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ORIGINAL RESEARCH ARTICLE

Perioperative blood transfusion in major abdominal cancer surgery: a multi-centre service evaluation and national survey

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Abstract

Background: Anaemia is associated with complications and death after surgery. Perioperative red-cell transfusion triggers are not well defined in patients having oncological surgery, or with cardiovascular disease.

Methods: We carried out a prospective multicentre cohort study and a clinician survey of UK transfusion practice in adult patients undergoing surgery for abdominal malignancy. The primary outcome was red cell transfusion. Secondary outcomes were transfusion trigger haemoglobin, incidence of complications, length of hospital stay, and acute hospital mortality.

Results: In this prospective cohort study, data were collected on 412 patients undergoing surgery for intrabdominal malignancy in 14 NHS hospitals. Twenty-two (5.2%) patients received preoperative, 42 (10.2%) intraoperative, and 52 (12.2%) postoperative red blood cell transfusion. The mean postoperative transfusion trigger was 75.3 g L^{-1}, and the mean number of units of red blood cells transfused was 1.5 (standard deviation, 1.1). Seventeen (4.0%) patients had a documented postoperative troponin elevation. Five (1.2%) patients died within 30 days of surgery. In the survey, 117 clinicians submitted complete responses, of whom 62 (53%) indicated that a transfusion threshold of 70 g L^{-1} was appropriate: however, this decreased to six (5.1%) if there was evidence of recent cardiac ischaemia. There were 100 (86%) respondents who indicated equipoise for a trial of restrictive *vs* liberal transfusion, decreasing to 56% if there was coexisting cardiovascular disease.

Conclusions: Many patients having oncological surgery receive red cell transfusion, the majority being given postoperatively. Restrictive transfusion practice is generally followed; however, variability exists especially in cardiovascular disease. Equipoise exists for a study of transfusion thresholds in this group.

Keywords: anaemia; blood transfusions; neoplasms; perioperative care; surgery

Observational studies in surgical populations suggest that anaemia is associated with an increased incidence of complications and death after surgery.[1] The reason for this is uncertain and may reflect underlying disease and comorbidity, rather than a causative relationship. Of the 2 million units of red blood cells transfused each year in the UK, many are given in the perioperative period. In the absence of major haemorrhage, perioperative red blood cell transfusions are typically given with the aim of improving oxygen delivery to organs and tissues. Concern exists regarding the potential for myocardial ischaemia in the context of anaemia, especially among patients with cardiovascular disease. Decision-making is also influenced by potential adverse effects of transfusion ranging from fluid overload to immune-mediated complications, such as increased postoperative infection[2] and tumour recurrence.[3]

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Red cell transfusion is also a costly and finite resource. Evidence and guidelines generally support restrictive haemoglobin transfusion triggers in hospitalised adult patients,[4–7] but the optimum transfusion threshold for surgical patients with cardiovascular disease remains uncertain.

Although there is no consistent definition, published research compares restrictive transfusion (typically a transfusion haemoglobin threshold of 70–80 g L^{-1}) with more liberal strategies (typically with 90 g L^{-1} or greater).[8–10] However, many of these trials excluded patients with co-existing cardiovascular disease, and those that included this population typically used less restrictive transfusion triggers (e.g. 80 g L^{-1}). This reflects concerns over precipitating or exacerbating cardiac complications by exposing patients with cardiovascular disease to anaemia. Myocardial injury after noncardiac surgery is a common and clinically relevant occurrence in patients undergoing surgery. It differs from myocardial infarction in being defined as a peak troponin measurement above the upper reference limit during or within 30 days of noncardiac surgery.[11] Although controversial, it is widely accepted that this occurs as a result of myocardial ischaemia. It is well recognised that patients suffering perioperative myocardial injury have significantly higher short- and long-term mortality and higher rates of complications and disability.[12–14]

