Avoidable, Delayed or Under/ Overtransfusion (ADU) and Incidents Related to Prothrombin Complex Concentrate (PCC) n=382

12

Authors: Paula Bolton-Maggs, Simon Carter-Graham, Catherine Booth, and Josephine McCullagh

Abbreviations used in this chapter

AAGBI	Association of Anaesthetists of Great Britain and Ireland	**ICH**	Intracranial haemorrhage
ADU	Avoidable, delayed or under/overtransfusion	**ICU**	Intensive care unit
BMS	Biomedical scientist	**INR**	International normalised ratio
BSH	British Society for Haematology	**IR**	Interventional radiology
CAS	Central alerting system	**IT**	Information technology
CT	Computed tomography	**MHP**	Major haemorrhage protocol
DOAC	Direct acting oral anticoagulant	**NHSE**	National Health Service England
ED	Emergency department	**PCC**	Prothrombin complex concentrate
FBC	Full blood count	**4F-PCC**	Four factor PCC
FFP	Fresh frozen plasma	**TACO**	Transfusion-associated circulatory overload
GI	Gastrointestinal	**TRALI**	Transfusion-related acute lung injury
Hb	Haemoglobin	**UK**	United Kingdom
		WBIT	Wrong blood in tube

Key SHOT messages

- Delays in blood component transfusion and PCC administration are often multifactorial and impact on patient safety
- Avoidable and overtransfusions could be reduced by improved management of haematinic deficiency
- Mistakes continue to be made with paediatric prescribing and administration
- Common contributory factors to reported incidents include suboptimal staffing levels, mismatched with workload, gaps in staff knowledge, poor staff training, failure to communicate effectively

Specific chapter-related recommendations are covered in the individual chapters. Only those applicable to all categories are covered here.

Recommendations

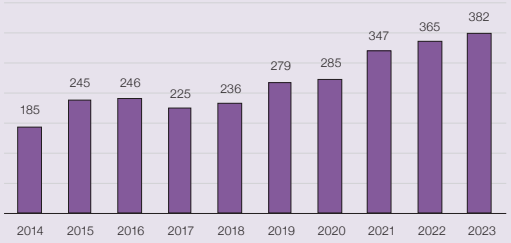
- Clear guidelines for patients being transferred between hospital departments, or between hospitals must be available and followed to ensure patient safety. This should include the need for adequately trained and skilled staff to supervise the transfer
- Major haemorrhage protocols should be reviewed and practiced end-to-end with drills to ensure that they are workable, and that staff are familiar with them

Action: Hospital chief executive officers, transfusion laboratory managers, hospital transfusion committees

Headline data 2023

Number of reports n=382
Deaths n=14
Major morbidity n=14

ADU reports by year



Demographic data

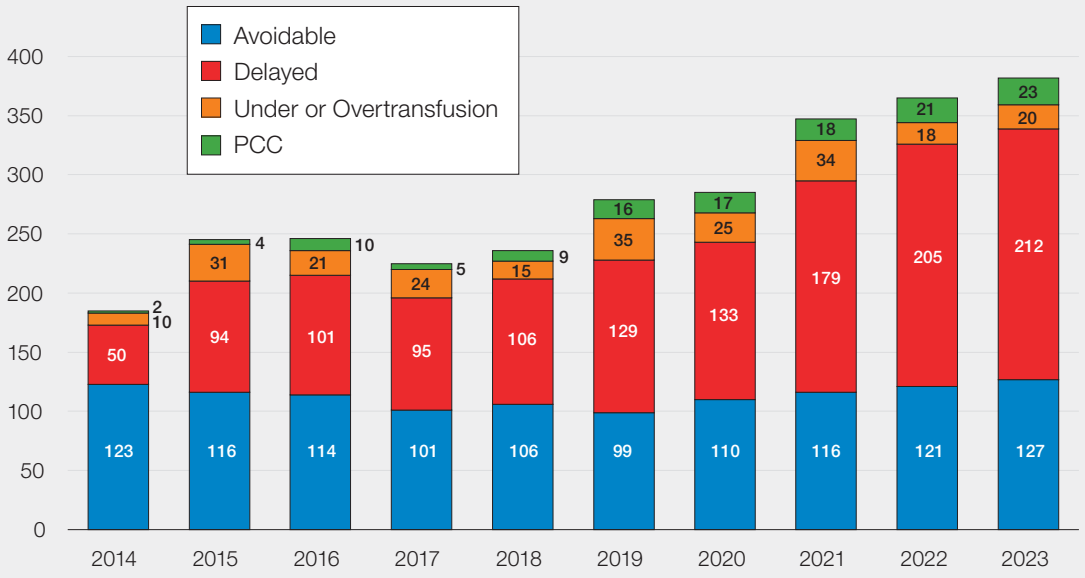
Male n=162
Female n=215
Unknown n=5

Adults n=331
Paediatric n=40
Unknown n=11

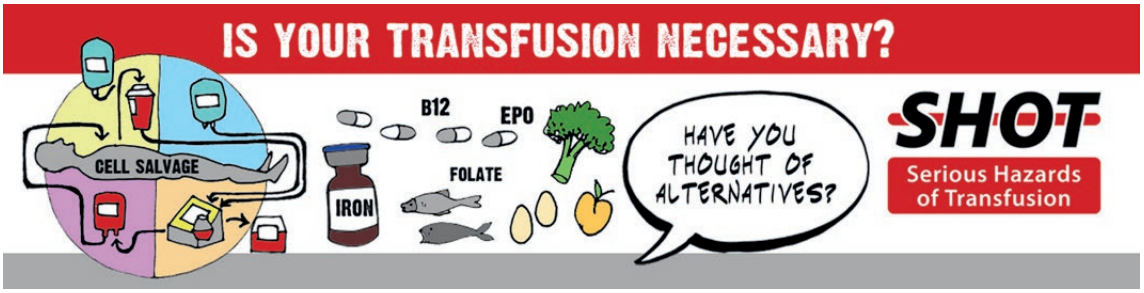
Blood component data

Red cells n=274
Platelets n=33
Plasma n=11
Multiple components n=25
PCC n=23
Granulocytes n=3
Cryoprecipitate n=1
Unknown n=12

Figure 12.1: ADU reports by category 2014-2023



PCC=prothrombin complex concentrates



Overview of ADU cases

Cases submitted to SHOT in the ADU categories have been increasing steadily in the recent years. The cases from 2023 are summarised in Table 12.1.

