

# 25 Transfusion-Associated Circulatory Overload (TACO)

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## Definition:

TACO includes any 4 of the following that occur within 6 hours of transfusion<sup>1</sup>

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

DATA SUMMARY							
Total number of cases: 82							
Implicated components				Mortality/morbidity			
Red cells		53		Deaths due to transfusion		0	
FFP		7		Deaths probably/likely due to transfusion		1	
Platelets		1		Deaths possibly due to transfusion		5	
Cryoprecipitate		0		Major morbidity		29	
Granulocytes		0		Potential for major morbidity (Anti-D or K only)		0	
Anti-D Ig		0					
Multiple components		21					
Unknown		0					
Gender		Age		Emergency vs. routine and core hours vs. out of core hours		Where transfusion took place	
Male	39	≥18 years	82	Emergency	15	Emergency department	2
Female	43	16 years to <18 years	0	Urgent	20	Theatre	5
Not known	0	1 year to <16 years	0	Routine	47	ITU/NNU/HDU/Recovery	14
		>28 days to <1 year	0	Not known	0	Wards	39
		Birth to ≤28 days	0			Delivery Ward	4
		Not known	0	In core hours	35	Postnatal	0
				Out of core hours	47	Medical Assessment Unit	11
				Not known/Not applicable	0	Community	2
						Outpatient/day unit	5
						Hospice	0
						Antenatal Clinic	0

A total of 82 cases of TACO are analysed, compared with 71 in 2011, which represents a 15.5% increase. Sixty-one questionnaires on TACO were received, 2 initially reported as acute transfusion reactions (ATR) and 3 as transfusion-related acute lung injury (TRALI), 6 were transferred in from the 'transfusion-associated dyspnoea' (TAD) chapter, 12 additional cases from ATR, 2 from TRALI, and 1 from the 'avoidable, delayed or undertransfusion' (ADU) group. The SHOT pulmonary questionnaire, to which reporters are directed if the predominant feature is respiratory distress, was completed in 5 of 12 ATR cases subsequently categorized as TACO.

## Patients

There were 39 males and 43 females. The median age was 71 (range 18–99) years (with the median age of cases initially reported as TACO 74 years and of those transferred from other categories 65 years). Forty-four patients (53.7%) were aged 70 years or more and 21 (25.6%) 50 years or less.

## Diagnosis of TACO

Cases were assessed by the reviewer for probability of a diagnosis of TACO based on the International Society for Blood Transfusion (ISBT) definition<sup>1</sup>, available on the SHOT website ([www.shotuk.org](http://www.shotuk.org))

TACO case probability (ISBT criteria)*	Number of cases
Highly likely	13
Probable	12
Possible	53
Excluded/unlikely	2
Not assessable	2
<b>Total</b>	<b>82</b>

**Table 25.1:**  
TACO case  
probability

\*10 cases where TACO was observed between 6 hours and 24 hours, and one fatal case which was diagnosed 2 days post-transfusion, are also included.

