

## 16. Transfusion-Associated Circulatory Overload (TACO)

### Definition

TACO includes any 4 of the following that occur within 6 hours of transfusion:

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

DATA SUMMARY													
Total number of cases		18		Implicated Components			Mortality / morbidity						
				Red cells		15		Deaths due to transfusion		0			
				FFP		6		Deaths in which reaction was implicated		1			
				Platelets		2		Major morbidity		6			
				Cryoprecipitate		1							
				20% human albumin solution		2							
				Unknown		0							
Gender		Age		Emergency vs. routine and core hours vs. out of core hours			Where transfusion took place						
Male Female Unknown	8 10	16 years+ to 18 years		0		Emergency		5		ED			
		1 year+ to 16 years		0		Routine		10		Theatre		1	
		28 days+ to 1 year		0		Not known		3		ITU/NNU/HDU/Recovery		4	
		Birth to 28 days		0		In core hours		10		Wards		11	
		Total		0		Out of core hours		7		Other (Haematology Day care)		1	
						Not known/applicable		1		Not known		1	

Data for 2008 have been collected on a new specifically designed questionnaire. Seventeen questionnaires were received; 2 were transferred in from the ATR section, resulting in a total of 19 cases. One of the 19 cases was assessed as unlikely to be TACO. This patient did not appear to exhibit classical features of an allergic reaction nor meet criteria for TRALI, and the reaction was categorised as a probable case of 'transfusion-associated dyspnoea' (TAD). It has not been included in this chapter but transferred to the new TAD chapter.

### TACO definition

Based on the above definition from the International Society of Blood Transfusion (ISBT),<sup>4</sup> cases were assessed by the reviewer for probability for a diagnosis of TACO. Overall 6/18 cases were assessed to be highly likely (imputability 3), 8/18 cases were assessed to be probable (imputability 2), and 4/18 possible (imputability 1). The classification according to diagnostic criteria is shown in Table 52 below.

Table 52

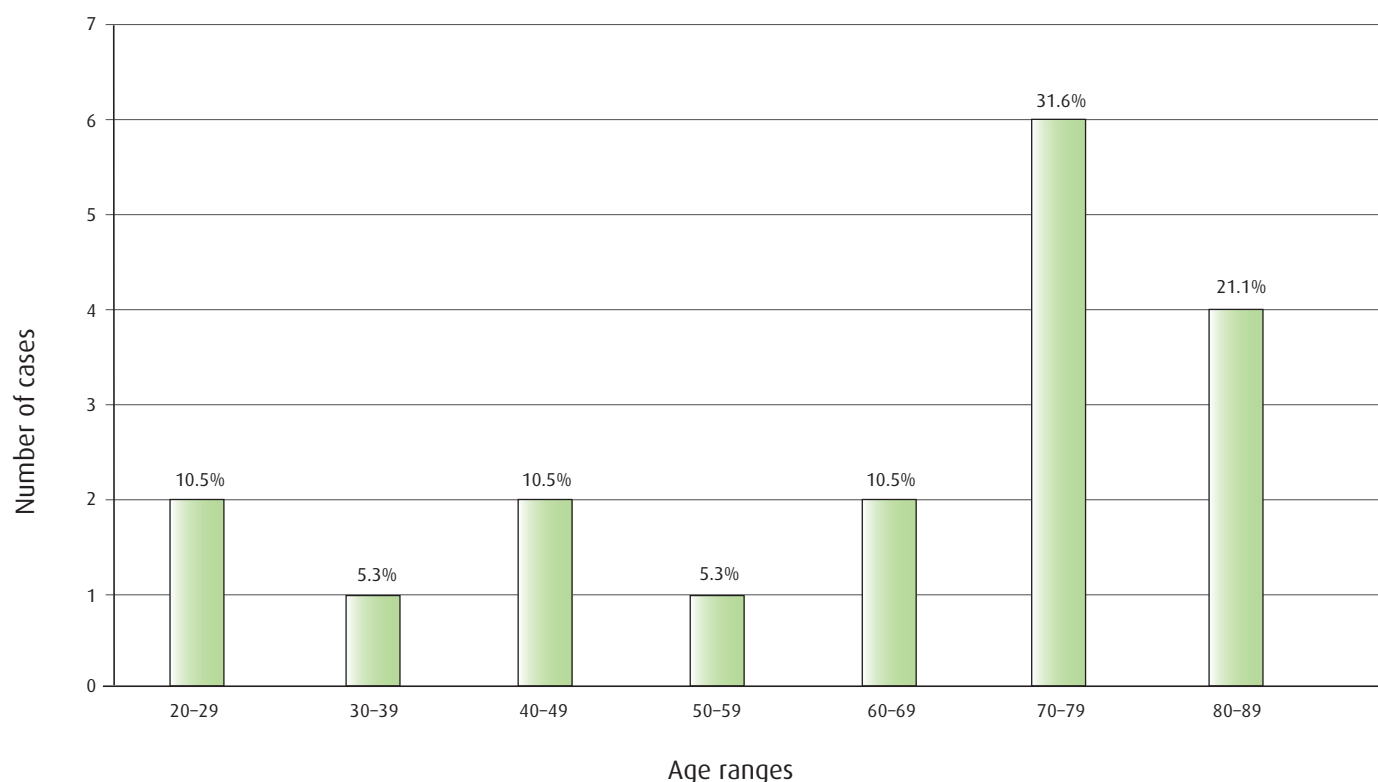
Classification of cases according to diagnostic criteria, probability of TACO and imputability