ADU category	Total cases	Deaths related to transfusion*	Major morbidity	Paediatric cases	Near miss cases
Delayed transfusions	212	9	12	23	0
Avoidable transfusions	127	0	0	8	3
Under or overtransfusion	20	1	2	9	1
Incidents related to PCC	23	4	0	0	0
Total	**382**	**14**	**14**	**40**	**4**

**There was 1 death that was definitely related to delayed PCC (imputability 3), and 3 deaths due to delays that were probably related (imputability 2). The remaining 10 deaths were possibly related to transfusion (imputability 1)*

Table 12.1: Overview of ADU cases in 2023 (n=382)

Problems with MHP activations n=65

In 65 cases, errors related to activation of the MHP were reported (28 of these occurred out-of-hours):

- 50 delays (2 deaths possibly related)
- 12 avoidable including 10 instances with use of O D-negative red cells
- 1 undertransfusion
- 2 overtransfusion (1 death possibly related)

For more information, analysis, and case studies on problems with MHP activations, please see the supplementary information on the SHOT website (https://www.shotuk.org/shot-reports/report-summary-and-supplement-2023/).

Recommended resources

Avoidable, Delay and Under or Overtransfusion (ADU) Cumulative Data
https://www.shotuk.org/resources/current-resources/data-drawers/avoidable-delay-and-under-or-overtransfusion-adu-cumulative-data/

12a Delayed Transfusions n=212

Authors: Paula Bolton-Maggs, Josephine McCullagh, Simon Carter-Graham

Definition:

Where a transfusion of a blood component was clinically indicated but was not undertaken or non-availability of blood components led to a significant delay (e.g., that caused patient harm, resulted in admission to ward, or return on another occasion for transfusion).

Key SHOT messages

- Poor communication at multiple points during the patient's care is common and exacerbates delays
- Delayed recognition of bleeding increases morbidity and mortality. Low blood pressure should alert clinicians to consider haemorrhage
- MHP are either not activated when indicated or not followed correctly
- Staffing issues contribute to delayed transfusions
- Lack of knowledge and awareness of correct procedures contributes to delays in transfusion

Recommendations

- Activation of MHP should be simple and standardised to avoid issues with hospital-specific procedures
- Hospitals should review their MHP and test them with drills and simulation to ensure they are fit for purpose. This should cover all the steps in the process from end-to-end and must include all staff groups involved
- MHP activations should be followed by a debrief with everyone involved to identify what went well and what could be improved
- Transfusion professionals should work closely with higher education institutes to ensure that the courses they are offering are fit for purpose and ensure all staff are equipped with the skills and knowledge they require to deliver safe transfusions

Action: Hospital transfusion committees, higher education institutes

Introduction

The number of delays in transfusion reported to SHOT has increased (n=212) when compared to the previous year (n=205) see Figure 12a.1. Incorrect activation of the MHP remains a key issue contributing to delays in transfusion, and this is consistent over the past 5 years. Increasing reports of delays prompted the publication of a CAS alert, with actions for hospitals (SHOT, 2022). A recent survey evaluating the effectiveness of the CAS national alert noted that 42% of responders did not have adequate resources to action the recommendations, and 71% identified staffing issues as the main barrier to implementing any actions. Inadequate staffing and poor skills mix in transfusion laboratories has increased over the last decade. See the 'Recommended resources' for a link to the survey report.

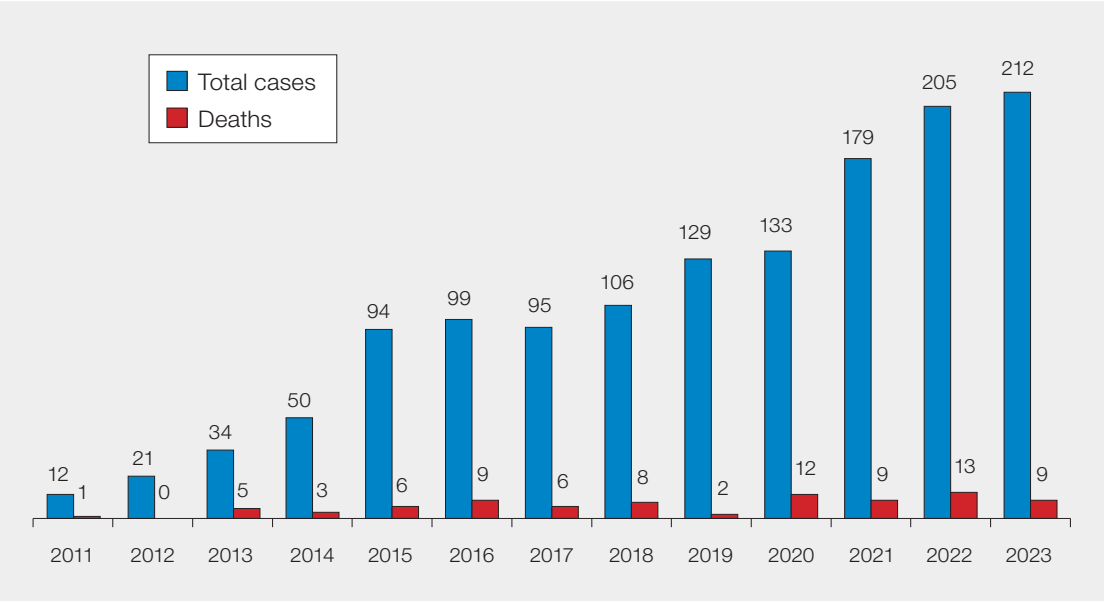


Figure 12a.1: Delayed transfusions by year 2011-2023

Deaths related to transfusion n=9

There were 9 deaths reported due to delays. This compares with 13 deaths in 2022 and 9 in 2021. More than half of all deaths were associated with delays in urgent or emergency transfusions for patients in the ED. Common themes were delays in decision-making and missing vital steps in the transfusion process due to lack of knowledge, training, and poor staffing levels. In 4 cases, there were transfusion delays in patients with acute bleeding. Three deaths were probably related (imputability 2) and 6 were possibly related (imputability 1) to the transfusion delay.

Case 12a.1: Delay in red cell transfusion in patient with a GI bleed awaiting a hospital bed contributes to death

An elderly patient with haematemesis, dark stool and shortness of breath was attended at home by a paramedic crew. The patient had tachycardia and was pale with low blood pressure. The patient was taken as an emergency to the ED. On arrival there were delays offloading from the ambulance due to lack of available space. Whilst still in the ambulance, the patient began to deteriorate and despite escalating care from the paramedics and a haemoglobin of 38g/L, treatment was delayed by more than 2 hours and the patient passed away from a cardiac arrest.

