Protocol:
The BLAST Audit: Blood Loss, Anaemia and HaemoSTasis management in major vascular surgery

Contents

Key Audit Contacts

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Summary

Full Title	The BLAST Audit: Blood Loss, Anaemia and HaemoSTasis management in major vascular surgery	
Short Title	BLAST	
Aim	To investigate the current management of perioperative anaemia, blood loss and transfusion during major open vascular surgery and compare practice to guidance issued by the Centre of Perioperative Care, NHS Enhanced Recovery Programme and NICE.	
Design	Prospective multi-centre international audit	
Audit participants	Patients undergoing major elective or emergency vascular surgery.	
Planned audit period	Each site will have a 3 month recruitment period and a 1 month follow up period.	
Planned audit start date	1st May 2024	
Planned audit end date	1st December 2024	
	Objectives	Outcome measures
Primary	Determine international practice in anaemia and blood loss management in patients undergoing major vascular surgery	Percentage adherence to guideline recommendations
Secondary	1. Explore the use of haemostatic agents during major vascular surgery 2. Assess the incidence adverse outcomes	1. Description of haemostatic agents used before, during and after surgery 2. Number of complications as classified by Clavien-Dindo

Schedule of Events

	Before Surgery	During Surgery	After Surgery	30 days
Eligibility check	x			
Baseline demographics	x			
Anaemia management	x	x	x	
Procedure details		x		
Haemostasis adjuncts	x	x	x	
Complications			x	x
Return to theatre			x	x
Mortality			x	x

Audit Definitions

Major haemorrhage: An event of major bleeding that resulted in a drop in haemoglobin <70g/L, transfusion of at least 1 unit of RBCC, transfusion >4 units of RBC within a 24 hour period, leads to an intervention to control bleeding (e.g. embolization, packing or vascular repair) or death. (REF: VISION, POISE-3)

Anaemia: haemoglobin level two standard deviations below the normal. For males over 15 years old this is Hb <130 g/L, non-pregnant females over 15 years old Hb <120g/L, pregnant females <110g/L, postpartum females <100g/L (1).

Definitions of cardiovascular outcomes are based on the agreed criteria by the Standardized Endpoints in Perioperative Medicine initiative (2):

Myocardial infarction (MI): defined as a rise in cardiac troponin levels above the 99th percentile of the upper reference limit and symptoms of MI or new ischaemic ECG changes or pathological Q waves or imaging demonstrating ischaemia damage or coronary thrombus identified.

Cardiac Death: death due to a vascular cardiac cause.

Non-fatal cardiac arrest: successful resuscitation from ventricular fibrillation, sustained ventricular tachycardia, asystole, or pulseless electrical activity.

Major adverse cardiac event: a composition of cardiac death, myocardial infarction, non-fatal cardiac arrest, and coronary revascularisation.

Pulmonary embolism (PE): diagnosis of a PE on ventilation/perfusion scan or pulmonary angiography, CT angiography.

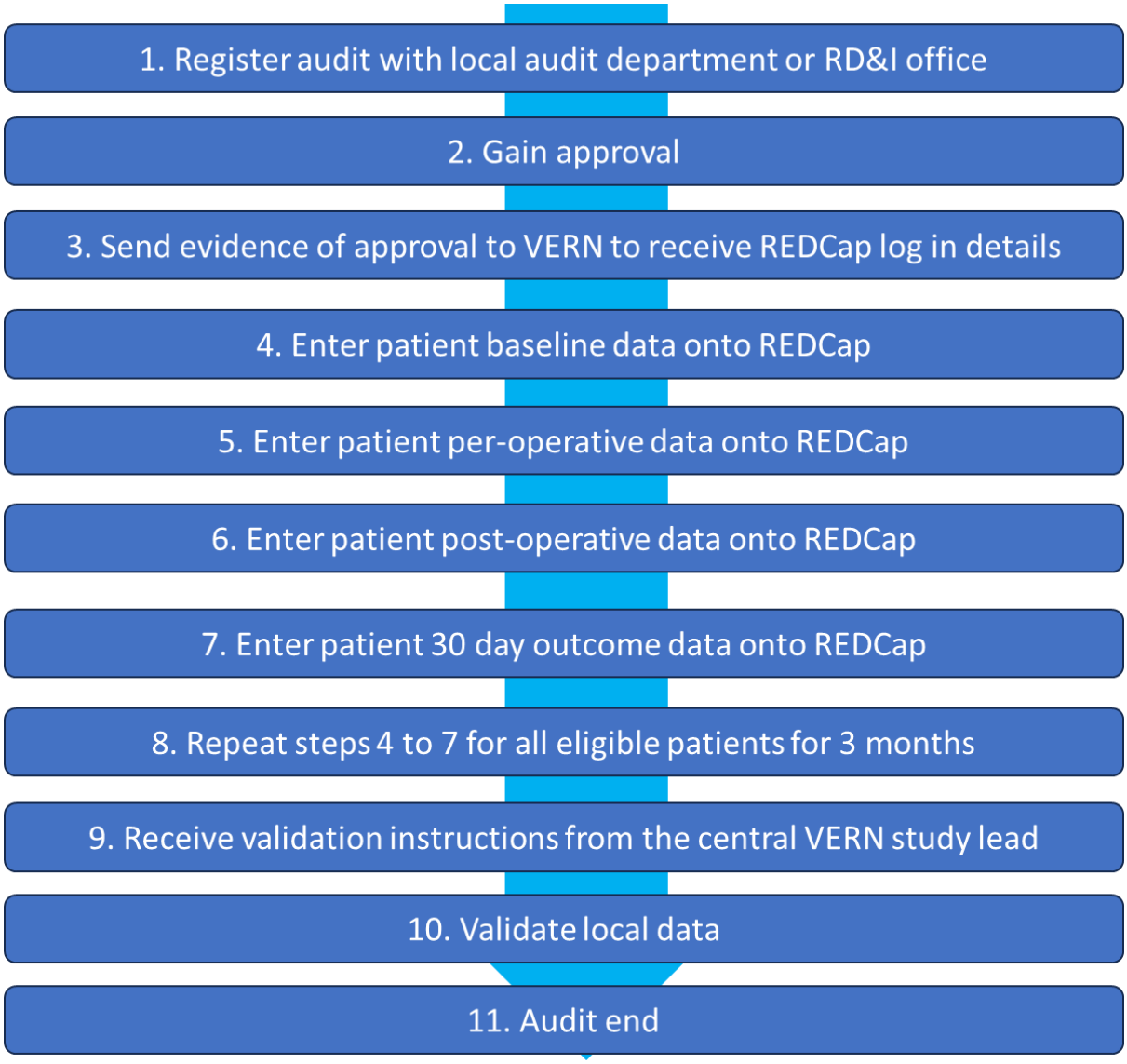
Deep venous thrombosis (DVT): diagnosis of a DVT on venography, B-mode compression ultrasonography or contrast CT.