Case number	Age & Sex	Acute respiratory distress	Tachycardia	Increased BP	Acute or worsening pulmonary oedema	Evidence of positive fluid balance	Probability of TACO	Imputability
1	M79	Yes	Yes	Yes	Yes	NR	Highly likely	3
2	M52	Yes	Yes	Yes	Yes	Yes	Highly likely	3
3	M77	Yes	No	Yes	Yes	Yes	Highly likely	3
4	F20	Yes	Yes	NS	Yes	Yes	Possible	1
5	F82	Yes	NS	NS	Yes	NR	Probable	2
6	M46	Yes	No	No	Yes	Yes	Possible	1
7	M60	Yes	Yes	No	Yes	Yes	Highly likely	3
8	M73	Yes	No	Yes	Yes	NR	Probable	2
9	M86	Yes	No	Yes	Yes	NR	Probable	2
10	F41	Yes	No	No	Yes	NR	Probable	2
11	M64	Yes	No	No	Yes	Yes	Probable	2
12	M74	Yes	Yes	Yes	Yes	Yes	Highly likely	3
13	F23	Yes	PEA arrest	No	Yes	No	Probable	2
14	M80	Yes	No	Yes	Yes	NR	Probable	2
15	F77	Yes	Yes	Yes	No	NS	Possible	1
16	F83	Yes	Yes	Yes	Yes	Yes	Highly likely	3
17	M36	NS	Yes	Yes	NS	NS	Possible	1
18	F73	Yes	Yes	No	NS	NS	Probable	2

### Patients

There were 18 patients with TACO, 8 men and 10 women. The median age of these 18 patients was 72.5 (range 20–86) years, with 5 patients under 50 years. Over half the cases of TACO (10/18; 56%) occurred in patients >70 years. There were no patients under 18 years. The distribution of the patients' ages in those who had TACO is shown in Figure 24.

Figure 24

TACO: Distribution of patients' ages  $n = 18$ 

## **Mortality $n = 1$**

One patient with TACO died with the transfusion reaction implicated.

### **Case 13**

#### ***A patient on ECMO receives massive red cell and platelet transfusion and suffers a fatal cardiac arrest***

*A 23-year-old woman was on extracorporeal membrane oxygenation (ECMO), which leads to consumption of RBC and platelets, and had liver failure. She was transfused 13 units of RBC, cryoprecipitate (1 adult dose) and platelets (3 pools), in ITU prior to a heart transplant. The rates of transfusion were not documented. The transfusion was followed by a severe hypotensive episode and a PEA (pulseless electrical activity) arrest. There was no evidence of bacterial contamination. The patient was multiply pre-transfused (as a childhood leukaemia survivor after a bone marrow allograft 20 years previously) and therefore screening for IgA deficiency was not performed. The referring team considered that the volume load probably triggered acute cardiac decompensation and the fatal cardiac arrest in this high risk patient (imputability 2).*

## **Major Morbidity $n = 6$**

Three of 18 patients with highly likely TACO ( $n = 1$ ) were stated to have been transferred to the ITU as a result of the reaction (Case 1, Case 11 and Case 14), and 1 of these (Case 14) required continuous positive airway pressure therapy (CPAP). Imputability in these cases was assessed to be 3, 2 and 2 respectively.

