

18a Transfusion-Associated Circulatory Overload (TACO) n=172

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Definition:

TACO is defined as acute or worsening respiratory compromise and/or acute or worsening pulmonary oedema during or up to 12 hours† after transfusion, with additional features including cardiovascular system changes not explained by the patient's underlying medical condition; evidence of fluid overload and a relevant biomarker‡.

† SHOT accepts cases up to 24 hours

‡ see Table 18a.1 for details of required and additional criteria for a surveillance diagnosis

Abbreviations used in this chapter

Hb	Haemoglobin	NBTC	National Blood Transfusion Committee
HFIT	Human factors investigation tool	NPSA	National Patient Safety Agency
ICU	Intensive care unit	NT-pro BNP	N-terminal-pro brain natriuretic peptide
IDA	Iron deficiency anaemia	TACO	Transfusion-associated circulatory overload

Key SHOT messages

- The number of TACO cases reported in 2023 is the highest to date. Although cases continue to increase, there is likely to be a level of under-reporting
- The continued adoption of the TACO risk assessment is encouraging although analysis of the data shows it is still under-used or used ineffectively
- TACO continues to be a major cause of transfusion-related mortality and morbidity
- Severe chronic anaemia (asymptomatic or minimally symptomatic) requires only minimal transfusion (usually a single unit) followed by pharmacological treatment where appropriate. Non-bleeding adult patients with severe chronic anaemia are particularly vulnerable to TACO even in the absence of comorbidities that predispose to TACO

Recommendation

- Perform a gap analysis and implement the recommendations of the NPSA alert on TACO (MHRA and SHOT, 2024). This incorporates ongoing SHOT recommendations and access to further guidance and supporting resources

Action: Hospital Trusts/Health Boards



Introduction

The TACO pre-transfusion risk assessment infographic (Figure 18a.1) was updated in the 2020 Annual SHOT Report to make it suitable for incorporation into clinical documents. Following feedback from reporters, a clarification has been added regarding the use of a prophylactic diuretic. The word 'checklist' has also been standardised to 'risk assessment'.

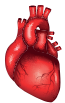


TACO Risk Assessment		YES	NO
	Does the patient have any of the following: diagnosis of 'heart failure', congestive cardiac failure (CCF), severe aortic stenosis, or moderate to severe left ventricular dysfunction?		
	Is the patient on a regular diuretic?		
	Does the patient have severe anaemia?		
	Is the patient known to have pulmonary oedema?		
	Does the patient have respiratory symptoms of undiagnosed cause?		
	Is the fluid balance clinically significantly positive?		
	Is the patient receiving intravenous fluids (or received them in the previous 24 hours)?		
	Is there any peripheral oedema?		
	Does the patient have hypoalbuminaemia?		
	Does the patient have significant renal impairment?		
If Risks Identified		YES	NO
Review the need for transfusion (do the benefits outweigh the risks)?			
Can the transfusion be safely deferred until the issue is investigated, treated or resolved?			
If Proceeding with Transfusion: Assign Actions			TICK
Body weight dosing for red cells			
Transfuse a single unit (red cells) and review symptoms			
Measure fluid balance			
Prophylactic diuretic prescribed (where appropriate/not contraindicated)			
Monitor vital signs closely, including oxygen saturation			
Name (PRINT):		<p>Due to the differences in adult and neonatal physiology, babies may have a different risk for TACO. Calculate the dose by weight and observe the notes above.</p>	
Role:			
Date:	Time (24hr):		
Signature:			

Figure 18a.1: TACO pre-transfusion risk assessment

TACO=transfusion-associated circulatory overload

Table 18a.1:
TACO surveillance
definition (adapted
from Wiersum-
Osselton, et al.,
2019)