In the UK, the need for more robust evidence is highlighted in recent recommendations from the National Institute of Health and Care Excellence (NICE)[4] and the Association of Anaesthetists.[5] These recommend restrictive transfusion practice, using 70 g L^{-1} as the 'default' threshold, but both recommend caution for patients with cardiovascular disease. NICE has made further research in populations with cardiovascular disease a priority. A recent meta-analysis of trial data restricted to populations with cardiovascular disease (excluding cardiac surgery) indicated higher rates of acute coronary syndrome with restrictive practice (relative risk=1.78; 95% confidence interval [95% CI], 1.18–2.70; P=0.01; number needed to treat=50), with substantial uncertainty remaining about mortality.[15] Uncertainty for patients with cardiovascular disease is also supported by meta-analysis of trial data in cardiac surgery populations.[16] Hence, there is uncertainty if a 'restrictive' perioperative transfusion strategy is safe in the setting of cardiovascular disease. However, concerns also remain about the effects of perioperative transfusion on immune function, particularly postoperative infectious complications, and tumour recurrence. We believe this question should be tested in an appropriately powered randomised trial. The purpose of this work was two-fold: to measure current perioperative transfusion practice in cancer surgery in the UK and to assess clinicians' attitudes, beliefs, and equipoise for such a trial to take place.

Methods

We undertook a prospective observational study and survey of clinicians of UK transfusion practice. The observational study was designated as service evaluation so ethical approval was not required and Caldecott approval was obtained at all sites.

Cohort study

Sites were recruited via the UK Perioperative Medicine Clinical Trials Network and the study ran between 1 June and 30 September 2019 in 14 UK NHS hospitals. Data on red cell transfusion in adult patients undergoing abdominal cancer surgery were collected. We did not aim to recruit to a predetermined sample size; rather, the study ran for a 4-month period with the aim of prospectively recruiting as many patients as possible. Data were entered into a REDCap (Research Electronic Data Capture) database hosted at the University of Edinburgh. REDCap is a secure, web-based application designed to capture and store data. Data were collected by the clinical teams at sites coordinated by a site lead. All adults undergoing oesophagectomy, gastrectomy, large bowel resection, small bowel resection, and liver and pancreatic resections for cancer were eligible for inclusion. Age, gender, comorbidities, ASA status, preoperative functional status (including method of assessment) outcome of surgery at discharge, length of hospital stay, and 30-day mortality were collected. The number, timing, and indication for red cell transfusions given was recorded along with blood loss, preoperative, nadir, pre- and post-transfusion, and hospital discharge haemoglobin concentration, plus any perioperative troponin measurements. Haemoglobin data could include point-of-care measurements if this was used to inform the decision to transfuse. Preoperative transfusion was defined as any transfusion of red blood cells in the month (30 calendar days) before surgery. Troponin measurements were not protocolised and were made at the discretion of the clinical team. No additional tests or interventions were performed other than that included in routine care.

The primary outcome was red cell transfusion. Secondary outcomes were transfusion trigger haemoglobin concentration, incidence of complications, length of hospital stay, and 30-day or acute hospital mortality.

Statistical analysis

Results were analysed according to an *a priori* analysis plan by an independent statistician. No formal sample size or power calculation was undertaken. Transfusion and other data were summarised, and appropriate statistical testing used. Multivariate analysis was planned to identify factors associated with transfusion. All analyses were performed using R (R Foundation, Vienna, Austria).

Clinician survey

The online survey was designed and constructed using smartsurvey (www.smartsurvey.co.uk). The survey was trialled through several iterations before circulation to check for ease of use and clarity. The survey was circulated to the membership of the UK Perioperative Medicine Clinical Trials Network and mailing lists of other professional networks in anaesthesia, critical care, and surgery. The respondent's details were collected followed by a series of responses to hypothetical clinical scenarios relating to red cell transfusion decisions before, during, and after major cancer surgery. The survey ran from April to July 2019 and is included in the Supplementary material.