A further 2 patients required ITU admission for other reasons, but the reporter stated that the reaction necessitated ventilation (Case 6 and Case 10, imputability 1 and 2 respectively). The reaction was stated to have necessitated CPAP in a sixth patient who was already in ITU (Case 7, imputability 3). Therefore, 5/18 patients with highly likely or probable TACO plus 1 possible case (i.e. 6/18; 33%) required ITU admission / ventilation / CPAP.

The details in these 6 cases are given below (asterisked).

## **Other serious morbidity $n = 4$**

In a further 4/12 cases (22.2% of the total 18 patients with TACO), the reporter assessed that the reaction was life-threatening even though it did not fulfil the criteria for major morbidity. Therefore, TACO is a significant cause of serious morbidity.

## **Minor morbidity $n = 8$**

All the remaining 8 patients with highly likely, probable or possible TACO experienced symptoms/signs.

## **Clinical details and transfused fluids in TACO cases**

Table 53 summarises the clinical diagnosis or indication for transfusion in each case, the blood components and products transfused and the rate of transfusion, as well as details of other IV fluids given and fluid balance during the 24 hours prior to the reaction. Details on the rate of transfusion were recorded in 14/18 cases of TACO. The median time between the transfusion and the onset of symptoms was 0–2 hours in 10/18 cases (55.6%), 2–6 hours in 4 cases (22.2%) and 6–12 hours in 4 cases (22.2%). Details regarding IV fluids were given in 9 cases. Fluid balance was recorded in 7 of these 9 cases, and in a further 2 cases.

**Table 53**  
Clinical diagnosis or indication for transfusion

Case no.	Sex & Age	Diagnosis/Indication for transfusion	RBC Units	FFP mL	Other	Rate of transfusion	IV fluids	Fluid balance mL
1*	M79	Chronic anaemia Hb 5.4g/dL	1+	0	0	NR	NR	NR
2	M52	Possible post-gastrointestinal bleed, varices, renal impairment, Hb 5.6g/dL, INR 1.9	3+	2000	20% HAS 400 mL	NR	0	+2200
3	M77	Sepsis / generally unwell, Hb 9.6g/dL	2+	0	0	4hrs/unit	2L crystalloid	+742
4	F20	Postpartum haemorrhage ~2L	4	0	0	4 RBC units/1 hr	2.5L colloid 1L crystalloid	+2800
5	F82	Myelodysplastic syndrome, thrombocytopenia platelets 3, Hb 9.6g/dL	2	0	Platelets 1 pool	RBC 2 hrs/unit Platelets 30 mins	NS	NR
6*	M46	Intraoperative haemorrhage: excision of tumour C4	9	300	0	Rapidly intra-op	2.2L colloid 3.5L crystalloid	+3700
7*	M60	Alcoholic cirrhosis, Acute renal failure	0	600	20% HAS 300 mL	30 mins/unit	1.9L colloid / crystalloid	+2465
8	F73	Coeliac disease, renal failure, history of MI Hb 7.6g/dL	2+	0	0	~3hrs/unit	NS	NR
9	F86	Atrial fibrillation, post-debridement of wound Hb 8.6g/dL	2	0	0	3hrs/unit	NS	NR
10*	F41	Postpartum haemorrhage ~3.5L	4	1000	0	rapidly	1L colloid 1L crystalloid	NR
11*	M64	Cholangiocarcinoma	0	2,750	0	1hr/unit	240 mL colloid 1L crystalloid	+1637
12	F74	Acute on chronic renal failure, recent MI Hb 6.9g/dL	1+	0	0	3hrs/unit	NS	+745
13	F23	Pre-heart transplant, on ECMO	13	0	Platelets 3 pools cryoprecipitate 1 adult dose	NR	NS	-640
14*	M80	Lymphoma Pre-op Hb 8.7g/dL	2+	0	0	~3.5hrs/unit	NR	NR
15	F77	Anaemia ?cause, recent MI, Hb 6.4g/dL	2	0	0	3hrs/unit	0	NS
16	F83	Myeloma, anaemia Hb 7.9g/dL	1+	0	0	4hrs/unit	1L crystalloid Oral fluid 800 mL	+1430
17	M36	Status epilepticus, liver impairment deranged clotting	0	1250	0	NS	NS	NS
18	F72	Chronic iron deficiency anaemia secondary to gastrointestinal loss, Hb 3.7g/dL, h/o IHD	2+	0	0	1-2hrs/unit	NS	NR

\* In these cases the patients required ITU admission / ventilation / CPAP

### Cases of acute haemorrhage in which more than one component type was transfused *n* = 4

There were 4 cases of TACO in which RBC plus other blood components/products and additional IV fluids were administered in situations of acute major haemorrhage. All the patients were relatively young, being 52, 20, 46 and 41 years of age respectively. In 3 of the 4 cases RBC and FFP were given, and in the fourth case RBC were given for PPH together with colloids and crystalloids only (Case 4).