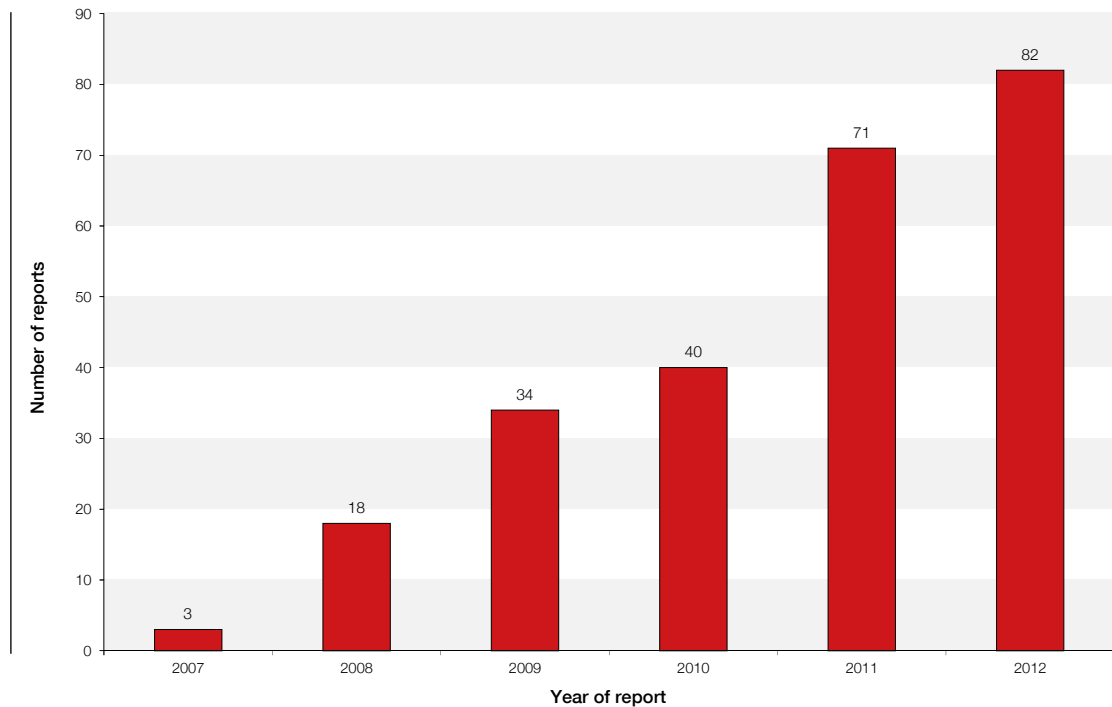
### Case 1: A case of possible TACO with features of ATR and TRALI

An elderly female received an emergency transfusion for upper gastrointestinal bleeding with 2 units of red cells, 2 of fresh frozen plasma (FFP) and 1 unit of apheresis platelets, transfused rapidly. She also received 2325 mL crystalloid. On commencement of the second unit of red cells she was noted to have developed a generalised rash. There was no wheeze, airway obstruction or tongue swelling. She was treated with hydrocortisone and chlorphenamine. Two hours later her O<sub>2</sub> saturation dropped to 80% on 40% O<sub>2</sub>. A chest X-ray showed bilateral infiltrates and suggested fluid overload. She was afebrile, pre- and post-reaction observations respectively showed pulse rate 90 and 95 beats per minute, blood pressure (BP) 140/80 and 103/70, respiratory rate 16 and 19/min, and post-reaction the pO<sub>2</sub> was 6.7 kPa and pCO<sub>2</sub> 5.5 kPa, with central venous pressure (CVP) 6 cm. She was documented to be in positive fluid balance of +2565 mL in the 24 hours prior to the reaction. She was admitted to the high dependency unit (HDU) and treated with diuretic therapy. Continuous positive airway pressure (CPAP) or invasive ventilation were not required. Fluid balance on the day of the reaction was 1000 mL in and 3000 mL out. An electrocardiogram (ECG) showed no acute changes, however troponin was significantly raised and she was diagnosed to have a non ST segment elevation myocardial infarction (NSTEMI). An echocardiogram (ECHO) showed mild left ventricular impairment, severe mitral calcification, no stenosis, and mitral and aortic valve disease. Investigations for TRALI showed that one donor who donated one of the red cell units had HLA antibodies (A2, A11, B13 and DR7) to which the patient had a cognate antigen A2. However, these findings were probably coincidental as she had evidence of pulmonary oedema with contributory factors being her myocardial infarction and fluid resuscitation for hypotension as a result of bleeding.