Case 12a.2: Lack of understanding on how to activate the MHP contributes to patient death

A patient with a perforated duodenal ulcer was being managed as an outlier in a COVID-19 bay. The clinical team caring for the patient identified that the patient was bleeding and there was a requirement for urgent blood components. Due to unfamiliarity with the management of MH, staff failed to correctly activate the MHP. Instead, a doctor instructed a nurse, not directly involved in this patient's care, to 'get blood' without conveying the urgency. Lack of vital information caused confusion between the laboratory staff and the nurse as to what was expected. The communication difficulties were compounded by lack of understanding among staff about how to activate the MHP. The patient was in a COVID-19 bay and the rarity of major bleeding in a ward environment caused delay in blood transfusion which contributed to the death of this patient.

One case resulted in the death of a patient due to incorrect laboratory procedures with delay in recognition and subsequent treatment. This involved a patient who presented with cytopenia with a delay in the diagnosis of acute promyelocytic leukaemia and died of bleeding. This case is described in detail in Chapter 15, Laboratory Errors (Case 15.1).

Learning points

- Failure to communicate urgency of requests leads to delays in blood component provision. Ensure that requests for samples and blood components are clear and that the urgency is stated
- Good handover is essential especially when serious bleeding occurs out-of-hours
- Recognition of bleeding is crucial for timely and appropriate treatment
- Laboratory staff working in transfusion must be adequately trained and competency-assessed, especially in identifying urgent cases when 'lone working' out-of-hours

Major morbidity n=12

Seven of 12 reports that resulted in major morbidity were associated with MHP and 10/12 were due to delays in urgent (2) or emergency (8) transfusion.

Delays associated with MHP n=50

There has been a general increase in the number of delays associated with MHP over the last few years of SHOT reporting, see Figure 12a.2.

Figure 12a.2: Number of delayed transfusions associated with MHP 2016-2023

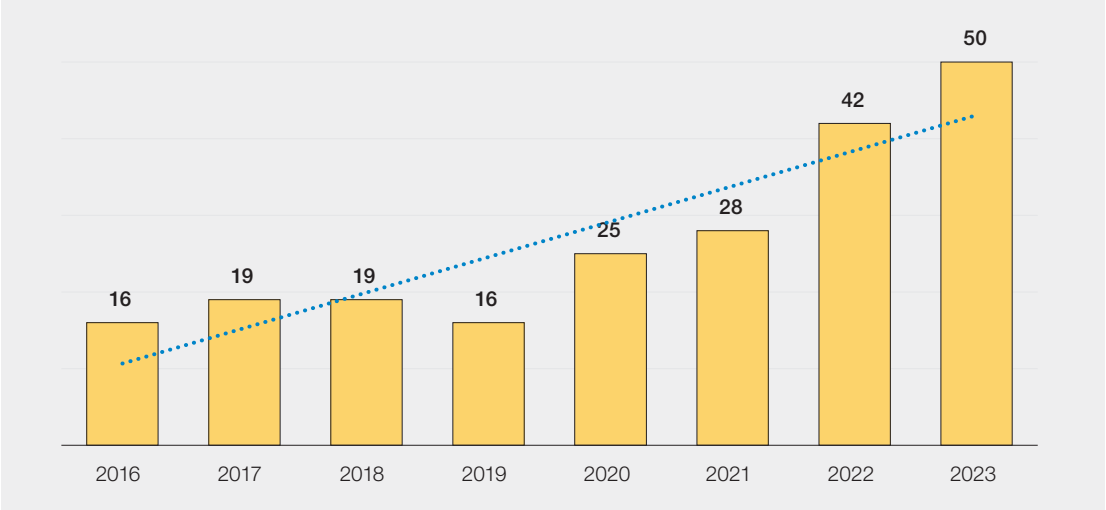


Figure 12a.3 illustrates the key factors contributing to delayed transfusion in major haemorrhage situations reported to SHOT in 2023.

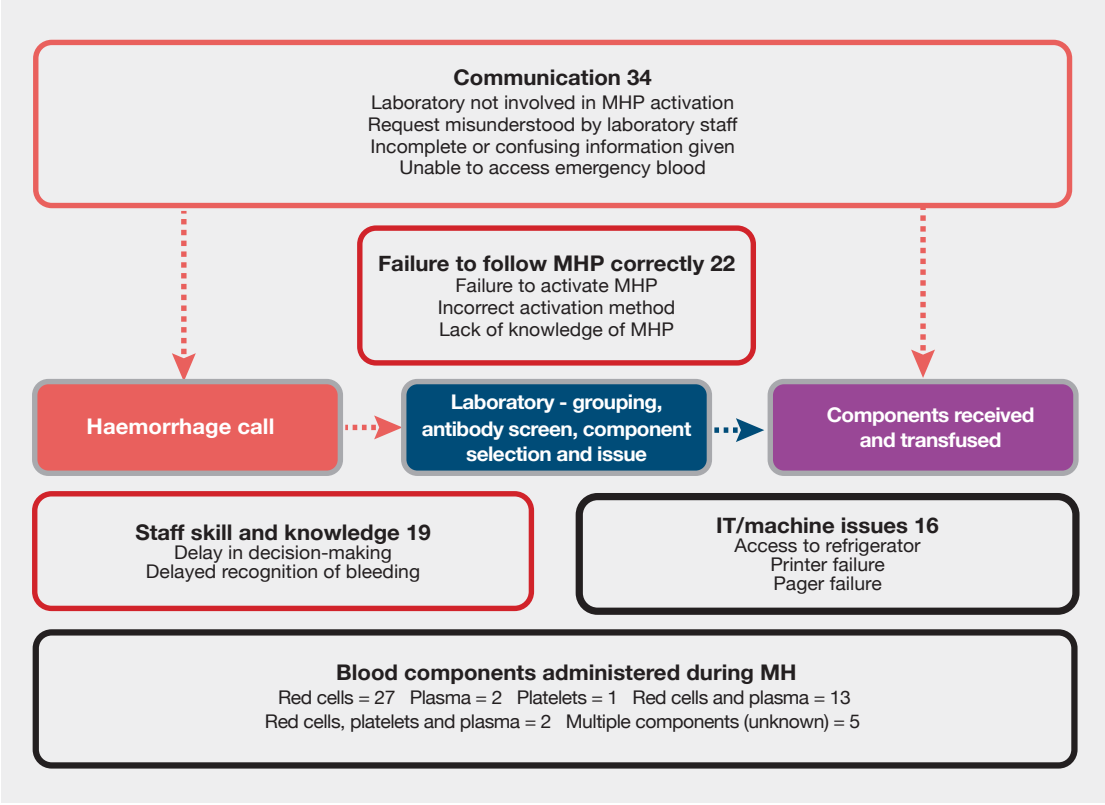


Figure 12a.3: Key factors contributing to delayed transfusions in major haemorrhage in 2023 (n=50)

MHP=major haemorrhage protocol; IT=information technology

Learning points

- Failure to communicate effectively in urgent situations causes unnecessary delays in transfusion
- MHP are either not activated when indicated or not followed correctly. Emergency procedures such as MHP should be simple and easy to follow

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Laboratory errors n=56

Laboratory errors discussed here cover both hospital transfusion laboratories and Blood Services. Key themes identified in laboratory errors resulting in delays were lack of knowledge and training of staff (n=17) and failure in effective communication (n=18).