#### Case 2

##### ***A man with acute major haemorrhage receives multiple components and develops TACO***

A 52-year-old man was admitted with acute encephalitis, renal impairment and a suspected gastrointestinal (GI) bleed due to varices. The Hb was 5.6 g/dL and he received 3450 mL of blood components / products within 18 hours, despite a reduced urine output. These comprised: 3 units RBC (900 mL) starting at 00.30 on Day 1; 4 units (400 mL) 20% human albumin solution (HAS) starting at 16.30 on Day 1; 8 units (2000 mL) FFP starting at approximately 01.30 on Day 2 (no start or stop times and no observations were documented for any of these units); and a further 150 mL of RBC starting at 19.15 on Day 2. This further unit of RBC was stopped because the patient became unwell – with SOB, raised JVP, coarse crackles in both lungs and peripheral oedema. The urine output was 80 mL/hr. The O<sub>2</sub> saturation was low at 66%. The increasing SOB was attributed to the patient's general condition and fluid overload. He was given furosemide 40 mg. The O<sub>2</sub> saturation rose to 96%, with a urine output of 625 mL in 30 mins, a further diuresis of 1325 mL over the subsequent 4 hours, and symptomatic improvement. He was found to have gram negative bacilli in an ascitic fluid sample, so that sepsis was probably contributory to his anaemia. Coagulation studies showed a pre-FFP prothrombin time (PT) of 26 seconds with INR 1.9 and fibrinogen 1.9 (NR 1.5-4.0) g/dL and a post-FFP PT of 17 seconds, INR 1.4 and fibrinogen 2.1 g/dL.

#### Case 4

##### ***Young woman with PPH treated with RBC, colloid and crystalloid develops TACO***

A 20-year-old woman had a PPH of 2L following emergency Caesarean section (CS) following failure to progress in labour. She was given 2.5L of colloid and 1L of crystalloid over 1 hr, and an RBC transfusion of 4 units (1200 mL) also over 1 hour. She became unwell, shivery and confused with tachycardia and dyspnoea. The O<sub>2</sub> saturations dropped to 50% with a pO<sub>2</sub> of 6 kPa. She was in positive fluid balance of 2800 mL (4700 mL in and 1900 mL out). She was given a diuretic resulting in a diuresis of 900 mL. After a further urine output of 1L her symptoms improved.

#### Case 6\*

##### ***Major intraoperative haemorrhage results in massive transfusion causing TACO and ITU admission***

A 46-year-old man underwent posterior removal of a vertebral tumour at C4 associated with a haemorrhage of 5L. He was transfused 9 units of RBC (2 L), 2 units of FFP (300 mL), 2200 mL colloid and 3500 mL crystalloid, all given rapidly intraoperatively. In recovery he had acute desaturation (82%) and bilateral crackles on auscultation of the chest. Furosemide was given, and he was transferred to ITU where he was ventilated and given a noradrenaline infusion plus furosemide, resulting in a diuresis of 4500 mL and immediate improvement, with the O<sub>2</sub> saturation rising to 92%. Charts revealed a positive fluid balance of 3700 mL (8700 mL in and 5000 mL out).

#### Case 10\*

##### ***PPH treated with RBC, FFP, colloid and crystalloid results in ITU admission with TACO***

A 41-year-old woman had a PPH of 3.5 L following elective CS for placenta praevia. She had been on enoxaparin and aspirin for recurrent deep venous thrombosis. She received 4 units of RBC and 4 units of FFP given rapidly in theatre plus 1L colloid and 1L of crystalloid. Postoperatively she developed pulmonary oedema and a 'white out' on the chest X-ray within 1–1.5 hours of the fluid given. The O<sub>2</sub> saturation fell to 80% with pO<sub>2</sub> 5.24 kPa. She was hypotensive (BP 95/52) and bradycardic (P 45/min). She was given furosemide and passed 300 mL urine. She was transferred to ITU and ventilated for 2 days. The lung bases were clear on auscultation the morning after the episode. There was no fluid balance chart. A diagnosis of TRALI was considered, but was thought to be very unlikely on expert review by NHSBT.