### Learning point

- It can be difficult to accurately diagnose pulmonary complications of transfusion, particularly where features of other pathological reactions coexist. The SHOT pulmonary questionnaire, to which reporters are directed if the predominant feature is respiratory distress, provides a common dataset which enables accurate categorization of pulmonary complications of transfusion. It should be used for all patients who develop respiratory distress in association with a blood transfusion. Accurate characterisation of pulmonary complications of transfusion underpins the development of targeted strategies to reduce these hazards of transfusion

**Figure 25.1:**  
Number of cases of  
TACO reported to SHOT  
each year



A further case of TACO resulted from an unnecessary transfusion given on the basis of an inaccurate haemoglobin result (ADU chapter (Chapter 12)).

### Deaths n=6

TACO was possibly (n=5) or probably/likely (n=1; described below) contributory to death in 6 patients. There were a further 9 deaths; in 7 the reporter considered that the transfusion was excluded/unlikely to be contributory to death and in 2 it was not assessable.

#### Case 2: Fatal TACO after over-transfusion to low body weight individual

*A 65 year old female was admitted to hospital with a gradual decline in health, weight loss and shortness of breath. She had 'short gut' syndrome and was of low body weight (35 kg) with severe anaemia, Hb 49 g/L, and renal impairment. She received 4 units of red cells transfused over 12 hours plus intravenous (IV) fluid, with 3 of the red cell units transfused overnight. Her cardiorespiratory manifestations came to light when she developed diarrhoea 40 hours after transfusion, when a chest X-ray, clear on admission, showed evidence of pulmonary oedema 2 days after transfusion. A blood count 3 days post transfusion showed polycythaemia with Hb 176 g/L. Her condition continued to deteriorate following the transfusion and she died.*

## Learning points

- Low body weight and renal impairment are risk factors for transfusion-associated circulatory overload (TACO). These and other risk factors, which include cardiac failure, hypoalbuminaemia and fluid overload, can be identified by pre-transfusion clinical assessment so that measures can be taken to avoid TACO. The concept that one unit of red cells gives a Hb increment of 10 g/L should only be applied as an approximation for a 70-80 kg patient. For patients of lower body weight the prescription should be reduced as detailed in the 2012 British Committee for Standards in Haematology (BCSH) addendum to the guidelines on blood administration<sup>26,27</sup>, which is based on SHOT observations and recommendations
- As recommended in previous SHOT Annual Reports and BCSH guidelines<sup>27</sup>, transfusion must only take place when there are enough staff available to monitor the patient and when the patient can be readily observed
- It is not clear when TACO developed in this case, as there appears to have been a delay in diagnosis. SHOT has consistently observed a small proportion of cases, that otherwise meet the International Society for Blood Transfusion (ISBT) criteria for TACO, between 6-24 hours post-transfusion, and it is important to undertake post-transfusion clinical assessment and monitor patients for evidence of TACO during the first 24 hours after transfusion so that appropriate and timely management can be instituted

## Major morbidity n=29

Twenty nine patients developed major morbidity, 28 of whom required intensive care/high dependency admission +/-ventilation, and one required dialysis (Case 2).

## 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 48/82 (58.5%) of cases. This year we requested body weights (BW) on the SHOT questionnaires, as low body weight is also a risk factor for TACO. These were provided by the reporter in 17/82 (20.7%) cases. Three of these patients had a BW of less than 50 kg, with 2 (adults) at 35 and 26.5 kg.

Complete details on fluid balance were supplied by the reporter in 20/82 (24.4%) of cases (10/71, 14.1% last year). The time interval between the transfusion and the onset of symptoms (information was available in 79/82 cases), was 0-2 hours in 45.1% (37/82), 2-6 hours in 39.0% (32/82) and between 6-24 hours in 12.2% (10/82) patients.

Two patients with chronic iron deficiency developed TACO following blood transfusion.

