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Supporting Information

Supplementary methods and results

Appendix to: The POSTVenTT Study Collaborative. The management of peri-operative anaemia in patients undergoing major abdominal surgery in Australia and New Zealand: a prospective cohort study. *Med J Aust* 2022; doi: 10.5694/mja2.51725.

Supplementary methods

1. Study protocol (25 March 2021)

POSTVenTT (POST operative Variations in anaemia treatmenT and Transfusions)

Prospective audit of anaemia after major abdominal surgery

POSTVenTT Protocol v5.0 25th Mar 2021
Clinical Trials Network Australia (CTANZ)

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Project Timeline

Patients will be collected in a prospective, sequential manner for two sets of two-week periods. The follow up is at 30 days.

The Audit will commence following full approvals and set up. There will be two periods of data collection, each of two-week duration. Data will be completed, cleaned and checked with data lock on December 31st 2021.

Introduction

Anaemia affects nearly a quarter of the world[1] and is common in surgical patients with a third of patients presenting with preoperative anaemia and three quarters of patients discharged from hospital with anaemia[2]. The World Health Organisation defines anaemia as an insufficient circulating red cell mass, with a haemoglobin (Hb) concentration of < 130 $g.l^{-1}$ for men and < 120 $g.l^{-1}$ for women[1].

Perioperative anaemia is associated with increased postoperative complications and delayed patient recovery leading to increased post-operative morbidity and mortality[1-7]. Anaemia also leads to an increased use of allogeneic blood transfusions[7-10], which is an independent risk for poorer patient outcomes[10-13].

Postoperative anaemia can be due to blood loss at operation or secondary to the inflammatory process associated with surgery, which causes an increase in hepcidin production resulting in functional iron deficiency[13-15] and reduced red cell production.

In recent years, there has been a significant increase in the use of intravenous iron therapy for preoperative anaemia in line with major international guidelines[15]. This is common practice in Australia and New Zealand.

The POSTVenTT (POST operative Variability in anaemia treatmenT and Transfusion) audit aims to increase our understanding of variability in adherence to anaemia management guidelines and to assess the impact of anaemia management in clinical care following major abdominal surgery[16].

Audit Standards

Relevant audit standards Australian National Blood Authority and AAGBI guidelines

Pre-operative Standards:	
1. Preoperative anaemia should be identified and managed	Patient Blood Management Guidelines, Australian National Blood Authority 2012 Module 2 - Perioperative[17] • preoperative anaemia should be identified, evaluated and managed to minimise RBC transfusion,

Intra-operative Standards:	
1. In major surgery tranexamic acid should be given	Patient Blood Management Guidelines, Australian National Blood Authority 2012 Module 2 - Perioperative[17] • the use of intravenous tranexamic acid is recommended

Post-operative Standards:	
1. Restrictive blood transfusion should be standard of care	The National Blood Authority's Patient Blood Management Guideline 2012 Module 4 – Critical Care[17], • In critically ill patients, a restrictive transfusion strategy should be employed
2. Post-Operative Hb levels should be measured	International consensus statement on the management of postoperative anaemia after major surgical procedures • All patients who have undergone major surgery (defined as blood loss > 500 ml or lasting > 2 h) and who had pre-operative anaemia or moderate-to-severe blood loss during surgery must be screened for anaemia after surgery[18].
3. Oral iron should not be prescribed	International consensus statement on the management of postoperative anaemia after major surgical procedures • In patients with postoperative anaemia, early oral iron therapy is not clinically effective; its routine use in this setting is not recommended.

The POSTVenTT audit is designed to be complementary to ongoing quality improvement efforts in acute and elective surgical care, for example the RECON audit in 2019 and The Australian and New Zealand Emergency Laparotomy Audit – Quality Improvement (ANZELA-QI)

Methods

1. Summary:

This is a clinical audit, which will involve mini-teams of 1 – 4 collaborators per speciality group per data collection period. These teams will collect data over two continuous 14-day periods on all consecutive patients undergoing major abdominal surgery at participating hospitals, with a follow-up of up to 30 postoperative days. A consultant will supervise all mini-teams.

2. Study Aims:

- ***Primary Aim:*** To audit compliance with pre-, intra-, and postoperative guidelines for management of anaemia in patients undergoing major abdominal surgery.
- ***Secondary Aims***
    - To characterise incidence of anaemia following major abdominal surgery.
    - To identify risk factors associated with postoperative anaemia.
    - To explore associations between postoperative anaemia and rate of postoperative complications.
    - To explore association of postoperative anaemia with short-term outcomes (length of stay, readmission to Hospital).
    - To audit the use or iron therapy or blood transfusion.

3. Project Timeline:

- The suggested overall data collection period will be four months. There will be two periods of data collection. In each period, each mini-team will collect data over a 2-week, consecutive period with subsequent 30-day follow-up.
- Patients should be included if they were operated on during the data collection periods as specified above.
- The 30-day follow-up is defined as 30-days from the day of discharge from hospital for the patient's index operation.
- Additional data collection periods may be added later in the study, to give flexibility to include further centres in Australia or New Zealand with logistical difficulties in study start up.

4. Patient Eligibility:

Summary: The study population will include consecutive adult patients undergoing major emergency or elective abdominal surgery.

Inclusion criteria:

- **Age**: Adult, 18 years or above.
- **Procedure:** A major abdominal surgery is defined as an operation with an incision into the abdominal cavity and anticipated duration of more than one hour. Procedures performed using any surgical approach, including open, laparoscopic, and robotic surgery are included.
- **Urgency**: Patients undergoing planned (elective or expedited) or unplanned (emergency) surgery.

Exclusion criteria:

- **Procedures:** Abdominal surgery classified as minor operations such as; laparoscopic appendicectomy (emergency or elective), endoscopy procedures, transanal or transurethral procedures.
- **Indication:** Palliative procedures as determined pre-operatively and explicitly stated in the medical record or consent form.
- **Extent of surgery:** Operations that are either
    - staged with a planned return for reoperation (such as but not exclusively, damage control laparotomy or burns surgery).
    - Change in operative plan such that during the first procedure it is determined that a re-operation is necessary, even if the patient was enrolled pre-operatively
- **Return to theatre**: Each patient should only be included in the study *once*. Patients returning to theatre due to complications following earlier surgery can be included, as long as their index procedure has not already been included in the POSTVenTT study.

5. Covariates:

Data will be collected on adherence to anaemia management guidelines, and confounding factors for risk of anaemia to permit accurate risk adjustment of outcomes, particularly the use of intravenous iron and also blood transfusion. Without appropriately adjusting for risk factors, it is likely that any findings would be biased and unable to be appropriately analysed. A full list of required data fields is available in the appendix, and on the REDCap database.

6. Outcome Measures, Follow Up, and Data Collection:

Primary outcome measure: Adherence to selected National Blood Authority and International consensus

statement guidelines for anaemia management (percentage, %).

Anaemia is defined as Haemoglobin < 120g/L in women and <130g/L in men.

Secondary outcome measures:

- Post-Operative anaemia following discharge from Post anaesthetic recovery area/ HDU / ICU and day 3, 7 (or weekly thereafter).
- Post-Operative Blood transfusion.
- Haemoglobin level at discharge from hospital
- 30-day postoperative complication rate (defined according to the Clavien-Dindo classification: see appendix).
- Critical care bed days up to 30 days postoperatively.
- Length of in-patient stay up to 30 days postoperatively.
- Trigger for MET call
- Re-admission to ICU or HDU
- Patient frailty
- Reoperations
- Readmission to hospital within 30 days and 90 days following discharge after index operation

Methods of data collection:

This project will involve the formation of mini-teams of of 1 – 4 collaborators.. These teams will prospectively collect data over a continuous 14-day period on all eligible patients undergoing abdominal surgery at participating hospitals, with a 30-day postoperative follow up for each patient. To ensure data is collected on all consecutive eligible patients these teams will review elective theatre lists, handover sheets/emergency admission and ward lists, and theatre logbooks (both elective and emergency) on a daily basis. Mini-teams should be supervised by up to two consultants (one surgeon, one anaesthetist) at each site.

Information will be collected through patient information systems, including accessing:patient charts (written and electronic)

- Medication charts
- Discharge summaries
- Relevant letters from outpatient clinics and surgeons' rooms

REDCap database:

All relevant data will be inputted into a Case Report Form (Appendix) and subsequently transferred into the REDCap database. All Case Report Forms will be stored securely with the Investigator Site File (ISF) for the time period required by institutional protocol and/or local governance approvals, and subsequently destroyed.

The REDCap application and data repository will be held in The University of Western Australia (UWA) data centre and governed by UWA information technology and security processes. This includes appropriate best practices such as network firewalls, system and security monitoring and two factor authentication.

REDCap access privileges will be managed and maintained by the UWA Clinical Trials Unit (CTU) to ensure that users can only access data relevant to their site. That is, each site user will only have access to their site's data. REDCap also implements authentication to validate the identity of users that log in to the system.

REDCap maintains an audit trail that logs user activity, including contextual information (e.g. the project or record being edited). Whether the activity be entering data, exporting data, modifying a field, running a report, or add/modifying a user, among a plethora of other activities, REDCap logs actions. The logging record can be viewed by users who have appropriate privileges.

Sites only hold the identifiable data (an identifiable master list of patients for this project will be kept at each site) and the de-identified data will be entered into the UWA REDCap. The master list will be retained on a password protected computer and have restricted access to only staff directly involved with the project as determined by data access groups at each site. The master list will be managed and retained on a password protected computer and destroyed once the project is closed (or when approvals have expired). No identifiable information from the master list will leave each site unless otherwise specified in an agreement or approved protocol. Data will be stored for at least five years after the completion of research activity.