TACO surveillance definition	
Patients classified with TACO (surveillance diagnosis) should exhibit at least one required criterion* with onset during or up to 12 hours after transfusion (SHOT continues to accept cases up to 24 hours), and a total of 3 or more criteria i.e., *A and/or B, and total of at least 3 (A to E)	
* Required criteria (A and/or B)	
<p>A. Acute or worsening respiratory compromise and/or</p> <p>B. Evidence of acute or worsening pulmonary oedema based on:</p> <ul style="list-style-type: none"> • clinical physical examination, and/or • radiographic chest imaging and/or other non-invasive assessment of cardiac function 	
Additional criteria	
<p>C. Evidence for cardiovascular system changes not explained by the patient's underlying medical condition, including development of tachycardia, hypertension, jugular venous distension, enlarged cardiac silhouette and/or peripheral oedema</p> <p>D. Evidence of fluid overload including any of the following: a positive fluid balance; clinical improvement following diuresis</p> <p>E. Supportive result of a relevant biomarker, e.g., an increase of BNP levels or NT-pro BNP to greater than 1.5 times the pre-transfusion value</p>	

The number of cases reported in 2023 is the highest to date and is an increase of 12 cases from 2022 (n=160). Although the pathophysiology of the pulmonary complications of transfusion is not fully understood, the evolving understanding of risk factors for TACO and the development of tools to mitigate risks has advanced significantly in recent years. This chapter describes the demographics of patients reported to have TACO, the adoption of risk-reduction strategies, and highlights areas for further focus based on signals from the data and ongoing trends.

Deaths related to transfusion n=15

There were 15 deaths related to TACO in 2023, 2 of which were probably related (imputability 2), and 13 were possibly related (imputability 1). In 2022 there was 1 case that was definitely related to transfusion (imputability 3). Although there are no cases that were evaluated as definitely related to transfusion reported in 2023, the number of deaths has almost doubled compared to 2022 when there were 8, which is a concerning signal in the data (Table 18a.2).

Major morbidity n=20

There were 20 cases of major morbidity in 2023 which is a slight reduction but broadly similar compared to recent years.

Table 18a.2:
Demographic
overview of TACO
cases in 2023

Demographic	Number of reports
Deaths (imputability 3)	0
Deaths (imputability 2)	2
Deaths (imputability 1)	13
Major morbidity	20
Age	Range: 2 months – 96 years (2 age under 18 years) Median: 75.5 years
Gender	104 female, 68 male
Body weight (adults)	Female (n=45): average 64.7kg (range 42-95.5kg) Male (n=36): average 71.1kg (range 50.9-122kg)
Top 4 medical specialties	Acute medicine=34, haematology=30, general medicine=14, emergency medicine=13
Bleeding patients (NBTC indication code R1 or 'massive bleeding' indicated) (NBTC, 2020)	21
Non-bleeding patients (other NBTC indication codes or not stated)	151

TACO is more commonly reported in elderly, non-bleeding patients but is seen across all age groups. These data are consistent with previous years. There were 2 cases in the under-18 age group (age 2 and 3 months). TACO was reported more frequently in female patients and appears to be a consistent characteristic compared to data from previous years. Weight was provided in 45 adult female cases, with an average of 64.7kg (42-95.5kg). Weight was provided in 36 adult male cases, with an average of 71.1kg (50.9-122kg). The apparent higher incidence of TACO in female patient may be attributed to the lower average weight of female patients compared to male, and increased risk of TACO in patients with lower body weight. This underlines the importance of weight-adjusted red cell dosing and single unit transfusion, particularly in patients with lower body weight. Adult medical specialties, including emergency medicine and haematology continue to be the most common specialties where TACO is reported. This should be considered when targeting TACO education and mitigation plans.

Case 18a.1: TACO risks failed to be identified leading to missed opportunities and death