## Learning points

- Close attention to fluid balance and its documentation is essential in all patients receiving transfusion of blood components
- Blood transfusion is not an appropriate treatment for iron deficiency anaemia, and puts individuals, particularly the elderly, at risk of TACO. Iron deficiency should be treated with iron and the underlying cause established and treated

The importance of appropriate clinical assessment of patients who receive transfusion of blood component(s) and the hazards of transfusion in patients transferred during a transfusion episode are highlighted in the 3 cases (3, 4 and 5) below.

### **Case 3: Over-transfusion due to inadequate assessment and monitoring leading to polycythaemia and circulatory overload**

A 42 year old female, BW 69 kg, in end stage renal failure (ESRF) was admitted for a brachio-axillary bypass graft. Her Hb on admission was 117 g/L with BP 120/80 falling to 96/58 just prior to surgery. The patient was on 2L of oxygen. The estimated perioperative blood loss was approximately 700 mL. She was given 1L of fluid in theatre (500 mL modified fluid gelatin and 500 mL normal saline). She remained hypotensive, and her Hb 2 hours post surgery was 58 g/L. Her BP fell further to 65/45 five and a half hours post surgery, and she was commenced on a 4 unit red cell transfusion. There was no overt bleeding. Her Hb approximately 3 hours later was 93 g/L and 30 minutes later, when the 4th red cell unit was underway, 102 g/L. Her BP at this time was 95/57. Two further red cell units were transfused over the next hour. Following this, the Hb rose to 162 g/L and potassium to 6.5 mmol/L. Her oxygen saturations remained normal throughout on 2L of oxygen. She was therefore venesected and dialysed for hyperkalaemia and volume overload. A root cause analysis identified a failure to recognise that sufficient blood had been transfused when the Hb was 102 g/L and also an inappropriate reliance on lower limb BP readings.

#### **Learning point**

- The risk of TACO can be minimised by pre-transfusion assessment such that an appropriate volume of red cells is prescribed as per the BCSH addendum<sup>26</sup>. This addendum states that in patients with minor but ongoing blood loss, Hb should be regularly monitored, as a minimum after every 2-3 units of red cells. This should also be applied when the volume of blood loss is uncertain

### **Case 4: Poor clinical handover resulting in inadequate clinical assessment and TACO**

An elderly female, BW 49.6 kg, with a history of hypertension and angina, was given a 3 unit red cell transfusion for anaemia associated with metastatic carcinoma of the breast. She was identified to be at risk for TACO and had 7 sets of observations done for the first unit, following which she was moved to another ward where the transfusion was completed. The concern about her risk of TACO was not picked up in the notes by this ward. Between 12 and 24 hours later she developed shortness of breath and her O<sub>2</sub> saturation dropped from 94 to 65%. This was associated with tachycardia and hypertension, with pre- and post pulse 76 and 122 beats per minute and pre and post BP 168/87 and 193/111 respectively. She also had clinical evidence of pulmonary oedema.

### **Case 5: TACO after patient transfer between hospitals for transfusion with no handover and no pre-transfusion clinical assessment**

A 79 year old female with anaemia (Hb 75 g/L) associated with haematological malignancy, and who also had a history of cardiac failure and renal impairment, was sent from the main hospital to a satellite hospital day unit for a 3 unit red cell transfusion. No case notes, consent or prescription accompanied the patient. Nursing staff therefore went to the clinic area in the satellite hospital where some pressure was exerted on a doctor, as the patient had already suffered a delay in starting her intended treatment, who prescribed 3 units of red cells. Her BP rose steadily during the transfusion, however the transfusion was continued regardless of this. The first unit was transfused over 3 hrs, the 2nd unit over 90 mins, and the 3rd unit over 2 hrs. The nurse caring for the patient stated that she contacted a haematology registrar at the main hospital. She was advised to stop the transfusion (possibly at the start of the third unit) for 45 mins to re-assess the BP – recorded as 165/85 although the time was not documented. The next BP was 219/105 when the transfusion was stopped and the patient was transferred back to the main hospital. There was no written documentation of the nursing staff actions during this patient's transfusion (other than observations and the volume of red cells infused). The reaction was not reported to the transfusion team or hospital transfusion laboratory until 1 week later.