All sites will flag and screen patients as per instutional protocol and will be required to keep a log of patient details in their ISF. Data capture can be on paper CRF and held locally or de-identified data can be entered directly to the UWA REDCap database. No identifiable data will be transferred to the REDCap database from any site. Patients will be only re-identifiable by their Redcap ID via the patient log at the site.

7. Quality assurance:

Design: This protocol was written with guidance from an expert cross-speciality advisory group and reviewed by the project expert advisory group, Professor Toby Richards (UWA, Australia), Dr Peter Pockney (University of Newcastle, Australia), Dr Deborah Wright (University of Otago, New Zealand) and inputs from the trainees involved in the core management of the project.

Data completeness: Following data collection, only data sets with >95% data completeness will be accepted for pooled national analysis. To emphasise the importance of data completeness to collaborators, data collection periods with >5% missing data points will be excluded from the study and collaborators from those periods

withdrawn from the published list of citable collaborators.

Validation: This methodology for snapshot audit has been widely validated across multiple datasets internationally demonstrating high levels of case ascertainment (typically 90 to 95%) and data accuracy (96 to 98%) [19-23].A process of data validation by independent assessors will be performed on a sample of participating centres in each country.

Patient and service user involvement: The James Lind Alliance (JLA) is an international non-profit initiative established in 2004 [24]. It brings patients, carers and clinicians together in Priority Setting Partnerships (PSPs) to identify and prioritise unanswered questions or evidence uncertainties that they agree are the most important. POSTVenTT will collect data to address the following JLA priority areas in Perioperative Care:

- How can patient care around the time of emergency surgery be improved?
- What outcomes should we use to measure the 'success' of anaesthesia and perioperative care?
- How can we improve recovery from surgery for elderly patients?

8. Authorship:

In accordance with Research Collaborative authorship guidelines [25], all research outputs from POSTVenTT will be listed under a single corporate authorship (POSTVenTT Collaborative). All collaborators will be listed as PubMed-citable collaborators within the POSTVenTT Collaborative in accordance with the roles defined below (so long as the minimum requirements for authorship are met).

- **Writing Group:** A group of medical students, junior doctors and external advisory board members responsible for the overall scientific content, data analysis, and preparation of research manuscripts.
- **Steering Committee**: A core group of medical students and junior doctors who have overall responsibility for protocol design, project co-ordination, and data handling.
- **Statistical Analysis**: A small team of dedicated statisticians who take overall responsibility for the statistical analysis plan and quality assurance of data analysis.
- **External Advisory Group**: A panel of cross-disciplinary field experts who are able to ensure contextual and scientific relevance of the protocol design, data fields and data interpretation.
- **Regional Leads**: A network of trainees and students across all ANZ training networks. They will be responsible for co-ordinating mini-teams at local hospitals, and act as a link between mini-teams / hospital leads, and the steering committee. Requirements for authorship on POSTVenTT outputs include:
    - Effective and responsive communication with the POSTVenTT steering committee, and with local collaborators throughout their time as Regional Leads.
    - Recruitment of at least two mini-teams in at least one centre in their area, with a minimum of one

centre meeting the criteria for inclusion within the POSTVenTT dataset.

- **Local (Hospital) Leads**: A single lead point of contact for data collection at each site who has overall responsibility for site governance registration and coordinating handover between local collaborator teams. Local Leads should be prospectively identified by Regional Leads (although remain an optional role), and these are recommended to be the junior doctor or a senior medical student within the mini-team, and only one person can fulfil this role. Minimum requirements for authorship on POSTVenTT outputs include:
    - Primary person responsible in obtaining local approvals for conduct of the POSTVenTT audit.
    - Active involvement in a mini-team during a data collection period at the centre, which meets the criteria for inclusion within the POSTVenTT dataset.
    - Co-ordination of handover between all local collaborator teams at the centre, and involvement in local dissemination of POSTVenTT results.
    - Presentation of local results at their centre from the POSTVenTT audit (or otherwise arranges another collaborator to present on their behalf).

- **Local collaborators (data collectors)**: A team of up to 4 people responsible for data collection per specialty group over a specific 2-week period at a particular centre. Reflecting the cross-specialty nature of the POSTVenTT study, up to one mini-team (4 members) will be permitted *per specialty group* (if these surgeries are conducted by separate speciality teams at the centre), defined as:
    (1) Colorectal surgery
    (2) Upper GI surgey/ Hepatobiliary surgery
    (2) Vascular surgery
    (3) Urology
    (4) Gynaecological surgery

    This gives a *maximum* of 20 collaborators per data period per hospital. Please note that, mini-team size and the total number of collaborators required at each site will be at the discretion of the regional lead according to the specialty organisation and caseload of each hospital. Minimum requirements for authorship on POSTVenTT outputs include:
    - Compliance with local audit approval processes and data governance policies.
    - Active involvement in data collection over at least one data collection period at a centre, which meets the criteria for inclusion within the POSTVenTT dataset.
    - Collaboration with the regional / local lead to ensure that the audit results are reported back to the audit office / clinical teams.

- **Supervising Consultant**: up to two consultants, one in a surgical specialty, and one in anaesthesia or critical care must supervise data collection in each hospital. Minimum requirements for authorship on POSTVenTT outputs include:
    - Sponsorship of local audit registration, and responsible to ensure local collaborators act in accordance with local governance guidelines.
    - Inclusion of at least one data collection period at their centre, which meets the criteria for inclusion within the POSTVenTT dataset.
    - Facilitation of local audit results presentation and support of appropriate post-audit interventions.
    - Completion of workplace-based assessments for students or trainees (e.g. RACS), if requested.

Criteria for centre inclusion within POSTVenTT:

- Obtain of all appropriate local approvals for conduct of the POSTVenTT audit.
- Successful completion of at least one data collection period at the centre (with a minimum of one eligible patient per period included). Individual data collection periods will only be included when:
    i. >95% data completeness has been achieved.
    ii. All data for the period has been uploaded within the specified deadlines.

Please note if these criteria are not met, then the contributing mini-team and/or the centre may be removed from the dataset and authorship list (please get in contact as soon as potential issues arise so we can support as many centres to be included as possible).

Appendix: Data Dictionary

Pre-operative Data Fields	Required data (definition / comment)	Suggested source(s)
1. **Patient age**	**Years** (whole years at the time of operation)	– Clinical notes
2. **Patient gender**	**Male** / **Female**	
3. **Cultural identity**	**European/Aboriginal/Torres Straights Islander/Maori/Pacific Peoples/Asian/Middle Eastern/Latin American/African/Other**	– Clinical notes
4. **Patient height**	**Meters** (record to two decimal places)	– Drug charts
5. **Patient weight**	**Kilograms** (record to one decimal places)	– Clinical notes
6. **Patient ASA grade**	**Grade I-V** (Full ASA classification available at: https://www.asahq.org/resources/clinical-information/asa-physical-status-classification-system).	– Anaesthetic notes
7. **History of cardiac disease**	**Yes** (myocardial infarction, angina, congestive cardiac failure within 30d prior to surgery, hypertension on Rx) / **No**	– Admission clerking – Anaesthetic notes – Outpatient letters
8. **Clinical Frailty Score**	**1 – 9**	
9. **History of chronic respiratory disease**	**Yes** (asthma, chronic obstructive pulmonary disease or pneumonia, bronchiectasis, pulmonary fibrosis, lung cancer, obstructive sleep apnoea, other) / **No**	
10. **History of Diabetes**	**Diabetes** (diet controlled, tablet controlled, insulin controlled)	
11. **History of neurological disease / stroke**	**Yes** / **No**	
12. **History of liver disease**	**Yes** / **No**	
13. **Smoking status**	**Current** (includes those who stopped smoking within 6 weeks), Ex-smoker, **Never**.	
14. **Anticoagulant/Antiplatelet**	**Yes** / **No**	
15. **Pre-operative blood test values**	**Haemoglobin** (grams / litre) / Creatinine / **estimated Glomerular Filtration Rate** (ml / min) / Ferritin (if done)	– Pathology systems
16. **Pre-operative anaemia management**	Oral or intravenous iron clinic **Yes** / **No** Number of days prior to operation patient received treatment	–

Abbreviations: ASA = American Society of Anaesthesiologists; Hb = Haemoglobin; PACS = Picture Archiving and Communication.

Intra-operative Data Fields	Required data (definition / comment)	Suggested source(s)
1. Operative urgency (NCEPOD Classification of Intervention)	**Immediate** (Immediate life, limb or organ-saving intervention – resuscitation simultaneous with intervention. Normally within minutes of decision to operate). **Urgent** (Intervention for acute onset or clinical deterioration of potentially life-threatening conditions, for those conditions that may threaten the survival of limb or organ, for fixation of many fractures and for relief of pain or other distressing symptoms. Normally within hours of decision to operate) **Expedited** (requiring early treatment where the condition is not an immediate threat to life, limb or organ survival. Normally within days of decision to operate). **Elective** (Intervention planned in advance of routine admission to hospital).	– Operative note – Admissions clerking – Clinical notes
2. Operative procedure	**Select main procedure** (closest option from the drop-down list or enter as free text by selecting "other"). (1) Upper gastrointestinal tract surgery (2) Colorectal surgery (3) Hepato-pancreato-biliary (HPB) surgery (4) Vascular surgery (5) Urology (6) Gynaecology	
3. Operative contamination	**Clean** (Gastrointestinal (GI) and genitourinary (GU) tract not entered). **Clean-Contaminated** (GI or GU tracts entered but no gross contamination). **Contaminated** (GI or GU tracts entered with gross spillage or major break in sterile technique). **Dirty** (There is already contamination prior to operation, e.g. faeces or bile).	– Operative note – Clinical notes – Theatre records
4. Tranexamic acid use	**Yes** / **No**	
5. Intraoperative blood transfusion	**0 / 1 / 2 / 3 / 4 / >4**	
6. Hb at transfusion	**Yes** / **No**	
7. Duration of procedure	**Minutes** – Total duration including anaesthetic time Duration from skin incision to completion of skin closure	
Abbreviations: NCEPOD: National Confidential Enquiry into Patient Outcome and Death. WHO = World Health Organisation		