A female patient weighing 52kg with a Hb level of 68g/L was prescribed two units of red cells. She had liver disease and sepsis with peripheral oedema. The cause of the anaemia was not clear, but she was not actively bleeding, and the NBTC indication code assigned to the transfusion was R2 (acute anaemia). A TACO pre-transfusion risk assessment was completed, and the clinician did not identify any risks, therefore no actions were assigned to mitigate TACO. The first unit of red cells was given without issue and the second unit was commenced 4 hours later without a clinical review. She became acutely unwell after the first hour, and an emergency call was made. She developed dyspnoea and tachypnoea with oxygen desaturation to 90% from a previously normal level and had tachycardia and systolic hypertension. The post-transfusion chest X-ray showed significant pulmonary oedema. The NT-pro BNP was significantly raised however there was no pre-transfusion value. An echocardiogram showed moderate left ventricular systolic dysfunction which had not been previously reported. A fluid balance was not reported but there had been a 5kg increase in weight post transfusion. Multiple doses of furosemide were given resulting in some diuresis, but respiratory symptoms remained unchanged. ICU admission was required, and continuous infusion of diuretic was administered, with morphine and antibiotics. The patient unfortunately died. Sepsis was clearly a major factor however the transfusion was assessed as contributory to the death.

A local structured review was performed in the form of an audit of the TACO pre-transfusion risk assessment completion, transfusions out-of-hours, and the single unit red cell policy.

Recommendations following the audit were broadly as follows:

- Education and training on single unit policy, transfusion triggers and Hb targets
- Review the operational use of the TACO risk-assessment tool
- Education on the TACO risk-assessment process
- Ensure the TACO risk assessment is applied to platelets and cryoprecipitate
- Additional education on stable patients with anaemia, overnight transfusion and adopting transfusion reaction e-learning



This is an example of the TACO risk assessment being completed incorrectly resulting in missed opportunities to prevent or mitigate TACO. The patient had peripheral oedema due to liver disease, sepsis, and hypoalbuminemia: therefore, there were clear signs of pre-transfusion fluid overload. The patient may have had previously undiagnosed heart failure which was uncovered by this episode of TACO. Had

this been correctly identified as a risk, several mitigation options could have been considered assuming deferral of the transfusion to manage the pre-transfusion overload was not clinically appropriate. A single unit policy or weight-adjusted red cell dosing would have prevented the transfusion of excessive and unnecessary volume of red cells. The patient had not developed signs of TACO after the first red cell unit. The patient was on a regular diuretic, and it may have been possible to give an additional prophylactic dose. Fluid balance monitoring was not in place, and it was only apparent after the transfusion that there was significant overload due to the increase in body weight when recorded post transfusion. The SHOT structured TACO incident investigation tool does not appear to have been used in this case, however actions concerning most of the preventable factors appear to have been identified.

Excessive red cell transfusion in non-bleeding adult patients with both chronic and acute anaemia continues to be a significant feature in TACO cases, particularly in patients with lower body weight. The team reporting this case should be commended for focussing education and training on transfusion triggers and the use of single unit transfusions. Organisations are encouraged to consider system changes such as embedding in electronic or other controlled processes to avoid the over-reliance on staff knowledge alone.

Potentially preventable factors in cases of mortality n=15

Table 18a.3 and Table 18a.4 below describe the use of the TACO risk assessment in 2023 and a review of potentially preventable factors following case review, with a summary of trends and themes which are similar findings compared to data from previous years.

Table 18a.3: Use of TACO risk assessment in TACO-related deaths in 2023

TACO risk assessment performed	9/15
Risk(s) identified on TACO risk assessment	8/9
Risk(s) NOT identified on TACO risk assessment when present on case review	1/9
Risks(s) identified on TACO risk assessment fully agree with risks present on case review	0/9
Instances of risks missed in the 6 cases where a TACO assessment was NOT performed:	Hypoalbuminaemia (2); renal impairment (2); fluids (3); cardiac impairment (1); peripheral oedema (2); positive fluid balance (1)
Instances of risks missed in the 9 cases where a TACO risk assessment WAS performed:	Positive fluid balance (3); fluids (2), pulmonary oedema (2); likely fluids involved (1); cardiac impairment (1); renal impairment (2); hypoalbuminaemia (3); peripheral oedema (1)
TACO mitigations assigned	7/15
Mitigation measures performed as assigned/planned	5/7

Key themes include:

- Failure to perform TACO risk assessment in a significant number of cases, and risks missed in all cases where the risk assessment was not performed. This is not limited to specific risks for TACO
- Risks not comprehensively identified in individual patients (additional risks were identified on case review). This is not limited to specific risks for TACO
- Missed opportunities to assign TACO mitigation measures
- Failure to perform TACO mitigation measures as assigned/planned

