Patients need to be educated to present this information at every hospital contact.

  Action: CMO's National Blood Transfusion Committee (NBTC) with patient support groups

- As people with haemoglobin disorders may attend any specialty, all core curricula for medical training should ensure that adequate education takes place about these disorders with particular attention to their transfusion needs.

  Action: Education subgroup of the NBTC

24.

MHRA Regulatory Haemovigilance

Author: Judy Langham

Definition

Implementing the requirements of the following European Union (EU) Directives:

- **Directive 2002/98/EC – setting standards of quality and safety for the collection, testing, processing, storage and distribution of human blood and blood components[2].**
- **Directive 2004/33/EC – regarding certain technical requirements for blood and blood components[3].**
- **Directive 2005/61/EC regarding traceability requirements and notification of serious adverse reactions and events[1].**
- **Directive 2005/62/EC regarding Community standards and specifications relating to a quality system for blood establishments[4].**

Table 24.1 SABRE data summary 2011

All UK SABRE reports submitted 2011	Number of cases
Serious adverse events (SAEs)	844
Serious adverse reactions (SARs)	417
Excluded reports	295
TOTAL	**1556**

Introduction

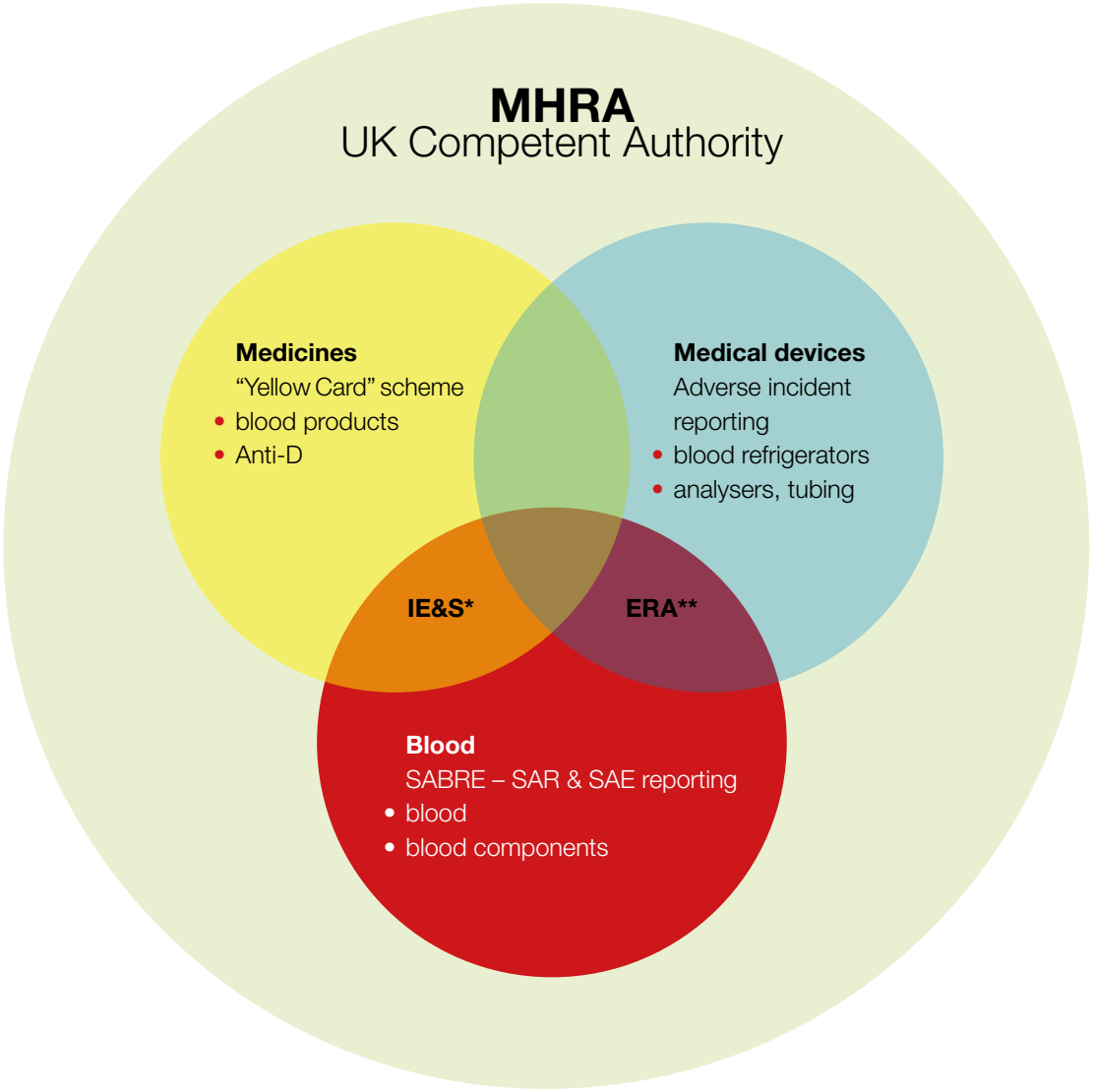
The Blood Safety and Quality (Amendment) (No.2) Regulations 2005 No. 2898[92] became effective in the United Kingdom (UK) on November 8, 2005. The Medicines and Healthcare products Regulatory Agency (MHRA) is the designated competent authority responsible for ensuring that blood establishments, hospital blood banks and blood facilities comply with these regulations. This requires an integrated approach between MHRA Divisions (see Chart 1), especially the Inspection, Enforcement and Standards (IES) Division and the medical devices Adverse Incident Centre (AIC), which manages the Serious Adverse Blood Reactions and Events (SABRE) reporting system.

Blood products such as Anti-D immunoglobulin, prothrombin complex concentrate (PCC) and Factor VIII are classed as medicinal products and as such any reactions resulting from their use should be reported to the MHRA using the Yellow Card scheme at http://yellowcard.mhra.gov.uk/

Much of the equipment used in hospital blood banks* is classed as a medical device e.g. blood refrigerator, blood grouping analyser, plasma thawer etc. Incidents reported on SABRE involving equipment failure may be forwarded to the MHRA Adverse Incident Centre for further investigation and discussion with the device manufacturers where appropriate.

The MHRA Devices European Regulatory Affairs (ERA) unit deals with regulatory, inspection and enforcement matters relating to medical devices. In the main this involves supporting negotiations on European Directives and the interpretation and implementation of the UK regulations.

Figure 24.1
MHRA divisional integration for blood safety and quality regulation



** The term 'blood banks' is used throughout this chapter for hospital transfusion laboratories because it is the term used in the EU legislation.*

** IE&S - Inspection, Enforcement & Standards*

*** ERA - Devices European & Regulatory Affairs*

Referred reports

It is a legal requirement for the responsible manager of each UK Blood Establishment, hospital blood bank, (and blood facilities with responsibility for haemovigilance), to ensure that any serious adverse blood reaction or event is reported to the MHRA as soon as they know about it. This should ideally be within 48 hours of occurrence. This enables the report to be reviewed quickly by the MHRA haemovigilance team and when necessary, forwarded to the MHRA Inspectors for further possible intervention in order to safeguard public health.

Clearly not all referred reports trigger a 'for cause' inspection, but they are taken into account by the Inspectors when calculating the risk score for each organisation as they review annual blood compliance reports. (A 'for cause' inspection means that a laboratory has a risk profile that indicates reason for inspection).

Table 24.2 Total No. of reports referred on to MHRA Inspectors in 2011

SABRE reports referred to MHRA Inspectors	Number of cases
Incorrect blood component issued	137
Pre-transfusion testing errors	44
Late reports	18
Repeat incidents	18
Failed recalls	12
Processing errors	7
TOTAL	**236**

The types of reports which should be referred are agreed with the MHRA inspectors at routine, internal blood liaison meetings. Any reports containing indications of dangerous practice are immediately referred for prompt follow-up.

MHRA relationship with Serious Hazards of Transfusion (SHOT)

As the designated competent authority the MHRA is responsible for ensuring that blood establishments, hospital blood banks and blood facilities comply with requirements of the EU Directives with respect to the notification of serious adverse reactions and events and the specific standards and specifications relating to a quality system.

The fully accessible on-line reporting system, SABRE, has been developed by the MHRA to help reporting organisations meet their legal reporting obligations. However, the report format and categories are set entirely as specified in Annexes II and III of EU Commission Directive 2005/61/EC. Unlike SHOT, the MHRA is not at liberty to change these reporting categories, specification and reaction types or to widen the scope of reporting to include clinical practice.

Reporting to SHOT has been encouraged in the UK since 1996 and is now professionally mandated. As an independent haemovigilance system SHOT is at liberty to alter the way they collect data to ensure they capture all emerging trends, including the safety aspects of clinical transfusion practice.

This provides a unique opportunity for UK haemovigilance to ensure that transfusion practice is regulated, informed and that relevant recommendations are made to encourage continuous safety improvements throughout the entire transfusion chain. MHRA and SHOT are committed to working more closely together to produce the most globally comprehensive haemovigilance reporting system in the best interests of patient care. Reporters should be reassured that this [i.e. reporting to SHOT] will not result in more inspections or punitive actions.

SABRE registration data 2011

Table 24.3 No. of registrants by country

Location of registrants	Number of registrants
England	230
Scotland	38
Wales	13
Northern Ireland	9

Non-reporters n=27

There are a number of registrants who have yet to submit any reports to SABRE. In most instances however, these registrants are based at blood facilities issuing low volumes of blood components and for whom adverse incidents are unlikely. If appropriate the MHRA haemovigilance team may propose an informal visit to help reporters understand the type of incidents which should be reported.

Last reported n=36 (since December 2010)

The MHRA haemovigilance team also monitor the frequency of reporting on SABRE. Whilst there are no right or wrong 'levels' of reporting, a noticeable drop in reporting frequency by a normally active reporting organisation may indicate a staffing crisis or problem with the operation of the quality system. In the first instance this might initiate a courtesy call from the SABRE Helpdesk to check the reporter is not having difficulties accessing the SABRE website. In the event that there are concerns over the organisation's ability to maintain their SABRE reporting obligations this would result in referral to the MHRA inspectors.

Reporting levels

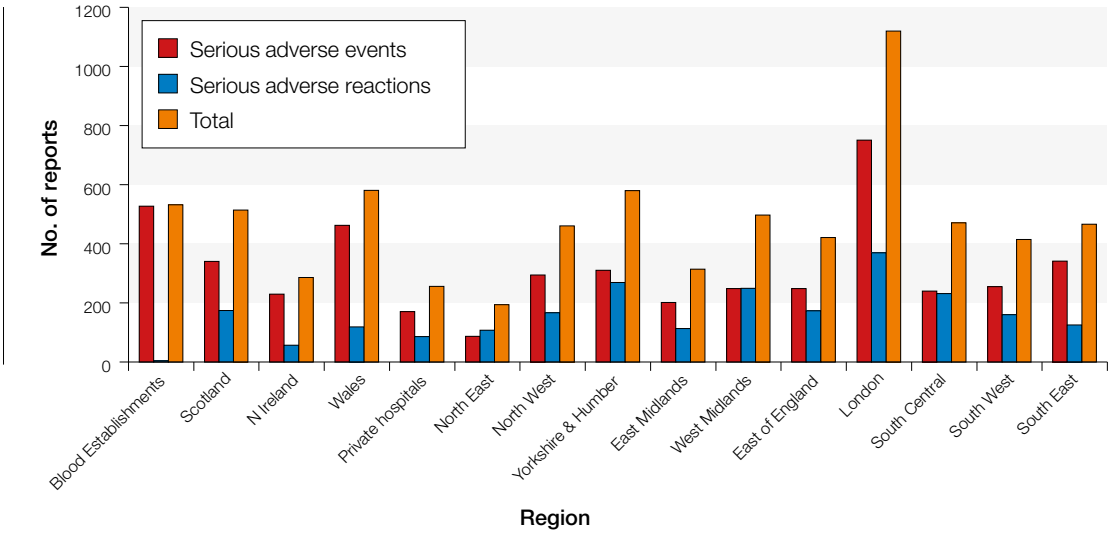
There is still a wide variation in reporting levels across the UK and this appears to relate more to the reporting culture of the organisation rather than to their size or activity level.

Figure 24.2 below shows the cumulative reporting levels of hospitals grouped by Regional Transfusion Committee (RTC), November 2005 to December 2011.

Note : Each region has different numbers of hospital blood banks operating within it and these comprise a range of small, medium and large units where;

Small	= < 10,000 red issues per year
Medium	= 10 – 20,000 red cell issues per year
Large	= > 20,000 red cell issues per year

Figure 24.2 Confirmed SABRE reports by RTC Region 2005 - 2011 (minus excluded reports)



Some perspective on reporting levels may be achieved by considering the number of SABRE reporters in each region and the associated activity in terms of number of red cells received and issued.

Collectively the Blood Establishments issue over two million units of red cells each year. They are inspected regularly by the MHRA at least every two years. The low number of incidents reported by these organisations is a good indicator of their effective quality management systems and provides reassurance to the hospital blood banks on the safety and quality of the components they receive.