Atrial Fibrillation (AF): new irregularly irregular heart rate with the absence of P waves on ECG for at least 30 seconds.

Major Adverse Cardiac Event (MACE): cardiac death, myocardial infarction, non-fatal cardiac arrest, or coronary revascularisation within 30 days of surgery.

Major Adverse Limb Event (MALE): acute limb ischaemia, critical limb threatening ischaemia and vascular major lower limb amputations (amputation above the forefoot) (3).

Audit Flow Chart



Audit Protocol:

The BLAST Audit: Blood Loss, Anaemia and HaemoSTasis management in major vascular surgery

1 – Introduction

The leading cause of death worldwide is cardiovascular disease (4) and the prevalence is predicted to significantly rise with the continuing ageing population (5). Vascular surgery involves the treatment of diseases in the cardiovascular system, namely arteries and veins, and has inevitably been impacted by this increase in burden of disease accompanied by an ageing and co-morbid population.

Major open vascular surgery broadly refers to lower limb open revascularization, open abdominal aortic aneurysm repair, carotid endarterectomy, and major lower limb amputations. Understandably surgery involving blood vessels can lead to bleeding, significant enough to require a dedicated intervention for haemostasis and transfusion of blood products. Vascular surgery is a fine balance between the need for anticoagulation or antiplatelet therapy to reduce the risk of thrombosis and side effect of bleeding (6).

Anaemia management has become a recognised therapeutic target, with the aim to improve patient outcomes (7), with recommendations focused on preoperative optimisation (8). However, this is often not feasible in the urgent timelines associated with vascular surgery (9). More recently the problem of anaemia on discharge has been associated with increased risk of post discharge complications requiring readmission. Post-operative anaemia is associated with increased morbidity and mortality (10–13) reinforcing the importance of adequate intra-operative haemostasis and treatment of anaemia.

The use of blood transfusion has changed in the last decade with outcomes of liberal compared to restrictive practices showing little difference in large randomised controlled trials (14). Nevertheless, lower limb revascularization surgery has been associated with up to 27% rate of transfusion (15), open abdominal aortic aneurysm repairs with up to 38% rate of transfusion (16) and a very substantial 64% rate of transfusion in major lower limb amputations (17).

Bleeding can lead to significant patient complication and even a minor complication can have negative long-term patient sequalae (11). There is a large armoury of dedicated interventions for haemostasis, both local and systemic agents to prevent blood loss and subsequent anaemia, however their use within vascular surgery varies greatly between individual operators and vascular centres. Systemic agents such as tranexamic acid have shown benefit in large clinical trials, that have also included vascular surgery patients (18) but trials in vascular surgery are lacking, with small data in aortic surgery (19,20) or individual series in Carotid surgery (21). Topical agents are usually categorized as haemostats, sealants or adhesives (22) and although reported to be effective in achieving haemostasis (23–25) there is no reported difference in requirements for blood transfusion (26).

Given the recent Cochrane meta-analysis which concluded that there was insufficient evidence to inform clinical practice with regards to systemic or topical haemostatic agents for the prevention of peri-operative bleeding in major, open vascular surgery (27) and their effects on blood loss and transfusion requirement, further research is urgently required. One problem with clinical trials in this field is that the easily quantifiable metric of blood transfusion has often

been used as the primary endpoint. Data on patient outcomes, bleeding (either local or systemic), transfusion complications (TRALI / TACO), or long-term effects of anaemia have not been reported.

2 – Study rationale

Bleeding complications arising from open, major vascular surgery cause significant morbidity and mortality. There is no consistency or consensus on the strategies implemented intra- and post-operatively to mitigate this risk. The Centre of Perioperative Care and the NHS Enhanced Recovery Programme outline the management of pre-operative anaemia in a guideline published in 2022 (8), and the NICE CG24 guidelines outline when the use of blood transfusion should be used (28).

Aim

The primary aim of this prospective audit is to investigate the current management of perioperative bleeding in major open vascular surgery and compare practice to guidance issued by the Centre of Perioperative Care, NHS Enhanced Recovery Programme and NICE, to determine adherence (See Appendix 3). Adherence will be reported for each recommendation to be audited.

Secondary aims are to investigate if this variation in practice is linked to:

1. 30 day mortality
2. 30 day Major Adverse Limb Events (MALE)
3. 30 day Major Adverse Cardiac Events (MACE)

3 – Objectives

The primary objective is to determine adherence of practices in managing perioperative bleeding in major open vascular surgery to the Centre of Peri-operative Care and NICE guidance (8,28).

Secondary objectives include:

1. To determine the impact of bleeding related complications on patient outcomes.
2. To determine the characteristics of patients that may be a high risk of bleeding.
3. To determine the efficacy of interventions to reduce bleeding.
4. To determine the use of transfusion pre-, peri- and post-operatively and its effects on morbidity, re-operation rates and mortality.
5. To determine the use of systemic and local haemostatic agents and their effects on re-operation rates, morbidity, and mortality.
6. To determine the effect of pre-operative use of anticoagulation/antiplatelet therapy on perioperative bleeding.