Transfusion NOT indicated	3/15 (includes 1 case of iron deficiency anaemia that could have been potentially treated with intravenous iron)
Indicated transfusions (n=12) that could have been deferred	1/12 (pre-transfusion overload with no clear urgency for transfusion)
Appropriate volume transfused	9/15 (clear evidence of overtransfusion in 2 cases)
Appropriate/close monitoring	14/15 (TACO not immediately recognised in 1 case)
Fluid balance monitoring	8/15
No prophylactic diuretic given	8/15
On regular diuretic (no additional prophylactic dose given)	4/15
Diuretic identified as required but unable to ascertain if given	1/15
No prophylactic diuretic and regular dose withheld	1/15
On regular diuretic and additional prophylactic dose given	1/15
Structured case review	6/15

Table 18a.4:
Preventable factors
for TACO-related
deaths in 2023

Key themes include:

- Some transfusions were inappropriate and could have been avoided altogether, including a case of IDA that could have been treated with iron replacement
- One case could potentially have been deferred to address the pre-transfusion overload
- Inappropriate volume of red cells transfused with clear cases of overtransfusion. Evidence for lack of application of weight-adjusted red cell dosing and single unit and review policy
- Fluid balance monitoring not performed in some cases. Unclear whether it was due to practical reasons or an oversight
- No prophylactic diuretic was administered in most cases. It is not possible to ascertain whether this was an oversight or that a diuretic was contraindicated. It is noted that there was some degree of renal impairment in 9/15 cases which may have influenced the decision not to give a prophylactic diuretic
- The transfusion contributed to death to some extent in all 15 cases. There was evidence of a structured review in only 6 cases, potentially leading to missed opportunities to improve practice and patient safety

A recent 10-year review of the TACO deaths, as reported to SHOT highlighted that TACO is rarely seen in the absence of risk factors identified on the pre-transfusion TACO risk assessment. This safety check appears to be under-utilised and often inaccurately completed, leading to inadequate mitigation strategies. Organisations are urged to implement SHOT recommendations to enhance patient safety (Firth, et al., 2024).

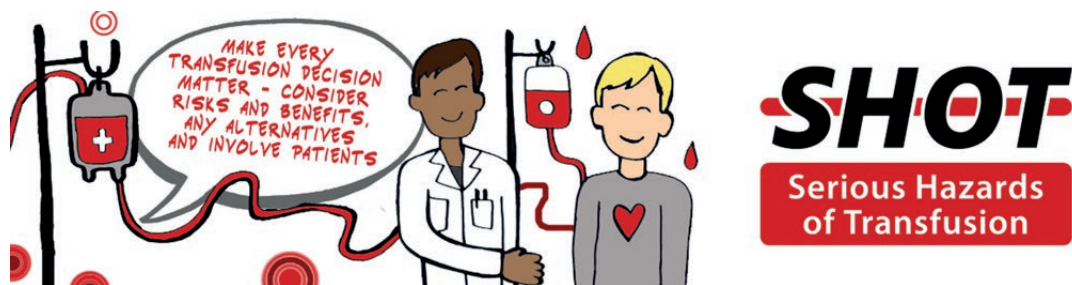


Transfusion management approach in non-bleeding adult patients: avoiding the risks of mismanagement in severe chronic anaemia

Accurate identification of the cause of anaemia is a critical step in safe and appropriate transfusion management. Acute anaemia is defined as anaemia of recent onset which is caused by bleeding, surgery, or critical illness in a haemodynamically stable patient. It corresponds to NBTC indication codes R2 and R3, the latter in the context of acute coronary syndrome. This contrasts with transfusion-dependent anaemia (R4) which may be caused by bone marrow failure or haemoglobinopathy, and severe chronic anaemia (e.g., caused by haematinic deficiency, or anaemia of chronic disease) (NBTC, 2020). There is no

universal Hb trigger or target for severe chronic anaemia. Physiological compensation means transfusion is not likely to be required if the Hb is $>70\text{g/L}$. The transfusion of a single unit may be indicated to alleviate symptoms in severe anaemia (Hb $<70\text{g/L}$) or prevent the acute complications of severe anaemia while the underlying cause is treated e.g., iron replacement in iron deficiency anaemia.