The most reports are received from the London RTC region which is to be expected given that they have many large blood banks in their region and issue considerably more red cells than the other regions. The private hospitals group has the most reporting organisations within it, but their hospital blood banks issue the least number of red cell units which may account for the lower reporting levels seen.

Table 24.4 RTC regions and associated hospital blood bank issue data

Region	No. of reporting organisations in the region	Approx no. of red cell issues per annum (thousands)
Blood Establishments		
- NHSBT	N/A	1,879
- SNBTS		203
- NIBTS		56
- WBS		88
Scotland	30	208
Wales	14	108
Northern Ireland	8	55
Private hospitals	49	40
London	37	378
North West	25	224
East of England	18	183
South West	17	178
Yorkshire and Humber	15	160
South East	11	135
South Central	13	126
East Midlands	11	125
North East	11	90

Denominator data for MHRA are supplied by the reporting organisations. There will be an element of double counting as some reporting organisations are sub-supplied by larger hospital blood banks.

Feedback for UK reporters

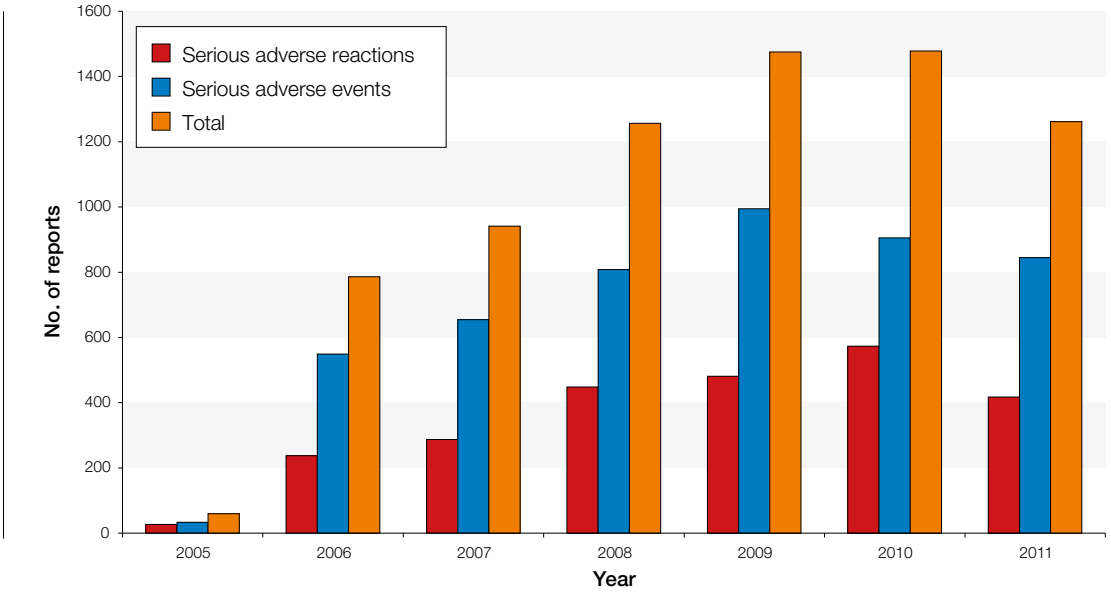
The MHRA recently published their Report on the UK Regulation of Blood Safety and Quality 2005 – 2010[93] in order to provide reporters with summarised haemovigilance data for the first five years of mandatory reporting. From November 2005 to December 2009 the numbers of SABRE reports submitted rose each year. However, in 2010 there was evidence that the numbers of reports had reached a plateau, possibly as reporters gained a better understanding of the reporting requirements. The MHRA haemovigilance team have focused their efforts on helping reporters recognise recurring incidents and have been encouraging effective root cause analysis to help target corrective and preventative actions. In this way it is hoped that the number of serious adverse events (SAEs) occurring each year might begin to decline. It is therefore very encouraging to see that in 2011 there were 61 fewer SAEs reported than in 2010 and 156 fewer serious adverse reactions (SARs). This represents a 12% decrease in adverse incidents reported overall since the peak (n=1764) in 2009.

The decline in SARs may also be attributed in part to a more rigorous approach to ensuring that only those reactions meeting the EU Commission definition of 'serious' are included in the annual report.

Table 24.5 All reports submitted to SABRE since Nov 8th, 2005

Report type	2005	2006	2007	2008	2009	2010	2011
SAE	33	549	654	808	994	905	844
SAR	26	237	287	448	481	573	417
Excluded	31	84	100	265	286	284	295
TOTAL	**90**	**870**	**1041**	**1521**	**1764**	**1762**	**1556**

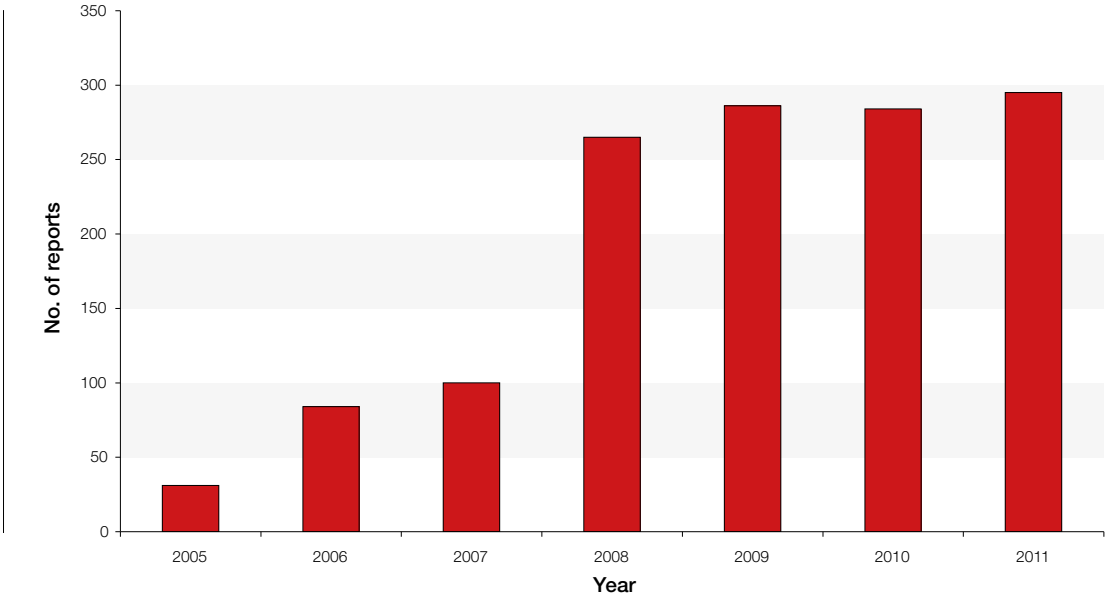
Figure 24.3
All UK SABRE reports 2005 - 2011 (minus exclusions)



Excluded reports

Each year a significant number of reports submitted to SABRE are excluded from the final annual summary report which is sent to the EU Commission. This is because they do not meet the specific EU reporting requirements. However, reports are only ever withdrawn after discussion with the reporter and with their full understanding and agreement.

Figure 24.4
SABRE reports excluded from EU Commission annual summary each year



The most common reasons for excluding reports remain as follows:

- They are duplicate reports e.g. hospital blood bank and blood establishment report a failed recall where a blood component has been transfused prior to recall (Usually the blood establishment will report this unless the patient has suffered a serious adverse reaction).
- Further investigation reveals that the incident does not meet the criteria for 'serious' i.e. it was not fatal, life-threatening, disabling, incapacitating and did not increase morbidity or prolong hospitalisation.
- The incident occurred in the clinical setting e.g. a phlebotomy error leading to a "wrong blood in tube" event or a bedside administration error leading to transfusion of the wrong component. These types of incident fall outside the remit of Competent Authority regulation.

- The incident relates to an error involving a blood product (which are licensed as medicines) e.g. Anti-D immunoglobulin, Octaplas, PCCs, Factor VIII blood product reactions should be reported to the MHRA via the medicines Yellow Card scheme.

Serious adverse events 2011

Table 24.6 Annual Summary report for UK serious adverse events

SAE deviation	Total number	Product defect	Equipment failure	Human error	Other
Whole blood collection	36	0	0	36	0
Apheresis collection	1	0	0	1	0
Testing of donations	8	0	0	8	0
Processing	37	3	1	32	1
Storage	228	1	3	224	0
Distribution	52	0	0	51	1
Materials	0	0	0	0	0
Other	449	3	10	436	0
Overall total	**811**	**7**	**14**	**788**	**2**

As in previous years the most frequently reported SAEs occur in the *Storage* and *Other* categories but both have decreased since last year. There were 52 fewer *Storage* incidents and 16 fewer '*Other*' incidents than were reported in 2010 although there were 9 more incidents attributed to human error. 97% of all SAEs continue to have the specification of human error.

Storage errors n=228

In total 228 *Storage* SAE confirmation reports were received in 2011. A significant number of these incidents were related to the use of transport boxes for storing blood in theatre and wards where no other temperature controlled equipment was available. Components were either packed incorrectly or left in the transport boxes beyond the validated times whilst still being available for transfusion. Keeping track of transport boxes and managing component recall within validated storage times continues to be a challenge for busy laboratories.

Only 3 storage errors were attributed to genuine equipment failure. In most instances of refrigerator and freezer alarm failures the investigations revealed that the alarms had either been erroneously muted or they had not been properly reset after routine maintenance checks. Whilst most laboratories have written procedures to describe operational qualification requirements post servicing and repair, the number of SAEs suggest that this is an area which requires further attention.

Other errors n=449

In total 449 *Other* SAEs confirmation reports were received in 2011. 436 of these were given the specification of human error by their reporter and in order to provide further information MHRA have further sub-categorised them as follows:

Table 24.7 Breakdown of other/ human error SAEs

Sub-category	Code	No of reports
Incorrect blood component selected and issued	IBCI	109
Data entry error	DEE	87
Component labelling error	CLE	73
Pre-transfusion testing error	PTTE	61
Sample processing error	SPE	42
Component collection error	CCE	19
Component available past dereservation date	CATPD	18
Expired component available for collection	ECAT	11
Incorrect blood component ordered and issued	IBCO	7
Out of temperature control	OTCOL	3
Handling damage	HD	1
Unspecified	UNS	5

Incorrect blood components issued n=109

Incorrect blood components may be issued when there is a communication failure between clinicians and laboratory staff. If the laboratory has **not** been notified that the patient has special requirements (e.g requires irradiated components post treatment with purine analogues) then it is not usually necessary to make a report to SABRE. However, there is an increasing reliance on laboratory information management systems (LIMS) to alert staff to the need for special requirements and it appears that for some systems this may be unreliable. An increasing number of incidents are being reported which indicate that there has been a LIMS failure and the flagging system has not been activated. Full validation of any LIMS is an essential part of the laboratory quality system and reporters are advised to pay particular attention to flagging systems if these form an integral part of the component selection process.

Data entry errors n=87

Data entry errors and component labelling errors continue to occur frequently. Root cause analysis of many of these errors suggests that staff are often very distracted by noise and interruptions during their work. Retraining staff is rarely required as most are well aware of what they should have done, but reflective exercises which encourage individuals to consider how they might manage the same situation in a more constructive way may be beneficial in reducing recurrences.

Pre-transfusion testing errors n=61

The pre-transfusion testing error accounted for 61/436 (14%) of all 'other/human error' reports in 2011. The most common failure was incomplete testing leading to either electronic issue of blood components which should have been fully crossmatched or the issue of crossmatched blood without full antibody identification having taken place. When this type of error leads to a transfusion reaction reporters are advised to resubmit their report as a SAR and are encouraged to include full details of the error and subsequent corrective and preventative actions.

Sample processing errors n=42

Sample processing errors are a cause for concern because they may indicate an early failure in the laboratory quality system. Most laboratories operate a process which incorporates several sample checking stages to reduce the risk of this type of incident. However, it is not necessary to report to SABRE those sample labelling errors which occur in the clinical setting i.e. at the phlebotomy stage. The wrong blood in tube event is generally reportable only to SHOT.

Incident investigation

MHRA continues to encourage thorough root cause analysis of all serious adverse events to ensure that corrective and preventive actions (CAPA) are appropriately targeted. This year insufficient investigation of anomalies and CAPA are cited as being in the top five of all deficiencies found during hospital blood bank inspections. SABRE reporters state the following reasons as being the most common cause of errors:

- Distraction and interruptions causing concentration lapses
- Incomplete or ineffective training
- Rushing or cutting corners due to urgency of request or lack of staffing
- Overriding IT alerts due to over-familiarity
- Absent IT alerts due to incomplete validation of LIMS or IT 'bugs'
- Inappropriate or out of date procedures

Continuously questioning why an incident has occurred remains the most effective way of uncovering the root cause(s) and any contributory factors. The MHRA will continue to analyse these and will provide feedback to reporters to support their incident management processes.

Learning points

- Human error remains the most common cause of Serious Adverse Events. Transfusion teams should be encouraged to consider strategies to minimise the effects of human error by focusing on root causes such as distraction, tiredness and over-familiarity with repetitive tasks.
- Each individual should be reminded to maintain awareness of their own areas of potential weakness, to take responsibility for following standard operating procedures (SOPs) precisely and for checking their own work.