Case 12a.3: A sample that did not meet acceptance criteria was sent to the Blood Service resulting in unnecessary delay in transfusion

An elderly person requiring transfusion for the treatment of chronic anaemia had a blood sample taken for group and screen. The sample was accepted by the hospital transfusion laboratory and referred to the laboratory in the Blood Service for further testing. The Blood Service staff telephoned the hospital laboratory to inform them that the surname on the sample did not match the surname on the request form and therefore the sample had been rejected. This required a repeat sample and caused a delay in the provision of red cells for the patient.

The labelling error should have been detected earlier in the process which would have avoided the delay.

Case 12a.4: BMS decided not to thaw cryoprecipitate due to previous high levels of wastage

The MHP was activated for a patient with major bleeding post-surgery. Cryoprecipitate was ordered as part of the initial 'Pack 1'. The BMS working in the transfusion laboratory decided not to thaw the cryoprecipitate because they had encountered wastage of frozen components in a previous shift. This decision resulted in a 75-minute delay in the issue of cryoprecipitate. The patient recovered and survived.

Case 12a.5: Printer failure caused delay in transfusion

The MHP was activated for a patient suffering from a GI bleed. There was a delay in the blood components being issued as the printer failed to print labels. The BMS did not realise that the printer had run out of labels and tried to reprint. The BMS contacted senior staff at home for advice. The printer was reloaded with labels, but they were misaligned. The patient was given two units of red cells after a 15-minute delay.

Laboratory staff failed to use backup label printer/emergency unit labels to allow issue of units in a timely manner.

Learning points

- Awareness of contingency/back up plans is essential to ensure smooth processes when technical issues arise
- Worries about component wastage should not result in delays in component provision especially in emergency situations
- Timely communication can prevent additional delays

Blood Service errors n=8

There were 8 reports due to Blood Service issues that resulted in delay in transfusion, an increase compared to 1 in the 2022 Annual SHOT Report (Narayan, et al., 2023).

Case 12a.6: Incorrect red cell units sent to the hospital results in delayed transfusion

Samples were sent from a hospital transfusion laboratory to a Blood Service reference laboratory for further testing and crossmatching of red cell units. The reference laboratory completed the testing but sent the blood components to the wrong hospital. This error resulted in a 2-hour delay in treatment.

Learning points

- Clear and adequate communication between Blood Service staff and hospital laboratory staff is essential to prevent miscommunication and to avoid delays in testing and supply of urgent blood components
- The risk of blood components being sent to the wrong location can be reduced by ensuring there are sufficient checks in place before sending blood components to hospitals transfusion laboratories

Conclusion

Patients should not die or suffer harm from transfusion delays. Poor communication, lack of staff knowledge and skills contributes to many cases of delay especially during major haemorrhage. The recommended actions in the SHOT CAS alert will help address preventable transfusion delays and improve patient safety (SHOT, 2022). Staffing levels and skill mix have been identified as barriers for effective implementation of the recommendations and must be addressed.

Recommended resources

SHOT Bite No. 8: Massive Haemorrhage Delays
https://www.shotuk.org/resources/current-resources/shot-bites/

SHOT Video: Delayed Transfusion in Major Haemorrhage
https://www.shotuk.org/resources/current-resources/videos/

SHOT Webinar: Every Minute Counts
https://www.shotuk.org/resources/current-resources/webinars/

2018 National Comparative Audit of Major Haemorrhage
https://hospital.blood.co.uk/audits/national-comparative-audit/reports-grouped-by-year/2018-audit-of-the-management-of-major-haemorrhage/

Can you PACE yourself? The power of language to flatten hierarchy and empower multi-disciplinary healthcare teams in simulated critical scenarios
https://www.gloshospitals.nhs.uk/work-for-us/training-staff/gsqia/quality-improvements/Can-you-PACE-yourself/

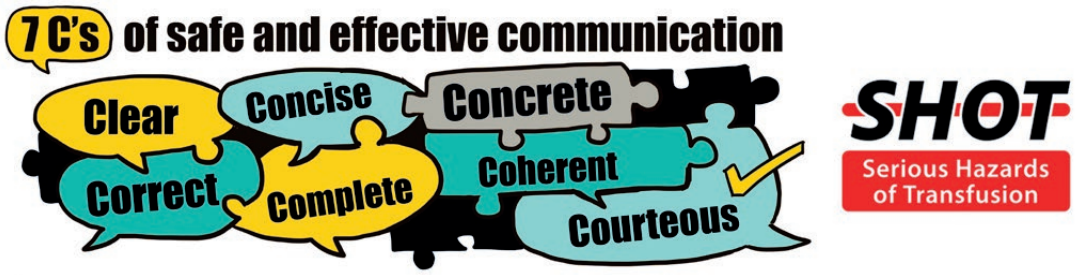
15s30m stands for 15 seconds, 30 minutes – taking a few extra seconds at the start of a process can save someone a lot of time further along, reducing frustration and increasing joy at work.
https://fabnhsstuff.net/fab-stuff/15-seconds-30-minutes

Transfusion 2024 – A 5-year Plan for Clinical and Laboratory Transfusion
https://www.nationalbloodtransfusion.co.uk/sites/default/files/documents/2023-03/Transfusion%202024%20Brochure%20FINAL%20%2811.12.2020%29.pdf

References

Narayan, S. et al., 2023. *The 2022 Annual SHOT Report,* Manchester: Serious Hazards of Transfusion (SHOT) Steering Group. doi: https://doi.org/10.57911/WZ85-3885.

Serious Hazards of Transfusion (SHOT), 2022. *Central Alerting System: Preventing transfusion delays in bleeding and critically anaemic.* [Online] Available at: https://www.cas.mhra.gov.uk/ViewandAcknowledgment/ViewAlert.aspx?AlertID=103190 (Accessed 08 April 2024).