SHOT data have shown that severe anaemia is an independent risk factor for TACO (Narayan, et al., 2019) and these patients are vulnerable to overtransfusion leading to TACO-related deaths and major morbidity. It is important that clinicians authorising transfusion understand the rationale for different approaches to transfusion management, and the risks of not recognising acute versus chronic anaemia. The presence of acute coronary syndrome and cardiac ischaemia in acute and chronic anaemia present additional challenges and risks. The decision to transfuse further units to achieve a higher Hb target in a patient with acute coronary syndrome/cardiac ischaemia should be balanced against the increased risk of TACO and exacerbation of heart failure. Strategies that support this such as education, training and process-embedded guidelines are key components of safe decision-making in transfusion. Figure 18a.2 describes the transfusion management approach for non-bleeding adult patients and details the specific approach that should be adopted for patients with severe chronic anaemia.

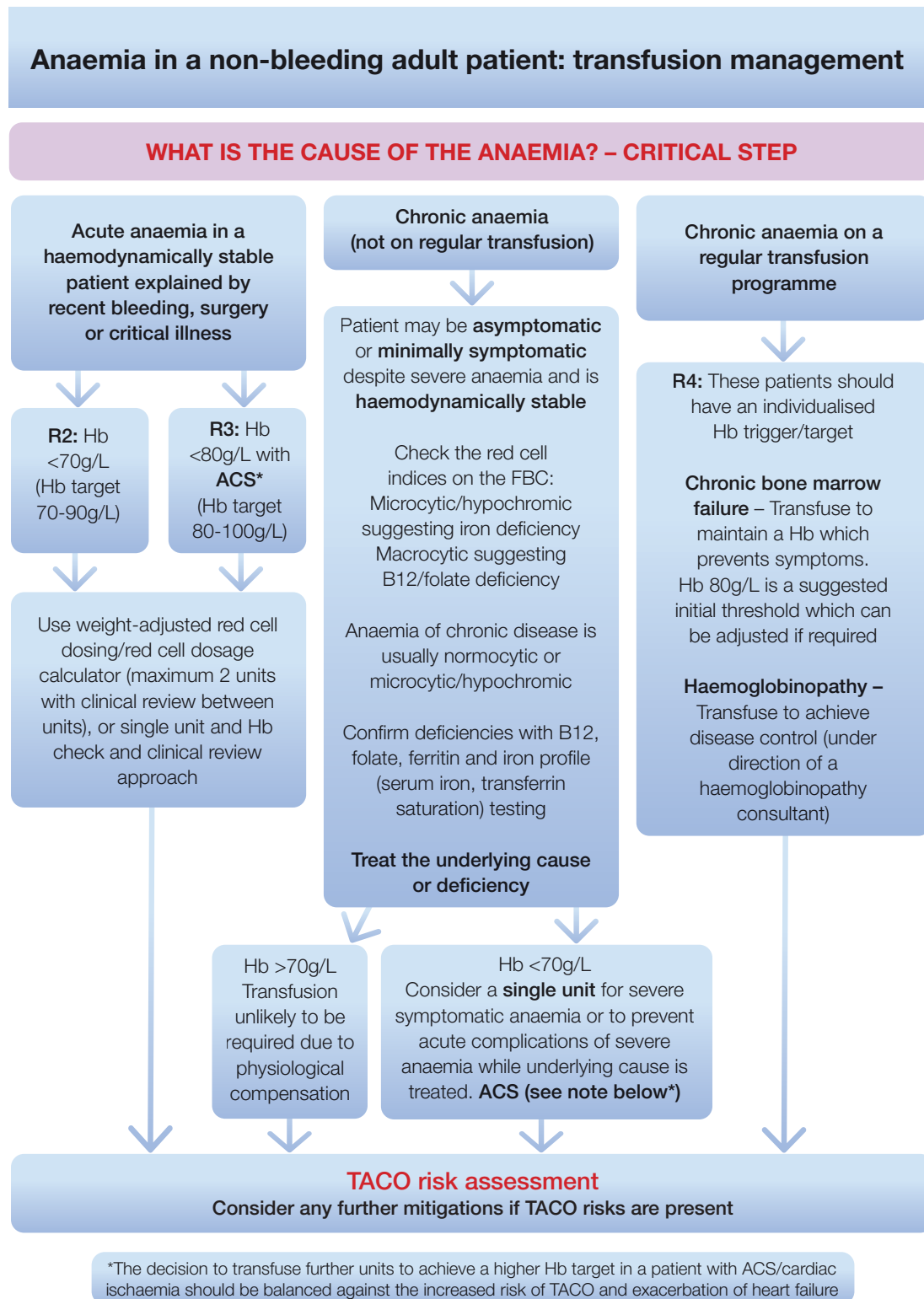


Conclusion

There has been slow adoption of the TACO pre-transfusion risk assessment tool since it was launched but this is increasing steadily. While encouraging, the analysis of the data shows it is still under-used or used ineffectively. Although there has been some uptake of the TACO structured incident investigation tool, there are still missed opportunities to enhance patient safety. The SHOT HFIT questions, and the analyses in the main chapter, are only included for reports in established error categories, but it can be demonstrated that some reaction cases may also be error-based. For the first time this year, a TACO case has been examined in the Human Factors and Ergonomics (HFE) supplementary information using the HFIT main headings to examine the significance of HFE involved (<https://www.shotuk.org/shot-reports/report-summary-and-supplement-2023/>).

