23 Transfusion-Associated Circulatory Overload (TACO)

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Definition:

The International Society of Blood Transfusion (ISBT) definition states that TACO includes any 4 of the following that occur within 6 hours of transfusion [76]

- **Acute respiratory distress**
- **Tachycardia**
- **Increased blood pressure**
- **Acute or worsening pulmonary oedema**
- **Evidence of positive fluid balance**

DATA SUMMARY
Total number of cases: n=96

Implicated components		Mortality/morbidity	
Red cells	78	Deaths definitely due to transfusion	0
Fresh frozen plasma (FFP)	2	Deaths probably/likely due to transfusion	5
Platelets	1	Deaths possibly due to transfusion	7
Cryoprecipitate	0	Major morbidity	34
Granulocytes	0	Potential for major morbidity (Anti-D or K only)	0
Anti-D Ig	0		
Multiple components	15		
Unknown	0		

Gender		Age		Emergency vs. routine and core hours vs. out of core hours		Where transfusion took place	
Male	36	≥18 years	96	Emergency	18	Emergency Department	3
Female	59	16 years to <18 years	0	Urgent	28	Theatre	9
Not known	1	1 year to <16 years	0	Routine	50	ITU/NNU/HDU/Recovery	10
		>28 days to <1 year	0	Not known	0	Wards	46
		Birth to ≤28 days	0			Delivery Ward	2
		Not known	0	In core hours	38	Postnatal	1
				Out of core hours	29	Medical Assessment Unit	14
				Not known/Not applicable	29	Community	1
						Outpatient/day unit	6
						Hospice	0
						Antenatal Clinic	0
						Other	4
						Unknown	0

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

A total of 96 cases of TACO are analysed, compared with 82 in 2012, which represents a 17.1% increase. Eighty-eight pulmonary questionnaires were received (2 initially reported as acute transfusion reaction (ATR), 3 as transfusion-associated dyspnoea (TAD) and 3 as transfusion-related acute lung injury (TRALI)), 6 additional cases were transferred from ATR and 2 from avoidable, delayed or undertransfusion (ADU).

The SHOT pulmonary questionnaire, to which reporters are directed if the predominant feature is respiratory distress, was completed in 2 of the 8 ATR cases subsequently categorized as TACO.

Patients

There were 36 males and 59 females (with gender not stated in 1 case). The median age was 77.5 (range 22-96) years. Sixty-one patients (63.5%) were 70 years or more and 18 (18.8%) 50 years or less. There were no patients under 18 years of age.

Diagnosis of TACO

Cases were assessed for probability of a diagnosis of TACO based on the ISBT definition, available on the SHOT website (www.shotuk.org) [76].

Cases were also assessed for probability of TACO using a definition based on the key features of this condition which comprise:

Any of the following, which occur within six hours of transfusion:

- Acute respiratory distress (in the absence of other specific cause)
- Acute or worsening pulmonary oedema
- Evidence of positive fluid balance
- Evidence of volume intolerance*

*volume intolerance – anybody, however young and fit can be volume-loaded into pulmonary oedema. Large volume or rapid infusion or both can produce TACO in normal subjects. Lower and slower volumes may provoke TACO in individuals with poor volume tolerance, which may result from renal, hepatic or more typically cardiac disease including any arrhythmia.

Cases should, as far as possible, include information about the confirmatory features for TACO (see SHOT definition above).

The following cases should also be reported:

- Cases where TACO is suspected even if the available information suggests that not all defining criteria for TACO are met
- Cases which occurred between 6 and 24 hours were included in the latter definition if key features detailed above were also present

TACO case probability	(ISBT criteria) Number of cases	Definition based on key features Number of cases
Highly likely	21	44
Probable	33	29
Possible	38	22
Excluded/unlikely	4	1
Total	**96**	**96**

Table 23.1: TACO case probability

Table 23.1 demonstrates that the definition of TACO impacts on the case probability of TACO and thus its identification. The cases below highlight the differences between ISBT and definition of TACO based on the key features of this condition detailed above: the potential implications for optimal recognition of TACO are discussed in the commentary below.