This case demonstrates multiple errors: failure to handover on transfer between hospitals, failure of pre-transfusion clinical assessment prior to prescription of red cells and therefore the rate of transfusion was too fast with no diuretic cover, failure to act appropriately on the observation of a rising BP, and delay in reporting the reaction to the hospital transfusion team.

### Learning points

- Risk factors for TACO include age (70 years or more), cardiac failure, renal impairment, hypoalbuminaemia, fluid overload as well as low body weight, and these should be taken into account in all patients who receive transfusion of blood component(s)
- 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 in patients identified to be at risk by clinical assessment pre transfusion

### Acute haemorrhage cases in which more than one component was transfused n=16

There were 16 cases of acute haemorrhage where more than 1 blood component was transfused. Red cells and fresh frozen plasma (FFP) were transfused in 4 cases of gastrointestinal (GI) haemorrhage and 1 retroperitoneal bleed; and together with platelets in 4 cases of obstetric haemorrhage; and together with platelets in 4 cases of obstetric haemorrhage, 1 case of trauma and 1 retroperitoneal haematoma. Red cells and platelets were transfused in 1 case of GI haemorrhage and 1 placental abruption; and red cells, FFP and cryoprecipitate were transfused in 1 case of trauma, and with platelets in 1 case of ruptured ectopic pregnancy.

### Cases in which red cell transfusion was implicated n=74 (some had multiple components)

Red cells were implicated in 53 cases (and in a further 21 cases multiple components were transfused). In 32/53 cases red cells were transfused in the absence of suspected acute haemorrhage. The median duration of transfusion/red cell unit, where details were given, was 3.0 (range 1–5) hours. TACO was observed after 1 unit of red cells or less in 14 cases and after 2 units or less in 9 cases.

### Learning point

- As in previous Annual SHOT Reports, it is emphasised that 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=22 (some had multiple components)

There were 22 cases where FFP was transfused, 14 during acute haemorrhage. In one case 1750 mL FFP was reported to be administered for the immediate reversal of warfarin anticoagulation to a 56 year old female (body weight not reported) with a history of excess alcohol intake who was admitted with abdominal pain secondary to a life-threatening retroperitoneal bleed.

### Learning point

- Prothrombin complex concentrate (PCC), and not FFP, should be used for warfarin reversal when this is indicated as per the BCSH guidelines<sup>105</sup> and as highlighted in previous Annual SHOT Reports



## Cases in which platelets were transfused n=16 (some had multiple components)

There were 16 cases where platelets were transfused, and in 9/16 this was in the context of acute haemorrhage. In the remaining 7 cases, platelets were transfused prophylactically in 4 patients with haematological malignancies, 2 with thrombocytopenia related to hepatic disease, and prior to endoscopy in an individual with a platelet count of  $56 \times 10^9/L$ .

## COMMENTARY

TACO remains an important cause of transfusion-related morbidity and mortality. This year TACO was contributory to death in 6 patients (possibly n=5 or probably/likely n=1) and to major morbidity in 29, with these serious outcomes together comprising 42.7% (35/82) of TACO cases analysed.

There has been a slight further increase of 15.5% (from 71 cases in 2011 to 82 in 2012) in the number of TACO cases reported, however TACO probably remains under-reported. The median age of TACO cases at 71 years is comparable with that of 73 years in the 2011 National Comparative Audit (NCA) of the use of blood in medical patients (personal communication, Dr Kate Pendry, consultant haematologist, NHSBT). The median age of cases initially reported as TACO was higher (74 years) than those transferred from other categories (65 years), and it is possible that there is a bias towards identifying TACO in older individuals.