12b Avoidable Transfusions n=127

Authors: Catherine Booth, Paula Bolton-Maggs and Simon Carter-Graham

Definition:

Where the intended transfusion is carried out, and the blood component itself is suitable for transfusion and compatible with the patient, but where the decision leading to the transfusion is flawed. Every unit transfused should be an individual decision, so this might include transfusion of multiple units where not all were appropriate/necessary.

Reporting should include:

- **Components that are not required or are inappropriate because of erroneous laboratory results, transcription errors, miscommunication, or faulty clinical judgement**
- **Components that are for an inappropriate indication**
- **Transfusion of an asymptomatic patient with haematinic deficiency**
- **Avoidable use of emergency group O blood (D-negative or D-positive) where group-specific or crossmatched blood was readily available for the patient or the laboratory could have supplied a more suitable component, including use of group O when time would allow a more appropriate group to be remotely allocated from a remote release refrigerator system**

Key SHOT messages

- It is essential to establish the cause of thrombocytopenia before transfusing platelets. A blood film should be examined to confirm a low platelet result even in patients who might be expected to have thrombocytopenia
- Accurate patient identification is fundamental in all healthcare interactions. This involves positive patient identification at the time of taking any blood sample. It is also important when carrying out tasks such as writing in notes or on a prescription chart

Recommendations

- Training in major haemorrhage protocols should be multidisciplinary and include all staff involved when MHP is activated
- Training should emphasise that group O red cells are only used when group-specific or crossmatched red cells are not readily available

Action: Hospital transfusion teams

Introduction

There were 127 reports of avoidable transfusions, similar to the 121 reported in 2022. Components involved were 109 red cells, 15 platelets, 2 FFP and 1 cryoprecipitate.

Note that where avoidable transfusions cause a reaction in a patient, such as a febrile, allergic or hypotensive reaction or TACO, these are included in the corresponding reaction chapter rather than here. The total number of transfusions reported to SHOT which were felt to be avoidable is therefore greater.

Deaths related to transfusion n=0

There were no deaths related to avoidable transfusions in 2023.

Major morbidity n=0

There were no patients suffering major morbidity because of an avoidable transfusion in 2023.

Classification of avoidable transfusions n=127

Group	Red cells	Platelets	Plasma components	Total reports
Flawed decision	32	7	2	**41**
Appropriate decision, inappropriate component	37	0	0	**37**
Decision based on inaccurate results	25	5	1	**31**
Failure to respond to change in circumstances	7	2	0	**9**
Transfusion without decision	7	1	0	**8**
Transfusion necessitated by equipment failure	1	0	0	**1**
Total	**109**	**15**	**3**	**127**

Table 12b.1: Classification of avoidable transfusions by error type and blood component (n=127)

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Flawed decision n=41

Cases of flawed decision included: transfusion for haematinic deficiency (n=15), transfusion of multiple units without reassessment (n=4), transfusion outside of guidelines without clinical justification (n=12: 6 of which were platelets), overestimation of blood loss (n=5), transfusion of someone who had withheld consent (n=3), misinterpretation of thromboelastography (n=1).

Case 12b.1: Unnecessary empirical transfusion given for upper gastrointestinal bleeding

A patient with alcoholic liver disease presented after vomiting blood at home. They were haemodynamically stable, but two units of red cells were transfused without any Hb check. The post-transfusion Hb was 125g/L.

The results suggest this patient had not lost a volume of blood sufficient to require transfusion. The 2022 National Comparative Audit of upper gastrointestinal bleeding, which is expected to be released later in 2024, has highlighted that overtransfusion is common in this patient group and is associated with adverse patient outcomes (Booth 2024, personal communication. 13 March).

Learning point

- Not all patients presenting with bleeding require transfusion. Unless there is haemodynamic instability, a Hb check should be performed first, and restrictive thresholds applied outside of major haemorrhage

Appropriate decision, inappropriate component n=37

These were all avoidable use of group O red cells.

In 7 patients there was delay in sending a group and screen sample, and in 4 there were laboratory delays in sample processing.

In 15 cases, crossmatched blood was available, in 5 of these the laboratory was not told that the patient needed blood urgently, and in 10 the clinical team collected group O units in error. There is a misconception that group O is the correct component to be given in all emergencies.

Case 12b.2: Lack of understanding of appropriate use of O D-negative red cells

The doctor caring for a trauma patient was not aware that crossmatched red cells were available and requested O D-negative emergency units. The porter delivered named patient units from the laboratory, but the nurse rejected these twice as she was expecting emergency O D-negative units rather than named patient units (D-positive). The nurse did not check the compatibility label which confirmed the units supplied were for that patient.

Learning point

- The whole multidisciplinary team need to understand the role of group O emergency units, in particular that these are to use only to preserve life until crossmatched units are available

In 5 cases there were problems with collection of crossmatched units, though this also highlights resilience in the system protecting the patient from delays to transfusion. Two reports described errors in IT systems preventing access to crossmatched units and 3 patients were given emergency group O units when transfusion was not urgent.

Decision based on inaccurate result n=31

Cases where decisions were based on inaccurate results included: FBC sample taken from a drip arm (n=9), inaccurate point-of-care sample (n=6), use of previous results (n=4), platelet clumping (n=4), WBIT in FBC sample (n=3), wrong patient's result used (n=2), analyser error (n=3).

Learning point

- Wrong blood in tube is not only significant for transfusion samples. WBIT in FBC or biochemistry samples can result in inappropriate patient treatment. Positive patient identification is essential before taking any sample

Case 12b.3: Platelet clumping in an oncology patient results in two unnecessary platelet transfusions

A FBC from a patient with leukaemia showed a significant drop in platelets compared to the previous day. The analyser flagged possible platelet aggregates, but the result was released. A blood film was made but only examined routinely the next day. This showed platelet clumping, and the count was visually normal. By this time the patient had been transfused with platelets. Another sample sent the next day again reported low platelets. No blood film was made, and a further platelet transfusion was given. The post-transfusion platelet count was 232x10^9/L.

Learning points

- Thrombocytopenia should be confirmed on a blood film even when a patient has a condition compatible with a low platelet count. Marked fluctuations in the platelet count should raise suspicion of a spurious result
- Review of blood film to confirm laboratory results in a timely manner can avoid unnecessary or incorrect treatment

Case 12b.4: Failure to correctly identify the patient at the time of authorising the transfusion leads to transfusion of the wrong patient

A doctor had reviewed the FBC for patient A and a red cell transfusion was indicated. The doctor mixed up two patients' names and results and authorised transfusion for patient B in error. Patient B's Hb was 100g/L and they received a red cell unit they did not require.