Case 1: Possible versus highly likely case of TACO

A 60 year old female returned to theatre due to haemorrhage following laparoscopic cholecystectomy. Whilst under anaesthetic and ventilated, she was transfused 4 units of red cells and 2 units of FFP. She was also given 2000mL crystalloid and 500mL colloid. Her fluid input in the 24 hrs prior to the

procedure was 3500mL, with her output not reported. During the procedure, her oxygen saturation ranged between 93% to 98% and her pulmonary artery wedge pressure was raised. At the end of the procedure, red froth was noted in the endotracheal tube. Her oxygen saturation was 94%. A chest X-ray was consistent with pulmonary oedema. Her pulse and blood pressure (BP) at baseline and at the time of the reaction were 87 and 90 beats per minute (bpm) and 132/81 and 100/50 respectively. She was admitted to the ITU for mechanical ventilation and remained there for 5 days.

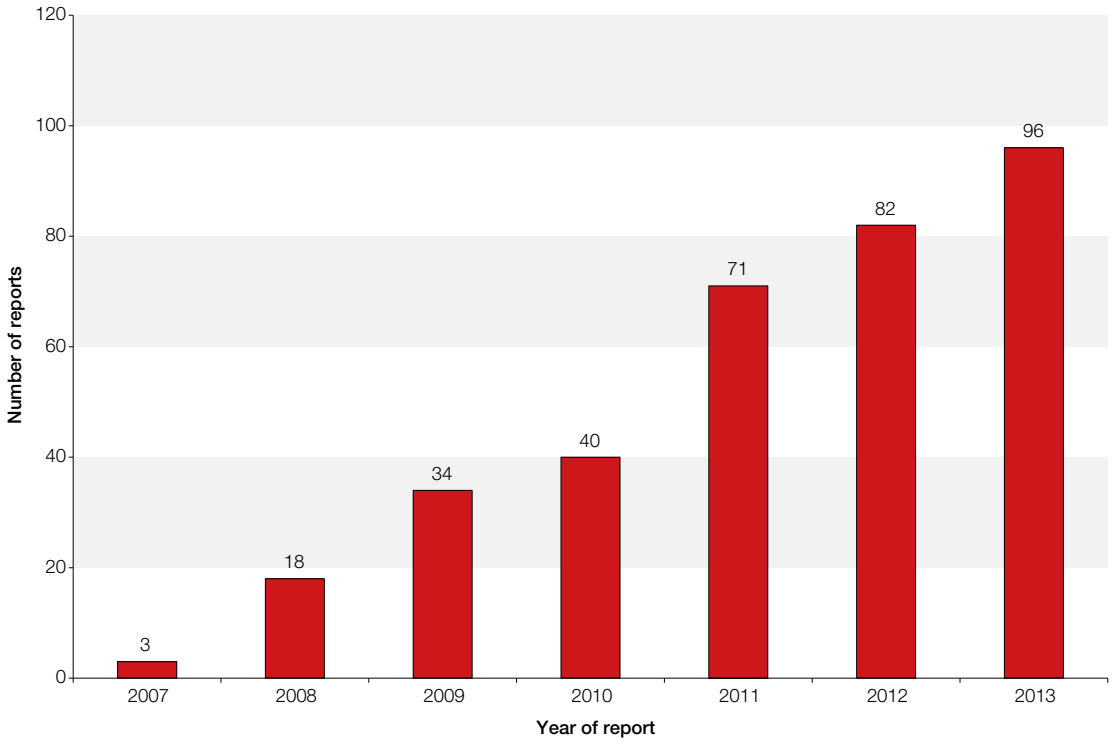
The absence of tachycardia, hypertension and fluid balance details make this a case of possible TACO according to ISBT criteria, whereas using a definition based on the presence of key features of TACO detailed above, this case would be categorized as highly likely to be TACO.

Case 2: TACO occurring more than 6 hours after transfusion of platelets

A 61 year old male patient with major haemorrhage - haematemesis and melaena due to a gastro-oesophageal tumour, on a background of alcoholic liver disease - developed respiratory compromise at 08:00 after a platelet transfusion completed at 01:00. The platelet transfusion was preceded by several other blood components: 16 units of red cells, 8 units of FFP and platelets (2 apheresis packs and 2 pools) over the preceding 36 hours. He also received colloid and crystalloid, with the total fluid volume input 13,050mL and output 2065mL (positive fluid balance of 10,985mL). The pO2 was 9.31 and 9.42 at baseline and at the time of the reaction respectively, with corresponding values for the pulse and BP 140 and 180bpm and 105/70 mmHg and 180/20 respectively. A chest X-ray showed pulmonary infiltrates. Treatment included an intravenous infusion (IVI) of furosemide. Copious amounts of fresh blood were found during oesophago-gastro-duodenoscopy (OGD). A large haematoma was found during laparotomy at the tumour site. A partial gastrectomy was carried out. He recovered with full resolution of his symptoms.