The 2012 BCSH addendum to the guidelines on blood administration, based on SHOT observations and recommendations, highlight the importance of undertaking 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. It states that for patients identified at 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<sup>26</sup>. A pre-transfusion checklist to reduce the risk of TACO has been suggested<sup>106</sup>.

Risk factors for TACO include cardiac failure, renal impairment, hypoalbuminaemia and fluid overload. Low body weight is also an important risk factor for TACO, highlighted in Case 2 above. In addition, pre-eclampsia remains an important cause of hypertensive acute pulmonary oedema in pregnancy<sup>107</sup> and affected women are therefore potentially also at risk of TACO. The 2011 NCA of the use of blood in medical patients showed that there was an over-transfusion rate of 33% (defined as Hb increment of more than 20 g/L above the threshold set for that patient or more than 20 g above the starting Hb in patients with reversible anaemia), and has demonstrated a correlation between low body weight and increasing Hb increment (personal communication, Dr Kate Pendry, consultant haematologist, NHSBT). The BCSH addendum<sup>26</sup> guidance includes the following: as a general guide, transfusing a volume of 4 mL/kg will typically give a Hb increment of 10 g/L. The concept that one unit of red cells gives a Hb increment of 10 g/L should only be applied as an approximation for a 70-80 kg patient. For patients of lower body weight the prescription should be reduced. Paediatric transfusions should be prescribed in mL. Single unit red cell transfusions are recommended where possible, especially in non-bleeding patients.

The median duration of transfusion/red cell unit where red cells were transfused in the absence of suspected haemorrhage was 3.0 (range 1-5) hours, and TACO continues to be observed after transfusion of relatively small volumes, even 1 red cell unit or less. 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<sup>26</sup>.

Transfer of patients during a transfusion episode has emerged as a further risk factor for TACO and should be avoided wherever possible. SHOT highlighted in the 2011 Annual SHOT Report<sup>2</sup> that appropriate clinical handover templates should be used whenever patients move between wards or hospitals or between shifts and these should be improved to include information about specific requirements. In patients identified to be at risk of TACO, clinical handover templates should also 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.

Complete details on fluid balance were supplied by the reporter in 20/82 (24.4%) cases compared with 10/71 (14.1%) last year. This modest increase is encouraging. Close attention to fluid balance and its documentation is essential in all patient receiving transfusion of blood components.

In one case, FFP was given for warfarin reversal. PCC is the therapeutic product of choice for warfarin reversal<sup>56</sup> and FFP should not be used for this indication.

Five cases of TACO in patients with obstetric haemorrhage were reported this year, bringing these to a total of 15 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 82 TACO cases analysed, 61 (74.4%) were reported as TACO, with the remainder transferred from several other categories and 1 case transferred out. The SHOT pulmonary questionnaire, launched on 1 January 2012, prompts collection of relevant information in all cases reported where respiratory distress is prominent. It provides a common dataset, which enables accurate categorization of pulmonary complications of transfusion, and is particularly useful in a number of cases where it is difficult to accurately diagnose pulmonary complications of transfusion because features of other pathological reactions coexist. Accurate characterisation of pulmonary complications of transfusion underpins the development of targeted strategies to reduce these hazards of transfusion.

A small proportion of cases continue to be observed to occur between 6-24 hours after transfusion, with the total after 6 hours 12.2% (10/82). It is important to be alert to evidence for TACO, particularly in patients with risk factors, during the 24 hours after transfusion.

A number of cases were 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. These observations, and the occurrence of TACO cases after 6 hours as detailed above, suggest that criteria for the definition of TACO should be revisited. Improved recognition of TACO would enable early institution of treatment which in turn may reduce the associated morbidity and mortality.

## Recommendations

### New recommendations from this report

- The 2012 British Committee for Standards in Haematology (BCSH) addendum to the blood administration guidelines<sup>26</sup> on measures to reduce the risk of transfusion-associated circulatory overload (TACO) 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 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 (see also Chapter 16)

### Action: All clinicians