4 – Study design

This will be a multicentre, prospective audit including patients undergoing major open vascular surgery. The audit will be delivered through the Vascular and Endovascular Research Network (VERN).

4.1 Eligibility criteria

Inclusion criteria

- Patients undergoing major open vascular surgery (elective or emergent/urgent) including:
    - Open abdominal aortic aneurysm repair.
    - Lower limb open revascularisation (any).
    - Carotid endarterectomy.
    - Major lower limb amputation (transtibial, through-knee, transfemoral, hip disarticulation).

Exclusion criteria

- Patients who have undergone revision surgery following major open vascular surgery, where the index procedure was not included in the audit in the last 30 days.
- Patients undergoing revision surgery as a consequence of bleeding where the index procedure was not major open vascular surgery.
- Patients undergoing major vascular surgery following trauma.
- Patients under 18 years of age.

4.2 Registration

This audit will be open to any vascular surgery centre performing major open vascular surgery. Each collaborating site must prospectively register their intention to participate in BLAST with VERN, via the BLAST registration form. Evidence of Research, Design and Innovation Office or Audit Department approval at each site must be shared with VERN prior to data collection. Obtaining local approval to participate in BLAST will be the responsibility of the local project lead.

The local study team will be responsible for the identification and recruitment of potential participants as per the eligibility criteria (Section 4.1). Queries with regards to participant eligibility will be dealt with by the local audit lead or, in case of non-resolution, referred to the VERN team.

4.3 – Data collection

Data collection will begin on 01/05/2024 and complete on 30/11/2024. Centres will be able to start on different dates, but recruitment will last for 3 months at each participating centre. Data points to be recollected as based on the StEP Delphi consensus and outcomes are based the StEP recommended cardiovascular outcomes (2).

Routine Practice Survey

Data will be collected on measures to department protocols to reduce blood loss, anaemia and prevent thrombotic events (Table 1). As part of the registration form data will be collected on:

- Screening for pre-operative anaemia.
- Management of pre-operative anaemia.
- Routine use of cell saver.
- Routine use of topical haemostatic agents.
- Routine use of systemic haemostatic agents.

Baseline data

- Patient demographics (age, sex, height, weight, smoking status).
- Pre-existing comorbidities.
- Diagnosis of anaemia.
- Current management of anaemia.
- Use of anticoagulation/antiplatelet medication and the timing of continuation/discontinuation of each pre-operatively (including bridging medication) and the planned timing of reintroduction after surgery.
- Procedure to be undertaken.
- Indication for procedure
- NCEPOD classification
    - 1 - immediate
    - 2 - urgent
    - 3 - expedited
    - 4 - elective
- Pre-operative blood results (within 28 days of surgery) including:
    - FBC
    - Electrolytes
    - Creatinine/Urea
    - Coagulation profile
    - Iron profile (if completed)
    - Troponin (if completed)
- Pre-operative transfusion (red cells, plasma products) (if applicable, to capture data on pre- and post-transfusion haemoglobin).
- Clinical Frailty score

Peri-operative data

- Pre-operative anticipated blood loss (WHO checklist, led by the most senior surgeon operating).
- Intraoperative blood loss (to note if unexpected bleeding occurred intra-operatively).
- Immediate post-operative blood loss (including recovery)
- Intra-operative transfusion (red cells, plasma products) (to include period in anaesthetic recovery).
- Use of a tourniquet for major lower limb amputations and type
- Use of systemic and/or topical haemostatic agents.
- Use of cell salvage (if applicable, volume transfused back to patient).
- Use of drain (number of drains, type, size).

Post-operative data

- Day 1 post-operative bloods (if longer inpatient stay to include last blood results prior to discharge after day 5)
    - FBC
    - Electrolytes
    - Creatinine/Urea
    - Coagulation profile
- Post-operative transfusion (red cells, plasma products) (if applicable, to capture data on pre- and post-transfusion haemoglobin).
- Use of other medications to manage anaemia post-operatively.

- Daily drain output (if applicable).
- Postoperative anticoagulation medications
- Use of tranexamic acid post-operatively
- Total length of stay in hospital

Complications related to bleeding and thrombosis

- Clavian-Dindo Class 1
- Clavian-Dindo Class 2
    - Anaemia requiring blood transfusion
- Clavian-Dindo Class 3a
    - Drainage of a haematoma under local anaesthetic
- Clavian-Dindo Grade 3b
    - Return to theatre for a general anaesthetic:
        - Evacuation of haematoma without active bleeding
        - Active bleeding
        - Graft Occlusion
        - Thrombectomy
        - Embolectomy
    - Embolic event: Acute Limb Ischaemia, Stroke
    - Thrombotic event: Graft occlusion
- Clavian Dindo Grade 4a
    - Myocardial Infarction
    - Acute kidney injury
    - Acute Limb Ischaemia
    - Stroke
    - PE
    - DVT
- Clavian Dindo Class 4b
    - Major haemorrhage
    - Disseminated Intravascular Coagulation
- Clavian Dindo Class 5
    - In hospital mortality
- Transfusion reactions:
    - Mild transfusion reaction (e.g. mild allergic reaction or febrile non-haemolytic transfusion reaction)
    - Major transfusion reaction e.g. transfusion related acute lung injury
    - Major transfusion reaction e.g. ABO incompatibility, Haemolytic Gram Negative/Positive Shock, Anaphylactic shock, transfusion associated circulatory overload, delayed haemolytic reaction

30 days outcomes

- 30 day complications related to anaemia and thrombotic complications
- 30 day wound healing (defined as completed wound closure without eschar or drainage) and incidence of surgical site infection (diagnosed with CDC criteria)
- 30 day mortality

5 – Data analysis

Descriptive analysis will be used to report adherence to guidance. Statistical analyses will be used to examine secondary outcomes. Continuous data will be tested for normality and

parametric or non-parametric tests used as appropriate. The Chi-squared test will be used to analyse for differences in categorical variables.