Results

Cohort study

Complete data were collected for 412 patients and details of the cohort characteristics are described in Table 1. The most frequent surgical specialty was colorectal surgery (229, 55.3%) followed by liver resection (62, 15.5%), pancreatic resection (46, 11.1%), oesophagectomy (29, 7.0%), and gastrectomy (24, 5.8%). The mean age of the cohort was 62.9 (standard deviation [SD], 13.7) yr, and 244 (59.2%) were male. One hundred and seventy-eight (43.2%) were ASA Physical Status (ASA-PS) 3 or 4. Comorbidities were common with diabetes (61, 14.8%), ischaemic heart disease (31, 7.5%), and other heart diseases (49, 11.9%) being amongst the most prevalent. Metastatic disease (64 15.5%), chemo- or radiotherapy in the preceding 3 months (88 21.4%) was also common. One hundred and fifty-nine (38.6%) patients had cardiopulmonary exercise testing (CPET) and 21 (5.1%) used Duke Activity Status Index scoring with the remainder undergoing subjective assessment only. There were significant differences between specialties, however, with more than half of those undergoing oesophagectomy or liver resection patients having CPET.

Transfusion

Details of haemoglobin concentrations and transfusion are outlined in Table 2. The mean preoperative haemoglobin was 126.9 (18.4) g L^{-1}. Thirty-six (8.8%) patients received preoperative treatment with intravenous iron and 22 patients (5.4%) received a preoperative blood transfusion, although this varies by surgical group from a rate of zero in oesophagectomy to 8.7% in small bowel resection and gastrectomy. A total of 42 (10.2%) patients received an intraoperative transfusion, varying from zero in oesophagectomy to 21.2% in small bowel resection. Indications for intraoperative transfusion are also reported in Table 2, with loss of 20% and 10% of circulating volume, respectively, being reported as the most common reasons for transfusion. No instances of transfusion for treatment or prevention of cardiac ischaemia were reported.

The nadir haemoglobin concentration was 102.9 (17.2) g. L^{-1} in the first 3 postoperative days and 98.6 (17.6) g L^{-1} before hospital discharge. Fifty-two (12.7%) patients received a blood transfusion before hospital discharge, 21 (5.1%) on more than one occasion. The mean pre-transfusion haemoglobin concentration was 75.3 (7.8) g L^{-1}. This was consistent across surgical groups. Fifty-two (12.7%) patients received at least one transfusion (21 [5.1%] received two or more) in the post-operative period. The mean number of units per transfusion episode was 1.5 (1.1) and the mean total units per patient requiring transfusion was 3.1 (3.5).

Univariate analysis suggested that male gender was less associated with transfusion (odds ratio [OR]=0.47; 95% CI, 0.29–0.76). Pre-existing metastatic disease (OR=1.93; 95% CI, 1.08–3.47) and preoperative haemoglobin concentration (OR=0.94; 95% CI, 0.93–0.96) were associated with an increased risk of transfusion (Supplementary Table S1).

Secondary outcomes

Postoperative troponin measurements were reported in 43 cases (10.5%). Of these, 17 were elevated with an overall rate of perioperative myocardial injury of 4.1%. The mean length of stay was 11.3 (9.5) days. Five patients (1.2%) died within 30 days of surgery or hospital discharge (Table 3).

Survey

The survey was completed by 117 respondents, of whom 98 (83.7%) were anaesthetists, 42 (35.9%) critical care physicians,

Table 1 Baseline characteristics. ASA: American Society of Anesthesiologists; CVS, cardiovascular system; SD, standard deviation.