Post-operative Data Fields	Required data (definition / comment)	Suggested sources
1. Critical care admission	**Date of admission**	– Clinical notes
2. Critical care bed days *(if yes)*	**Date of discharge**	
3. Highest inpatient complications	**None / Clavien-Dindo Grade I-V** (see appendix for the Clavien-Dindo scale).	
4. Reoperation	**Yes/No** **Date** **List operation performed & date**	
5. Post-operative length of stay (hospital)	**Date of Discharge**	
6. Iron Therapy in post-operative period	Iron Oral / IV / none	– Discharge letter
7. Blood Transfusion in post-operative period	None/Units 1/2/3/4/>4 Hb immediately prior to transfusion Subsequent transfusions in remainder of post op period Y/N	– Pathology systems
8. Discharge Destination	Home / rehabilitation / nursing or supported care	– Discharge letter
9. Haemoglobin level	Admission to HDU / ICU / extended recovery	– Pathology systems
	Discharge from HDU / ICU / extended recovery	
	Lowest Hb in first 3 days postoperatively	
	Last recorded before discharge from hospital	

30-day Data Fields	Required data (definition / comment)	Suggested sources
1. RE – admission	**Yes / No** **If yes complete readmission form**	– Telephone follow-up – Follow up clinic – Clinical notes
2. Hb level	4-6 weeks	
3. Location	Home/rehabilitation/nursing or supported care	
4. 30-day Infection	**Was there post-operative infection Yes/ No** **Respiratory / urinary / wound / other**	
5. Highest 30-day complication grade	**None / Clavien-Dindo Grade I-V** (see appendix for the Clavien-Dindo scale).	
6. Clinical Frailty score	1-9	– Clinical Notes

Readmission Data Fields	Required data (definition / comment)	Suggested sources
1. **Reason for Readmission**	**Planned Y reason free text** **Unplanned Y see appendix** **Scored as per CD scale**	– Clinical notes
2. **Haemoglobin level**	On admission	– Pathology systems
	Lowest Hb day 1-3	
	Last recorded before discharge from hospital	
3. **Blood transfusion**	**0 / 1 / 2 / 3 / 4**	
4. **Readmission to HDU / ICU**	**Date of admission**	
5. **Discharge from HDU / ICU** *(if yes)*	**Date of discharge**	
6. **Reoperation**	**Yes / No date** **List operation performed & date** **repeat intraoperative and post-operative data**	– Discharge letter – Clinical notes
7. **Length of stay (hospital)**	**Number** (days from the first re-admission day to day of discharge. If the patient has not been discharged prior to the end of 30-day re-admission, enter '31').	
8. **Discharge Destination**	Home / rehabilitation / nursing or supported care	

Appendix: Clavien-Dindo Classification System:

Adverse post-operative events may be classified in different ways:

- **Failure of treatment** – This occurs when the original surgery fails to achieve its intended benefits; for example, persistent pain following laparoscopic cholecystectomy or tumour recurrence following cancer surgery.
- **Sequelae**: The recognised consequences of a given procedure; for example, gut malabsorption following an extensive small bowel resection or immune deficiency following splenectomy.
- **Complication**: Any deviation from the normal post-operative course that has an adverse effect on the patient and is not either a treatment failure or sequel.

In the Clavien-Dindo classification [26], the factor determining the severity of a complication is the treatment required. Consequently, a given complication may be graded differently depending on how it has been managed. For example, an anastomotic leak may be managed just with antibiotics if it is contained (grade II) or it may require re-operation under anaesthetic (grade IIIb).

Some other considerations:

- Intra-operative complications are not considered unless they have an adverse effect on the patient post-operatively. The only exception to this is intra-operative death; this is classified as grade V.
- All post-operative adverse events are included, even when there is no direct relationship to the surgery.
- All adverse events within the follow-up period (30 days) are included, even after following discharge.
- Diagnostic procedures are not included. For example, a diagnostic oesophagoduodenoscopy (OGD) to look for a source of bleeding without any intervention would not be considered a complication, but a therapeutic OGD with clipping of a bleeding vessel would be considered a grade IIIa complication. Since negative exploratory laparotomies are considered to be diagnostic procedures, they should not be recorded as complications.

Grade	Definition (examples listed in italics)
I	Any deviation from the normal postoperative course without the need for pharmacological (other than "allowed therapeutic regimens"), surgical, endoscopic or radiological intervention. Allowed therapeutic regimens are: selected drugs (antiemetics, antipyretics, analgesics, diuretics and electrolyte replacement), physiotherapy and wound infections opened at the bedside but not treated with antibiotics. ***Examples**: Ileus (deviation from the norm); hypokalaemia treated with K; nausea treated with cyclizine; acute kidney injury treated with intravenous fluids.*
II	Requiring pharmacological treatment with drugs beyond those allowed for grade I complications. Blood transfusions and total parenteral nutrition are also included. ***Examples**: Surgical site infection treated with antibiotics; myocardial infarction treated medically; deep venous thrombosis treated with enoxaparin; pneumonia or urinary tract infection treated with antibiotics; blood transfusion for anaemia.*
IIIa	Requiring surgical, endoscopic or radiological intervention, not under general Anaesthetic (GA). ***Examples**: Therapeutic endoscopic therapy (do not include diagnostic procedures); interventional radiology procedures.*
IIIb	Requiring surgical, endoscopic or radiological intervention, under GA. ***Examples**: Return to theatre for any reason.*
IVa	Life-threatening complications requiring critical care management with single organ dysfunction, or neurological complications including brain haemorrhage and ischemic stroke (excluding TIA). ***Examples**: Single organ dysfunction requiring critical care management, e.g. pneumonia with ventilator support, renal failure with filtration; SAH; stroke*
IVb	Life-threatening complications requiring critical care management with multi-organ dysfunction.
V	Death of a patient

Appendix: Infection

Abdominal collections	Postoperative collection altering the normal postoperative course management and requiring antibiotics or radiological/endoscopic/surgical intervention
Respiratory infections	Pneumonia defined by the US Centers for Disease Control criteria as CXR evidence of – New or progressive and persistent infiltrates – Consolidation – Cavitation AND one of – Fever (>38°C) with no other recognised cause – Leucopenia (WCC <4 × 109 /L) or Leucocytosis (WCC >12 × 109 /L) – Age >70 years AND altered mental status (no other recognised cause) OR two of – New onset purulent sputum or change in character of sputum – Increased respiratory secretions – Bronchial breath sounds.•New onset cough, dyspnoea or tachypnoea.•Worsening gas exchange (hypoxaemia, increased oxygen demand.
Urinary infections	A positive culture on urine sample
Wound infections	An infection that occurs after surgery in the part of the body where the surgery took place requiring either medical, radiological, endoscopic or surgical intervention (defined by Centers for Disease Control and Prevention)
Others	

Appendix: Clinical Frailty Score

Clinical Frailty Scale*

1 **Very Fit** – People who are robust, active, energetic and motivated. These people commonly exercise regularly. They are among the fittest for their age.

2 **Well** – People who have **no active disease symptoms** but are less fit than category 1. Often, they exercise or are very **active occasionally**, e.g. seasonally.

3 **Managing Well** – People whose **medical problems are well controlled,** but are **not regularly active** beyond routine walking.

4 **Vulnerable** – While **not dependent** on others for daily help, often **symptoms limit activities.** A common complaint is being "slowed up", and/or being tired during the day.

5 **Mildly Frail** – These people often have **more evident slowing,** and need help in **high order IADLs** (finances, transportation, heavy housework, medications). Typically, mild frailty progressively impairs shopping and walking outside alone, meal preparation and housework.

6 **Moderately Frail** – People need help with **all outside activities** and with **keeping house**. Inside, they often have problems with stairs and need **help with bathing** and might need minimal assistance (cuing, standby) with dressing.

7 **Severely Frail** – **Completely dependent for personal care**, from whatever cause (physical or cognitive). Even so, they seem stable and not at high risk of dying (within ~ 6 months).

8 **Very Severely Frail** – Completely dependent, approaching the end of life. Typically, they could not recover even from a minor illness.

9. **Terminally Ill** - Approaching the end of life. This category applies to people with **a life expectancy <6 months**, who are **not otherwise evidently frail.**

Scoring frailty in people with dementia

The degree of frailty corresponds to the degree of dementia. Common **symptoms in mild dementia** include forgetting the details of a recent event, though still remembering the event itself, repeating the same question/story and social withdrawal.

In **moderate dementia**, recent memory is very impaired, even though they seemingly can remember their past life events well. They can do personal care with prompting.

In **severe dementia**, they cannot do personal care without help.

Appendix: Reason for Re-admission to Hospital

List admitting diagnosis and group to: -

INFECTION – GENERAL
Such as; chest, urinary etc

INFECTION – WOUND
Wound related complications including abscess

POST OPERATIVE COMPLICATION – GENERAL
Such as; ileus, urinary retention, blocked drain, 'off legs'.

POST OPERATIVE COMPLICATION – PAIN
Where the main complication is 'in pain'

TRANSFUSION – BLOOD or IRON

References

1. McLean E, Cogswell M, Egli I, Wojdyla D, De Benoist B. Worldwide prevalence of anaemia, WHO vitamin and mineral nutrition information system, 1993–2005. Public health nutrition. 2009;12(4):444-454.