### Cases in which RBC transfusion was implicated *n* = 15

In 15/18 (83%) of cases red blood cells (RBC) had been given, with 13/15 RBC in additive solution and 2/15 plasma reduced red cells. RBC were transfused for anaemia in the absence of acute haemorrhage in 11/15 patients, and in the presence of acute haemorrhage in 4 cases (detailed above). In 10 of these 11 patients (i.e. excluding the patient on ECMO, Case 13 above), the onset of symptoms occurred during the second unit in 3 cases, after completion of transfusion of 2 units in 3 cases, and during the third unit in 4 cases. These 10 patients were all elderly, age range 72–86 years. Details are given above in Table 53 and in the cases below.

### Cases in which FFP was transfused *n* = 6

There were 6 cases in which transfusion of FFP was implicated in TACO, of which 3 occurred in the presence of acute haemorrhage with RBC prescribed as well. These are described in the section above. Of the remaining 3 cases, Case 11 consisted of a very large volume transfusion of FFP, Case 17 was a case in which FFP was given for coagulopathy in the absence of bleeding (as occurred in Case 12 also), and in Case 7 FFP was given together with 20% HAS (see also Case 2 above).

#### Case 11\*

##### ***Large volume FFP transfusion in a very sick patient causes pulmonary oedema***

*A 64-year-old man with cholangiocarcinoma was given 11 units of FFP (~2750 mL) as well as 250 mL of colloid and 1L of crystalloid. The indication for FFP transfusion was stated to be the patient's disease, although he was not bleeding. There was no record of vitamin K being given. The patient developed dyspnoea, wheeze and peripheral oedema, with O<sub>2</sub> saturation 98%. He was in positive fluid balance of 1637 mL (3397 mL in and 2655 mL out). The chest X-ray indicated pulmonary oedema. He was admitted to ITU where he was given a diuretic resulting in a diuresis of 1200 mL. The patient died from his disease, but the transfusion reaction was not implicated.*

#### Case 17

##### ***Young patient develops TACO after transfusion of a large volume of FFP***

*A 36-year-old man with status epilepticus, unconscious and with deranged clotting due to liver impairment, was issued 5 units of FFP. While he was having the fifth unit, he was noted to have tachycardia and hypertension.*

#### Case 7\*

##### ***Transfusion of FFP and HAS results in severe episode of TACO in patient with renal failure***

*A 60-year-old man with alcoholic liver cirrhosis and acute renal failure was given approximately 600 mL of FFP over 30 minutes and 300 mL of 20% HAS. Halfway through the second unit of FFP he became very tachycardic, oliguric and wheezy, coughing up copious black frothy sputum. He was tachypnoeic, RR 40/min, with raised JVP and bilateral crackles in the chest. The pO<sub>2</sub> was 7.5 kPa. He was in positive fluid balance of 2465 mL (2817 in and 352 out). He was given a diuretic, but had no diuresis (urine output 33 mL) and his condition worsened. He was already in ITU, but the reaction necessitated CPAP.*

### TACO following RBC transfusion to elderly patients with concomitant conditions that increase the risk of TACO *n* = 7

Table 54 summarises the presence of concomitant medical conditions that increase the risk of TACO in the 18 cases reported. Of the 10 elderly patients who received RBC in the absence of acute blood loss (see above), 7 had concomitant medical conditions that could increase the risk of TACO: 4 had cardiac failure (1 with severe aortic stenosis and 1 with hypertension and right bundle branch block), 2 had renal impairment (1 with hypoalbuminaemia), and 1 had hypoalbuminaemia. In 3/7 of these cases, there was fluid overload, and in the remainder (4/7), fluid balance does not appear to have been recorded. TACO was assessed to be highly likely in 3 of the 7 cases detailed below, and probable in the other 4.