This case would be a highly likely case of TACO as although it occurred more than 6 hours after the platelet transfusion, the patient displayed key features of TACO detailed above. However, the occurrence of the reaction more than 6 hours after completion of the platelet transfusion would exclude a diagnosis of TACO by ISBT criteria.

Figure 23.1: Number of cases of TACO reported to SHOT each year



Learning point

- These two cases emphasise the importance of recognition of transfusion-associated circulatory overload (TACO) even in the absence of full International Society of Blood Transfusion (ISBT) criteria. Improved recognition of TACO enables early institution of treatment which in turn may reduce the associated morbidity and mortality

Deaths n=12

TACO was possibly (n=7) or probably/likely (n=5) contributory to death in 12 patients. There were a further 10 deaths where the transfusion was excluded/unlikely (n=7) to be contributory to death or not assessable (n=3).

Case 3: Fatal TACO following red cell transfusion for probable chronic iron deficiency anaemia

A 78 year old female, weight 63.3kg, was brought to the attention of a Trust transfusion practitioner with a possible allergic transfusion reaction. On assessment, there was no evidence of an allergic reaction and a diagnosis of TACO was made. The patient had been admitted to the emergency department (ED) unwell and feeling faint. All vital signs were within normal limits, and her Hb was 59g/L with a microcytic blood picture, with the likely cause chronic iron deficiency. Two units of red cells were ordered by the ED doctor. The first unit was commenced at 14:12 and she was transferred to the acute medical unit (AMU). During a consultant led ward round on AMU, 2 more red cell units were prescribed. She received 3 red cell units and approximately 290mL of the fourth unit when she developed massive pulmonary oedema and left ventricular failure. Her pulse and blood pressure at baseline and at the time of the reaction were 98 and 82bpm and 120/75mmHg and 152/111 respectively. An electrocardiograph showed atrial fibrillation and T wave changes. She was admitted to ITU where she received continuous positive airway pressure (CPAP) and a furosemide infusion, however she subsequently died.

Learning points

- As stated in previous Annual SHOT Reports, red cell transfusion is not an appropriate treatment for chronic iron deficiency anaemia. It puts individuals, particularly the elderly, at risk of transfusion-associated circulatory overload (TACO), with even fatal consequences as in this case
- Iron deficiency should be treated with iron and the underlying cause established and treated
- 'Don't give two without review*' - When transfusing adult patients at increased risk of TACO, clinical review should be undertaken after each red cell unit to check that the patient has not developed any evidence of TACO, and single units considered where appropriate, irrespective of whether the individual has a low body weight. Risk factors for TACO include cardiac failure, renal impairment, hypoalbuminaemia or fluid overload, age more than 70 years and low body weight
- The 2012 British Committee for Standards in Haematology (BCSH) addendum to the guidelines on blood administration states that for patients identified at increased risk of TACO, a written request should be made that during the administration of blood components, specific attention should be given to monitoring the patient for signs of circulatory overload, including fluid balance [23, 25]. This information should be included in clinical handover templates

**This advice is inspired by a campaign devised by NHSBT's Patient Blood Management (PBM) team with resources on the Hospitals and Science Website http://hospital.blood.co.uk*

Major morbidity n=34

34 patients developed major morbidity, all of whom required ITU/HDU admission +/-ventilation.