Learning point

- Patient identification errors resulting in inappropriate treatment can occur without the patient being present. It is essential to correctly identify the patient during any interaction

Failure to respond to a change in circumstances n=9

Cases where there was a failure to respond to change in circumstances included: transfusion given before a procedure which was cancelled (n=3), units authorised 'just in case' for surgery transfused routinely (n=1), authorisation written in advance and recent results not checked (n=1), transfusion already given (n=2), change in decision not communicated (n=1).

One patient was given a transfusion as part of a trial protocol but was subsequently found to be ineligible for the trial.

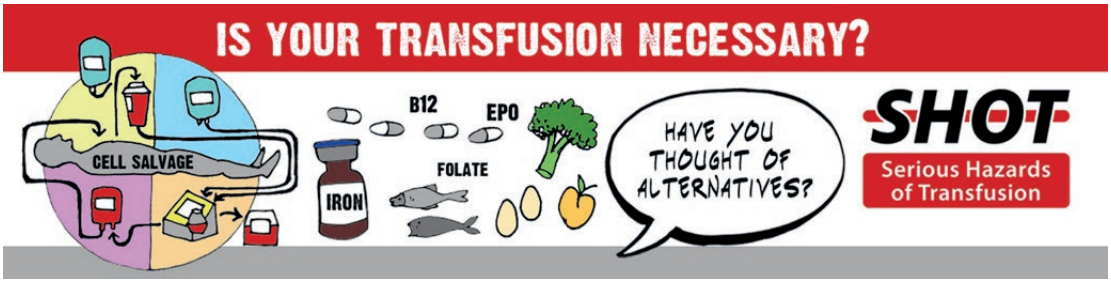
Transfusion without decision n=8

Seven patients received a transfusion without any completed authorisation. Three of those were patients regularly attending a day unit, and it is notable that one reporter cited staff shortage due to the junior doctors strikes as a contributory factor.

One patient had a red cell transfusion authorised rather than albumin as a result of a verbal request.

Transfusion necessitated by equipment failure n=1

Malfunction of a haemodialysis machine resulted in a patient losing 200-300mL of blood into the circuit and a red cell transfusion was then required.



Near miss avoidable transfusions n=3

These included 1 drip arm sample, detected due to abnormal biochemistry results taken at the same time, 1 multiple unit transfusion stopped when a family raised concerns and 1 inappropriate use of group O serendipitously blocked due to incorrect use of the remote issue refrigerator.

Conclusion

Avoidable transfusions constitute a diverse group, but lack of knowledge, failure to question unusual results and failure of correct patient identification emerge as recurring themes. Creating additional opportunities for checks and challenge, for example use of computerised decision support and empowering laboratory and nursing staff to question inappropriate or unusual requests can increase the chance of errors being corrected before transfusion proceeds.

Recommended resources

E-learning modules:

Anaemia
Includes modules 'Anaemia - the only introduction you need', 'Anaemia in primary care patients', 'Anaemia in hospital patients' and 'Anaemia of inflammation and chronic disease'. Accessible via:
https://hospital.blood.co.uk/training/clinical-courses/

Blood component use in major haemorrhage
https://www.e-lfh.org.uk/programmes/blood-component-use-in-major-haemorrhage/

The NHSBT O D-negative toolkit
https://hospital.blood.co.uk/patient-services/patient-blood-management/o-d-negative-red-cell-toolkit/

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Under or Overtransfusion n=20

12c

Authors: Paula Bolton-Maggs, Catherine Booth and Simon Carter-Graham

Definition:

A dose inappropriate for the patient's needs, excluding those cases which result in TACO and usually resulting in a haemoglobin or platelet level significantly outside the intended target range. Infusion pump errors leading to under or overtransfusion with clinical consequences (if no clinical consequences, then it is reportable as a handling and storage error).

Key SHOT message

- As in previous years, more than half the cases of overtransfusion were in children (8/14)

Recommendations

- Paediatric transfusion protocols should be readily accessible to all clinical staff
- Hospitals should have clear guidelines for patients being transferred between hospitals to reduce the risk of adverse outcomes

Action: Hospital transfusion teams

Introduction

The number of reports (20) is similar to last year (18). In 2023, there were 14 reports of overtransfusion and 6 of undertransfusion. The majority were clinical incidents (19/20).

Many cases were reported in children, 9/20. Eight of these were overtransfused and 1 was undertransfused.

Deaths related to transfusion n=1

Case 12c.1: A patient died following surgery where overtransfusion was justified

Shortly after an uneventful elective surgery (exchange of ureteric stents), the patient developed hypotension and tachycardia and was only minimally responsive to intervention (including intravenous fluids and vasopressors). The abdomen appeared distended, and the patient began complaining of back pain. The patient was thought to have major haemorrhage and was transfused three units of red blood cells and two units of FFP (emergency MHP). CT showed no evidence of bleeding, but there was evidence of pulmonary oedema. The patient was transferred to critical care and remained extremely unstable. TACO was considered but not supported by bedside echocardiography. Sadly, the patient died. Subsequently blood cultures from the patient grew E. coli. This death was referred to the coroner who concluded multi-organ failure, E Coli urosepsis with chronic ureteric obstruction caused the patient's death. The blood transfusion could have contributed to the patient's deterioration, but the relationship to the patient's outcome was not certain.

Initial investigation by hospital transfusion team felt this was unlikely to be TACO/TRALI or anaphylaxis to blood components. However, in the absence of an identifiable source of bleeding and rise in Hb from

114 to 184g/L, it was concluded that this was a clinically justified overtransfusion where the anaesthetist had substantial grounds to believe the patient was experiencing major haemorrhage.

Major morbidity n=2

A child received a full adult unit of red cells (300mL) when the correct volume would have been 150mL. The post-transfusion Hb was 190g/L. As a result, the child was admitted to ICU overnight and required venesection.

An adult with a platelet count of $27x10^9$/L who presented with haematuria received four platelet pools inappropriately prescribed by a junior doctor without adequate knowledge; only one was indicated. There was misunderstanding following discussion between the doctor and haematologist. The patient, already with pulmonary oedema, developed shortness of breath and required admission to ICU for 3 days. The patient later died but this was unrelated to the transfusion.

Overtransfusion n=14

More than half of the reported cases (8/14) were in paediatric patients. These are discussed in more detail in Chapter 24, Paediatric Cases.

Six adults received excess transfusion, 1 caused by a WBIT.

Case 12c.2: WBIT in FBC sample impacts two patients

A patient was transfused based on a wrong FBC result involving incorrectly labelled blood samples. Labels for Patient 1 were printed, but the phlebotomist was unable to get a sample from the patient. At the same time, there was a request for bloods to be taken from Patient 2 but the IT system defaulted to the Patient 1's record following an incorrect hospital number data entry. This resulted in labels belonging to Patient 1 being printed. PPID was not undertaken correctly at the time of phlebotomy, and the incorrect labels were attached to the FBC sample which contained Patient 2's blood.