Serious adverse reactions 2011

The total number of SAR reports submitted in 2011 was 501. Of these 86 were excluded leaving 417 for review. This represents a 27% decrease since 2010 when the total was 573.

According to article 3(h) of the Blood Directive 2002/98/EC[2], a serious adverse reaction is *"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."*

The MHRA haemovigilance team have been encouraging reporters to apply this definition more rigorously this year which may in part account for the decrease in the number of reports submitted.

Annual Summary report for all UK SAR reports (Table 24.8)

(Breakdown is by reaction type, blood component implicated and imputability level.)

NOTE: Imputability level *not assessable* is not presented but is included in the totals. The annual summary report submitted to the European Commission comprises 445 reports as it also includes some reports which were notified in 2010 but not confirmed until 2011.

No reports have been submitted for any blood component in the following reportable reaction types:

- Transfusion-transmitted viral infection (Other)
- Transfusion-transmitted parasitical infection (Malaria)
- Transfusion-transmitted parasitical infection (Other)
- Graft-versus-host disease

As in previous years the majority of reports received are for *Anaphylaxis/ hypersensitivity* type reactions.

176 reports were submitted in the '*Other'* reaction type. The total number of reports in this category for 2011 was 185 which represents a 65% decrease since 2010 when the total was 287.

Table 24.8 Annual summary report for all UK SAR reports.

Type of reaction		Imputability level 0	Imputability level 1	Imputability level 2	Imputability level 3
Immunological haemolysis due to ABO incompatibility:					
Red cells	Total: 1	0	0	1	0
Platelets	Total: 2	1	1	0	0
	Deaths: 1	0	1	0	0
Immunological haemolysis due to other allo-antibody					
Red cells	Total: 26	5	7	6	8
Non-immunological haemolysis					
Red cells	Total: 1	0	0	1	0
Transfusion-transmitted bacterial infection					
Red cells	Total: 12	7	5	0	0
Platelets	Total: 4	2	2	0	0
Anaphylaxis/ hypersensitivity					
Red cells	Total: 82	8	38	31	5
Plasma	Total: 31	1	17	12	1
Platelets	Total: 68	1	20	39	8
Other	Total: 4	0	2	2	0
	Deaths: 1	0	0	1	0
Transfusion-related acute lung injury					
Red cells	Total: 14	7	5	2	0
Plasma	Total: 2	2	0	0	0
Platelets	Total: 4	2	2	0	0
Other	Total: 8	2	4	0	1
	Deaths: 3	0	2	1	0
Transfusion-transmitted viral infection (HBV)					
Other	Total: 1	1	0	0	0
Transfusion-transmitted viral infection (HCV)					
Other	Total: 3	3	0	0	0
Transfusion-transmitted viral infection (HIV 1/2)					
Red cells	**Total: 1**	1	0	0	0
Post-transfusion purpura					
Red cells	Total: 2	2	0	0	0
Platelets	Total: 1	0	0	0	1
Other	Total: 1	0	1	0	0
Other					
Red cells	Total:144	17	83	36	7
Plasma	Total: 6	0	3	2	0
Platelets	Total: 16	3	6	6	1
Other	Total: 11	1	2	7	1

**Other components (includes buffy coats, granulocytes and multiple components)*

Reports submitted as 'other' reaction type n=177. These are sub-categorised as follows:

Table 24.9 Sub-categorisation of reaction type 'Other'

Sub-category	Code	No. of reports
Febrile non-haemolytic transfusion reaction	FNHTR	128
Transfusion-associated circulatory overload	TACO	33
Transfusion-associated dyspnoea	TAD	6
Non-febrile non-haemolytic transfusion reaction	NFNHTR	5
Other	Other	5

Deaths

Total No. of deaths reported in 2011 = 5

No. of deaths where imputability level ≥2 = 2

Case 1
TRALI (transfusion-related acute lung injury)
This case was notified and confirmed in September, 2011 and is therefore included in the annual summary data. However, the case was referred to the Blood Establishment who has since indicated that the laboratory results do not support a case of antibody-mediated TRALI. An inquest is pending and the reporter will make their final decision on the reaction type and imputability level when they have received the coroner's report. This demonstrates how SABRE data may be subject to change as further information becomes available and reports are updated.

Case 2
Anaphylaxis/hypersensitivity (Case 1 in Chapter 13 – Acute transfusion reactions)

Case 3
Death attributed to immunological haemolysis due to ABO incompatible transfusion (imputability level 1)
This case was reported in November 2010 but due to the complexities of this case the investigations and confirmation report were not completed until September, 2011. In this case the incident related to the death of an A RhD positive patient who received Group O apheresis platelets in November 2010. The patient suffered a hypertensive reaction to the transfusion with evidence of a modest haemolytic reaction. Donors who contribute to Group O apheresis platelets are routinely tested for high titre anti-A,B antibodies and are labelled for "Group O Patients only" if they exceed the limit defined by the Red Book. On this occasion, this donor was found to pass this test, but had failed in the past. The patient was undergoing chemotherapy for an advanced glioblastoma and it is not clear how significant a contribution the transfusion reaction made to her sad demise, hence it was ultimately assigned an imputability level of 1.

Data reconciliation with SHOT

Each year SHOT and MHRA meet to discuss some of the differences seen between their respective sets of data. In 2011 there were 8 deaths reported to SHOT where transfusion was implicated and only 5 were reported on SABRE. Although it is appreciated that it may be difficult to assign a definite imputability level when patients have complex underlying pathology, all fatalities which follow the transfusion of blood or blood components **must** be reported to the MHRA. SHOT does not include deaths after transfusion where it is clear that the cause is not related, i.e. imputability 0.

It is becoming increasingly apparent that changes made to reports on one system (whether SABRE or SHOT) may not be updated in the other, and this leads to disparity of data. This may be because reporters mistakenly believe that SHOT and MHRA are able to see reports made on each other's systems. This is not the case. Alternatively reporters may simply not have sufficient resources to ensure that both haemovigilance systems are kept updated. For this reason the two organisations are currently reviewing the feasibility of a joint reporting system. Additionally, as part of the ongoing commitment to closer collaboration, SHOT and MHRA have agreed to undertake more frequent data reconciliation meetings.

This will allow timely discussion of anomalies with their respective clinical experts and the reporters. In this way it is hoped that a more standardised approach to assigning reaction types will be achieved.

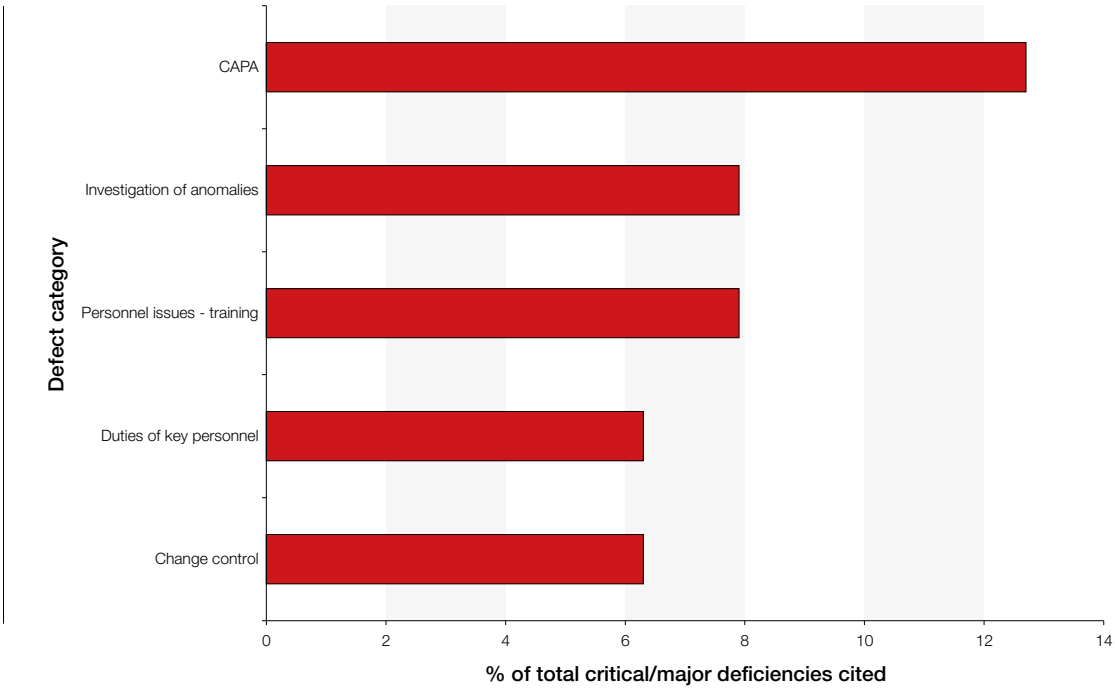
MHRA inspection data 2010/11

Fifty eight sites were selected for inspection in 2010/11 following a risk review of the blood compliance reports submitted by hospital blood banks and blood facilities in April 2010. Nine further sites were selected as controls.

Blood establishments are inspected as part of a regular timed review as are overseas plasma fractionation sites. Only 4 UK Blood Establishment Authorisation inspections and only 1 overseas plasma site resulted in a major deficiency being cited.

The following graph is based on the top five deficiencies by percentage of those raised as either Critical or Major Deficiencies. The data is taken from 57 inspections completed up to the 29th February 2012, some of which were repeat inspections following concerns raised on initial inspection of the site.

Figure 24.5 Hospital blood bank critical and major deficiencies – Top 5 deficiencies by %



Corrective and preventive actions (CAPA)

The principle reasons for citation were:

- Sites not utilising CAPA elements within investigations to ward against repetition of the event
- Repeat events which should have been remediated by effective CAPA
- No review of CAPA effectiveness

Investigation of anomalies

The principal reasons for citation were as follows:

- Ineffective system – some sites have ceased using local systems and use the hospital risk management system instead. In most cases the hospital system does not address the potential for harm and does not capture all non conformances
- Lack of root cause analysis
- Lack of detail in investigations
- True root causes often not identified
- Lack of trend analysis to raise awareness of developing issues

Training

The principal reasons for citation were:

- Lack of training on key quality management systems for out of hours staff
- Lack of periodic competency assessment, especially for out of hours staff

Duties of key personnel

The principal reasons for citation were:

- No defined time allocation for quality management activities
- Lack of up to date job descriptions highlighting key quality management responsibilities (not just quality manager)
- Short term appointments with no defined role

Change control

- Change controls not being raised
- Change controls acting as change approval only rather than managing the process from conception to completion
- Lack of assessment on the effectiveness of the change

Learning point

- Hospital blood banks should ensure that ALL staff working in the transfusion department receive regularly updated training in the principles of Good Manufacturing Practice and the effective operation of their laboratory Quality Management System.

MHRA haemovigilance activity in 2011

The MHRA haemovigilance team have a responsibility to check every report submitted via SABRE for quality, timeliness and accuracy. Alongside this they run a telephone helpdesk and are committed to supporting reporters with help, advice and education whenever possible.

The table below details some of the other activities the team have been involved in during the course of 2011:

Table 24.10 MHRA haemovigilance team external activity 2011

MHRA haemovigilance team external activity	Number of visits
Competent Authority/EU working party meetings	2
Blood Consultative Committee meetings	2
National Transfusion Committee meetings	2
National Transfusion Laboratory Managers Meeting	1
Regional Transfusion Committee (RTC) Educational seminars	6
Regional Transfusion Committee Meetings	5
Poster presentations	2
Informal site visits	2
SABRE reporting system demonstrations	2

Recommendations

There are no new recommendations

For active recommendations made by MHRA from previous years (but not previously reported by SHOT) and an update on their progress, please refer to the SHOT website

25.

Near Miss (NM) Reporting

Author: Alison Watt

Definition

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

Near misses were fully analysed for the first time in 2010 and the 2011 data have been analysed using the same categories to allow comparisons to be made. Some comparisons with historical data are also able to be drawn, because similar categories have been used for previous analyses of near miss events in pilot studies and audits. Some sub-classifications used in 2010 have been removed from the tables below, because no incidents meeting those criteria were reported in 2011.

The SABRE User Guide[94] definition of a Serious Adverse Event (SAE) is:

'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.'

Therefore, many of the near miss events reported to SHOT are categorised as SAEs by MHRA. Further information on SABRE SAEs collected by the Medicines and Healthcare products Regulatory Agency (MHRA) is contained in Chapter 24.

Near misses n=1080

A total of 1080 near miss events have been analysed. Errors detected at sample booking are not included in the Annual SHOT Report, because they have been detected by the quality management system at the first opportunity. However, they should not be regarded as trivial and local audits on sample labelling might be beneficial to improve performance in this area.

Table 25.1 Numbers of near misses according to category

Category of incidents	Number of cases	Percentage of cases
Sample errors	508	47%
Request errors	70	6.5%
Laboratory procedural or testing errors	173	16%
Laboratory component selection errors	103	9.5%
Component collection/administration errors	55	5.1%
Expired components available	70	6.5%
Cold chain events	100	9.3%
Other (Electronic failure, no blood available)	1	0.1%
TOTAL	**1080**	**100%**

The category of 'expired components available' includes units not removed from the refrigerator at the appropriate time according to the sample validation guidelines[37].