Case 4: ITU admission for TACO following red cell transfusion for chronic anaemia

An 80 year old male with renal impairment, chronic anaemia, Hb 91g/L, and a history of angina and previous myocardial infarction, became acutely breathless part way through the second unit of a two unit red cell transfusion. He had not been given diuretic cover. The first red cell unit had been commenced at 06:20 and transfused over 3 hours. The second unit of red cells was commenced at 10:30 and stopped at 11:30 because he had become acutely breathless. His respiratory rate rose from 20 to 26 per minute, his oxygen saturation fell from 98% to 79%, with his pulse 114 and 120 and his BP 67/57 and 108/50 at baseline and at the time of the reaction respectively. He was in positive fluid balance (3800mL), with fluid input 4150mL and output 350mL. A chest X-ray showed pulmonary oedema. He was admitted to ITU where he received continuous CPAP and made a full recovery.

Learning points

- Patients at increased risk of transfusion-associated circulatory overload (TACO) should be carefully assessed for the risks versus benefits of transfusion
- This case highlights that all clinical staff involved in blood transfusion should be aware of and receive education and training on measures to avoid TACO. If red cell transfusion is undertaken, the 2012 British Committee for Standards in Haematology (BCSH) addendum to the guidelines on blood administration [25] should be followed. These state that in patients at increased risk of TACO, such as with renal impairment as in this case, risk factors should be documented, and considered when prescribing the volume and rate of transfusion, and in deciding whether diuretics should be prescribed

The following 2 cases of TACO, both associated with major morbidity, occurred after transfusion as a day case.

Case 5: Respiratory arrest after patient sent home following outpatient red cell transfusion

A 67 year old female was transfused 3 units of red cells for chronic anaemia related to myelodysplastic syndrome (MDS), between 10:00 and 17:00, in the haematology day unit. She was sent home after the transfusion, but felt ill on the way home and returned immediately to the ED, where she suffered a respiratory arrest and was admitted to ITU. The chest X-ray appearances were reported to be in keeping with LVF. She made a full recovery.

Case 6: TACO necessitating HDU admission in patient at increased risk of TACO after transfusion as a day case

A 78 year old female with myeloma, weight 56kg, was transfused 3 units of red cells as a day case despite being at increased risk of developing TACO (renal impairment, hypoalbuminaemia, age ≥70 years, low bodyweight). She developed fluid overload and pulmonary oedema with hypertension and hypoxia before the end of the third unit of red cells. She initially responded to diuretic administration and was sent home by a junior doctor, but was unable to lie flat all night because of shortness of breath. She was readmitted to the HDU within 24 hours with pulmonary oedema and an ST segment elevation myocardial infarction (STEMI).

Learning point

- Patients who receive red cell transfusion in the day case setting should be assessed post transfusion with specific attention to symptoms and signs of transfusion-associated circulatory overload (TACO) prior to being discharged. Consideration should be given to elective inpatient admission for transfusion if the patient is at increased risk of TACO

Clinical details and transfused fluids in TACO cases

One or more concomitant medical conditions that increase the risk of TACO (cardiac failure, renal impairment, hypoalbuminaemia or fluid overload) were reported in 56/96 (58.3%) of cases (not reported

in 16 cases). Since 2012 we have requested body weights, as low body weight is also a risk factor for TACO. These were provided by the reporter in 25/96 cases (26.0%; 20.7% in 2012); 5 of these 25 patients had a body weight of 50kg or less.

Complete details on fluid balance were supplied by the reporter in 27/96 (28.1%) of cases (24.4% last year). The time interval between the transfusion and the onset of symptoms (information was available in 93/96 cases), was 0-2 hours in 51.6% (48/93), 2-6 hours in 33.3% (31/93) and between 6-24 hours in 15.1% (14/93) patients.

As in previous years, several patients with (in one case probable) chronic iron deficiency (5 this year) developed TACO following red cell transfusion.

Learning points

- Risk factors for transfusion-associated circulatory overload (TACO) should be identified in all patients prior to transfusion of a blood component, so that measures can be taken to reduce the risk of TACO. This includes the concomitant medical conditions detailed above, fluid overload and low body weight individuals
- Fluid balance should be prescribed and monitored carefully during transfusion to minimize the risk of development of TACO

Acute haemorrhage cases in which more than one component was transfused n=14

There were 14 cases of acute haemorrhage where more than 1 blood component was transfused. Red cells and FFP were transfused in 7 cases: 3 surgical bleeds, 2 obstetric, 1 gastrointestinal and 1 not specified; and together with platelets in 3 cases: 2 gastrointestinal (GI) bleeds (one related to alcoholic liver disease and to aspirin ingestion) and 1 to bleeding from a puncture site following femoral access for an atrial fibrillation ablation. Red cells, FFP, platelets and cryoprecipitate were transfused in 3 cases, 1 patient had a major bleed related to alcoholic cirrhosis, 1 had an obstetric haemorrhage and in 1 the indication was not specified. Red cells, FFP and cryoprecipitate were transfused in 1 case of obstetric haemorrhage.