Missing data will be analysed to determine the pattern of missingness and, if appropriate, multiple imputations will be used using the Markov chain Monte Carlo method. Subsequent analyses conducted on imputed data will be compared to sensitivity analyses using 'complete-case analysis'.

Univariate and multivariate regression analyses will be used to identify independent predictors (as stated in the guidance) of: need for peri-operative blood transfusion, post-operative blood transfusion, 30 day rate of complications (by aetiology and Clavien-Dindo Grade) and 30 day mortality. Variables reaching threshold of $p<0.10$ on univariate analysis will be put forward to the multivariate regression analysis. $P<0.05$ will be used to define statistical significance.

6 – Data management

6.1 Data collection tools and source document identification

All data will be collected prospectively using the purpose-built electronic database Research Electronic Data Capture (REDCap) platform, which is overseen by Bristol University. Data will be collected and uploaded by a member of the audit team with appropriate REDCap training from VERN.

6.2 Data handling and record keeping

All audit data will be preferably uploaded directly to REDCap, however, all centres will be provided with printable case report forms (CRFs) (See Appendix 1) to be used at their discretion where access to REDCap may be limited (e.g. in operating theatres). Oversight of paper CRFs used at centres will be the responsibility of the centre's local project lead. All CRFs used will be securely stored in an appropriate location on-site until data is uploaded to REDCap, at which point the centre's lead clinician will be responsible for ensuring they are appropriately destroyed.

A specific audit identification number will be assigned to each patient to allow anonymised data to be collected prospectively using a purpose-built REDCap database that will be accessible at each centre. Each centre's lead clinician will be responsible for ensuring a database containing each participants' local hospital ID and corresponding audit ID is maintained to ensure accurate follow-up data is uploaded. The lead clinician at each centre is responsible for ensuring this database is stored securely on an appropriate hospital computer. Data should be kept for two years – to allow a possible follow-up study – and destroyed thereafter. Throughout this audit's REDCap database design, no identifiable data can be uploaded.

6.3 Source data

Source documents are original documents, data and records from which participants' CRF data are obtained. These include, but are not limited to, hospital records (from which medical history and previous and concurrent medication may be summarised into the CRF/REDCap

database), clinical and office charts, laboratory and pharmacy records, diaries, microfiches, radiographs, and correspondence.

6.4 Participant confidentiality

The audit staff will ensure that the participants' anonymity is maintained. The participants will be identified only by a participant's ID number on the REDCap database. The audit will comply with the Data Protection Act which requires data to be anonymised as soon as it is practical to do so.

6.5 Data completeness and accuracy

Following the initial data collection period, data completeness will be quantified. Patient records with less than 95% completeness of mandatory datapoints will be returned to the centre for completion and, if not possible, the record will be excluded from analysis.

All centres will be required to validate data accuracy. Each centre will identify an additional team member (not involved in initial data collection) to re-capture 25% of the datapoints (at random) for 20% of the cases (at random) for their centre. Any centre reporting less than 95% accuracy will be required to validate a further 20% of their cases, and the lead to investigate and report back to the BLAST management team.

All centres will be required to assess case ascertainment. The lead at each centre (or delegate of) will be required to review theatre records or registry data (e.g. National Vascular Registry) and report the total number of eligible procedures performed during the study period to the BLAST management team for comparison with cases submitted to REDCap.

7 - Ethics and approvals

7.1 Ethical approval and research governance

The audit will be conducted in compliance with the principles of the ICH GCP guidelines and in accordance with all applicable regulatory guidance including, but not limited to, the UK Policy Framework for Health and Social Care Research. Ethical approval will not be sought as no patient identifiable data will be available to VERN. There will also be no change to routine patient care. Local audit approval will be sought from the Research and Development or Audit department at each participating centre; this will be the responsibility of the local project lead at each centre.

7.2 Data protection and patient confidentiality

The audit will comply with the Data Protection Act 2008. Participants will be assigned a unique REDCap identifier upon enrolment into the audit to allow pseudonymisation of patient identifiable data. Access to patient identifiable data will be restricted to members of the patient's usual clinical team. Any hard copies of audit documents will be stored in locked filing cabinets in secure entry-card protected sites only and will be the responsibility of the lead at each centre.

7.3 Centre set-up and pre-audit questionnaire

Healthcare professionals or medical students interested in contributing to the audit may contact the BLAST audit team through a dedicated email address: blast.vern@gmail.com. Centres can join the BLAST audit between 01/05/2024 and 31/07/2024 by completing the BLAST registration form which also contains the pre-audit questionnaire of routine practice (See Appendix 2). Once the BLAST registration form is completed the centre will receive log-in details for the REDCap database.

7.4 Collaborating Centre Study Team

The collaborating team at each collaborating centre is permitted to have six members. This must include a consultant vascular surgeon lead, who will have overall responsibility of ensuring the audit is conducted in line with the methods outlined in the protocol and complies with local governance, ethics and regulations at that site. Any instances of protocol non-compliance will be reported to the local study lead, who in turn will report to the VERN BLAST audit team.

The other five team members can be other vascular healthcare professionals including doctors, nurses, and allied healthcare professionals. Each team member (excluding the consultant lead) must enter at least 10 cases to be recognised as contributing to the audit.

It is the responsibility of the entire local team to keep a record of the number of eligible cases and the number of eligible cases entered into the audit during the recruitment period. It is the responsibility of the entire team to ensure data is entered contemporaneously into REDCap and to comply with the methods of the protocol. All team members must comply with local regulations and training requirements for undertaking the audit.