Sample errors n=508

Sample errors again accounted for approximately half of all near miss events, a proportion that has been seen consistently throughout SHOT's previous studies of near misses. Of the 508 sample errors, 469 were incidents of wrong blood in tube (WBIT). The International Haemovigilance Network (IHN) refers to this error as wrong name on tube (WNOT) and defines it as "a sample labelled with the identification details of a different patient"[15] (http://www.ihn-org.com/). Another definition by Dzik et al is "the blood in the tube is different from that of the patient whose name is on the label"[95].

Therefore, the SHOT category of WBIT includes incidents where:

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

Either error could result in a transfusion of a component of the wrong blood group to a patient.

The other 39 of 508 sample errors were labelling errors, where the right blood was in the tube and the labelling contained mostly the intended patient's details, but there was a mismatch e.g. of the patient's name, date of birth, identification number etc. Most of these labelling errors will be noticed during the sample booking-in process and the samples will be rejected. However, if these mislabelled samples are tested and the mistakes discovered it becomes a SHOT-reportable incident. Such labelling errors might be indicative of incorrect procedures or lack of concentration when sampling, and such lack of attention to labelling could lead to an incident where the sample is taken from the wrong patient or labelled with another patient's details and therefore becomes wrong blood in tube as case 1 shows.

Case 1

Earlier rejected sample indicated lack of correct patient identification

A crossmatch sample received in the laboratory was rejected due to insufficient identification data, i.e. this would have been classified as a sample labelling error. A repeat sample was accepted and processed, because all information on the sample and form matched. At the pre-transfusion bedside check the patient's details did not match those on the compatibility label. On investigation, it was found that on both occasions the doctor had labelled the samples away from the bedside with another patient's details hence both samples were wrong blood in tube.

Wrong blood in tube n=469

469 cases of WBIT have been reported in 2011 out of a total of 1080 near misses. This gives an incidence of 43% compared to an incidence of 45% in 2010 when 386 WBIT cases were reported out of a total of 863 near misses.

Table 25.2 Staff responsible for wrong blood in tube incidents

Staff responsible for taking sample	Number of cases	Percentage of cases
Doctor	176	37.5%
Nurse	88	18.8%
Midwife	78	16.7%
Healthcare assistant	25	5.3%
Phlebotomist	32	6.8%
Medical student	1	0.2%
Unknown/not stated	69	14.7%
Total	**469**	**100%**

Doctors are once again the staff group most often responsible for WBIT. Accurate denominator data is not available, but it is generally acknowledged that many more samples are taken by other staff groups such as phlebotomists, nurses and midwives, and that doctors continue to make a disproportionately high number of sample labelling errors.

Case 2

A repeat sample is also WBIT

As a result of a WBIT incident a further sample was taken from a patient in neonatal intensive care, which again proved to be a wrong blood in tube, discovered by comparison with the historical grouping record. A locum doctor had taken the repeat sample without checking the patient identification correctly.

Learning point

- Unfamiliarity with the process of sampling patients appears to lead to more errors being made, with a consequent higher incidence of wrong blood in tube events. Those who do not sample patients routinely should take particular care to follow procedures correctly.

Table 25.3 Practices leading to wrong blood in tube

Practices leading to WBIT	Number of cases	Percentage of cases
Patient not identified correctly	174	37.1%
Sample not labelled at bedside	174	37.1%
Sample not labelled by person taking blood	23	4.9%
Pre-labelled sample used	10	2.1%
Other/unknown	88	18.8%
Total	**469**	**100.0%**

There are a large number of cases (88/469) where the practice leading to WBIT has been reported as 'Other', but it is apparent from the description of the event that some are essentially related to poor identification of the patient, such as using details from an incorrect patient in the Patient Administration System (PAS) or using addressograph labels from a different patient. Although most organisations do not accept samples labelled with addressographs, an incorrect label on the request form can lead to a mislabelling of the sample if patient identification procedures are not followed correctly.

Case 3

Patient not identified correctly and sample labelled from details on request form

The doctor put patient A's blood test form in her file and escorted patient A to phlebotomy. She gave what she thought was patient A's form to the phlebotomist, but later found patient A's form still in her file, though patient B's form was not. She phoned phlebotomy and was told not to worry as all patients are identified verbally. However, the doctor then found results on the IT system for patient B. Therefore, patient A had not been identified by phlebotomy as per Standard Operating Procedure (SOP) and patient A's samples were processed as though they were from patient B. The laboratory was alerted to discard the sample and remove the results from patient B's record.

Transposed labelling in maternity situations have been reported as WBIT incidents, including transposition of labelling on cord samples from twins, which would often not be discovered. However, the more common transposed labelling of maternal and cord samples could be identified with the routine use of a simple alkali denaturation test to indicate resistant cord red blood cells.

Learning point

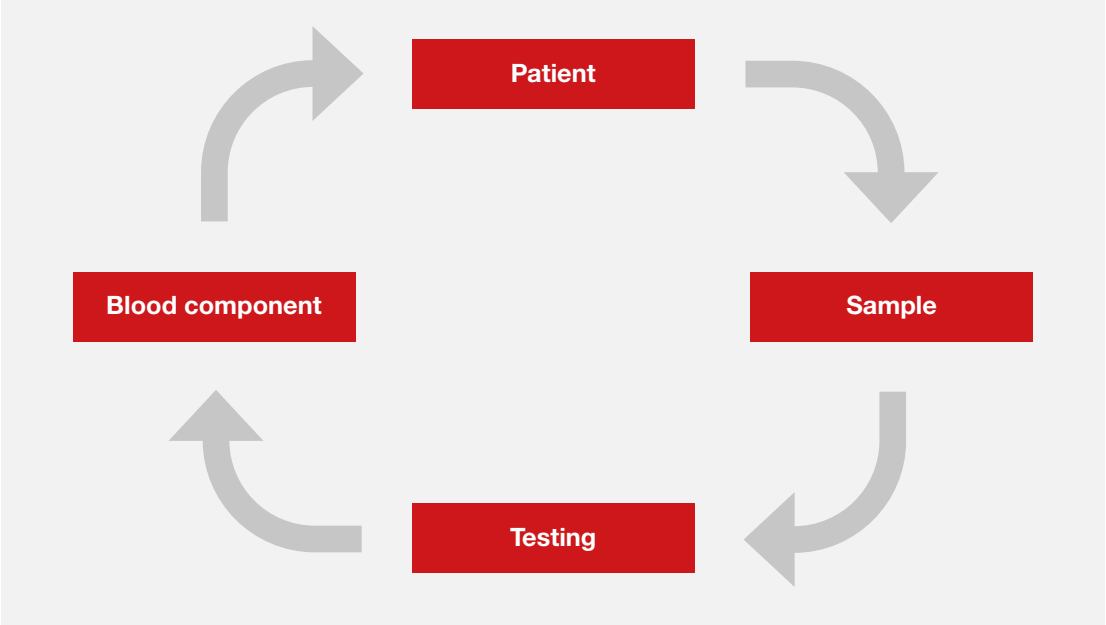
- An alkali denaturation test is a simple way to distinguish adult and cord haemoglobin and should be used routinely whenever there is a possibility that maternal and cord samples could have been mislabelled, e.g. if both give the same group or if the maternal sample does not match historical records.

Table 25.4 Circumstances leading to the detection of WBIT

How WBIT error was detected	Number of cases	Percentage of cases
At authorisation	161	34.3%
During testing	151	32.2%
Prior to testing	32	6.8%
Further sample differed	18	3.9%
Pre-administration checks	16	3.4%
Results from non-transfusion samples (e.g. FBC)	16	3.4%
Sample taker realised their error and informed laboratory	5	1.1%
Other/unknown	70	14.9%
Total	**469**	**100%**

In the incorrect blood component transfused section (Chapter 6) a total of 5 incidents are reported where an incorrect component was transfused due to WBIT. If that number is compared to the 469 near misses it raises the question of how many more incidents of WBIT are going undetected. The circumstances leading to detection are mostly not secure, relying on random chances such as a historical group being different or staff realisation of an error. Without fortunate circumstances as listed above, most WBITs would not be detected and 18 (3.9%) of these 469 errors were only detected by differing results from a further sample, which indicates the original WBIT samples were processed without detection at the time. Therefore, it must be assumed a number of WBITs remain completely undetected, and have resulted in transfusion of fortuitously group-compatible components.

Figure 25.1 The transfusion cycle shows the vital importance of a correct sample and can be summarised as:



If the sample is incorrect, then the cycle is broken and no amount of testing to prepare a blood component can guarantee a safe transfusion to the patient.

Request errors n=70

Table 25.5 Categories of request errors

Category	Number of cases	Percentage of cases
Special requirements not requested	45	64.3%
Request based on erroneous haematology tests	13	18.6%
Inappropriate request for clinical situation	9	12.8%
Request for incorrect patient	3	4.3%
TOTAL	**70**	**100.0%**

Special requirements not requested n=45

The classification of 'special requirements not requested' includes two cases of special requirements being requested when they were not needed, which is not in itself a serious hazard to the patient, but these have been included as near misses because such lack of attention to patient needs could equally result in the opposite outcome of special requirements not being requested when they *were* needed.

Table 25.6 Mode of detection that special requirements had not been requested n=45

Mode of detection	Number of cases	Percentage of cases
At the bedside pre-administration check	29	64.4%
In laboratory, based upon the clinical details provided	16	35.6%
TOTAL	**45**	**100.0%**

Request based on erroneous haematology tests n=13

The 13 of 70 request errors based on erroneous haematology tests include 12 cases related to full blood count (FBC) results and one case of an erroneous coagulation screen result that led to thawing of fresh frozen plasma (FFP) before the error was realised and the components were not transfused.

The failure to request special requirements is often detected in the laboratory by comparison with historical records or hazard flags, clinical details or other information provided on the request, but more commonly these errors are not detected until the pre-administration checks at the bedside when it is realised that components of the appropriate specification have not been provided. This can lead to a delay while the correct components are ordered and prepared.

Inappropriate request for clinical situation n=9

Of the 9 inappropriate requests, 8 related to obstetrics cases. Seven were mistakes made when requesting provision of anti-D Ig prophylaxis and the eighth was a patient with antibodies who delivered twins, but only one cord blood was taken for investigation of haemolytic disease of the fetus and newborn (HDFN). No request was made to investigate the other twin. Case 4 describes the 9th of these inappropriate requests, which related to a general practitioner (GP) request to transfuse on a probable incorrect Hb result without rechecking:

Case 4

Patient referred from GP for transfusion due to incorrect Hb

A specimen was received from a GP and the FBC was processed. A low Hb (6.8 g/dL) was noted, so the GP sent the patient to hospital for a 3 unit transfusion. The first unit of blood was collected, but the ward then rang the laboratory to say the blood was not needed as there had been an error with the Hb result. The hospital doctor reviewing the patient had already repeated the FBC, because the previous results did not match the patient's clinical picture and the new sample showed the patient's Hb to be 11.4 g/dL.

Requests for the incorrect patient n=3

All 3 requests made for an incorrect patient were related to requests for platelets for the wrong patient.

Case 5

Incorrect patient seen and prescribed platelets on the basis of another patient's platelet count

A haematology specialist registrar (SpR) went to the ward to see a new patient. He asked the nurses for the patient by name and was taken to the room of a patient with a similar first name. The doctor did not fully identify the patient and there was a language barrier. After seeing the patient he requested a pool of platelets to be given to the patient, because her platelet count was low and she had a swelling on her head from a fall that morning. The doctor had already called the hospital transfusion laboratory to order the platelets, using the correct name of the patient seen. A nurse later printed a blood collection form while she checked the patient's platelet level to confirm, but realised that her platelet count was within normal range. She rechecked the SpR's documentation and the drug chart with another staff nurse to confirm this. She bleeped the medical officer on call and after speaking to the haematology SpR they realised that another patient, next door to the patient who had the unnecessary prescription for platelets, was the patient with a low platelet level. Therefore the haematology SpR had seen the wrong patient and incorrectly prescribed and documented platelets based on a different patient's platelet count.

Laboratory procedural or testing errors n=173

Table 25.7 Categories of laboratory procedural or testing errors

Category	Number of cases	Percentage of cases
Component mislabelled	89	51.5%
Incomplete testing prior to issue	16	9.2%
Transcription errors*	13	7.5%
Incorrect patient identifiers entered into LIMS	12	6.9%
Manual grouping errors	8	4.6%
Incorrect patient mergers on LIMS (or PAS)	7	4.0%
Incorrect sample used for crossmatching	5	2.9%
Inappropriate editing of results from analyser	5	2.9%
Invalid sample used in crossmatching for a frequently transfused patient	4	2.3%
Sample booked in under incorrect record	2	1.2%
Barcode reader errors	1	0.6%
Incorrect sample used for grouping	1	0.6%
Other/unknown	10	5.8%
Total	**173**	**100.0%**

**A category for transcription errors has been added to this table (25.7) as a separate category for 2011, because transcription errors account for several laboratory procedural or testing errors.*

Component labelling errors n=89

By far the most common laboratory procedural or testing error is component labelling, which accounted for over 50% of such laboratory errors. This is a large increase on last year when 34 of 119 (29%) laboratory procedural or testing errors involved component labelling. The most common cause of mislabelling was transposition of the compatibility labels, which occurred in 48 of the 89 mislabelling cases. Mostly this error is made with units for the same patient and the labels are transposed between two or more units after matching. At worst that error would lead to an incident of 'right blood to right patient' (RBRP), but occasionally a mistake is made with labels transposed between patients, leading to the potential risk of a component being transfused to the incorrect patient. A potential risk for transposed labels occurs when there are excess labels printed as detailed in both cases 6 and 7.