Patient characteristics	Summary measure						
	Total	Colorectal resection	Oesophagectomy	Gastrectomy	Liver resection	Pancreatic resection	Small bowel resection
n	412	228	29	24	62	46	23
Age (yr)							
Mean (SD)	62.9 (13.7)	64.3 (13.4)	68.3 (8.2)	63.4 (15.3)	57.6 (15.0)	62.5 (10.8)	56.0 (17.0)
Sex, *n* (%)							
Female	168 (40.8)	95 (41.7)	4 (13.8)	10 (41.7)	26 (41.9)	20 (43.5)	13 (56.5)
Male	244 (59.2)	133 (58.3)	25 (86.2)	14 (58.3)	36 (58.1)	26 (56.5)	10 (43.5)
Comorbidities, *n* (%)							
Metastatic disease	64 (15.5)	21 (9.2)	0 (0.0)	2 (8.3)	36 (58.1)	2 (4.3)	3 (13.0)
Chemo- or radiotherapy (past 3 months)	88 (21.4)	33 (14.5)	23 (79.3)	8 (33.3)	21 (33.9)	1 (2.2)	2 (8.7)
Diabetes mellitus	61 (14.8)	34 (14.9)	3 (10.3)	6 (25.0)	7 (11.3)	9 (19.6)	2 (8.7)
Ischaemic heart disease	31 (7.5)	18 (7.9)	3 (10.3)	1 (4.2)	4 (6.5)	3 (6.5)	2 (8.7)
Heart failure	3 (<1)	1 (<1)	0 (0.0)	2 (8.3)	0 (0.0)	0 (0.0)	0 (0.0)
Other CVS disease	49 (11.9)	39 (17.1)	3 (10.3)	2 (8.3)	3 (4.8)	2 (4.3)	0 (0.0)
Atrial fibrillation	24 (5.8)	15 (6.6)	3 (10.3)	2 (8.3)	3 (4.8)	1 (2.2)	0 (0.0)
Chronic kidney disease	19 (4.6)	16 (7.0)	1 (3.4)	1 (4.2)	1 (1.6)	0 (0.0)	0 (0.0)
Dialysis	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
ASA grade, no. (%)							
1	19 (4.7)	12 (5.3)	0 (0.0)	0 (0.0)	1 (1.7)	2 (4.7)	4 (19.0)
2	205 (51.0)	130 (57.0)	13 (44.8)	7 (30.4)	21 (36.2)	24 (55.8)	10 (47.6)
3	171 (42.5)	82 (36.0)	15 (51.7)	15 (65.2)	36 (62.1)	17 (39.5)	6 (28.6)
4	7 (1.7)	4 (1.8)	1 (3.4)	1 (4.3)	0 (0.0)	0 (0.0)	1 (4.8)
Assessment of functional status							
Cardiopulmonary exercise testing	159 (38.6)	51 (22.4)	23 (79.3)	12 (50.0)	41 (66.1)	27 (58.7)	5 (21.7)
Duke Activity Status Index	21 (5.1)	1 (<1)	3 (10.3)	1 (4.2)	7 (11.3)	9 (19.6)	0 (0.0)

Table 2 Transfusion data. Hb, haemoglobin; IQR, inter-quartile range; POC, point-of-care; POD, postoperative days; SD, standard deviation.