If the collaborating centre wishes to make a change to the local team, the consultant lead must email the VERN BLAST audit team to request the change to be made. It is at the discretion of the VERN BLAST study team on whether the change is approved.

8 - Funding

Any funding bodies will have no involvement in the audit design and will not be involved in data collection and analysis, preparation of manuscripts or decision to publish.

9 - Dissemination and authorship policy

Data will be submitted for presentation at national and international academic conferences. Further, a manuscript will be prepared for peer reviewed publication.

A writing team, including those involved with the design, implementation and dissemination of the BLAST audit, and those contributing to data analysis will be responsible for both presentation(s) and publication(s). For both presentation(s) and publication(s) a collaborative authorship model will be used. Criteria to qualify for collaborative authorship are defined as:

1. Had a significant role in the set up and management of the BLAST audit; including audit department registration/ethical approval, creation of a data collection team and engagement with VERN to ensure timely upload of data (with validation as required),

OR

2. Captured sufficient data to warrant authorship – this would be the equivalent of collecting baseline and follow up data on at least 10 patients, although it is appreciated individuals may participate in only baseline data collection or only follow up data capture. Data collection is expected to be complete (>95% variables completed) and submitted within 7 months of starting data collection,

OR

3. (for local study leads) provide oversight and support as detailed in sections,

AND

4. Review and approve any resultant manuscript(s) for submission to a peer-reviewed journal.

The corresponding author will take primary responsibility for communication with the journal throughout the submission process.

The anticipated number of audit team members per centre is 1 local study lead + 5 other team members (medical trainees, allied healthcare professionals, medical students). If centres include more than 5 additional team members, it is expected that allied healthcare professionals and/or medical students are included.

Table 1 – A survey of routine practice

Unit Name	**(Drop down)**
Local lead consultant/attending	
Local lead consultant/attending email	
Team member 1	
Team member 2	
Team member 3	
Team member 4	
Team member 5	
Research/Ethical/Research and Development/Audit Department Contact Name	
Research/Ethical/Research and Development/Audit Department Contact email address	
Date of approval	**dd/mm/yyyy**
Local Department Policies for Minimising Blood Loss and Treating Anaemia	
Pre-operatively, is there a local policy for the screening of anaemia in all patients undergoing major vascular surgery routinely	**Yes** **All** **Major lower limb amputation** **Aortic aneurysm repair** **Lower limb revascularisation** **Carotid Endarterectomy** **No**
Pre-operatively, is there a local policy for the investigation of patients diagnosed with anaemia?	**Yes** **All** **Elective** **Urgent** **No**
Pre-operatively, is there a local policy for the management of patients diagnosed with anaemia who are awaiting major vascular surgery, including referring the patient back to primary care ?	**Yes** **All** **Major lower limb amputation** **Aortic aneurysm repair** **Lower limb revascularisation** **Carotid Endarterectomy** **No**

Pre-operatively, is there a local guideline for the investigation of malignancy while starting iron replacement in those with new true iron deficiency anaemia awaiting major vascular surgery?	**Yes** **All** **Major lower limb amputation** **Aortic aneurysm repair** **Lower limb revascularisation** **Carotid Endarterectomy** **No**
Pre-operatively, is there a local pathway for the optimisation of patients' medical comorbidities prior to major vascular surgery?	**Yes** **All** **Major lower limb amputation** **Aortic aneurysm repair** **Lower limb revascularisation** **Carotid Endarterectomy** **No**
Perioperatively, is there a local protocol for the management of anaemia during the peri-operative period in patients undergoing major vascular surgery?	**Yes** **All** **Major lower limb amputation** **Aortic aneurysm repair** **Lower limb revascularisation** **Carotid Endarterectomy** **No**
Perioperatively, is there a local protocol for the management of anaemia during the peri-operative period in patients undergoing major vascular surgery who have been identified as frail?	**Yes** **All** **Major lower limb amputation** **Aortic aneurysm repair** **Lower limb revascularisation** **Carotid Endarterectomy** **No**
Is there a specific local policy for transfusion thresholds in patients undergoing major vascular surgery?	**Yes** **All** **Major lower limb amputation** **Aortic aneurysm repair** **Lower limb revascularisation** **Carotid Endarterectomy** **No**
Does your local unit use perioperative haemodynamic goal directed therapy?	**Yes** **All** **Major lower limb amputation** **Aortic aneurysm repair** **Lower limb revascularisation** **Carotid Endarterectomy** **No**

Appendix 1 – Case Report Form

Baseline Demographics	
Record ID	
Age at time of procedure	**years**
Sex	**Male** **Female**
Ethnicity	**White British** **White Irish** **Any other White background** **White and Black Caribbean** **White and Black African** **White and Asian** **Any other mixed background** **Indian** **Pakistani** **Bangladeshi** **Any other Asian background** **Black Caribbean** **Black African** **Any other Black background** **Chinese** **Other** **Free text**
Height	**_____cm**
Weight	**_____kg**
Smoking	**Smoker** **Ex-smoker** **Non-smoker**
Anaemia identified pre-operatively	**No** **Yes** **Iron deficiency** **Anaemia related to inflammation (chronic inflammation, chronic disease, functional iron deficiency)** **Megaloblastic anaemia** **Inherited disorders** **Others**
Comorbidities	**COPD** **CKD**

	IHD **CVD** **T1DM** **T2DM**
Ferrous fumarate/sulphate	**Yes** **No**
Hydroxocobalamin in the previous 3 months	**Yes** **No**
Folic acid	**Yes** **No**
Intravenous iron in the previous 3 months	**Yes** **No**
Antiplatelets	**Yes** **No**
Anticoagulation	**No** **Yes** **If yes, heparin bridging (Y/N)** **If yes, discontinued preoperatively (Y/N)** **If yes, how long prior to the procedure, ____ hours** **Warfarin** **DOAC** **Treatment dose LMWH**
Pre-operative Practices	
Preoperative Tranexamic Acid	**Yes** **No**
Preoperative IV unfractionated heparin	**Yes** **No**
Procedure (select those that apply)	**Open AAA repair (tube)** **Open AAA repair (bifurcated)** **Open aorto-iliac bypass** **Open aorto-femoral bypass** **Common femoral endarterectomy** **Profundoplasty** **Open fem-fem crossover** **Open axillo-femoral bypass** **Open femoro-popliteal bypass** **Open femoro-distal bypass** **Open popliteal-crural bypass** **Other major vascular surgery**