Case 6

Transposition due to excess labels being printed

A biomedical scientist (BMS) crossmatched 2 units of red cells for a patient, but the request was for 3 units. The 2 units had to be unauthorised in the laboratory information management system (LIMS) in order to crossmatch the extra unit and assign all 3 to that patient. This meant there were now 5 compatibility labels on the printer. The BMS took 3 of the 5 printed compatibility labels, but did not realise two were duplicate labels, so one unit was labelled with the correct patient details, but an incorrect component number. On checking at the bedside the nurses detected the error and returned the unit to the laboratory for the BMS to replace the compatibility label with the correct compatibility label.

Case 7

Printing of a test label leads to incorrect labelling

Whilst validating a new version of the LIMS, a blood transfusion compatibility label was generated for the test patient 'Iggle Piggle'. At the same time, another member of staff was issuing prophylactic Anti-D Ig for an antenatal patient. The label generated for 'Iggle Piggle' was attached to this vial of Anti-D Ig in error, and dispatched to the antenatal clinic (ANC). On realising the error, the laboratory staff telephoned ANC immediately and changed the label on the Anti-D immunoglobulin.

A few cases occurred where the component included an extra incorrect patient label on the unit, such as a previous compatibility label not removed from a unit when returning it to stock. A few cases related to components issued with no labels at all.

Learning point

- Careful control when printing compatibility labels could help to reduce the potential for errors. Any excess labels printed for whatever reason should be destroyed immediately (see Case 8 in Chapter 6 Incorrect Blood Component Transfused (IBCT)).

Incomplete testing prior to issue n=16

Some of these cases were not directly related to blood issue at the time, but insufficient testing was performed prior to a report being issued and could have led to an erroneous issue of blood. Alongside this, some incidents related to insufficient testing prior to electronic issue (EI) or where EI was used in circumstances where a full crossmatch should have been performed. On occasions testing was incomplete because a known history of antibodies was missed, the antibody was now sub-detectable, and so antibody identification tests were not performed.

Transcription errors n=13

Mistakes in transcription contributed to 13 laboratory procedural or testing errors and there were a further 2 transcription errors, which are classified under manual grouping. Common mistakes are transcribing results incorrectly onto laboratory worksheets or from worksheets into the LIMS. It is worth noting that transcription can also be a problem in the clinical area e.g. when writing results into patient notes, particularly for antenatal patients.

Incorrect patient identifiers entered into LIMS n=12

Errors when entering patient details into the LIMS are often detected only at the pre-administration bedside checks and this can lead to delays in providing correctly labelled components. Errors can also lead to creation of a new record for a known patient meaning the previous transfusion history is unavailable. Duplication of records is a particular problem for patients with haemoglobinopathy and this is discussed in Chapter 23.

Manual grouping errors n=8

The manual grouping errors included 2 cases where the error was due to transcription and 6 where erroneous results were reported due to incorrect manual testing or interpretation of results.

Incorrect patient mergers on LIMS n=7

As well as traditional incorrect mergers of patients within a LIMS this classification also includes occasions where the incorrect patient record has been selected on the LIMS prior to issue of components that are being prepared without a crossmatch, such as electronic issue of red cells or preparation of FFP or platelets. It appears that some LIMS merger errors are related to mergers that have been made in the hospital patient administration system (PAS) and transferred into the LIMS as described in Case 8. Further examination of such IT issues can be found in Chapter 8.

Case 8

Twins merged on PAS

A sample from a patient grouped as A RhD positive, but the historical group showed as O RhD positive. It was discovered this patient has a twin and records had been erroneously merged for this patient and their twin on the hospital PAS and linked into the LIMS.

Incorrect sample used for crossmatching n=5

Errors involved selecting the wrong group and save samples from storage or in one case taking the wrong sample out of a centrifuge. Correct procedures to check the patient identification details during the crossmatching process were not followed and in one case this led to delays in the clinical area during which a unit of blood was left out of storage beyond acceptable limits, because an old sample with incorrect spelling of a surname was used instead of the newer replacement sample. Case 9 shows the added complication of staff unfamiliar with local procedures:

Case 9

Selection of incorrect sample compounded by staff member unfamiliar with local procedures

A request was received for 1 unit of red cells to be matched against a previous group and save sample. A member of reception staff retrieved the wrong patient's sample from storage. The error was not noticed by the qualified BMS. The result from an automated analyser indicated that the unit of blood was incompatible (patient's known group A RhD positive, sample group O RhD positive). The BMS failed to notice this result on the printout from machine, but the results were electronically uploaded from the analyser to the LIMS. However the error was further compounded because the BMS entered manually the negative results for the crossmatch into the LIMS; this being the standard protocol in BMS's previous workplace. Again the sample patient identification (PID) was not checked prior to labelling and issue of the blood unit to reception. The error was detected by a BMS on the next shift who was countersigning previous shift forms. This member of staff noticed the positive crossmatch result on the printed result sheet and took corrective action.

Inappropriate editing n=5

Automation enhances safety but this can be compromised by inappropriate editing of results or patient identification details.

Invalid sample used in crossmatching for a frequently transfused patient n=4

The British Committee for Standards in Haematology (BCSH) guidelines for compatibility procedures in blood transfusion laboratories[37] list appropriate timings for requirement of a fresh sample for crossmatching a transfused patient. There were four reports of near misses when the sample validation was not appropriate according to these guidelines.

Sample booked in under incorrect record n=2

There were only two cases of samples booked in under the incorrect record, but one led to a report being issued with an incorrect group on it:

Case 10

Report from rejected sample issued with another patient's group on it

An initial request was received from the pre-assessment clinic, but the sample was rejected due to a delay in reaching the laboratory. The patient was booked in to the LIMS system to generate a report of the rejected sample and was matched to a record with the same name and date of birth that had been copied across from the legacy system (previous LIMS). The report indicating rejection of the sample was sent out from the laboratory to the clinic showing the history group to be A RhD positive. A repeat sample was received later and grouped as O RhD positive. Investigation showed that there were two patients with the same name and date of birth and the rejected sample had been booked in against a different patient's record. Normally, any error brought across from the legacy system would be detected on grouping the sample, because the current group and history would not match. In this case, because the sample was rejected and not tested, the historical group from a different patient on the legacy system was incorrectly issued on the report.

Barcode reader errors n=1

There was only one case directly attributed to a barcode reading error, when an incorrect expiry date for a unit was read into the LIMS. However, there were several other cases which have been reported in the component labelling errors (see above) where incorrect donation details in the LIMS have been transferred to the compatibility label. It is not known whether the reason for these details being incorrect in the LIMS is human error or whether they might have been due to barcode errors.

Incorrect sample used for grouping n=1

Only one sample was used incorrectly for grouping, but the errors involved would be similar to those for incorrect samples used for crossmatching.

Laboratory component selection errors n=103

Table 25.8 Categories of laboratory component selection errors

Category	Number of cases	Percentage of cases
Special requirements or specification not met	59	57.3%
Incorrect component selected	23	22.3%
Anti-D Ig errors	20	19.4%
Component selected for a non-urgent transfusion with a reservation period beyond the expiry date	1	1.0%
TOTAL	**103**	**100.0%**

Special requirements or specification not met by laboratory n=59

This remains the most common component selection error.

Table 25.9 Failure to issue components with special requirements or specification

Special requirement or specification missed	Number of cases	Percentage of cases
Irradiated	22	37.3%
Red cell phenotyped	16	27.1%
Cytomegalovirus (CMV) negative	11	18.6%
Cytomegalovirus (CMV) negative and irradiated	6	10.2%
Human leucocyte antigen (HLA) typed	1	1.7%
Incorrect specification selected for "emergency O RhD negative"	1	1.7%
Platelets in platelet suspension medium (PSM)	1	1.7%
Other (LIMS corruption of record)	1	1.7%
TOTAL	**59**	**100.0%**

Case 11

Patient might have required transfusion before antibody was identified

A patient known to have a positive antibody screen required four units of red cells urgently to cover a surgical procedure before the Blood Service could identify the antibody. Four units of red cells were crossmatched, found to be compatible and issued. Subsequently a verbal report was received from the Blood Service stating anti-Fy^a had been identified. The fate of the four units issued was established, and found not yet transfused. The four units were withdrawn and four phenotyped units urgently requested, crossmatched and issued. Three of the four non-phenotyped units originally issued were found to be Fy^a positive.

In case 11 the laboratory staff acted correctly under the circumstances in an emergency situation, but there are some potential areas of concern, especially when risk assessing provision of networked laboratory services. Reasons were not given as to why referral to a Blood Service laboratory was needed to identify the antibody, although it can be assumed to have been a weak antibody if three antigen positive units gave a negative crossmatch. It is routine in some laboratories to refer all positive antibody screens at whatever strength, without attempting to identify the antibody. Although most laboratories serving a facility where emergency surgery takes place might be expected to have the resources to identify an anti-Fy^a and arrange for supply of appropriately phenotyped blood, increasingly such resources are not available at a local level. In those instances robust systems are needed to ensure blood cover is well planned for elective surgery and in the event of an emergency, a true picture of clinical urgency is required. In this case the units had not been transfused before the antibody was identified, so possibly the level of urgency had been mistaken.

Learning point

- This case underlines the fact that crossmatch-compatible units are not always suitable. Every attempt should be made to identify an antibody before issuing blood unless the clinical urgency prevents this. The nature of the emergency and the need to supply blood urgently should be carefully risk-assessed against the option of delaying until phenotyped blood is available.

Incorrect component selected n=23

Six of the 23 component selection errors were made due to complications related to haemopoietic stem cell transplants (HSCT) and could have resulted in blood of the incorrect ABO or RhD type being given.

Case 12

A complicated cord transplant leads to selection of incorrect component

A double cord transplant patient (donors O RhD positive and A RhD positive) required a 3 unit red cell transfusion. The patient's historical blood group was AB RhD negative. The LIMS stated that group O RhD negative, high titre (HT) negative, irradiated units were required for this patient. The A RhD positive cord donor had appeared to be engrafting, which was subsequently confirmed by blood grouping results at a later date. The BMS issuing the blood supplied irradiated units, but selected group A RhD negative, HT negative instead of the O RhD negative, HT negative as instructed by the LIMS.

Anti D Ig errors n=20

Errors related to incorrect selection of Anti-D Ig have been separated out from the list of component selection errors and further categorised in Table 25.10. Further discussion on anti-D errors can be found in Chapter 12.

Table 25.10 Categories of Anti-D Ig selection errors

Anti D Ig selection errors	Number of cases	Percentage of cases
Anti-D Ig issued for an RhD positive woman	7	35%
Wrong dose Anti-D Ig	6	30%
Anti-D Ig issued after delivery of RhD negative baby	4	20%
Anti-D Ig issued for a woman with immune anti-D	3	15%
TOTAL	**20**	**100%**

Component collection/administration errors n=55

Table 25.11 Categories of collection/ administration errors

Collection/administration errors	Number of cases	Percentage of cases
Incorrect units collected by ward staff/porters	30	54.6%
Wrong details on collection slip	12	21.8%
Attempted administration to incorrect patient	5	9.1%
Other/unknown (including multiple errors)	8	14.5%
TOTAL	**55**	**100.0%**

Case 13

Multiple errors made in the collection and administration procedure

A transfusion practitioner was carrying out a bedside audit and saw two qualified nurses checking a unit of blood at the nurses' station and not at the patient's bedside. They had signed the fating ticket, which states the patient has received the blood and the peel off label, which indicates two independent bedside checks have been carried out. No pre-transfusion observations were performed, no equipment had been made ready in preparation for the transfusion, blood had been out of the refrigerator 30 minutes before transfusion commenced, so blood charted for transfusion over 4 hours would have been out of refrigerator >4 hours. The transfusion practitioner was informed by 5 qualified nurses on duty that checking the blood in this manner was what they were told by their manager to do.

Actions taken: The transfusion practitioner raised concerns about these events to the Hospital Transfusion Committee (HTC), Patient Safety & Quality Committee, Risk Management Team and Head of Service. The transfusion practitioner held a meeting with qualified nurses and the Ward Manager regarding correct procedure, handouts were given out to reinforce the information. All staff are to redo collection and administration competency relevant to their clinical status.