Table 54

## Presence of concomitant medical conditions that increase the risk of TACO

Case number	Sex & Age	Cardiac failure	Renal impairment	Hypoalbuminaemia	Fluid overload
1	M79	No	No	No	NR
2	M52	No	No	No	Yes
3	M77	Yes	No	No	Yes
4	F20	No	No	No	Yes
5	F82	Yes	No	No	NR
6	M46	No	No	No	Yes
7	M60	No	Yes	Yes	Yes
8	F73	No	Yes	No	NR
9	F86	No	No	No	NR
10	F41	No	No	No	NR
11	M64	No	Yes	No	Yes
12	F74	No	Yes	Yes	Yes
13	F23	Yes	Yes	Yes	No
14	M80	Yes	No	No	NR
15	F77	No	No	No	NS
16	F83	No	No	Yes	Yes
17	M36	NS	NS	NS	NS
18	F73	Yes	No	No	NS

**Case 14\******Preoperative top-up transfusion in elderly man results in myocardial damage and ITU admission***

An 80-year-old man with lymphoma and Hb 8.7g/dL was given an RBC transfusion overnight, at the anaesthetist's request, prior to a lymph node biopsy. He had a history of hypertension, heart failure and right bundle branch block, and was experiencing shortness of breath (SOB). The transfusion proceeded although it was against hospital policy to issue blood products out of hours without verification from the on-call haematology consultant. Three units of RBC were provided and transfused commencing at 23.35, 03.30 and 08.00 respectively resulting in a Hb 12.5 g/dL. At 10.30 the patient became SOB, sweaty and confused, with  $pO_2$  low at 7.3 kPa. He developed chest pain, pulmonary oedema and renal failure. The troponin was 0.32 µg/L (local reference range > 0.05 indicative of myocardial damage and, or, infarction). He required transfer to ITU for fluid management and CPAP and slowly recovered. Fluid balance details were not recorded.

**Case 3*****Frail elderly patient develops severe TACO during third unit of RBC***

A 77-year-old male patient with peripheral vascular disease, severe aortic stenosis and cardiac failure underwent a right below-knee amputation. Four weeks later he had a chest infection and heart failure. The Hb was 9.6 g/dL. He was given a 2 unit RBC transfusion. He developed dyspnoea and reduced  $O_2$  saturation during the first unit, which resolved after stopping the transfusion and restarting after 45 minutes. The following day a third RBC unit was started, and after 45 minutes the patient developed hypertension, reduced  $O_2$  saturation (nadir 80%) and bradycardia. He complained of mild chills but remained afebrile. Following medical review, the transfusion was discontinued. A chest X-ray showed severe pulmonary oedema. In the 24 hours leading up to this reaction the patient had also had 2L of crystalloid. Analysis of fluid balance over this period showed: input 2407 mL, output 1625 mL and a positive balance of 782 mL. He was treated with a diuretic, following which he had a diuresis of 2L and his symptoms improved.



### Case 5

#### **Elderly woman with known cardiac failure develops TACO following routine top-up transfusion**

An 82-year-old woman with myelodysplastic syndrome was transfused 2 units of RBC and 1 pool of platelets on the Haematology Day Care Unit. She had pre-existing cardiac failure. The pre-transfusion Hb was 9.6 g/dL with the platelet count  $3 \times 10^9/L$ . Two weeks later she was admitted as an emergency complaining of chest pain and SOB since the evening of transfusion. On examination she was in cardiac failure. She was given furosemide 40 mg and her symptoms improved.

### Case 8

#### **An elderly lady with cardiac impairment goes to ITU following a top-up transfusion**

A 73-year-old woman with coeliac disease, renal failure and a history of myocardial infarction had a Hb of 7.6 g/dL and was given an RBC transfusion. The first unit was transfused over approximately 3 hours. While receiving the second RBC unit within 24 hours, she became breathless and hypertensive (BP 201/90), with pitting oedema of both lower limbs. Her cardiac failure necessitated ITU admission. There was no fluid balance chart in use. She was given a diuretic resulting in a diuresis of 830 mL with improvement in her symptoms.

### Case 12

#### **Elderly woman with anaemia due to renal failure develops TACO after a top-up transfusion**

A 74-year-old woman with acute on chronic renal failure who had hypoalbuminaemia, a recent myocardial infarction and a Hb of 6.9 g/dL, was prescribed a 2 unit RBC transfusion. During the second unit she became wheezy, shaky, tachycardic (pulse (P) 113/min) and hypertensive (BP 159/127). The  $O_2$  saturation was 96%. On examination she was in cardiac failure. She was in positive fluid balance of 745 mL. She was reviewed by the critical care outreach team and given oxygen, hydrocortisone and a diuretic (following which she passed 200 mL of urine) and nebulisers with good effect.