	Vein graft **Prosthetic graft** **Hip disarticulation** **Above knee amputation** **Below knee amputation** **Through knee amputation** **Carotid endarterectomy** **Vein patch** **Bovine patch** **Prosthetic patch**
Indication **Lower limb revascularisation** **Aortic aneurysm** **MLLA** **Carotid**	 **ALI: Rutherford I, IIa, IIb, III** **CLTI: Rest pain/Tissue loss/WIfI** **Infrarenal/ juxtarenal/ suprarenal AAA** **Size _____cm** **PAD with tissue loss (WIfI)** **PAD with rest pain** **DM foot complication (WIfI)** **Other** **Stroke/TIA/Other**
Preoperative blood (<28 days prior) **Hb** **MCV** **MCH** **MCHC** **Haematocrit** **WCC** **Plt** **Ur** **Creatinine** **PT** **APTT** **Ferritin** **Folate** **B12** **Troponin T**	 **g/L** **fL** **pg** **g/L** **L/L** **10^9/L** **10^9/L** **mmol/L** **umol/L** **s** **s** **ug/L** **ug/L** **pmol/L** **ng/L**
Pre-operative blood transfusion **If yes** **Indication**	**Yes/No** **Hb<70, major haemorrhage, symptomatic anaemia, other** **Platelet count <10x10^9/L, platelet count <50x10^9/L & undergoing an invasive procedure, <75x10^9/L &**

Products **Number of units** **Post-transfusion Hb**	**high risk, significant bleeding, fibrinogen <1.5g/L** **Packed red cells/ platelets/ FFP/cryoprecipitate** **_____** **_____g/L**
Fluid resuscitation?	
Frailty score (CFS)	**1 to 9**
Intraoperative data	
Expected blood loss	**mls**
Estimated blood loss in theatre	**mls**
Immediate post-operative blood loss in recovery	**mls**
IV unfractionated heparin use	**No** **Yes** **Units**
Cell saver	**Yes** **No**
Protamine	**Yes** **No**
Activated Coagulation Time (ACT) checked	**No** **Yes** **____seconds**
Rapid infusers used	**Yes** **No**
Tranexamic acid administered	**Yes** **No**
Topical haemostatic agent	**No** **Yes** **If Yes** **Collagen based e.g. CoStasis** **Gelatin based e.g. FloSeal, Surgifoam** **Cellulose based e.g. Surgicell**

	Albumin derived e.g. BioGlue **Polysaccharide based e.g. Actifoam** **Inorganic e.g. Quikclot** **Fibrin based e.g. Tisseel** **Polymeric e.g. BioHaemStat**
Intraoperative blood transfusion **If yes** **Indication** **Products** **Number of units** **Pre-transfusion Hb** **Post-transfusion Hb**	**Yes/No** **Hb<70, major haemorrhage, other** **Platelet count <10x10^9/L, fibrinogen <1.5g/L** **Packed red cells/ platelets/ FFP** **_____** **g/L** **g/L**
Intravenous fluids	**Crystalloid** **Colloid** **mls**
On table cardiac arrest	**Yes, No, Fatal**
Post-op	
Post-operative blood transfusion **If yes,** **Indication** **Products** **Number of units** **Pre-transfusion Hb** **Post-transfusion Hb**	**Yes/No** **Hb<70, major haemorrhage, symptomatic anaemia, other** **Platelet count <10x10^9/L, platelet count <50x10^9/L undergoing an invasive procedure, <75x10^9/L and high risk, significant bleeding, fibrinogen <1.5g/L** **Packed red cells/ platelets/ FFP** **_____** **g/L** **g/L** **(have extra sections if more than one transfusion given)**
Intravenous fluids if resuscitation	**Crystalloid** **Colloid** **mls**
IV unfractionated heparin use	**No** **Yes** **Length of treatment (days)**
Regular anticoagulation recommenced if held	**Yes** **No. days postoperatively** **No**

	N/A
Regular antiplatelet recommenced if held	**Yes** **No** **N/A**
Day 1 **Taken** **Hb** **MCV** **MCH** **MCHC** **Haematocrit** **WCC** **Plt** **Ur** **Creatinine** **PT** **APTT** **Troponin T**	 **No/Yes** **g/L** **fL** **pg** **g/L** **L/L** **10^9/L** **10^9/L** **mmol/L** **umol/L** **s** **s** **ng/L**
Day 2 Hb **Taken** **Hb**	 **No/Yes** **g/L**
Day 5 **Taken** **Hb**	 **No/Yes** **g/L**
Tranexamic acid	**No** **Yes** **Duration**
Oral iron replacement therapy	**Yes** **No**
Intravenous iron replacement therapy	**Yes** **No**
Length of stay	**days**
Clavian-Dindo Class	**1-5** **None**
Transfusion Reaction	**N/A** **None** **Mild** **Major**
Return to theatre	**No** **Yes**