Expired components still available n=70

Reports were made of 70 near miss incidents where expired components were available, which is an increase from 29 cases in 2010. Most of these, 59 of 70 (84.3%), were time expired, i.e. units available past their expiry date and time. A further 8 of 70 were erroneously held beyond their normal reservation period and another 3 of 70 were available past the time at which the sample was no longer suitable for compatibility testing according to the BCSH guidelines for compatibility procedures in blood transfusion laboratories[37]

Table 25.12 Categories of errors related to expired components being available

Reasons for expired components being available	Number of cases	Percentage of cases
Time expired component available	59	84.3%
Available past dereservation date/time	8	11.4%
Outside sample suitability	3	4.3%
TOTAL	**70**	**100.0%**

Errors related to management of the cold chain n=100

Table 25.13 Categories of errors related to management of the cold chain

Cold chain error	Number of cases	Percentage of cases
Units kept in transport container for longer than the recommended period, including 3 cases where units were delivered to the incorrect location	23	23%
Attempts to return units to stock, which had been out of a temperature controlled environment >30 minutes	21	21%
Red cells stored in a non-designated refrigerator	12	12%
Platelets stored in a refrigerator	8	8%
Incomplete audit trails	8	8%
Refrigerator alarms unheeded/muted (of which only 1 was not a satellite refrigerator)	7	7%
Failure to follow procedure for transfer of units with the patient	6	6%
Incorrect packaging of transport containers	5	5%
Satellite refrigerator failures	3	3%
Red cells placed in a satellite refrigerator known to be malfunctioning (alarming/awaiting engineer)	1	1%
Other	6	6%
Total	**100**	**100.0%**

The category 'Incomplete audit trail' includes failure to change temperature charts on refrigerators or not following procedure when signing units into satellite refrigerators.

Several of the cases classified as out of temperature control for >30 minutes were actually incidents where units were 'found' a significant amount of time after issue, often having remained unnoticed within a clinical area for a long time, sometimes stretching to days.

Case 14

Unused unit supposedly wasted was left on the ward for another day

A patient was issued 4 units of blood at 15:00 after admission to Accident and Emergency (A&E) for an acute gastrointestinal bleed. The patient was taken to endoscopy and transfused 3 units en route and during investigation. Then the patient was transferred to the gastroenterology ward, where a staff nurse found 1 unit left 6½ hours later, so called the laboratory. The nurse was told to dispose of the unit and the laboratory updated the status of the unit as wasted. At 17.00 the following day a staff nurse called the laboratory saying a doctor had handed her a unit of blood to transfuse to the patient, who was in peri-arrest, but it had no paperwork, so she was reluctant to give it, in spite of the doctor's insistence. The laboratory checked the number and found it was the unit that had been 'wasted' the previous day, but had instead been left on the ward for a further 19½ hours, 26 hours in total after the blood had originally been issued.

Near misses related to haemopoietic stem cell transplants

A number of the near misses, 17/1080, related to patients who were undergoing a haemopoietic stem cell transplant (HSCT). Although this is not a large percentage overall, it is worth highlighting that this is a growing area leading to confusion and can be compounded by the lack of communication between healthcare professionals, especially where patients are post allogeneic transplant which has changed their blood group.

These cases are included in the relevant classifications above, but are summarised here to highlight the errors made:

- 5 components were selected with an unsuitable ABO type.
- 1 component was selected with an unsuitable RhD type.
- 1 was a compound error starting with a WBIT, which then led to discovery that the correct patient was post HSCT, so their historical grouping record would also not have matched a recently taken sample, meaning the discovery of a WBIT was especially fortuitous.
- 10 were potential special requirements not met.

Learning point

- Special attention should be paid to patients undergoing haemopoietic stem cell transplants (HSCT) because this can cause confusion when requesting or selecting components. A transplant timetable with clear instructions about blood groups and transfusion should be part of the routine transplant protocol.

Blood service adverse events n=10

These 10 near misses that originated from the Blood Services have been included in the relevant classifications above, but are listed here for information.

- No ‘Rad-Sure’ irradiation indicator attached to a supposedly irradiated unit
- 2 cases of incomplete phenotype
- Wrong phenotype
- Heat seal damage
- Haemolysed unit
- K negative units not selected
- Wrong ABO group for an HLA matched platelet
- Incorrect typing on a unit sent to the frozen blood bank
- Platelet issued for the wrong patient

Categorisation of near misses according to SHOT definitions

The near miss events have been categorised in table 25.14 according to the category they would probably have been placed in had the error not been identified.

Classifications have been restricted to near misses of adverse events, but the end result of some of the errors made could have led to clinical pathological reactions such as haemolytic transfusion reactions (e.g. where inappropriate components were selected, including ABO incompatible) or transfusion-associated circulatory overload (e.g. where inaccurate results were used to request components). Other pathological sequelae could have resulted including antibody production; most notably immune anti-D if not protected by prophylactic anti-D immunoglobulin and, although very rare, transfusion-associated graft versus host disease (TA-GvHD) remains a potential risk for patients not receiving irradiated components.

Table 25.14 Near misses classified by probable SHOT category

SHOT category	Number of cases	Percentage of cases
IBCT-WBIT	469	43.4%
IBCT-WCT	195	18.1%
HSE	174	16.1%
IBCT-SRNM	90	8.3%
I&U	71	6.6%
RBRP	61	5.6%
Anti-D	20	1.9%
Total	**1080**	**100.0%**

COMMENTARY

The root causes of these near misses are similar to those found in actual transfusion errors as discussed in other chapters. Common causes are lack of knowledge or not following SOPs correctly and these issues are sometimes compounded by staff following practices common in a previous employment, but not part of the SOPs in their current establishment. A recurring theme is the effect of distraction leading to a loss of concentration.

Sixteen of the near miss reports indicate there was a delay to treatment of the patient and in one case a unit of O RhD negative emergency blood was given as a result of the delay. There is insufficient information to know whether a small number of such cases might have more appropriately been reported in the category of Inappropriate, Unnecessary, Under and Delayed (I&U) Transfusion. Although the errors reported in this chapter were spotted before transfusing, hence categorised as a near miss, some patients may have been adversely affected by the consequent delay to getting the correct components ready for transfusion.

Recommendations

No new recommendations

Recommendations active from last year:

- All Trusts must ensure that medical staff are trained and competency assessed for taking blood samples in accordance with the requirements of National Patient Safety Agency (NPSA) safer practice notice (SPN) 14[21].

  Action: Deaneries, clinical risk managers, Hospital Transfusion Teams (HTTs)

- Education for staff involved in the transfusion process should include knowledge of the correct storage conditions for all blood components.

  Action: HTTs

- Each Trust should possess a policy and procedure for the transfer of blood components with a patient which reflects the guidance given by the National Blood Transfusion Committee (NBTC) and the NHSBT Appropriate Use of Blood Group[96]. There is also guidance on transfer of stocks between hospitals that Medicines and Healthcare products Regulatory Agency (MHRA) have provided with clarification and guidance regarding Blood Safety and Quality Regulations (BSQR) requirements and compliance which is available as follows: http://www.transfusionguidelines.org.uk/index.aspx?pageid=7722&section=23&publication=REGS&Highlight=transfer

  Action: Hospital Transfusion Committees (HTCs)

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References

1. European 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 (Text with EEA relevance) Official Journal L 256 , 01/10/2005 P. 0032 - 0040. *http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2005:256:0032:01:EN:HTML* 2005.

2. European Commission. 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. . *http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32002L0098:EN:NOT* 2003.

3. European Commission. Directive 2004/33/EC Commission of 22 March 2004 implementing Directive 2002/98/EC of the European Parliament and of the Council as regards certain technical requirements for blood and blood components (Text with EEA relevance). *http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32004L0033:en:NOT* 2004.

4. European Commission. Directive 2005/62/EC of 30 September 2005 implementing Directive 2002/98/EC of the European Parliament and of the Council as regards Community standards and specifications relating to a quality system for blood establishments (Text with EEA relevance). Official Journal L 256 , 01/10/2005 P. 0041 - 0048. *http://eur-lex.europa.eu/Notice.do?val=412535:cs&lang=en&list=570176:cs,562144:cs,506932:cs,503373:cs,428540:cs,426440:cs,412535:cs,412534:cs,343174:cs,&pos=7&page=1&nbl=9&pgs=10&hwords=&checktexte=checkbox&visu=#texte* 2005.

5. CPA. Standards for the medical laboratory. *http://www.cpa-uk.co.uk/files/PD-LAB-Standards_v2.02_Nov_2010.pdf 2010*

6. Health Service Circular. Better Blood Transfusion (archived): Department of Health, 1998. *http://www.dh.gov.uk/prod_consum_dh/groups/dh_digitalassets/@dh/@en/documents/digitalasset/dh_4011919.pdf*

7. Health Service Circular. Better Blood Transfusion Appropriate Use of Blood. *http://www.dh.gov.uk/prod_consum_dh/groups/dh_digitalassets/@dh/@en/documents/digitalasset/dh_4012293.pdf* 2002

8. Health Service Circular. Better Blood Transfusion-Safe and Appropriate use of Blood HSC 2007/001. *http://www.dh.gov.uk/prod_consum_dh/groups/dh_digitalassets/documents/digitalasset/dh_080803.pdf* 2007.

9. Welsh Assembly Government . Doing Well, Doing Better. Standards for Health Services in Wales. *http://www.wales.nhs.uk/sites3/Documents/919/ENGLISH%20WEB%20VERSION.pdf* 2010.

10. Healthcare Improvement, Scotland . NHS Quality Improvement Scotland (2006). Clinical Standards: Blood Transfusion (Standard Statement 4b). *http://www.healthcareimprovementscotland.org/previous_resources/standards/blood_transfusion.aspx* 2006.

11. Stainsby D (Ed.), Cohen H, Jones H, Todd A, Knowles S, et al. on behalf of the Serious Hazards of Transfusion (SHOT) Steering Group. SHOT Annual Report 2001/2002 (2003). *http://www.shotuk.org*

12. Knowles S (Ed.) and Cohen H on behalf of the Serious Hazards of Transfusion (SHOT) Steering Group. The 2010 Annual SHOT Report (2011):1-146. *http://www.shotuk.org*

13. BCSH. Tinegate H, Birchall J. et al. BCSH Guideline on the investigation and management of acute transfusion reactions. In preparation 2012.

14. BCSH.Harris AM, Atterbury C, et al. Guideline on the Administration of Blood Components. *http://www.bcshguidelines.com/documents/Admin_blood_components_bcsh_05012010.pdf* bcshguidelines.com: BCSH, 2010.

15. Popovsky MA, Robillard P, Schippers M, Stainsby D, Tissot JD, Wiersum J. ISBT Working Party on Haemovigilance. Proposed standard definitions for surveillance of non-infectious adverse transfusion reactions. *http://www.ihn-org.com/wp-content/uploads/2011/06/ISBT-definitions-for-non-infectious-transfusion-reactions.pdf* 2011(accessed 2 March 2012).

16. Keidan AJ. Routine Antenatal Anti-D Prophylaxis. Transfus Med 2012; Transfus Med 2012; 22(3):217

17. Bolton-Maggs P. Commentary on Keidan 2012 - routine antenatal anti-D prophylaxis - is the protection adequate? Transfus Med 2012; Transfus Med 2012; 22(3):155

18. Davies J, Chant R, Simpson S, Powell R. Routine antenatal anti-D prophylaxis--is the protection adequate? Transfus Med 2011;21(6):421-6.

19. BCSH Keeling D, Baglin TP, Tait C, et al. Guidelines on oral anticoagulation with warfarin - fourth edition. Br J Haematol 2011;154(3):311-324..

20. SaBTO. Patient Consent for Blood Transfusion. *http://www.dh.gov.uk/prod_consum_dh/groups/dh_digitalassets/@dh/@ab/documents/digitalasset/dh_130715.pdf* 2011.

21. NPSA. NPSA Safer Practice Notice 14, Right Patient Right Blood. *http://www.nrls.npsa.nhs.uk/resources/collections/right-patient-right-blood/*, 2006.

22. NPSA. NPSA Rapid Response Report RRR017. The transfusion of blood and blood components in an emergency. *http://www.nrls.npsa.nhs.uk/resources/?entryid45=83659&p=4*: NPSA, 2010.

23. Chaffe B, Jones J, et al. UK Transfusion Laboratory Collaborative: recommended minimum standards for hospital transfusion laboratories. Transfus Med 2009; 19(4):156-8.
Chaffe B, Jones J, Milkins C, Taylor C, Asher D, Glencross H, Murphy M, Cohen H. Recommended minimum standards for hospital transfusion laboratories – UK Transfusion Laboratory Collaborative. Biomedical Scientist 2010; 54(10): 711–712.

24. Taylor C (Ed.), Cohen H, Mold D, Jones H et al. on behalf of the Serious Hazards of Transfusion (SHOT) Steering Group. The 2008 Annual SHOT Report (2009):82-89. *http://www.shotuk.org*

25. DH. The 'never events' list 2011/2012. *http://www.dh.gov.uk/prod_consum_dh/groups/dh_digitalassets/documents/digitalasset/dh_124580.pdf* 2011.

26. BCSH. Treleavan J, Gennery A, et al. Guidelines on gamma irradiation of blood components for the prevention of transfusion-associated graft-versus-host disease. BCSH Blood Transfusion Task Force. Transfus Med 1996;6(3):261-71.