Cases in which red cells were transfused n=92 (some had multiple components)

Red cells were transfused in a total of 92 cases, in the absence of suspected acute haemorrhage in 54 cases. In these 54 cases, where details were given, the median duration of transfusion/red cell unit was 2.5 (range 1.5-5) hours. TACO was observed after transfusion of 2 red cell units or less in 28 cases, in 13 of these after transfusion of 1 unit or less. Three cases of obstetric haemorrhage (one related to an ectopic pregnancy) received red cell transfusion alone.

Learning point

- As in previous Annual SHOT Reports, it is emphasised that transfusion-associated circulatory overload (TACO) can occur after relatively small volumes of red cells, even 1 unit or less, particularly in patients at increased risk of developing TACO in whom the rate of transfusion should be carefully assessed and the use of diuretics considered

Cases in which FFP was transfused n=16 (some had multiple components)

There were 16 cases where FFP was transfused, in 14 within the context of acute haemorrhage. One patient who experienced a postpartum haemorrhage with subsequent disseminated intravascular coagulation (DIC) and who was not actively bleeding, received FFP and platelets to prevent bleeding during dialysis catheter removal.

Cases in which platelets were transfused n=9 (some had multiple components)

There were 9 cases where platelets were transfused, 6 for acute haemorrhage.

COMMENTARY

TACO remains a leading cause of transfusion-related morbidity and mortality. This year TACO was contributory to death in 12 patients (possibly (n=7) or probably/likely (n=5)) and to major morbidity in 34, with these serious outcomes together comprising 47.9% (46/96) of TACO cases analysed. There has been a further increase of 17.1% (from 82 cases in 2012 to 96 in 2013) in the number of TACO cases reported, however TACO probably remains under-reported as it is likely that many cases are unrecognized and therefore unreported. Improved recognition of TACO is of key importance as it enables early institution of treatment, which in turn may reduce the associated morbidity and mortality.

TACO was observed (as previously noted) after transfusion of 2 red cell units or less, in 28 cases, in 13 of these after transfusion of 1 unit or less. When transfusing adult patients at increased risk of TACO, clinical review should be undertaken after each red cell unit, and single units considered where appropriate, irrespective of whether the individual has a low body weight. Risk factors for TACO include cardiac failure, renal impairment, hypoalbuminaemia or fluid overload, age more than 70 years and low body weight. In last year's report, being transferred (between wards or hospitals) during a transfusion episode was also identified as a risk factor for TACO [3].

Cases this year also highlight that all clinical staff involved in blood transfusion should be aware of TACO and be educated and trained in measures to reduce this potentially avoidable complication. The 2012 BCSH addendum to the guidelines on blood administration, based on SHOT observations and recommendations, highlights the importance of clinical assessment prior to a blood transfusion to identify patients at increased risk of TACO, so that measures can be taken to reduce the risk of TACO. The dose of red cells and rate of transfusion are critical in avoidance of TACO. A dose of 4 mL/kg raises the haemoglobin concentration by approximately 10g/L. The concept that one unit of red cells gives a Hb increment of 10g/L only applies to patients with a weight around 70kg [25]. The risk of TACO is reduced by careful pre-transfusion clinical assessment and use of single-unit transfusions, or prescription in millilitres, for elderly or small, frail adults where appropriate [24, 25]. The median duration of transfusion/red cell unit where red cells were transfused in the absence of suspected haemorrhage was 2.5 (range 1.5-5) hours. It is emphasised that, particularly in patients at increased risk of developing TACO, risk factors should be documented, and considered when prescribing the volume and rate of transfusion, and in deciding whether diuretics should be prescribed [25]. Infusion devices should be monitored regularly during transfusion to ensure the correct volume is being delivered at the correct rate [3]; this also applies to rapid infusion devices.