	Evacuation of haematoma, active bleeding, graft occlusion, thrombectomy, embolectomy, other
Acute Kidney Injury ***AKI is defined as:*** ***- A rise in serum creatinine of 26micromol/L or greater within 48 hours.*** ***- A 50% rise in creatinine from baseline*** ***- A fall in urine output to less than 0.5mL/kg/hour for more than 6 hours if measurable***	**Yes** **No**
Stroke	**Yes, No**
Myocardial Infarction	**Yes, No, Fatal**
Arrhythmia	**Yes** **No** **If yes: AF, other**
Cardiac arrest	**Yes, No, Fatal**
New Congestive heart failure	**Yes, No**
Pulmonary embolism	**Yes, No, Fatal**
Deep Vein Thrombosis	**Yes, No, Fatal**
Acute Limb Ischaemia	**Yes, No**
Death	**Yes, No**
30 Day Outcomes	
Readmission to hospital	**Yes** **No**
Blood transfusion **If yes,** **Indication** **Products** **Number of units** **Pre-transfusion Hb** **Post-transfusion Hb**	**Yes/No** **Hb<70, major haemorrhage, symptomatic anaemia, other** **Platelet count <10x10^9/L, platelet count <50x10^9/L undergoing an invasive procedure, <75x10^9/L and high risk, significant bleeding, fibrinogen <1.5g/L** **Packed red cells/ platelets/ FFP** **_____** **g/L**

	g/L **(have extra sections if more than one transfusion given)**
Transfusion Reaction	**N/A** **None** **Mild** **Major**
Return to theatre	**No** **Yes** **Evacuation of haematoma, active bleeding, graft occlusion, thrombectomy, embolectomy, other**
Acute Kidney Injury	**Yes, No**
Stroke	**Yes, No, Fatal**
Myocardial Infarction	**Yes, No, Fatal**
Acute Limb Ischaemia	**Yes, No**
Major Lower Limb Amputation	**Yes, No**
Death	**Yes, No**

Appendix 2 – Sign up form

BLAST Registration form

Please complete the form below to register to the BLAST audit with VERN. Following registration you will receive access to REDCap for data entry.

When providing contact emails, please use work (i.e. nhs.net) or university based emails, please do not use personal emails (gmail, hotmail, etc).

* Indicates required question

1. Name of hospital, city and country

2. Name of Lead Clinician (consultant/attending) *

3. Contact email for Lead Clinician *
   (Please provide ORCID ID if available)

4. Please provide name, role and contact email of a team member responsible for patient identification, recruitment and data entry. *
   (Please provide ORCID ID if available)

5. Please provide name, role and contact email of a team member responsible for patient identification, recruitment and data entry. *
   (Please provide ORCID ID if available)

6. Please provide name, role and contact email of a team member responsible for patient identification, recruitment and data entry. *
   (Please provide ORCID ID if available)

7. Please provide name, role and contact email of a team member responsible for patient identification, recruitment and data entry. *
   (Please provide ORCID ID if available)

8. Please provide name, role and contact email of a team member responsible for patient identification, recruitment and data entry. *
   (Please provide ORCID ID if available)

9. Please provide date of local governance/audit approval *

10. Please provide name of responsible/nominated local governance/audit officer. *

11. Please provide contact email of responsible/nominated local governance/audit officer. *

12. Please provide evidence of local governance/audit approval *

    Files submitted:

Appendix 3 – Guideline Recommendations for Auditing

Centre of Peri-Operative Care: Guidelines for the Management of Anaemia in the Peri-operative Pathway - September 2022 (REF)

Recommendations for auditing in BLAST

Recommendations for staff working in surgical outpatients and preoperative assessment services:

- Ensure Hb is checked as early as possible for patients being considered for surgery according to NICE preoperative testing guidelines

Adherence will be assessed with pre-operative Haemoglobin level.

- Assess for causes of newly identified anaemia if patient undergoing surgical procedures with anticipated moderate-to-high (>500ml) blood loss.

Adherence will be assessed by whether a diagnosis of anaemia has been made, if a haemoglobin level below the normal range has been detected.

Adherence will also be assessed with the route practices survey on screening for anaemia in the pre-operative assessment.

- Document whether the patient is being referred back to primary care for further assessment and inform the patient accordingly. This information should include detail on when results might be available and the Hb threshold for surgery to proceed

Adherence will also be assessed with the route practices survey on management for anaemia in the pre-operative assessment.

- Ensure documentation of who will review results of investigations for cause of anaemia and plan further treatment

Adherence will be assessed with the routine practices survey on anaemia management.

- Investigate for malignancy in case of new true iron deficiency anaemia, and simultaneously start replacement of iron

Adherence will be assessed with the routine practices survey on anaemia management.

- Give advice to patients about whether to stop anticoagulants (and other medications that may increase the risk of bleeding) before elective surgery, and if so how and when

Adherence will be assessed with pre-operative anticoagulation and processes for withholding and recommencing anticoagulants.

- Ensure coexisting medical comorbidities are assessed and optimised to improve physiological reserve (eg optimisation of chronic obstructive airways disease or cardiac disease39)

Adherence will be assessed with the routine practices survey.

Recommendations for staff admitting emergency patients for surgery

- Complete urgent serum blood tests to include: Hb, Ferritin, T-Sats, CRP, eGFR or Creatinine, B12 and folate, and LFTs, Lactate and Group & Save if relevant

Adherence will be assessed with preoperative blood tests.

- Develop specialty specific protocols for preoperative optimisation then intraoperative and postoperative management of patients with anaemia, particularly in those with frailty

Adherence will be assessed with the routine practices survey.

- Vascular – Critical Limb Ischaemia (CLI) patients may need higher blood transfusion thresholds

Adherence will be assessed with the routine practices survey.

Recommendations for all staff in theatre and recovery

- Make appropriate use of anti-fibrinolytics (ie Tranexamic acid)

Adherence will be assessed by reported use of antifibrinolytic use.

- Consider techniques to minimise blood loss including tourniquets, meticulous haemostasis and laparoscopic surgery

Adherence will be assessed with reported operative practices.

- If considering the benefit versus cost of using cell salvage, or if the team are unable to predict blood loss during the proposed surgery, consider initially setting up equipment for 'collection only'

Adherence will be assessed with reported operative practices.