27. Taylor C (Ed.), Cohen H, Mold D, Jones H et al. on behalf of the Serious Hazards of Transfusion (SHOT) Steering Group. The 2009 Annual SHOT Report (2010). *http://www.shotuk.org*

28. Haynes AB, Weiser TG, Berry WR, Lipsitz SR, Breizat AH, Dellinger EP, et al. A surgical safety checklist to reduce morbidity and mortality in a global population. N Engl J Med 2009;360(5):491-9.

29. Talbot M. Monkey see, monkey do: a critique of the competency model in graduate medical education. Medical Education 2004;38:580-81.

30. Royal College of Anaesthetists. Curriculum for Higher Specialist Training in Anaesthetics *http://www.gmc-uk.org/CCT_in_Anaesthetics_Aug_2010__2_.pdf_32486124.pdf* 2010.

31. NCA. National Comparative Audit of Blood Transfusion - Re-audit of bedside transfusion practice *http://hospital.blood.co.uk/library/pdf/NCA_2011_bedside_tx_re-audit_report.pdf* 2011:1-75.

32. Watson D, Murdock J, et al. Blood transfusion administration-one- or two-person checks: which is the safest method? Transfusion 2008;48(4):783-9.

33. SaBTO. Cytomegalovirus tested blood components - position statement *http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH_132965* 2012.

34. BCSH Treleaven J, Gennery A, et al. Guidelines on the use of irradiated blood components prepared by the British Committee for Standards in Haematology blood transfusion task force. Br J Haematol 2011;152(1):35-51.

35. Taylor C (Ed.), Cohen H, Jones H et al. on behalf of the Serious Hazards of Transfusion (SHOT) Steering Group. The 2007 Annual SHOT Report (2008):65-70. *http://www.shotuk.org*

36. BCSH. Guidelines for compatibility testing. In preparation 2012.

37. BCSH, Chapman JF, Elliott C, et al. Guidelines for compatibility procedures in blood transfusion laboratories. Transfus Med 2004;14(1):59-73.

38. Murphy M, Taylor C, Hyare J, Newland AC, Little T. Survey of IT Systems in Blood Transfusion Laboratories (July/August 2011)
http://www.transfusionguidelines.org.uk/docs/pdfs/nbtc_bbt_survey_it_2011v2.pdf 2011.

39. BCSH. Allard S, Burgess G, et al.. BCSH guidelines for validation & qualification, including change control, for hospital transfusion laboratories. Transfus Med 2012;22:5-43.

40. MHRA. Guidance on Electronic Issue.
http://www.mhra.gov.uk/Howweregulate/Blood/index.htm 2010.

41. BCSH. Guidelines on the insertion and management of central venous lines. Br J Haematol 1997;98(4):1041-7. (archived guideline)

42. Leonard A, Thompson J. Anaesthesia for ruptured abdominal aortic aneurysm. Continuing Education in Anaesthesia, Critical Care and Pain 2008;8(1):11-15.

43. BCSH. Murphy M, Brown M, et al. Guidelines for the use of platelet transfusions. Br J Haematol 2003;122(1):10-23.

44. Lumadue JA, Boyd JS, Ness PM. Adherence to a strict specimen-labeling policy decreases the incidence of erroneous blood grouping of blood bank specimens. Transfusion 1997;37(11-12):1169-72.

45. BCSH. Murphy M, Atterbury CL, et al. The administration of blood and blood components and the management of transfused patients. Transfus Med 1999;9(3):227-38. (Archived guideline)

46. Scotland HI. Documentation for transfusion components.
http://www.healthcareimprovementscotland.org/previous_resources/implementation_support/blood_transfusion_record.aspx 2010.

47. Brunskill S, Thomas S, et al. What is the maximum time a unit of RBCs can safely be left out of controlled temperature storage? Transfus Med Rev 2012.(in press)

48. BSQR. The Blood Safety and Quality Regulations.
http://www.opsi.gov.uk/si/si2005/20050050.htm 2005.

49. Resuscitation Council (UK) . Emergency treatment of anaphylactic reactions.
http://www.resus.org.uk/pages/reaction.pdf 2008

50. NICE. Clinical Guideline 134. Anaphylaxis: assessment to confirm an anaphylactic episode and the decision to refer after emergency treatment for a suspected anaphylactic episode.
http://publications.nice.org.uk/anaphylaxis-assessment-to-confirm-an-anaphylactic-episode-and-the-decision-to-refer-after-emergency-cg134 2011.

51. Latiff AH, Kerr MA. The clinical significance of immunoglobulin A deficiency. Ann Clin Biochem 2007;44(Pt 2):131-9.

52. Payne V, Kam PC. Mast cell tryptase: a review of its physiology and clinical significance. Anaesthesia 2004;59(7):695-703.

53. Robson P, Lucas G, Green F, Bourn R, Massey E. The investigation of severe non-haemolytic febrile transfusion reactions: an audit of adherence to NBS guidelines.
http://www.optimalblooduse.eu/_assets/pdf/39_UK%20Report%20AUDIT%20OF%20TRANSFUSION%20REACTIONS.pdf 2008.

54. Dewachter P, Castro S, et al. Anaphylactic reaction after methylene blue-treated plasma transfusion. Br J Anaesth 2011;106(5):687-9.

55. Padmore RF. Hemolysis upon intravenous immunoglobulin transfusion. Transfus Apher Sci 2012;46(1):93-6.

56. Kahawaji J, Barker E, et al. Acute Hemolysis after high-dose intravenous immunoglobulin therapy in highly HLA sensitised patients. Clin J Am Soc Nephrol 2009;4:1993-97.

57. Daw Z, Padmore R, et al. Hemolytic transfusion reactions after administration of intravenous immune (gamma) globulin: a case series analysis. Transfusion 2008;48(8):1598-601.

58. EU. Human normal immunoglobulin for intravenous administration.and the method as 'Anti-A and anti-B haemagglutinins, Method B: direct method. General Chapter 2.6.20. European Pharmacopoeia. Strasbourg: Council of Europe, 2012.

59. European Medicines Agency. Guidelines on core SmPC for human normal immunoglobulin for intravenous use (IVIg). EMA/CHMP/BPWP/94038/2007 rev 3 2010.

60. Kleinman S, Caulfield T, et al. Towards an understanding of transfusion-related acute lung injury: statement of a consensus panel. Transfusion 2004;44( ):1774-89.

61. Goldman M, Webert KE, et al. Proceedings of a consensus conference: towards an understanding of TRALI. Transfus Med Rev 2005;19(1):2-31.

62. Bolton-Maggs PH, Perry DJ, et al. The rare coagulation disorders--review with guidelines for management from the United Kingdom Haemophilia Centre Doctors' Organisation. Haemophilia 2004;10(5):593-628.

63. McClelland DBL (Editor). Handbook of Transfusion Medicine. *http://www.transfusionguidelines.org.uk/docs/pdfs/htm_edition-4_all-pages.pdf* 2007.

64. Murphy M. Post-transfusion purpura. In: Murphy M, Pamphilon D, editors. Practical Transfusion Medicine. 3rd ed: Wiley-Blackwell, 2009:117-21.

65. JPAC. Joint UKBTS/NIBSC Professional Advisory Committee Position Statement Creutzfeld-Jacob Disease. *http://www.transfusionguidelines.org.uk/Index.aspx?Publication=DL&Section=12&pageid=794* 2010.

66. Blajchman MA, Beckers EA, Dickmeiss E, Lin L, Moore G, Muylle L. Bacterial detection of platelets: current problems and possible resolutions. Transfus Med Rev 2005;19(4):259-72.

67. HPA. Safe Supplies: Focusing on Epidemiology. Annual Review from the NHS Blood and Transplant/Health Protection Agency Colindale Epidemiology Unit 2010. *http://www.hpa.org.uk/Topics/InfectiousDiseases/ReferenceLibrary/BIBDReferences/* 2011.

68. Ijaz S, Vyse AJ, Morgan D, Pebody RG, Tedder RS, Brown D. Indigenous hepatitis E virus infection in England: more common than it seems. Journal of clinical virology : the official publication of the Pan American Society for Clinical Virology 2009;44(4):272-6.

69. MHRA. One liners issue 82. *http://www.mhra.gov.uk/Publications/Safetyguidance/OneLiners/CON105973* 2011.

70. MHRA. 'one liners'. *http://www.mhra.gov.uk/Publications/Safetyguidance/OneLiners/index.htm*

71. UK Intraoperative Cell Salvage Group . Policy for the provision of Intraoperative Cell Salvage. *http://www.transfusionguidelines.org.uk/docs/misc/bbt-03_icsag-policy-v11.doc* 2007.

72. Christensen RD, Lambert DK, Gordon PV, Baer VL, Gerday E, Henry E. Neonates presenting with bloody stools and eosinophilia can progress to two different types of necrotizing enterocolitis. J Perinatol. 2011 Nov 10. doi: 10.1038/jp.2011.163. 2011.

73. Blau J, Calo JM, Dozor D, Sutton M, Alpan G, La Gamma EF. Transfusion-related acute gut injury: necrotizing enterocolitis in very low birth weight neonates after packed red blood cell transfusion. J Pediatr 2011;158(3):403-9.

74. NCA. National Comparative Audit Re-audit of the use of platelets in haematology. *http://hospital.blood.co.uk/library/pdf/Platelet_Re-audit_report-St_Elsewheres_NHS_Foundation_Trust_2010.pdf* 2010

75. Drasar E, Igbineweka N, et al. Blood transfusion usage among adults with sickle cell disease - a single institution experience over ten years. Br J Haematol 2011;152(6):766-70.

76. Jordan LC, Casella JF, Debaun MR. Prospects for primary stroke prevention in children with sickle cell anaemia. Br J Haematol 2012. In press.

77. UKTS. Standards for the Clinical Care of Children and Adults with Thalassaemia in the UK. *http://www.ukts.org/pdfs/awareness/standards/ukts-standards-2008.pdf* 2008.

78. Hebbel RP. Reconstructing sickle cell disease: a data-based analysis of the "hyperhemolysis paradigm" for pulmonary hypertension from the perspective of evidence-based medicine. Am J Hematol 2011;86(2):123-54.

79. Vichinsky EP, Luban NL, Wright E, Olivieri N, Driscoll C, Pegelow CH, et al. Prospective RBC phenotype matching in a stroke-prevention trial in sickle cell anemia: a multicenter transfusion trial. Transfusion 2001;41(9):1086-92.

80. Pham BN, Peyrard T, Juszczak G, Beolet M, Deram G, Martin-Blanc S, et al. Analysis of RhCE variants among 806 individuals in France: considerations for transfusion safety, with emphasis on patients with sickle cell disease. Transfusion 2011;51(6):1249-60.

81. Campbell-Lee SA. Red blood cell alloimmunization in sickle cell anemia: more questions than answers? Transfusion 2012;52(2):214-6.

82. de Montalembert M, Dumont MD, Heilbronner C, Brousse V, Charrara O, Pellegrino B, et al. Delayed hemolytic transfusion reaction in children with sickle cell disease. Haematologica 2011;96(6):801-7.

83. Garratty G. What do we mean by "hyperhaemolysis" and what is the cause? Transfus Med 2012;22(2):77-9.

84. Win N, Lee E, Needs M, Chia LW, Stasi R. Measurement of macrophage marker in hyperhaemolytic transfusion reaction: a case report. Transfus Med 2012;22(2):137-41.

85. Babb A, Diamantos N, Sekhar M. Hyperhaemolysis syndrome treated with corticosteroids and darbopoietin in a patient with mantle cell lymphoma. Transfus Med 2012;22(2):142-4.

86. Bank I, Ermens AA, Van Der Linden JM, Brand A. A life-threatening episode of treatment-resistant haemolysis in a pregnant patient with dyserythropoietic anaemia (CDA) type I. Transfus Med 2012;22(2):145-7.

87. Win N, Yeghen T, Needs M, Chen FE, Okpala I. Use of intravenous immunoglobulin and intravenous methylprednisolone in hyperhaemolysis syndrome in sickle cell disease. Hematology 2004;9(5-6):433-6.

88. Sickle Cell Society. Standards for the Clinical Care of Adults with Sickle Cell Disease in the UK. *http://www.sicklecellsociety.org/app/webroot/files/files/CareBook.pdf* Sickle Cell Society, 2008.

89. Dick M. Sickle Cell Disease in Childhood Standards and Guidelines for Clinical Care. 2nd ed: NHS Sickle Cell and Thalassaemia Screening Programme, 2010.

90. Verduzco LA, Nathan DG. Sickle cell disease and stroke. Blood 2009;114(25):5117-25.

91. Priddee NR, Pendry K, Ryan KE. Fresh blood for transfusion in adults with beta thalassaemia. Transfus Med 2011;21(6):417-20.

92. BSQR. Blood Safety and Quality (Amendment) (No.2) Regulations 2005 No. 2898 *http://www.legislation.gov.uk/uksi/2005/2898/contents/made* 2005.

93. MHRA. MHRA Blood Safety and Quality Report, 2010 *http://www.mhra.gov.uk/home/groups/dts-bs/documents/websiteresources/con146675.pdf* 2010.