2. Shander A, Knight K, Thurer R, Adamson J, Spence R. Prevalence and outcomes of anemia in surgery: a systematic review of the literature. The American journal of medicine. 2004;116(7):58-69.

3. Nutritional anaemias: report of a WHO scientific group [meeting held in Geneva from 13 to 17 March 1967]. World Health Organization. 1968.

4. Dunne JR, Malone D, Tracy JK, Gannon C, Napolitano LM. Perioperative anemia: an independent risk factor for infection, mortality, and resource utilization in surgery. Journal of Surgical Research. 2002;102(2):237-244.

5. Halm EA, Wang JJ, Boockvar K, Penrod J, Silberzweig SB, Magaziner J, et al. The effect of perioperative anemia on clinical and functional outcomes in patients with hip fracture. Journal of orthopaedic trauma. 2004;18(6):369.

6. Beattie WS, Karkouti K, Wijeysundera DN, Tait G. Risk associated with preoperative anemia in noncardiac SurgeryA single-center cohort study. Anesthesiology: The Journal of the American Society of Anesthesiologists. 2009;110(3):574-581.

7. Carson JL, Duff A, Poses RM, Berlin JA, Spence RK, Trout R, et al. Effect of anaemia and cardiovascular disease on surgical mortality and morbidity. The Lancet. 1996;348(9034):1055-1060.

8. Engoren M, Habib RH, Hadaway J, Zacharias A, Schwann TA, Riordan CJ, et al. The effect on long-term survival of erythrocyte transfusion given for cardiac valve operations. The Annals of thoracic surgery. 2009;88(1):95-100. e3.

9. Karkouti K, Wijeysundera DN, Beattie WS. Risk associated with preoperative anemia in cardiac surgery. Circulation. 2008;117(4):478-84.

10. Gombotz H, Rehak PH, Shander A, Hofmann A. Blood use in elective surgery: the Austrian benchmark study. Transfusion. 2007;47(8):1468-1480.

11. Keating EM, Meding JB, Faris PM, Ritter MA. Predictors of transfusion risk in elective knee surgery. Clinical orthopaedics and related research. 1998 (357):50-59.

12. van Klei WA, Moons KG, Rheineck Leyssius A, Knape JT, Rutten CL, Grobbee DE. A reduction in type and screen: preoperative prediction of RBC transfusions in surgery procedures with intermediate transfusion risks. British journal of anaesthesia. 2001;87(2):250-257.

13. Ong A, Sim K, Boey S. Preoperative prediction of intra and postoperative red blood cell transfusion in surgical patients. Annals of the Academy of Medicine, Singapore. 1997;26(4):430-434.

14. Hébert PC, Wells G, Blajchman MA, Marshall J, Martin C, Pagliarello G, et al. A multicenter, randomized, controlled clinical trial of transfusion requirements in critical care. New England Journal of Medicine. 1999;340(6):409-417.

15. Sharma S, Sharma P, Tyler LN. Transfusion of blood and blood products: indications and complications. American family physician. 2011;83(6):719-724.

16. Ljungqvist O, Scott M, Fearon KC. Enhanced recovery after surgery: a review. JAMA surgery. 2017;152(3):292-298.

17. Australia NBA. In: Patient Blood Management Guidelines. 2012 National Blood Authority Australia.

18. Muñoz M, Acheson A, Bisbe E, Butcher A, Gómez-Ramírez S, Khalafallah A, et al. An international consensus statement on the management of postoperative anaemia after major surgical procedures. Anaesthesia. 2018;73(11):1418-1431.

19. Student Audit and Research in Surgery (STARSurg) Collaborative. Multicentre prospective cohort study of body mass index and postoperative complications following gastrointestinal surgery. Br J Surg. 2016;103(9):1157-72.

20. Student Audit and Research in Surgery (STARSurg) Collaborative. Prognostic model to predict postoperative acute kidney injury in patients undergoing major gastrointestinal surgery based on a national prospective observational cohort study. British Journal of Surgery Open. 2018.

21. Student Audit and Research in Surgery (STARSurg) Collaborative. Impact of post-operative non-steroidal anti-inflammatory drugs on adverse events after gastrointestinal surgery. Br J Surg. 2014 101(11):1413-23.

22. EuroSurg Collaborative. Body mass index and complications following major gastrointestinal surgery: a prospective, international cohort study and meta-analysis. Colorectal Dis. 2018;20(8):O215-O225.

23. GlobalSurg Collaborative. Surgical site infection after gastrointestinal surgery in high-income, middle-income, and low-income countries: a prospective, international, multicentre cohort study. Lancet Infect Dis. 2018;18(5):516-525.

24. James Lind Alliance. Top 10s of priorities for research. 2015 [29/11/18]. Available from: www.jla.nihr.ac.uk

25. National Research Collaborative & Association of Surgeons in Training Collaborative Consensus Group. Recognising contributions to work in research collaboratives: Guidelines for standardising reporting of authorship in collaborative research. Int J Surg. 2017;52:355-360.

26. Clavien P, Barkun, J, de Oliveira, ML, Vauthey, JN, Dindo, D, Schulick, RD, de Santibañes, E, Pekolj, J, Slankamenac, K, Bassi, C, Graf, R, Vonlanthen, R, Padbury, R, Cameron, JL, Makuuchi, M. The Clavien-Dindo classification of surgical complications: five-year experience. Annals of surgery. 2009;250(2):187-196.

2. Hospitals participating in the POSTVENTT study

New Zealand

Auckland District Health Board, Bay of Plenty District Health Board, Canterbury District Health Board, Capital and Coast District Health Board, Counties Manukau District Health Board, Hawkes Bay District Health Board, Hutt Valley District Health Board, Northland District Health Board, South Canterbury District Health Board, Southern Cross Hospital (Auckland), Southern District Health Board, Tairawhiti District Health Board, Waikato District Health Board, Wairarapa District Health Board, Waitemata District Health Board, Whanganui District Health Board

Australia

New South Wales: Bankstown Hospital, Concord Hospital, Gosford Hospital, John Hunter Hospital, Maitland Hospital.

Queensland: Cairns Hospital, Logan Hospital, Princess Alexandra Hospital, Queen Elizabeth II (Jubilee)

South Australia: Flinders Medical Centre, Lyell McEwin Hospital, Mount Gambier and Districts Health Service, Port Augusta Hospital and Regional Health Services, Port Lincoln Health and Hospital Service, Royal Adelaide Hospital, The Queen Elizabeth Hospital, Whyalla Hospital and Health Services

Tasmania: Hobart Hospital, Launceston Hospital, North West Regional Hospital

Victoria: Albury-Wodonga Health, The Alfred, Austin Health, Barwon (Geelong), Bendigo Hospital, Eastern Health, Monash (Casey), Monash (Clayton), Monash (Dandenong), Northern Health, Royal Melbourne Hospital, St Vincent's Hospital, Western Health (Footscray), Western Health (Sunshine)

Western Australia: Armadale Hospital, Fiona Stanley Hospital, Hedland Health Campus, Royal Perth Hospital, Sir Charles Gardner Hospital, Saint John of God Midland

3. Statistical analysis plan

Primary outcomes

Definition of adherence to audit standards

1. *Identification, investigation, and management of pre-operative anaemia*
    - Compliance was defined as the composite endpoint of non-anaemic patients, or anaemic patients without iron deficiency or patients with iron deficiency anaemia who received intravenous iron therapy.
2. *Tranexamic acid should be used when the risk of blood loss is high*
    - Use of tranexamic acid in patients requiring intraoperative blood transfusion.
3. *Restrictive blood transfusion should be standard of care*
    - Patients with a pre-transfusion haemoglobin of <70 g/L (or <80 g/L in patients with a history of cardiac disease) prior to post-operative blood transfusion.
4. *Post-operative haemoglobin levels should be measured*
    - Patients who have a haemoglobin measured post-operatively in hospital.
5. *Oral iron should not be prescribed post-operatively*
    - Patients with post-operative anaemia who are not prescribed oral iron.

Analysis

Adherence to each of the audit standards was assessed as described above, and presented as a percentage. For audit standards 1, 2, and 3, compliance with relevant post-operative outcomes was investigated in chi-squared, independent-samples t test, or Kruskal-Wallis tests. Multivariate adjusted analyses were performed investigating the effect of audit standard adherence with post-operative outcomes. For each outcome, the effect of audit standard adherence on relevant postoperative outcomes was adjusted for age, sex, ethnic background, surgery type, and surgical urgency, using binary logistic regression or Cox regression models.

Variation between hospitals was visually assessed in unadjusted funnel plots with 95% and 99% confidence intervals. Length of stay was analysed as time-to-event data using the log-rank test with censoring for patients not discharged by end of study follow-up.

Secondary outcomes

Anaemia was measured at various time points (preoperatively, nadir haemoglobin on postoperative day 1-3, at discharge, and 30-day post-discharge follow up), defined according to the World Health Organization sex-specific cut-off values (<130g/L for men, <120g/L for women).

Intra-operative and post-operative packed red blood cell transfusion was measured both as a binary variable (Yes/No), and as the number of units transfused in total during the intraoperative or in-hospital postoperative period. For analysis, the number of units was grouped as a categorical variable

(0, 1, 2, ≥3), and analysed in chi-squared tests.

Post-operative complications were defined for each patient as the worst post-operative complication according to the Clavien-Dindo classification, and measured in-hospital during the index surgical admission. These were further grouped as ‘no complications’, ‘minor complications’ (Grade I-II), or ‘major complications’ (Grade III-V).

Length of stay was defined as the duration of post-operative hospital stay in days.

Re-admission was defined as a binary variable (Yes/No), according to re-admission to hospital for any reason (planned or unplanned) within 30 days of discharge.