### Case 16

#### **Frail elderly woman develops cardiac failure during second unit of red cells**

An 83-year-old woman with myeloma, intestinal obstruction, hypoalbuminaemia and a Hb of 7.9 g/dL was prescribed a 2 unit RBC transfusion. She also received 1000 mL of crystalloid and her oral fluid intake was 800 mL that day, resulting in a positive fluid balance of 1430 mL. Halfway through the second RBC unit she became breathless, tachycardic (P 105/min), hypertensive (BP 185/100) and pyrexial (T 39°C), with a raised JVP and acute pulmonary oedema (confirmed on a chest X-ray) and reduced  $O_2$  saturation (89% on air). Following the reaction the patient was reviewed and a decision was made between medical staff and the family to place the patient on an end of life care pathway in view of her myeloma.

### Case 18

#### **Woman with gross iron deficiency anaemia transfused rapidly and develops TACO**

A 72-year-old woman was admitted by ambulance to the ED at 1420 with jaundice, dramatic weight loss and mild SOB. She had chronic iron deficiency anaemia, Hb 3.7 g/dL, secondary to gastrointestinal loss. She had a probable diagnosis of chronic obstructive pulmonary disease (COPD), and ischaemic heart disease (IHD). The first unit of RBC was started at 01.00 the following day, the second unit at 02.00 and the third at 04.20. About 45 minutes into the third unit she complained of worsening SOB and headache, and was found to have tachycardia (P 120/min) with a respiratory rate (RR) of 22/min. The  $O_2$  saturation was 95% on 40–60%  $O_2$ . The RBC transfusion was stopped, she was treated with diuretic and oxygen and her symptoms improved. Her post-transfusion Hb was 7.9 g/dL. The reaction was thought to have been caused by her underlying cardiac condition and the speed at which she was transfused.

### **TACO in the absence of concomitant medical conditions that increase the risk $n = 3$**

Three cases (cases 1, 9 and 15) where TACO was considered to be highly likely ( $n = 1$ ; Case 1 below), probable ( $n = 1$ ) or possible ( $n = 1$ ) occurred in elderly individuals in the absence of an obvious medical condition that increases the risk of TACO.



### Case 1\*

#### **Elderly man with chronic anaemia but no risk factors develops TACO during second unit of blood**

A 79-year-old male with chronic anaemia, Hb 5.4 g/dL, was admitted via the ED to the ward with a 3 day history of SOB, wheeziness and cyanosis. He was prescribed 2 units of RBC. The rate of transfusion was not documented. He became increasingly SOB part way through the second unit, with tachycardia (P 114/min), RR 24/min, a rise in BP (from 131/70 to 173/84), and a fall in O<sub>2</sub> saturation from 100% to 88% on 12 litres of O<sub>2</sub>. He was mildly acidotic and agitated. The reaction resulted in admission to the ITU where he was given steroids and furosemide, following which he had a diuresis of 500 mL, and his symptoms settled within 2 hours. Details of fluid balance were not recorded.

### Procedural Review

In 17/18 cases, the reaction was reported to the Hospital Transfusion Committee (HTC) and 1 was reported to the blood transfusion laboratory. One hospital did not have a HTC, but reported the case to the clinical governance department and the risk managers. Three hospitals reported the case to the clinical risk department or committee and 1 also on a local incident reporting scheme (Datix) as well as to the HTC. Five cases had been reviewed by the HTC and a further 11 were awaiting review by the HTC.