Overtransfusion of red cells remains an issue which could be minimised by weight-adjusted or single unit transfusion in non-bleeding patients. The transfusion management of patients with severe chronic anaemia is concerning and continues to contribute to patient deaths due to excessive transfusion. There are several strategies available to mitigate the risk of TACO based on many years of haemovigilance data. Everyone involved in the transfusion process has a professional duty to protect patients from TACO wherever possible. With an increasing number of TACO cases reported to SHOT year-on-year, including instances of preventable deaths, a National Patient Safety Alert has been released UK-wide by SHOT through the MHRA (MHRA and SHOT, 2024). This is intended to support and provide a structure for organisations to implement measures to enhance safety and facilitate appropriate transfusion decisions. The NBTC indication codes are also being reviewed currently and an updated version is expected to be released in due course. Identifying risk-factors for TACO in vulnerable patients prior to transfusion helps initiate appropriate mitigating measures. TACO deaths are potentially preventable.

Figure 18a.2:
Transfusion
management
approach in
non-bleeding
adult patients



ACS=acute coronary syndrome; FBC=full blood count; Hb=haemoglobin; TACO=transfusion-associated circulatory overload



Recommended resources

Example of weight-adjusted red cell dosing implemented in clinical practice

NHS MHRA and UKCA Marked blood transfusion Red Cell Dosage Calculator Software App (rcdcalculator.co.uk)

TACO Incident Investigation Guidance Tool

TACO Risk assessment in alternative format for incorporation into clinical documents

<https://www.shotuk.org/resources/current-resources/>

SHOT Bite No. 11: Respiratory Symptoms During Transfusion

<https://www.shotuk.org/resources/current-resources/shot-bites/>

SHOT Video: TACO – Transfusion-Associated Circulatory Overload

<https://www.shotuk.org/resources/current-resources/videos/>

NPSA Alert (2024): TACO

National Patient Safety Alert: Reducing risks for transfusion-associated circulatory overload (NatPSA/2024/004/MHRA) - GOV.UK (www.gov.uk)

Transfusion-Associated Circulatory Overload (TACO) Cumulative Data

<https://www.shotuk.org/resources/current-resources/data-drawers/transfusion-associated-circulatory-overload-taco-data-drawer/>

National Comparative Audit of TACO

<https://hospital.blood.co.uk/audits/national-comparative-audit/reports-grouped-by-year/transfusion-associated-circulatory-overload-audit-2017/>

References

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