Table 1. Surgical procedures included in the POSTVenTT study for 2730 patients who underwent major abdominal surgery in 56 Australian and New Zealand hospitals, July 2021

Operation	Number
All operations	**2730**
Colorectal	***760 (27.8%)***
Anterior resection	159 (5.8%)
Right hemicolectomy	146 (5.3%)
Other operation on Colon (bypass, colostomy)	103 (3.8%)
Incisional hernia > 1 hr	91 (3.3%)
Hartmann's procedure	72 (2.6%)
Reversal of Hartmann's procedure / colostomy	37 (1.4%)
Extended excision of right hemicolon/Extended right hemicolectomy	30 (1.1%)
Multivisceral resections (defined as resections involving >/= 2 distinct parts of gastrointestinal tract or genitourinary or gynaecological (excluding ovaries only) or hepatopancreatobiliary)	26 (1.0%)
Caecectomy	18 (0.7%)
Excision of left hemicolon	17 (0.6%)
Abdominoperineal resection	15 (0.5%)
Excision of sigmoid colon	11 (0.4%)
Panproctocolectomy and ileostomy	9 (0.3%)
Total excision of colon and ileorectal anastomosis	9 (0.3%)
Excision of transverse colon	7 (0.3%)
Extended excision of left hemicolon/Extended left hemicolectomy	6 (0.2%)
Abdominoperineal pull through resection with colo-anal anastomosis +/- colonic pouch and associated stoma	2 (0.1%)
Pelvic Exenteration	2 (0.1%)
Gynaecology	***153 (5.6%)***
Total/Subtotal abdominal hysterectomy (+/- oophorectomy)	70 (2.6%)
Multivisceral resections (defined as resections involving >/= 2 distinct parts of gastrointestinal tract or genitourinary or gynaecological (excluding ovaries only) or hepatopancreatobiliary)	31 (1.1%)
Ovarian cystectomy +/- omental biopsy (as sole procedure and including bilateral)	28 (1.0%)
Hysterectomy with excision/biopsy and or removal of omentum and uterine adnexa for ovarian malignancy	13 (0.5%)
Myomectomy	5 (0.2%)
Block dissection of pelvic lymph nodes (as sole procedure)	1
Hepatopancreatobiliary	**1224 (44.8%)**
Laparoscopic/Laparoscopic converted to open/Open cholecystectomy +/- exploration of common bile duct +/- cholangiogram	1112 (40.7%)
Liver resection	55 (2.0%)
Pancreatectomy/Pancreatoduodenectomy (Whipple's procedure)	41 (1.5%)
Splenectomy	13 (0.5%)
Hepatojejunostomy	3 (0.1%)
Transplant	***32 (1.2%)***
Kidney Transplant	24 (0.9%)
Liver Transplant	8 (0.3%)
Upper Gastrointestinal	***436 (16.0%)***
Other operations on small bowel including formation/reversal of Ileostomy	216 (7.9%)
Bariatric Surgery	82 (3.0%)
Anti-reflux surgery	61 (2.2%)
Total/Partial gastrectomy+/- excision of surrounding tissue	54 (2.0%)

Oesophagectomy (Any)	17 (0.6%)
Hellers Cardiomyotomy	6 (0.2%)
Urology	***113 (4.1%)***
Nephrectomy	50 (1.8%)
Radical prostatectomy, reconstruction of bladder neck including bilateral pelvic lymphadenectomy	38 (1.4%)
Nephroureterectomy	11 (0.4%)
Partial / Total cystectomy + with construction of intestinal conduit or bladder	7 (0.3%)
Radical hysterectomy and lymphadenectomy (Wertheim's)	5 (0.2%)
Laparoscopic/open pyeloplasty	4 (0.1%)
Construction of ileal conduit including ureteric implantation	3 (0.1%)
Vascular	***12 (0.4%)***
Open abdominal aortic aneurysm repair	7 (0.3%)
Aorto-bifemoral bypass	5 (0.2%)

Table 2. Missing data, by variable

Variable	Number
Date of Birth	0
Sex	0
Height	97 (3.6%)
Weight	41 (1.5%)
Body Mass Index	99 (3.6%)
American Society of Anesthesiologists Physical Status Classification	10 (0.4%)
Past medical history - Cardiac	0
Past medical history - Respiratory	0
Past medical history - Diabetes Mellitus	0
Past medical history - Neurological	0
Past medical history - Liver disease	0
Past medical history - No information	0
Past medical history - Not available in the medical record	0
Past medical history – Diabetes Mellitus Management	0
Past medical history – Liver Disease Severity	0
Preoperative Clinical Frailty Score	29 (1.1%)
Smoking	21 (0.8%)
Antiplatelet	5 (0.2%)
Anticoagulation	3 (0.1%)
Anticoagulation Bridging	3 (0.1%)
Preoperative full blood count performed	3 (0.1%)
Preoperative haemoglobin	3 (0.1%)
Preoperative urea and electrolytes performed	5 (0.2%)
Preoperative creatinine	7 (0.3%)
Preoperative estimated glomerular filtration rate	11 (0.4%)
Preoperative iron studies completed	6 (0.2%)
Preoperative ferritin	7 (0.3%)
Preoperative Oral Iron	4 (0.1%)
Preoperative intravenous Iron	10 (0.4%)
Preoperative intravenous Iron Timing	11 (0.4%)
Date of Operation	0
Operation Urgency	4 (0.1%)
Operative Procedure	0
Operative Contamination Classification	16 (0.6%)
Intraoperative Tranexamic Acid Use	2 (0.1%)
Intraoperative Transfusion	3 (0.1%)
Haemoglobin prior to Intraoperative Blood Transfusion	6 (0.2%)
Procedure Duration	33 (1.2%)
Intensive Care Unit Admission	0
Date of admission to critical care	2 (0.1%)
Date of discharge from critical care	4 (0.1%)
Intensive Care Unit Admission full blood count	2 (0.1%)
Intensive Care Unit Admission haemoglobin	2 (0.1%)
Intensive Care Unit Discharge full blood count	3 (0.1%)
Intensive Care Unit Discharge haemoglobin	2 (0.1%)
Intensive Care Unit Readmission	1 (<0.1%)

Intensive Care Unit Readmission Start	1 (<0.1%)
Intensive Care Unit Readmission End	1 (<0.1%)
Postoperative Complication	0
Postoperative Complication Highest	1 (<0.1%)
Postoperative Reoperation	0
Postoperative Reoperation Date	0
Postoperative Reoperation String	0
Number of Medical Emergency Team Calls	2 (0.1%)
Postoperative Antibiotics	5 (0.2%)
Postoperative Antibiotics Respiratory	2 (0.1%)
Postoperative Antibiotics Urinary Tract Infection	2 (0.1%)
Postoperative Antibiotics Wound Infection	2 (0.1%)
Postoperative Antibiotics Prophylactic	2 (0.1%)
Postoperative Antibiotics Other	2 (0.1%)
Postoperative Antibiotics No Information	0
Postoperative Antibiotics Not Available	0
Other reason for antibiotics	2 (0.1%)
Postoperative Transfusion Units	2 (0.1%)
Haemoglobin prior to Postoperative Blood Transfusion	2 (0.1%)
Postoperative Iron	1 (<0.1%)
Postoperative Haemoglobin	4 (0.1%)
Postoperative Haemoglobin Nadir	13 (0.5%)
Postoperative Haemoglobin Discharge	9 (0.3%)
Discharge date	0
Discharge destination	1 (<0.1%)
Follow up Full blood count	54 (2.0%)
Follow up haemoglobin	55 (2.0%)
Patient location at 30 days post discharge/censor date	71 (2.6%)
Follow up Complication Grade	76 (2.8%)
Follow up Clinical frailty score	194 (7.1%)
Follow up Readmission	55 (2.0%)
Readmission Date	54 (2.0%)
Type of readmission	53 (1.9%)
Reason for planned admission	46 (1.7%)
Reason for unplanned readmission	47 (1.7%)
Follow up Readmission Complication Grade	47 (1.7%)
Follow up Readmission Full Blood Count	55 (2.0%)
Follow up Readmission Haemoglobin	47 (1.7%)
Follow up Readmission Full Blood Count Additional	47 (1.7%)
Follow up Readmission Haemoglobin Lowest	47 (1.7%)
Follow up Readmission Transfusion	55 (2.0%)
Haemoglobin prior to Follow up Readmission Blood Transfusion	65 (2.4%)
Follow up Readmission Haemoglobin Discharge	47 (1.7%)
Follow up Readmission Intensive Care Unit Admission	55 (2.0%)
Follow up Readmission Reoperation	55 (2.0%)
Readmission operation date	47 (1.7%)
Readmission operation performed	47 (1.7%)
Readmission Operation Urgency	47 (1.7%)

Table 3. Prevalence of anaemia from before surgery to 30 days after surgery. A total of 2676 patients with complete data are included in this table and in Box 3

	Pre-operative	Post-operative days 1-3	Discharge	30-Day Follow Up
Anaemic	677 (25.3%)	1451 (54.2%)	1283 (47.9%)	276 (10.3%)
Not Anaemic	1738 (64.9%)	669 (25.0%)	835 (31.2%)	222 (8.3%)
Not Checked	261 (9.8%)	556 (20.8%)	558 (20.9%)	2178 (81.4%)