In patients identified to be at risk of TACO, clinical handover templates should include information on measures to avoid TACO, such as furosemide and a slower rate of transfusion, as well as appropriate monitoring for symptoms and signs of TACO. A pre-transfusion checklist to reduce the risk of TACO has been suggested [77]. Specific attention should be given to monitoring the patient for signs of circulatory overload, including fluid balance [23, 25]. Complete details on fluid balance were supplied by the reporter in 28.1% of cases (24.4% in 2012 and 14.1% in 2011). This sustained increase is encouraging. Close attention to fluid balance and its documentation is essential in all patients receiving transfusion of blood components.

There were several cases of TACO in the outpatient/day case setting, in some with identifiable risk factors for TACO. Patients who receive red cell transfusion in the day case setting should be assessed post transfusion with specific attention to symptoms and signs of TACO prior to being discharged. Consideration should be given to elective inpatient admission for transfusion if the patient is at increased risk of TACO.

Eight obstetric patients were reported to develop TACO in the context of transfusion after major haemorrhage, bringing these to a total of 23 cases reported since 2008, and highlighting that this complication does occur in these young individuals who are often regarded to be 'immune' to TACO. Contributory factors are difficulties in estimating actual blood loss, particularly because of the changing blood volume and circulatory capacity. In addition, pre-eclampsia remains an important cause of hypertensive acute pulmonary oedema in pregnancy [78] and affected women are therefore potentially also at risk of TACO.

A number of cases are observed where the case probability of TACO was designated to be possibly lower than it was. Examples are pulmonary oedema occurring post transfusion where the pulse and BP have not been provided by the reporter, or patients where a clinical picture suggestive of TACO is associated with hypotension rather than hypertension, particularly but not exclusively in cases associated with acute haemorrhage, and cases occurring more than 6 hours after transfusion (15.1% of cases this year). This year, cases were assessed for probability of a diagnosis of TACO based on the ISBT definition [76], available on the SHOT website (www.shotuk.org), and also assessed using a definition of TACO based on the presence of key features of this condition detailed above in this chapter. There was a two-fold increase in the number of cases of highly likely TACO cases using the latter versus the ISBT definition (44 versus 21). These findings should be taken into consideration in the current review of the ISBT criteria for TACO. Improved recognition of TACO enables early institution of treatment which in turn may reduce the associated morbidity and mortality.

Recommendations

New recommendations from this report

- All clinical staff should be receive education and training on measures to avoid transfusion-associated circulatory overload (TACO) and the recognition of TACO, which should be included in the curricula of trainee doctors, nurses and midwives

Action: The Royal Colleges (of Physicians, Surgeons, Anaesthetists, Obstetricians and Gynaecologists, and Pathologists) in association with the General Medical Council and the Nursing and Midwifery Council

- 'Don't give two without review': When transfusing adult patients at increased risk of TACO, clinical review should be undertaken after each red cell unit, and single units considered where appropriate, irrespective of whether the individual has a low body weight

Action: Hospital Transfusion Committees, Hospital Transfusion Teams

- Patients with chronic iron deficiency anaemia, particularly those who are elderly, should receive iron replacement therapy, with the underlying cause of iron deficiency identified and treated

Action: Royal College of Physicians, Royal College of General Practitioners

Recommendations still active from previous years

The recommendations in the 2012 report, detailed below, remain pertinent.

- The 2012 British Committee for Standards in Haematology (BCSH) addendum to the blood administration guidelines on measures to reduce the risk of transfusion-associated circulatory overload (TACO) [23, 25] should be followed
- Transfer of patients during a transfusion episode is potentially hazardous and should be avoided wherever possible. If unavoidable, clinical handover templates should include information on measures to reduce the risk of TACO and appropriate monitoring in patients identified to be at risk by clinical assessment pre transfusion
- Post-transfusion clinical assessment should be also be undertaken and patients monitored for evidence of TACO during the first 24 hours after transfusion so that appropriate and timely management can be instituted
- Transfusions should only take place where there are facilities and trained staff to monitor and manage adverse incidents

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

Recommendations still active from previous years are available in the 2013 Annual SHOT Report Supplement located on the SHOT website, www.shotuk.org under SHOT Annual Reports and Summaries, Report, Summary and Supplement 2013.