The FBC results were issued against Patient 1. The laboratory staff noticed the discrepant Hb result in relation to the previous results from this patient but attributed this to surgery because the request had originated from a surgical ward. The junior medical and nursing staff had also discussed the discrepancy of both Hb and mean cell volume but the possibility of WBIT was not considered. Patient 1 was unnecessarily transfused a unit of red cells resulting in a post-transfusion Hb of 151g/L with no adverse symptoms. Patient 2, whose Hb had been 91g/L fell to 71 then 69g/L resulting in a delay before they were transfused. A mismatch between workload, staff provision, an ineffective IT system and communication factors were noted to be contributory factors in this incident.

Case 12c.3: Hypotension attributed to GI bleeding results in overtransfusion

An elderly woman with pre-existing cardiac failure and poor renal function suffered a major GI bleed requiring a red cell transfusion and endoscopy which confirmed arterial bleeding from a duodenal ulcer. She was stabilised but the following morning had hypotension. No formal laboratory sample was taken between the first transfusion and the second the day after. An urgent Hb was recorded mistakenly as 49g/L but on the venous gas was 119g/L. Based on the erroneous result, she received six units of red cells; her Hb rose to 198g/L and she required venesection. CT angiogram showed no evidence of bleeding. She was admitted to ICU following IR treatment with gastroduodenal artery coil. Four days later she returned to the ward, Hb 152g/L. Although she subsequently died this was not related to the overtransfusion.

Learning point

- Hypotension can have different causes and is not always due to bleeding. Thorough evaluation of the patient is crucial for guiding appropriate management. This will ensure the patient receives the care they need promptly and effectively

Haematinic deficiency n=1

A child with a Hb of 35g/L due to iron deficiency was intentionally transfused to Hb 96g/L and at a rate (6.13mL/kg/hr) greater than recommended (3-5mL/kg/hr). Iron deficiency is very well tolerated in young children. A smaller volume at a slower rate would have been more appropriate, but not every child, even with such a low Hb, requires transfusion as they are often very chronically anaemic.

There were a further 16 avoidable transfusions in patients with haematinic deficiencies, see Chapter 12b, Avoidable Transfusions.

Undertransfusion n=6

Of the 6 reports of undertransfusion, 2 involved FFP. In 1 case, two bags were given instead of three and in the other case one bag with 250mL of FFP was issued by the laboratory instead of the 1L requested resulting in delay of a planned procedure.

There were 3 reports of red cell undertransfusion, 1 in a child. A sample was run as a neonatal one, but the child was over a year of age and a paedipack was issued instead of a full unit. Another was in a patient whose target Hb was >100g/L because of radiotherapy. The patient received only one of five units of red cells resulting in failure to achieve the target. The 3rd case is described in Case 12c.4.

A patient with leukaemia failed to receive granulocytes as they had not been prescribed and were therefore wasted. There was no harm to the patient.

Case 12c.4: Splenic rupture with major haemorrhage requiring interhospital transfer

An elderly man on oral anticoagulants developed abdominal pain found to be caused by splenic rupture. He required emergency transfer to another hospital site for IR. Transfusion of red cells was started and planned to continue throughout the transfer. He also received PCC and tranexamic acid. There was no nurse available to accompany the patient, and the paramedics did not know how to manage the infusion pump when it stopped working and the transfusion was not completed. The transfusion laboratory at the transferring hospital had not been informed of the transfer, so the available crossmatched red cell units and patient sample were not sent with him. During the IR procedure he was peri-arrest and received emergency group O D-negative units and FFP. The splenic embolisation was successful and he was transferred to a ward.

The report noted that there was a lack of clarity on inter-site transfer for patients who require intervention. There were multiple handovers and unclear information among teams. Such transfers are known to be associated with risks of adverse events (Haji-Michael, 2005). The laboratory protocol for transfer of red cell units with patients was not followed. Guidelines are available for interhospital transfer noting the importance of appropriate equipment and personnel (AAGBI, 2006; Ahmed & Majeed, 2008; Warren, et al., 2004).

Learning points

- Transfer of seriously ill patients between sites carries additional risks; ideally patients should be accompanied by medical or nursing staff
- Handovers concerning seriously ill patients are essential and should be concise and accurate

Near miss n=1

A child avoided an excessive transfusion because an error in the prescription was detected by the staff member undertaking the pre-administration check.

Conclusions

Errors in paediatric transfusion continue to be a cause for concern. Transfusion training should ensure that clinicians authorising transfusions understand the use of all blood components including indications, monitoring, recognising, and managing adverse reactions.

Ensuring safety when transferring patients between hospitals involves careful coordination and communication between clinical teams, verifying patient information, transport with appropriate staff accompanying to monitor and manage patients during transfer. Clear protocols for communication and continuity of care are essential to minimise risks and ensure a smooth transition for the patient.

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

Recommended resources

SHOT Bite No.4: Paediatrics
https://www.shotuk.org/resources/current-resources/shot-bites/

BSH guidelines for paediatric transfusion
https://b-s-h.org.uk/guidelines/guidelines/transfusion-for-fetuses-neonates-and-older-children

Guidance on: Transfer of the critically ill adult
https://ics.ac.uk/resource/transfer-critically-adult.html

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Incidents Related to Prothrombin Complex Concentrates n=23

12d

Authors: Paula Bolton-Maggs, Josephine McCullagh and Simon Carter-Graham

Definition:

Hospitals are asked to report incidents related to PCC infusion where there was delay or inappropriate transfusion. (Allergic reactions should be reported to the MHRA through the yellow card scheme, https://yellowcard.mhra.gov.uk/).

Key SHOT messages

- PCC administration is an emergency treatment used for reversal of oral anticoagulants (warfarin and DOAC) which should be started within an hour of the decision being made and before the patient is transferred to other wards or departments
- Patients with suspected ICH are at high risk of death or serious sequelae and require urgent anticoagulant reversal

Recommendations

- The ED should ensure they have a protocol with clear instructions for dose and administration of PCC. Staff should be appropriately trained in their use
- A standardised single first dose for emergency use should be adopted to reduce PCC administration delays in urgent situations
- Use of PCC should be regularly audited for timeliness and appropriateness

Action: Medical directors, hospital transfusion teams, audit leads

Introduction

A total of 23 cases were reported in this category. Most PCC incidents were reported in the elderly population, median age 85 years. Only 1 patient was under 70 years of age. There were 17/23 (73.9%) reports of delayed PCC infusion. Other errors included inappropriate doses, either under or over recommended units, infusion pumps set at the wrong rate and lack of trained staff to administer the PCC.