Table 4. Association of preoperative anaemia with in-hospital outcomes

	Patients with anaemia	**Patients without anaemia**	*P*
Patients	689	1772	
Intra-operative transfusion			<0.001
Yes	56 (8.1%)	22 (1.2%)	
No	631 (91.6%)	1749 (98.7%)	
Missing data	2 (0.3%)	1 (0.1%)	
Post-operative transfusion			<0.001
Yes	121 (17.6%)	44 (2.5%)	
No	568 (82.4%)	1727 (97.5%)	
Missing data	0	1 (0.1%)	
Post-operative complications			<0.001
None	411 (59.7%)	1397 (78.8%)	
Minor (Clavien-Dindo I-II)	185 (26.9%)	287 (16.2%)	
Major (Clavien-Dindo ≥3)	93 (13.5%)	87 (4.9%)	
Missing data	0	1 (0.1%)	
Re-operation			<0.001
Yes	37 (5.4%)	43 (2.4%)	
No	652 (94.6%)	1729 (97.6%)	
Post-operative Medical Emergency Team Call			<0.001
Yes	61 (8.9%)	77 (4.3%)	
No	617 (89.6%)	1686 (95.1%)	
Missing data	11 (1.6%)	9 (0.5%)	
Length of stay (days)			<0.001
Median (Interquartile range)	6 (3-13)	3.00 (1-6)	

Figure 1. Identification, investigation, and management of preoperative anaemia, in A) elective, and B) expedited/urgent/immediate procedures

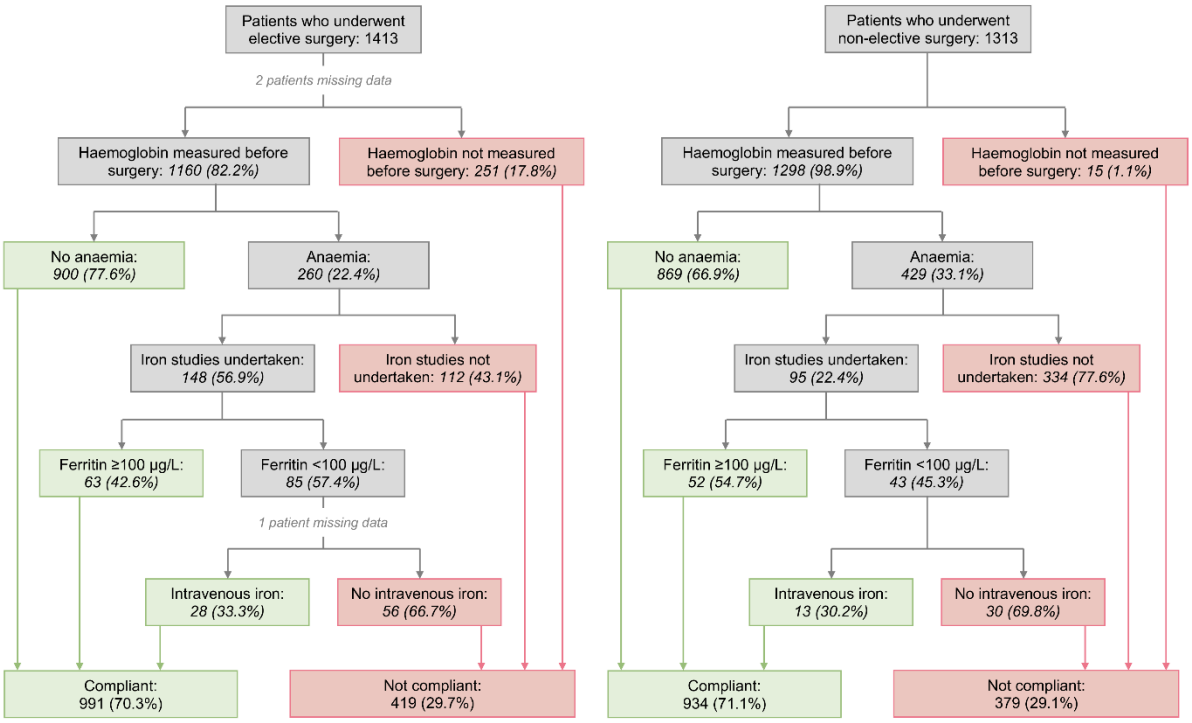
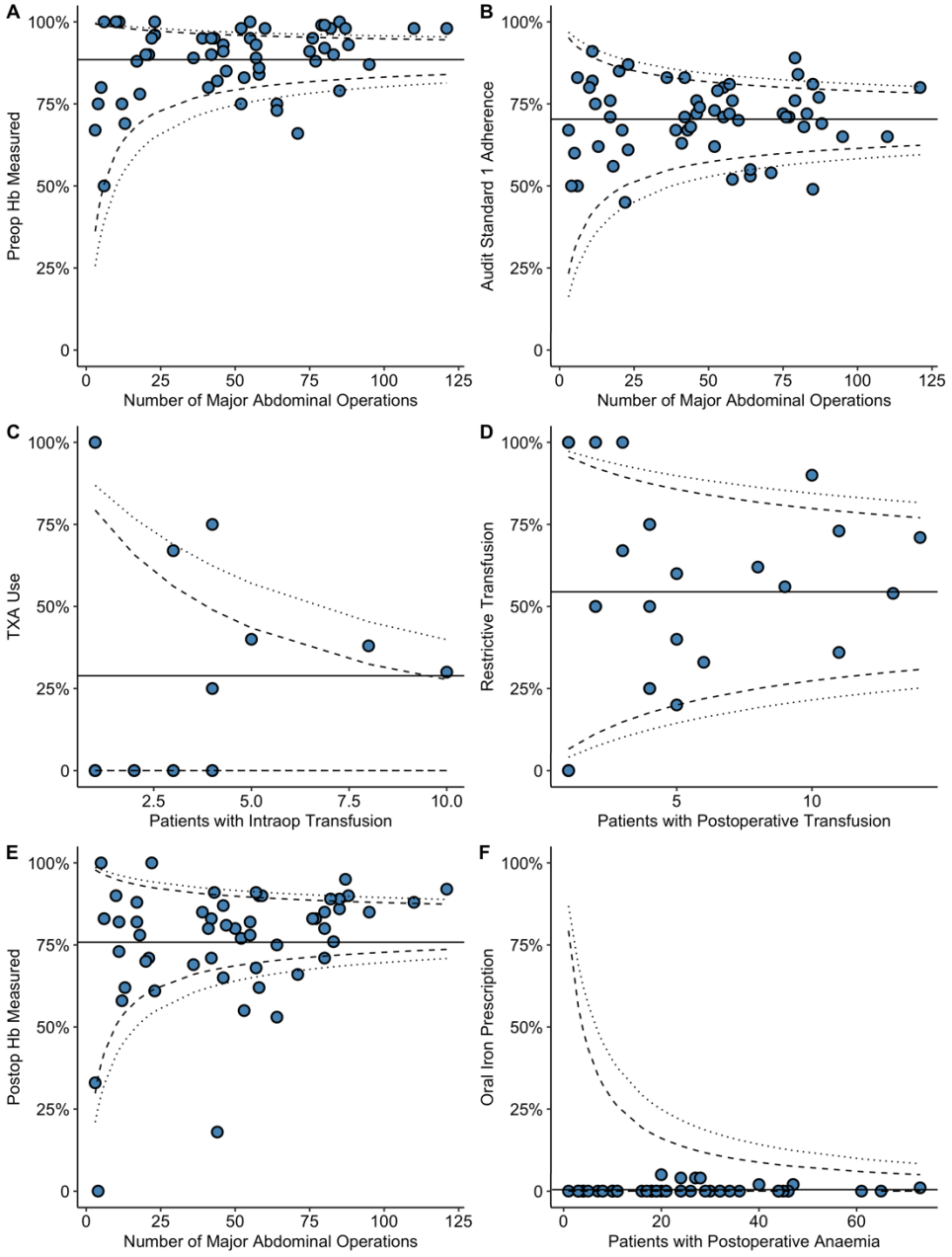


Table 5. Use of tranexamic acid by specialty, preoperative haemoglobin, and operative urgency

Variable	Tranexamic Acid Use	No Tranexamic Acid Use	*P*
Number of patients	128 (4.7%)	2600 (95.3%	
Surgical urgency			< 0.001
Immediate	13 (20.3%)	51 (79.7%)	
Urgent	20 (3.2%)	603 (96.8%)	
Expedited	15 (2.4%)	611 (97.6%)	
Elective	80 (5.7%)	1331 (94.3%)	
Surgical specialty			< 0.001
Hepatopancreatobiliary	21 (1.7%)	1202 (98.3%)	
Colorectal	35 (4.6%)	724 (95.4%)	
Upper gastrointestinal	23 (5.3%)	413 (94.7%)	
Gynaecology	34 (22.2%)	119 (77.8%)	
Urology	13 (11.5%)	100 (88.5%)	
Transplantation	1 (3.1%)	31 (96.9%)	
Vascular	1 (8.3%)	11 (91.7%)	
Preoperative haemoglobin (g/L)			< 0.001
<70	5 (55.6%)	4 (44.4%)	
70-79	2 (11.8%)	15 (88.2%)	
80-89	4 (7.1%)	52 (92.9%)	
90-99	6 (7.7%)	72 (92.3%)	
100-109	4 (3.1%)	126 (96.9%)	
110-119	11 (4.0%)	267 (96.0%)	
120-129	21 (4.8%)	421 (95.2%)	
130-139	28 (4.7%)	568 (95.3%)	
140-149	25 (5.2%)	458 (94.8%)	
>150	16 (4.3%)	354 (95.7%)	
Not checked	6 (2.2%)	263 (97.8%)	

Figure 2. Hospital-level variation in adherence to audit standards (funnel plots).* A) Haemoglobin measurement prior to surgery. B) Anaemia assessed prior to surgery. C) Tranexamic acid for patients who received blood transfusions during surgery. D) Restrictive transfusion for patients who received blood transfusion after surgery. E) Haemoglobin assessment after surgery. F) Prescription of oral iron for patients with post-operative anaemia.



* Each blue dot represents one hospital.