- Consider blood transfusion when haemoglobin levels <70g/.49 The theatre and recovery team should be aware of the transfusion threshold individualised to the patient

Adherence will be assessed with reported indication for blood transfusion and routine practises survey.

- Re-check haemoglobin levels between each unit of blood, unless actively haemorrhaging, and utilise point of care testing to inform decision making

Adherence will be assess with reported post transfusion haemoglobin level.

<u>Recommendations for the Intraoperative Team</u>

- Consider prophylactic antifibrinolytics to reduce blood loss prior to the removal of a tourniquet

Adherence will be assessed with reported operative practices.

- Consider topical haemostatic agents to assist with localised bleeding

Adherence will be assessed with reported operative practices.

- Consider the use of cell salvage where appropriate

Adherence will be assessed with reported operative practices.

- Consider antifibrinolytic (ie tranexamic acid) if expected blood loss >500m

Adherence will be assessed with reported operative practices.

- Consider perioperative haemodynamic goal directed therapy (GDT) in high-risk surgical patients.

Adherence will be assessed with the routine practices survey.

<u>Recommendations for staff delivering postoperative ward care</u>

- Check Hb postoperatively based on local policies or patient symptoms. Be aware that Hb will be falsely elevated in hypovolaemic patients

Adherence will be assessed with reported post-operative haemoglobin level.

- Use haemoglobin and coagulation status point of care tests where indicated

Adherence will be assessed with reported post-operative haemoglobin and coagulation levels.

- Do not prescribe oral iron in the immediate postoperative period

Adherence will be assessed with medications used post-operatively.

- Note that intravenous iron should be avoided or used with caution in active infection due to concerns it could worsen infection.

Adherence will be assessed with medications used post-operatively.

NICE: Blood Transfusion NG24

- Do not offer erythropoietin to reduce the need for blood transfusion in patients having surgery, unless:
    - the patient has anaemia and meets the criteria for blood transfusion, but declines it because of religious beliefs or other reasons or
    - the appropriate blood type is not available because of the patient's red cell antibodies.

Adherence will be assessed with reported pre-operative management of anaemia.

- Offer oral iron before and after surgery to patients with iron-deficiency anaemia

Adherence will be assessed with reported pre-operative management of anaemia, if present.

- Consider intravenous iron before or after surgery for patients who:
    - have iron-deficiency anaemia and cannot tolerate or absorb oral iron, or are unable to adhere to oral iron treatment (see the NICE guideline on medicines adherence)
    - are diagnosed with functional iron deficiency
    - are diagnosed with iron-deficiency anaemia, and the interval between the diagnosis of anaemia and surgery is predicted to be too short for oral iron to be effective.

Adherence will be assessed with reported pre-operative management of anaemia, if present, and the routine practices survey.

- Offer tranexamic acid to adults undergoing surgery who are expected to have at least moderate blood loss (greater than 500 ml)

Adherence will be assessed with reported use of tranexamic acid.

- Do not routinely use cell salvage without tranexamic acid.

Adherence will be assessed with reported use of tranexamic acid and cell salvage.

- Consider intra-operative cell salvage with tranexamic acid for patients who are expected to lose a very high volume of blood

Adherence will be assessed with reported use of tranexamic acid and cell salvage.

- Use restrictive red blood cell transfusion thresholds for patients who need red blood cell transfusions and who do not:
    - have major haemorrhage or
    - have acute coronary syndrome or
    - need regular blood transfusions for chronic anaemia.

Adherence will be assessed with the routine practices survey.

- When using a restrictive red blood cell transfusion threshold, consider a threshold of 70 g/litre and a haemoglobin concentration target of 70–90 g/litre after transfusion.

Adherence will be assessed with reported indication for blood transfusion.

- Consider a red blood cell transfusion threshold of 80 g/litre and a haemoglobin concentration target of 80–100 g/litre after transfusion for patients with acute coronary syndrome

Adherence will be assessed with reported indication for blood transfusion and complications.

- Consider single-unit red blood cell transfusions for adults (or equivalent volumes calculated based on body weight for children or adults with low body weight) who do not have active bleeding

Adherence will be assessed with reported number of units transfused, without major haemorrhage.

- Offer platelet transfusions to patients with thrombocytopenia who have clinically significant bleeding
- Use higher platelet thresholds (up to a maximum of 100×109 per litre) for patients with thrombocytopenia and either of the following:

    - severe bleeding (WHO grades 3 and 4)
    - bleeding in critical sites, such as the central nervous system

Adherence will be assessed by reported indication for platelet transfusion.

- Offer prophylactic platelet transfusions to patients with a platelet count below 10×109 per litre who are not bleeding or having invasive procedures or surgery, and who do not have any of the following conditions:
    - chronic bone marrow failure
    - autoimmune thrombocytopenia
    - heparin-induced thrombocytopenia
    - thrombotic thrombocytopenic purpura.

Adherence will be assessed by reported indication for platelet transfusion.

- Consider prophylactic platelet transfusions to raise the platelet count above 50×109 per litre in patients who are having invasive procedures or surgery.

Adherence will be assessed by reported indication for platelet transfusion.

- Consider a higher threshold (for example 50–75×109 per litre) for patients with a high risk of bleeding who are having invasive procedures or surgery, after taking into account:
    - the specific procedure the patient is having
    - the cause of the thrombocytopenia
    - whether the patient's platelet count is falling
    - any coexisting causes of abnormal haemostasis.

Adherence will be assessed by reported indication for platelet transfusion.

- Only consider fresh frozen plasma transfusion for patients with clinically significant bleeding but without major haemorrhage if they have abnormal coagulation test result

Adherence will be assessed by reported indication for fresh frozen plasma transfusion.

- Consider cryoprecipitate transfusions for patients without major haemorrhage who have:
    - clinically significant bleeding and
    - a fibrinogen level below 1.5 g/litre.

Adherence will be assessed by reported indication for cryoprecipitate transfusion.

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