## COMMENTARY

- TACO appears to be a significant cause of transfusion-related serious morbidity and mortality, which is potentially preventable in many cases. In this relatively small series (n = 18), there was 1 death where TACO was probably contributory (imputability 2) and 6/18 (approximately 33%) patients required ITU admission / ventilation / CPAP. In a further 4/18 cases (approximately 22% of the total), the reporter assessed that the reaction was life-threatening.
- The incidence of TACO reported to SHOT this year was 0.63/100,000 components compared with 3.7/100,000 components reported to TRIP (Transfusion Reactions in Patients, the Dutch Haemovigilance System) in 2005. The Quebec Haemovigilance System (QHS) reported that from 2000 to 2006, of 11,548 reports, 508 (4.4%) were categorised as TACO, with a case-fatality rate of 1.4%, and 21% of cases were considered life-threatening. The QHS also noted a steadily increasing incidence resulting in TACO becoming the most frequent serious transfusion hazard. This is the first year that SHOT has introduced TACO as a separate category, and it is anticipated that reporting will increase with increased awareness.
- The 2008 SHOT reports included cases of TACO associated with the transfusion of relatively modest volumes of RBCs (2 cases occurred during the second unit, 1 after two units and 4 during the third unit), particularly in elderly individuals (age range 72–86 years) who had concomitant medical conditions such as cardiac failure, renal impairment, hypoalbuminaemia or fluid overload, factors that increase the risk of TACO. Cases were also seen in elderly individuals in the absence of obvious comorbidity. In addition, TACO was observed in younger patients (<50 years), particularly in the context of severe haemorrhage when large volumes of IV fluids and blood components were transfused. There were no reports to SHOT of TACO in patients <18 years, whereas these accounted for 2.6% of TACO cases reported to the QHS. The incidence of TACO in the UK paediatric population is unknown.
- Symptoms of TACO may occur during the transfusion or after completion of the transfusion. This also applies to several other serious transfusion hazards.
- In 2 cases, large volumes of FFP were administered (Case 3: 2 L and Case 12: 2.75 L). While there are few proven indications for FFP, if FFP is indicated, BCSH guidelines state that the conventional dose is 10–15 mL/kg, with the dose dependent on the clinical situation and its monitoring.<sup>30</sup> A limiting factor to administration of an adequate volume of FFP is the patient's ability to tolerate the volume transfused. Prothrombin complex concentrate (PCC), in which the volume of a therapeutic dose is small, is the product of choice for reversal of warfarin anticoagulation associated with severe bleeding. Preliminary data suggest that PCC may also have a role in the reversal of coagulopathy in non-warfarinised patients with severe bleeding. However,

PCC are potentially thrombogenic and remain unlicensed for this indication. In acute traumatic massive haemorrhage, there is considerable interest in early formula replacement with FFP (e.g. 1:1 ratio of red cells to FFP). This approach is based on largely retrospective data in particular from the military. An observational study of transfusion practice in trauma patients is now in progress (personal communication, Dr Shubha Allard and Dr Simon Stanworth). National guidelines require updating to guide local practice.

- In 2 cases of TACO associated with FFP transfusion, the patients also received 20% HAS, which is hyperoncotic and may therefore lead to circulatory overload.
- The rate of transfusion was documented in 14/18 cases (78%) and fluid balance was recorded in only 10/18 cases (56%).
- Brain natriuretic peptide (BNP) was not measured in any of the cases reported. Preliminary data suggested that BNP and N-terminal pro-BNP were potentially useful in the diagnosis of TACO; however, a recent prospective study showed that these markers are of limited diagnostic value in the differentiation of TACO from TRALI in patients with acute pulmonary oedema after transfusion.<sup>31</sup>

## RECOMMENDATIONS

- Increased recognition of TACO by clinicians and reporting to SHOT is needed, to raise awareness and increase focus on this important and in many cases potentially avoidable complication of blood transfusion.

### Action: HTT

- Education and training aimed at the recognition and avoidance of TACO is required for doctors across all specialties, and nurses at both national and local levels. Education and training of junior doctors, to ensure appropriate decision making as regards transfusion of blood components / products and appropriate prescription, remains a key priority.

### Action: NBTC

- Doctors should ensure careful clinical assessment of each patient to whom transfusion of components is being considered, to ensure that the proposed transfusion is appropriate. This is particularly important in the case of RBC transfusion to patients  $\geq 70$  years, regardless of the presence or not of concomitant medical conditions that may increase the risk of TACO. The minimum volume of blood components required should be prescribed to be transfused at an appropriate rate, in accordance with BCSH Guidelines on Blood Administration<sup>32</sup> (revised guidelines are in preparation).
- If it is necessary to transfuse RBCs to a patient with chronic anaemia, the risk of precipitating congestive cardiac failure may be minimised by administering a diuretic (e.g. oral furosemide 20 mg), and by reassessing the patient after the transfusion of each unit of red cells. The decision to give a diuretic must be based on clinical assessment of the patient.

### Action: HTT, BCSH

- Nursing staff should record the rate of transfusion and fluid balance in patients receiving blood components and act on signs suggestive of TACO. Transfusions should be administered at times, and in locations, permitting careful observation of patients throughout the transfusion and upon its completion. Out-of-hours transfusions should be avoided unless appropriate facilities are available. BCSH guidelines on blood administration in preparation should address these issues.<sup>32</sup>

### Action: HTT, BCSH