Sensitivity analyses excluding patients who underwent cholecystectomy

After excluding patients undergoing cholecystectomy (n=1,112), 1,618 patients were included in the sensitivity analysis. Overall, 857 patients were female (53.0%), and the mean age was 59.9 (SD 16.6) years. In-hospital complications occurred in 561 patients (34.7%), of which 154 (9.5%) were major (Clavien-Dindo ≥3). The median length of hospital stay was 6 days (IQR 3-10).

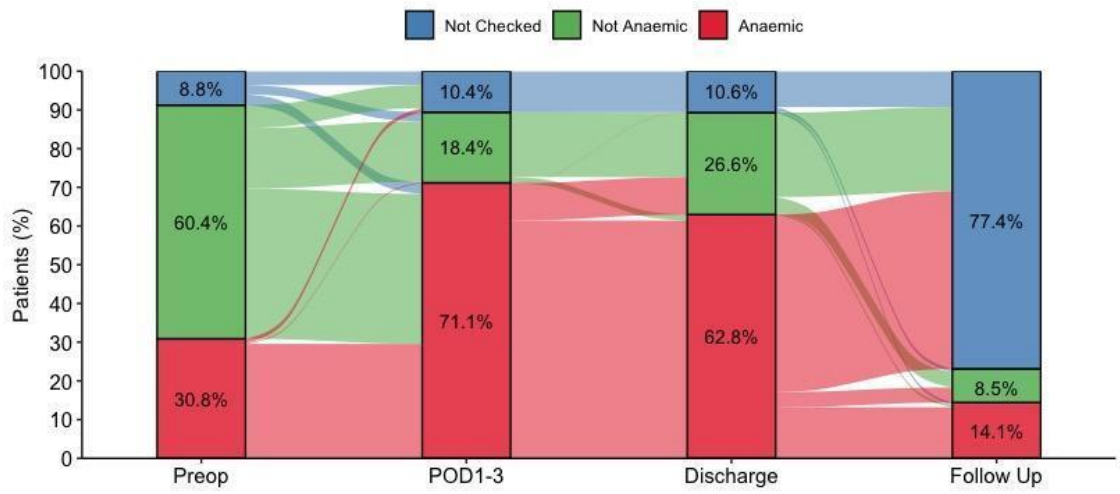
	Overall
Number of patients	**1618**
Age (years)	
Mean (Standard deviation)	59.9 (16.6)
Female Sex	857 (53.0%)
Ethnicity	
Aboriginal or Torres Strait Islander	26 (1.6%)
Māori	55 (3.4%)
Pacific Islander	27 (1.7%)
Asian	110 (6.8%)
European/other	1090 (67.4%)
Missing	*310 (19.2%)*
Body mass index (kg/m^2)	
Mean (SD)	29.5 (7.7)
Missing	*38 (2.3%)*
ASA physical status	
I-II	776 (48.0%)
III-IV	828 (51.2%)
V	8 (0.5%)
Missing	*6 (0.4%)*
Other medical conditions	
Cardiac	502 (31.0%)
Respiratory	302 (18.7%)
Diabetes Mellitus	263 (16.3%)
Neurological	128 (7.9%)
Liver Disease	73 (4.5%)
Smoking	
Current	280 (17.3%)
Previous	460 (28.4%)
Never	873 (54.0%)
Missing	*5 (0.3%)*
Surgical Specialty	
Colorectal	760 (47.0%)
Gynaecology	153 (9.5%)
Hepatopancreaticobiliary	112 (6.9%)
Transplant	32 (2.0%)
Upper gastrointestinal	436 (26.9%)
Urology	113 (7.0%)

Vascular	12 (0.7%)
Operative Urgency	
Immediate	55 (3.4%)
Urgent	348 (21.5%)
Expedited	192 (11.9%)
Elective	1023 (63.2%)
Operative Duration (minutes)	
Median (Interquartile range)	173 (115-242)

Of the cohort, 1,536 (95.0%) had been discharged alive from hospital at the time of follow up, after a median hospital stay of six days (IQR, 3-9 days). Follow up at 30-days post-discharge was completed for 1507 patients (98.1% of patients discharged alive), of whom 188 (12.5%) had been readmitted (171 unplanned, 17 planned).

Audit Standard 1 - Investigation and management of preoperative anaemia

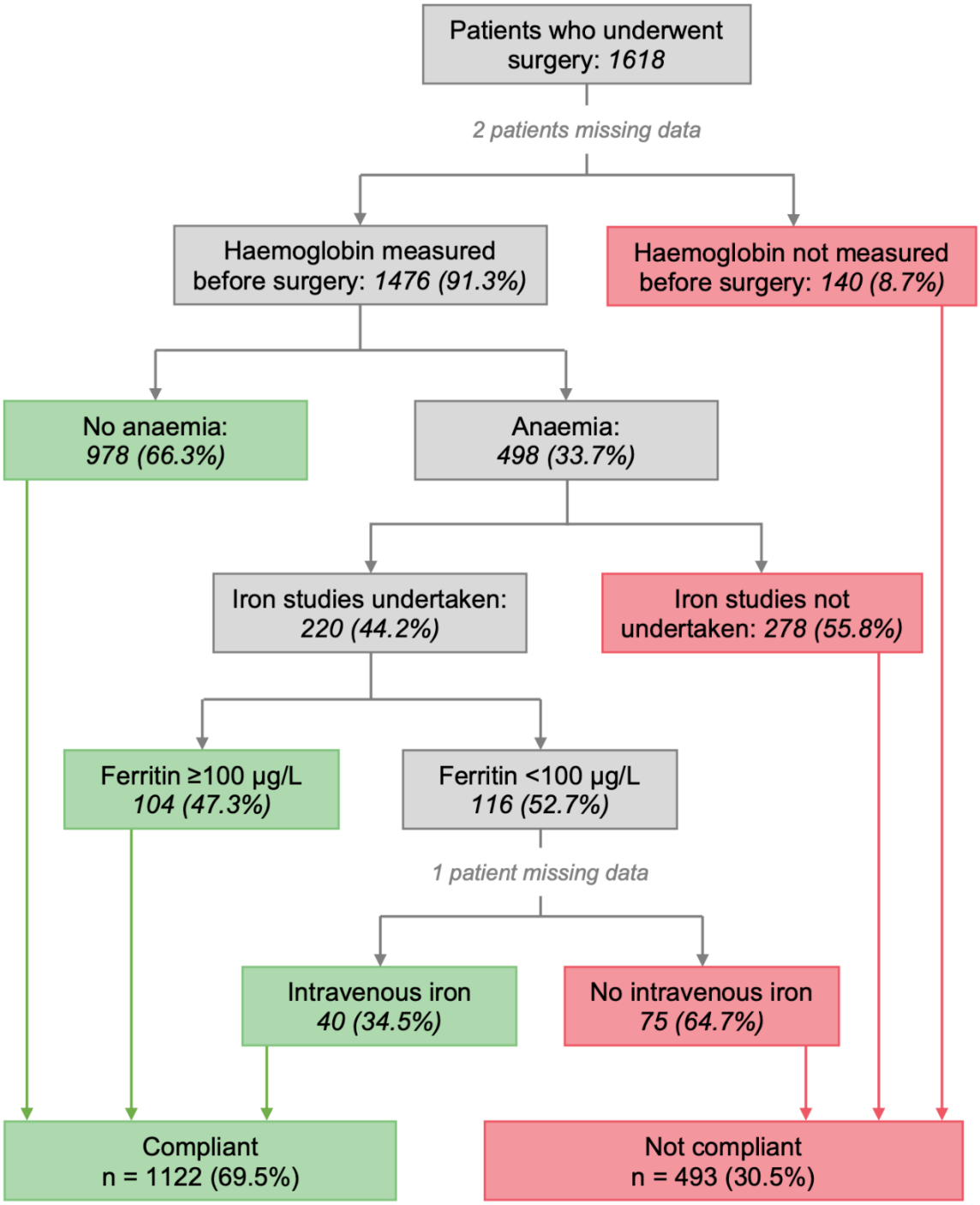
Haemoglobin levels were documented preoperatively for 1476 of 1616 patients (91.3%; elective surgery, 890 of 1021 patients [87.2%]; non-elective surgery, 586 of 595 patients [98.5%]), with a mean haemoglobin of 129.0 (SD 20.4) g/L. More than one-third (498/1476, 33.7%,) had preoperative anaemia.



Preoperative anaemia was associated with an increased risk of intraoperative and postoperative red blood cell transfusion, postoperative complications, reoperation, medical emergency team calls, and a longer length of hospital stay.

	Anaemic	**Not Anaemic**	**p value**
Number of patients	498 (33.7%)	978 (66.3%)	
Intraoperative Transfusion			<0.001
Yes	56 (11%)	20 (2.0%)	
No	440 (88.4%)	957 (97.9%)	
Missing	*2 (0.4%)*	*1 (0.1%)*	
Postoperative Transfusion			<0.001
Yes	116 (23.3%)	41 (4.2%)	
No	382 (76.7%)	937 (95.8%)	
Postoperative Complications			<0.001
None	249 (50.0%)	681 (69.6%)	
Minor (Clavien-Dindo I-II)	168 (33.7%)	229 (23.4%)	
Major (Clavien-Dindo ≥3)	81 (16%)	67 (6.9%)	
Missing	*0 (0%)*	*1 (0.1%)*	
Reoperation			0.005
Yes	35 (7.0%)	35 (3.6%)	
No	463 (93.0%)	943 (96.4%)	
Postoperative Medical Emergency Team Call			0.001
Yes	53 (11%)	58 (5.9%)	
No	435 (87.3%)	913 (93.4%)	
Missing	*10 (2.0%)*	*7 (0.7%)*	
Length of Stay (days)			<0.001
Median (Interquartile range)	9 (5-14)	5 (3-8)	

Iron studies were performed in 220 patients (44.2%) with preoperative anaemia, of whom 116 (52.7%) had a ferritin <100 µg/L, and 58 (26%) had a ferritin <30 µg/L. Of the patients with iron deficiency anaemia, 40 (35% of 116) received IV iron preoperatively.