94. Serious Adverse Blood Reactions and Events - SABRE. User guide for mandatory haemovigilance reporting in the UK, updated December 2010 Serious Adverse Blood Reactions and Events (SABRE) - User guide for mandatory haemovigilance reporting in the UK, updated December 2010 - *http://www.mhra.gov.uk* (full link = *http://www.mhra.gov.uk/home/groups/dts-aic/documents/websiteresources/con2022529.pdf*) 2010.

95. Dzik WS, Beckman N, Selleng K, Heddle N, Szczepiorkowski Z, Wendel S, et al. Errors in patient specimen collection: application of statistical process control. Transfusion 2008;48(10):2143-51.

96. Appropriate Use of Blood Group. Guidance for the Emergency Transfer of Blood and Components with Patients between Hospitals. *http://www.transfusionguidelines.org.uk/docs/pdfs/bbt_transfer_Blood_Guidance_Final_24311.pdf* 2011.

97. GMC Good Medical Practice 2012. http://www.gmc-uk.org/Good_Medical_Practice_2012___Draft_for_consultation.pdf_45081179.pdf Accessed May 24, 2012.

98. GMC. Raising and Acting on concerns about patient safety. http://www.gmc-uk.org/Raising_and_acting_on_concerns_about_patient_safety_FINAL.pdf_47223556.pdf Accessed May 24, 2012

99. James C. Doctors' duty to report poor practice. BMJ 2012; 344:e1695.

100. NMC Nursing and Midwifery Standards http://www.nmc-uk.org/Documents/Standards/The-code-A4-20100406.pdf Accessed May 24, 2012

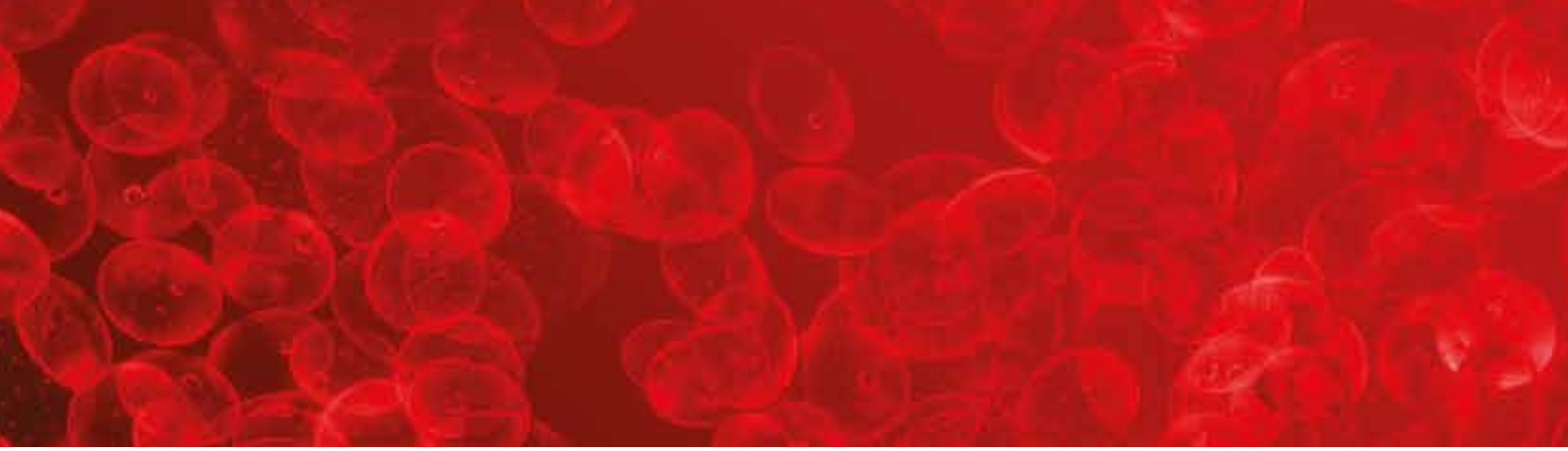
101. Dornan, T, Ashcroft D, Heathfield H. et al. An in depth investigation into causes of prescribing errors by foundation trainees in relation to their medical education. EQUIP study. Date accessed 31 May 2012. http://www.gmc-uk.org/FINAL_Report_prevalence_and_causes_of_prescribing_errors.pdf_28935150.pdf

Glossary

AAA	Abdominal aortic aneurysm
A&E	Accident and Emergency
AAGBI	Association of Anaesthetists Great Britain and Ireland
ACD	Acid citrate dextrose
ACE	Acetylcholinesterase
ACS	Acute coronary syndrome
ANC	Antenatal clinic
AHTR	Acute haemolytic transfusion reaction
AIHA	Auto immune haemolytic anaemia
ALI	Acute lung injury
ALL	Acute lymphoblastic leukaemia
AML	Acute myelotic leukaemia
ANH	Acute normovolaemic haemodilution
ARDS	Acute respiratory distress syndrome
ARF	Acute renal failure
ATD	Adult therapeutic dose
ATG	Anti-thymocyte globulin
ATR	Acute transfusion reaction
ATRA	All-trans retinoic acid
BBT	Better Blood Transfusion
BBTS	British Blood Transfusion Society
BCSH	British Committee for Standards in Haematology
BiPAP	Variable/bilevel positive airway pressure
BMI	Body Mass Index
BMS	Biomedical Scientist
BMT	Bone marrow transplant
BP	Blood pressure
bpm	Beats per minute
BS	Blood service
BSQR	Blood Safety and Quality Regulations
CABG	Coronary artery bypass graft
CAPA	Corrective and preventative actions
CCF	Congestive cardiac failure
CD	Component donation
CEO	Chief Executive Officer
CDC	Complement dependent cytotoxicity
CfH	Connecting for Health
CLL	Chronic lymphocytic leukaemia
CML	Chronic myeloid leukaemia
CMO	Chief Medical Officer
CMV	Cytomegalovirus
COPD	Chronic obstructive pulmonary disease
CPA	Clinical pathology accreditation
CPAP	Continuous positive airway pressure
CPR	Cardiopulmonary resuscitation
CRF	Chronic renal failure
Cryo	Cryoprecipitate
CS	Caesarean section or Cell salvage
CTS	Controlled temperature storage
CVP	Central venous pressure
CXR	Chest X-ray
DAT	Direct antiglobulin test
DAEDS	Donor adverse events of donation
DH	Department of Health
DHTR	Delayed haemolytic transfusion reaction
DIC	Disseminated intravascular coagulation
DNA	Deoxyribose nucleic acid
DOB	Date of birth
DSTR	Delayed serological transfusion reaction
DTR	Delayed transfusion reaction
DU	Duodenal ulcer
EBMS	Electronic blood management system
ECG	Electrocardiogram
ECHO	Echocardiogram
ECMO	Extracorporeal membrane oxygenation
ED	Emergency department
EDTA	Ethylenediaminetetraacetic acid
EDN	Electronic delivery note
EI	Electronic issue
ET	Exchange transfusion
EU	European Union
EWTD	European Working Time Directive
FBC	Full blood count
FFP	Fresh frozen plasma
FMH	Fetomaternal haemorrhage
FNHTR	Febrile non-haemolytic transfusion reaction
FY	Foundation year
G&S	Group & Save
GI	Gastrointestinal
GCS	Glasgow Coma Scale/Score
GMC	General Medical Council
GMP	Good Manufacturing Practice
GP	General Practitioner
Gynae	Gynaecology
HAV	Hepatitis A virus
Hb	Haemoglobin
HBV	Hepatitis B virus
HCV	Hepatitis C virus
HDFN	Haemolytic disease of the fetus and newborn
HDN	Haemolytic disease of the newborn
HDU	High dependency unit
HEV	Hepatitis E virus
HHTR	Hyper haemolytic transfusion reaction
HIV	Human immunodeficiency virus
HLA	Human leucocyte antigen
HNA	Human neutrophil antigen
HPA	Human platelet antigen or Health Protection Agency
HPLC	High-performance liquid chromotography
HSC	Health service circular
HSCT	Haemopoietic Stem Cell Transplant
HSE	Handling and storage errors
HT	High titre
HTC	Hospital Transfusion Committee
HTLV	Human T-cell leukaemia virus
HTR	Haemolytic transfusion reaction
HTT	Hospital Transfusion Team
I&U	Inappropriate, unnecessary, under/delayed transfusion
IAT	Indirect antiglobulin test
IBCT	Incorrect blood component transfused
IBGRL	International Blood Group Reference Laboratory

IBMS	Institute of Biomedical Science
ICS	Intraoperative cell salvage
ID	Identification
Ig	Immunoglobulin
IgAD	IgA deficency
iu	International units
IHD	Ischaemic heart disease
IHN	International Haemovigilance Network
IM	Intramuscular
INR	International Normalized Ratio
ISBT	International Society of Blood Transfusion
IT	Information technology
ITU	Intensive Therapy Unit
IUT	Intrauterine transfusion
IV	Intravenous
IVIg	Intravenous immunoglobulin
JVP	Jugular venous pressure
LDF	Leucocyte depletion filter
kPa	Kilo Pascal
LDH	Lactate dehydrogenase enzyme
LIMS	Laboratory information management system
LFT	Liver function test
LVF	Left ventricular failure
MAU	Medical assessment unit
MB-FFP	Methylene-blue fresh frozen plasma
MCT	Mast cell tryptase
MDS	Myelodysplastic syndrome
MHRA	Medicines and Healthcare products Regulatory Agency
MLA	Medical laboratory assistant
MOF	Multi-organ failure
NAITP	Neonatal alloimmune thrombocytopenia
NBTC	National Blood Transfusion Committee
NCA	National Comparative Audit
Neg	Negative
NHL	Non-Hodgkin's lymphoma
NHS	National Health Service
NHSBT	NHS Blood and Transplant
NIBTS	Northern Ireland Blood Transfusion Service
NICE	National Institute for Health and Clinical Excellence
NICU	Neonatal Intensive Care Unit
NISS	Normal ionic strength saline
NMC	Nursing and Midwifery Council
NNU	Neonatal unit
NOS	National occupational standards
NPSA	National Patient Safety Agency
NR	Normal range
NSAID	Non-steroidal anti-inflammatory drug
NWIS	NHS Wales Informatics Service
OAS	Optimal additive solution
OBOS	Online blood ordering system
Obs	Obstetric
OCP	Official contact person
ODP	Operating Department Practitioner
O&G	Obstetrics and Gynaecology
PAD	Preoperative autologous deposit
PAS	Platelet additive solution or Patient Administration System
PBSC	Peripheral blood stem cells
PCC	Prothrombin complex concentrate
PCR	Polymerase chain reaction
PCS	Postoperative cell salvage
PE	Pulmonary embolism
PEA	Pulseless electrical activity
PEX	Plasma exchange
PID	Patient identifiable data or Patient ID
PICU	Paediatric intensive care unit
PMETB	Postgraduate Medical Education Board
POCT	Point of care testing
Pos	positive
pO2	Partial pressure of oxygen
PPH	Post partum haemorrhage
PR	Per rectum
PSE	Potentially sensitising episode
PSM	Platelet suspension medium
PTP	Post-transfusion purpura
PUCT	Previously uncategorised complication of transfusion
PV	Per vaginum
RA	Rheumatoid arthritis
RAADP	Routine antenatal anti-D Ig prophylaxis
RBC	Red blood cells
RBCOA	Red blood cells in optimal additive solution
RBRP	Right blood right patient
RCA	Root cause analysis
RCI	Red cell immunohaemotology
RCP	Royal College of Physicians
RNA	Ribonucleic acid
RR	Respiratory rate
RTA	Road traffic accident
RTC	Regional transfusion committee or Road traffic collision
SABRE	Serious Adverse Blood Reactions and Events
SaBTO	Advisory Committee on Safety of Blood Tissues and Organs
SAE	Serious adverse event
SAR	Serious adverse reaction
SCA	Sickle cell anaemia
SCT	Stem cell transplant
SCTAC	Scottish Clinical Transfusion Advisory Committee
SD	Solvent detergent
SD-FFP	Solvent detergent treated fresh frozen plasma
SG	Steering Group
SHO	Senior house officer
SNBTS	Scottish National Blood Transfusion Service
SOB	Shortness of breath
SOP	Standard operating procedure
SPN	Safer practice notice
SpR	Specialist registrar
SRNM	Special requirements not met
TACO	Transfusion-associated circulatory overload
TAD	Transfusion-associated dyspnoea
TA-GvHD	Transfusion-associated graft versus host disease
THR	Total hip replacement
TKR	Total knee replacement
TP	Transfusion practitioner
TPH	Transplacental Haemorrhage
TRALI	Transfusion-related acute lung injury
TTI	Transfusion-transmitted infection
TTP	Thrombotic thrombocytopenic purpura
Tx	Transfusion (can also mean treatment)
U&E	Urea and Electrolytes
UK	United Kingdom
UK NEQAS BTLP	UK National External Quality Assessment Service for Blood Transfusion Laboratory Practice
UKTLC	UK Transfusion Laboratory Collaborative
UKRC	UK Resuscitation Council
vCJD	Variant Creutzfeld-Jakob Disease
WBIT	Wrong blood in tube
WBS	Welsh Blood Service
WCC	White cell count
WEG	Working Expert Group
WNOT	Wrong name on tube

Notes



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