All patients were taking anticoagulants, either warfarin or apixaban/edoxaban. Nine patients had ICH, 5/9 following falls. Six patients had GI bleeding.

Deaths related to transfusion n=4

Four patients died (all on warfarin) possibly (n=3) or definitely (n=1) related to the delay in administration of PCC. This case has been described in Case 12d.1.

Case 12d.1: Failure to reverse warfarin and inadequate red cell transfusion

An elderly person was admitted with a suspected cerebrovascular accident which was not confirmed on CT. However, they were found to have a Hb of 44g/L and very high INR (confirmed on repeat testing). The patient received a single unit of red cells but no reversal of the high INR. They had

epistaxis earlier in the day but no other bleeding. No bleeding source was sought. The patient collapsed and died 15 hours after admission. The patient was on an acute ward which was very short staffed and usually relied on bank and agency staff.

Of the 3 deaths with possible imputability, 1 was a patient with ICH where the long delay in receiving PCC (8 hours) was associated with expansion of the haematoma. An elderly patient fell downstairs sustaining a head injury with confirmed ICH, and the PCC administration was delayed for 5 hours. Another elderly patient on warfarin was admitted with GI bleeding where PCC was delayed by 3.5 hours due to a delay in decision-making and incorrect use of the recently implemented electronic prescribing system.

Learning point

- The finding of a high INR should prompt urgent communication to the clinical team and appropriate actions taken especially when patients are on anticoagulants. If a decision has been made for anticoagulant reversal with PCC, this should be administered without delay

Major morbidity n=0

There were no patients that suffered major morbidity in 2023 as a result of the PCC administration.

Fixed dose PCC for emergencies

Delay can be reduced by using a fixed emergency dose avoiding both the need for finding the weight and use of calculations. Patients on warfarin should also receive vitamin K and follow up of the INR to ensure reversal and to determine if further PCC is required.

Continued confusion about dose and rate of infusion suggest that a fixed dose regimen might be safer. The literature demonstrates good correction of the INR in most (Bizzell, et al., 2021) including patients with ICH with a fixed dose of 2000IU (Dietrich, et al., 2021). A recent systematic review comparing fixed- versus variable-dose 4F-PCC included three randomised trials and 16 cohort studies with extracranial haemorrhage as the main indication. The authors concluded that fixed dose provides benefits in terms of dose reduction, more rapid administration, better haemostasis with reduced mortality and fewer thromboembolic events (Alwakeal, et al., 2024).

One UK centre has used a fixed dose of 1000IU for both warfarin and DOAC reversal since 2017 with clear benefit (Davies, et al., 2019). Their protocol provides for PCC removal from the refrigerator without laboratory or haematology clinical staff approval. A significant reduction in time from request to administration was demonstrated (for warfarin, mean 48 compared with 126 minutes). No significant difference was noted in mortality for standard dose (13%) and fixed dose (3%) (p=0.2117), although the data suggest that a fixed-dose regime may reduce mortality risk. Dose reduction resulted in significant financial savings. No inappropriate use occurred.

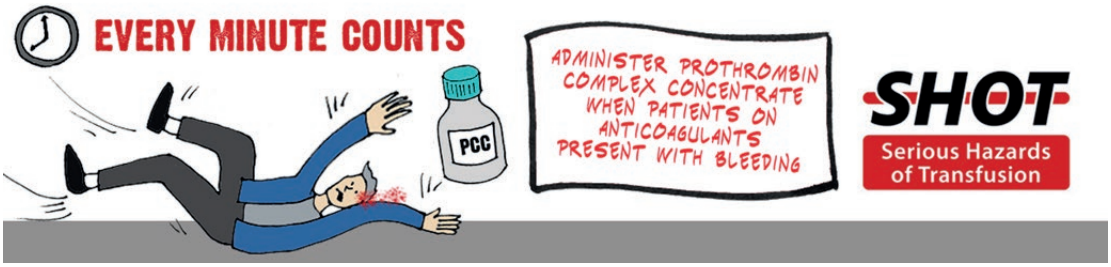
Further evidence is presented in Chapter 6, Acknowledging Continuing Excellence in Transfusion (ACE), Case 16, where a fixed-dose regimen (1000IU) was introduced to improve management of patients with ICH and GI bleeding. Subsequent local audit results identified that 67% of patients received PCC within 1 hour of the decision being made compared with 36% pre implementation of the project. Patient survival rate has increased to 86% from 53% pre implementation. In 43% of cases, the initial dose of 1000IU of PCC was sufficient to reverse the INR without need for further PCC.

Previous publications have also supported a fixed-dose approach. Haemostatic efficiency was shown in an open-label, multicentre, randomised clinical trial. Patients with non-intracranial bleeds requiring vitamin K reversal with 4F-PCC were allocated to either a 1000IU fixed-dose of 4F-PCC or a variable dose based on weight and INR. Effective haemostasis was achieved in 87.3% (n=69 of 79) in fixed and 89.9% (n=71 of 79) in the variable dosing cohort. Median door-to-needle times were reduced to 109 minutes (range 16 to 796) in fixed compared with 142 (17 to 1076) for the variable dose (P=.027). An INR < 2.0 at 60 minutes after 4F-PCC infusion was reached in 91.2% versus 91.7% (P=1.0) (Abdoellakhan, et al., 2022). Another meta-analysis of fixed-dose versus variable-dose of PCC reviewed data from 10 studies

including 988 patients. Fixed-dose PCC was associated with reduced mortality and a shorter order-to-needle time. These authors advocated further studies focusing on clinical outcomes (Mohammadi, et al., 2022). It is not clear what the optimal fixed dose should be. Whether a fixed-dose or weight-based regimen is used, follow up of the INR for patients on warfarin (who should also receive vitamin K) is essential to ensure the dose was adequate and to determine if further PCC is required.

Conclusion

Delayed administration is the most frequent cause for PCC incident reports (73.9%). PCC are an important treatment for immediate reversal of vitamin K antagonists and other oral anticoagulants and should be given immediately a decision is made, and certainly within an hour (NHSE, n.d.). All medical staff involved in the acute care of patients with suspected serious haemorrhage, particularly ICH, who are eligible for reversal should ensure that they know how to obtain and how to administer PCC. Delay can contribute to patient death.



Recommended resource

CAS Alert - Preventing transfusion delays in bleeding and critically anaemic patients
https://www.cas.mhra.gov.uk/ViewandAcknowledgment/ViewAlert.aspx?AlertID=103190

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