Adherence with this audit standard was achieved for 69.5% of the cohort. Audit standard adherence was associated with lower rates of intraoperative and postoperative pRBC transfusion, lower risk of major complications, and a shorter length of hospital stay.

	Adherent	**Not Adherent**	**Overall**	**p value**
Standard #1: Preoperative Anaemia	**1122 (69.3%)**	**493 (30.5%)**	**1618**	
Intraoperative units transfused				**0.005***
0	1084 (96.6%)	452 (91.7%)	1539 (95.1%)	
1	10 (0.9%)	10 (2.0%)	20 (1.2%)	
2	18 (1.6%)	15 (3.0%)	33 (2.0%)	
≥3	9 (0.8%)	14 (2.8%)	23 (1.4%)	
Postoperative units transfused				**<0.001***
0	1048 (93.4%)	409 (83.0%)	1459 (90.2%)	
1	30 (2.7%)	34 (6.9%)	65 (4.0%)	
2	17 (1.5%)	23 (4.7%)	40 (2.5%)	
≥3	27 (2.4%)	27 (5.5%)	54 (3.3%)	
Postoperative Complications				**0.006***
None	761 (67.8%)	293 (59.4%)	1056 (65.3%)	
Minor	270 (24.1%)	137 (27.8%)	407 (25.2%)	
Major	90 (8.0%)	63 (13%)	154 (9.5%)	
Length of Stay (days)	5.5 (3-9)	7 (3-19)	6 (3-10)	**<0.001***

Multivariable adjusted analyses, adjusted for age, gender, ethnicity, surgical specialty, and operative urgency, demonstrated similar results to the univariate analysis.

	OR (95% CI)	**p value**
Standard #1: Preoperative Anaemia		
Intraoperative Blood Transfusion	0.31 (0.18-0.55)	**<0.001***
Postoperative Blood Transfusion	0.34 (0.22-0.50)	**<0.001***
Postoperative Complication	0.70 (0.54-0.90)	**0.006***
Major Postoperative Complication	0.68 (0.46-1.01)	0.06
Length of Stay	1.10 (0.97-1.24)	0.16

Audit Standard 2 - Intraoperative tranexamic acid administration

Intraoperative tranexamic acid was used in 114 procedures (7.1% of 1616). The proportion of patients undergoing hepatopancreaticobiliary procedures other than cholecystectomy who received tranexamic acid was 7 of 111 (6%) Use of tranexamic acid was more common in patients with preoperative haemoglobin <80 g/L, and in those undergoing non-elective procedures.

Variable	Tranexamic Acid Use	No Tranexamic Acid Use	*P*
Number of patients	114 (7.1%)	1502 (92.9%)	
Surgical urgency			< 0.001
Immediate	13 (24%)	42 (76%)	
Urgent	15 (4.3%)	333 (95.7%)	
Expedited	10 (5.2%)	182 (94.8%)	
Elective	76 (7.4%)	945 (92.6%)	
Surgical specialty			< 0.001
Hepatopancreatobiliary	7 (6.3%)	104 (93.7%)	
Colorectal	35 (4.6%)	724 (95.4%)	
Upper gastrointestinal	23 (5.3%)	413 (94.7%)	
Gynaecology	34 (22%)	119 (77.8%)	
Urology	13 (12%)	100 (88.5%)	
Transplantation	1 (3%)	31 (97%)	
Vascular	1 (8%)	11 (92%)	
Preoperative haemoglobin (g/L)			< 0.001
<70	5 (63%)	3 (38%)	
70-79	2 (13%)	13 (87%)	
80-89	3 (6%)	46 (94%)	
90-99	6 (9%)	58 (91%)	
100-109	3 (3%)	93 (97%)	
110-119	9 (5%)	177 (95.2%)	
120-129	17 (6.9%)	230 (93.1%)	
130-139	25 (7.7%)	301 (92.3%)	
140-149	24 (9.1%)	240 (90.9%)	
>150	16 (7.3%)	203 (92.3%)	
Not checked	4 (3%)	138 (97.2%)	

Of the 76 patients (4.7% of total cohort) who received an intraoperative pRBC transfusion representing procedures with potentially significant blood loss, 22 (29%) received tranexamic acid. Adherence with this audit standard amongst patients having intraoperative transfusion was not associated with any significant difference in the number of units transfused intraoperatively or postoperatively, postoperative complications, or length of stay.

	Adherent	**Not Adherent**	**Overall**	**p value**
Standard #2: Tranexamic Acid Use	**22 (28.9%)**	**54 (71.8%)**	**76**	
Intraoperative units transfused				0.88
1	4 (18%)	16 (30%)	20 (26%)	
2	10 (46%)	23 (43%)	33 (43%)	
≥3	8 (36%)	15 (28%)	23 (30%)	
Postoperative units transfused				0.97
0	11 (50%)	25 (46%)	36 (47%)	
1	3 (14%)	10 (19%)	13 (17%)	
2	1 (5%)	6 (11%)	7 (9%)	
≥3	7 (32%)	13 (24%)	20 (26%)	
Postoperative Complications				0.49
None	6 (27%)	27 (50%)	33 (43%)	
Minor	8 (36%)	12 (22%)	20 (26%)	
Major	8 (36%)	15 (28%)	23 (30%)	
Length of Stay (days)	13 (7.25-27)	11.5 (8-21.2)	12.0 (7.75-24.2)	0.92

Multivariable adjusted analyses, adjusted for age, gender, ethnicity, surgical specialty, and operative urgency, demonstrated similar results to the univariate analysis.

	OR (95% CI)	**p value**
Standard #2: Tranexamic acid use		
Postoperative Blood Transfusion	0.47 (0.11-1.86)	0.29
Postoperative Complication	3.73 (0.79-22.61)	0.12
Major Postoperative Complication	1.10 (0.20-5.94)	0.91
Length of Stay	1.18 (0.58-2.42)	0.64

Audit Standard 3 - Restrictive postoperative transfusion

Postoperatively, 159 patients (9.8%) received at least one pRBC transfusion, and all had a haemoglobin measurement prior to transfusion, mean 73.6 (SD 11.6) g/L (range 34-117). Overall, 65 (41%) received one unit, 40 (25%) two units, 16 (10%) three units, and 38 (24%) four or more units. Restrictive transfusion guidelines were followed in 92 patients (58% of 159), but was not associated with any statistically significant difference in number of units transfused, postoperative complications, or length of stay.

	Adherent	**Not Adherent**	**Overall**	**p value**
Standard #3: Restrictive Transfusion	**92 (57.9%)**	**67 (42.1%)**	**159**	
Postoperative units transfused				
1	31 (34%)	34 (51%)	69 (41%)	0.31
2	25 (27%)	15 (22%)	43 (26%)	
≥3	36 (39%)	18 (27%)	55 (33%)	
Postoperative Complications				0.97
None	23 (25%)	20 (30%)	43 (27%)	
Minor	34 (37%)	22 (33%)	56 (35%)	
Major	35 (38%)	25 (37%)	60 (38%)	
Length of Stay (days)	13 (7-22)	13 (7.5-22.5)	13 (7-22)	0.97

Multivariable adjusted analyses, adjusted for age, gender, ethnicity, surgical specialty, and operative urgency demonstrated similar results to the univariate analysis, except for length of stay, which demonstrated patients with restrictive transfusion were more likely to be discharged (HR 1.75, 95% CI 1.01-3.03).

	OR (95% CI)	**p value**
Standard #3: Restrictive Transfusion		
Postoperative Complication	1.21 (0.35-4.76)	0.77
Major Postoperative Complication	2.39 (0.74-8.13)	0.15
Length of Stay	1.75 (1.01-3.03)	0.045

Audit Standard 4 - Identification of postoperative anaemia

Haemoglobin was measured on postoperative day 1-3 in 89.6% (1449/1618) of patients, and the mean nadir was 108 g/L (SD 19.8 g/L). More than three-quarters (79.4%, 1151/1449) of patients had anaemia during the first three days postoperatively. Of patients with preoperative anaemia, 3.4% did not have a postoperative haemoglobin measured during their inpatient stay.

Excluding the 28 patients who died in hospital, and 54 who had not yet been discharged at follow-up, haemoglobin values were recorded for 1368 of 1536 patients prior to discharge (89.1%). The mean haemoglobin value was 115 g/L (SD 17.8 g/L, range 64-180 g/L), and anaemia was identified in 946 patients (69.2%). Readmission within 30 days of discharge was more common amongst patients discharged with anaemia (142 of 930 patients followed up, 15.3% vs. 34 of 410 8.3%). A larger proportion of the 286 patients discharged with haemoglobin levels below 100g/L (18.6%) were readmitted within 30 days (61 of 283 patients followed up, 22% vs. 115 of 1057, 10.9%).

Haemoglobin measurements at 30-days post-discharge were recorded for 342 of 1536 patients (22.5%); of these 208 (60.8%) had anaemia. Of the 946 patients with anaemia at discharge, follow up haemoglobin measurements were recorded in hospital records for 249 (26.3%), of whom 189 still had anaemia (75.9%).

Audit Standard 5 - Management of postoperative anaemia

Oral iron was prescribed postoperatively for six of 946 patients with anaemia at discharge (0.6%), and three of 422 patients without anaemia at discharge (0.7%). Intravenous iron was administered to 65 of 946 patients with anaemia at discharge (6.9%), and to 37 of 286 patients with haemoglobin values below 100 g/L (13%).

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