Transfusion characteristics	Number of patients with available data, n (%)						
	Overall (n=412)	Colorectal resection (n=228)	Oesophagectomy (n=29)	Gastrectomy (n=24)	Liver resection (n=62)	Pancreatic resection (n=46)	Small bowel resection (n=23)
Preoperative Hb (g L−1), mean (sd)	126.9 (18.4)	126.8 (18.7)	128.0 (10.3)	118.3 (20.9)	129.5 (18.0)	128.7 (18.4)	124.8 (21.3)
Preoperative i.v. iron, n (%)	36 (8.8)	15 (6.6)	4 (13.8)	8 (34.8)	3 (4.8)	3 (6.5)	3 (13.0)
Preoperative transfusion, n (%)	22 (5.4)	13 (5.7)	0 (0.0)	2 (8.7)	4 (6.5)	1 (2.2)	2 (8.7)
Intraoperative POC Hb testing, n (%)							
Blood gas	320 (77.7)	146 (64.0)	29 (100.0)	22 (91.7)	59 (95.2)	44 (95.7)	20 (87.0)
Haemocue	3 (<1)	3 (1.3)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Other	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Intraoperative transfusion, n (%)	42 (10.2)	20 (8.8)	0 (0.0)	1 (4.3)	12 (19.4)	4 (8.7)	5 (21.7)
Indication for transfusion, n (%)							
Blood loss >10% circulating volume	8 (19.0)	5 (25.0)	0 (0.0)	0 (0.0)	2 (16.7)	1 (25.0)	0 (0.0)
Blood loss >20% circulating volume	11 (26.2)	5 (25.0)	0 (0.0)	0 (0.0)	2 (16.7)	1 (25.0)	3 (60.0)
Hb <70 g L−1	1 (2.4)	1 (5.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Hb <90 g L−1	8 (19.0)	7 (35.0)	0 (0.0)	0 (0.0)	1 (8.3)	0 (0.0)	0 (0.0)
Hypotension	6 (14.3)	2 (10.0)	0 (0.0)	0 (0.0)	2 (16.7)	1 (25.0)	1 (20.0)
Cardiac ischaemia	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Other	8 (19.0)	0 (0.0)	0 (0.0)	1 (100.0)	5 (41.7)	1 (25.0)	1 (20.0)
Nadir Hb first 3 POD (g L−1), mean (sd)	102.9 (17.2)	104.6 (16.9)	100.6 (16.9)	99.0 (17.2)	100.5 (16.9)	99.1 (17.7)	106.2 (18.1)
Nadir Hb hospital discharge/30 days (g L−1), mean (sd)	98.6 (17.6)	101.4 (17.4)	90.3 (15.6)	96.7 (17.8)	95.3 (15.6)	93.3 (18.0)	103.3 (19.8)
Number of postoperative transfusions, n (%)							
0	359 (87.3)	203 (89.0)	25 (86.2)	21 (91.3)	54 (87.1)	35 (76.1)	21 (91.3)
1	31 (7.5)	16 (7.0)	1 (3.4)	1 (4.3)	6 (9.7)	6 (13.0)	1 (4.3)
2	15 (3.6)	8 (3.5)	2 (6.9)	1 (4.3)	1 (1.6)	3 (6.5)	0 (0.0)
3+	6 (1.5)	1 (<1)	1 (3.4)	0 (0.0)	1 (1.6)	2 (4.3)	1 (4.3)
Pre-transfusion Hb (g L−1), mean (sd)	75.3 (7.8)	77.2 (9.3)	73.2 (5.0)	70.0 (5.7)	74.8 (7.1)	72.8 (5.1)	76.8 (1.8)
Units of blood per transfusion episode, median (IQR)	1 (1–2)	1 (1–2)	1 (1–2)	2 (1–3)	1 (1–2)	1 (1–1)	1 (1–2)
Post-transfusion haemoglobin (g L−1), mean (sd)	92.7 (12.6)	96.2 (11.8)	82.5 (4.3)	79.8 (8.1)	98.8 (13.1)	87.4 (12.9)	90.5 (12.0)
Total units blood transfused per patient, mean (sd)	3.1 (3.5)	2.4 (1.4)	2.8 (1.3)	4.5 (2.6)	4.3 (5.7)	4.4 (6.3)	2.9 (1.3)

and 14 (12%) surgeons (some individuals identified as both anaesthetists and critical care physicians). Eighty-five (72.6%) respondents were consultants, 26 (22.2%) specialist trainees, and four (3.4%) core or foundation grades. There was a clear trend toward a preference for a higher starting haemoglobin concentration depending on cardiovascular disease status, but only 23% said they would transfuse preoperatively if the haemoglobin concentration was too low (Fig. 1). Eighty-eight percent of responders reported that their institution delivered a preoperative intravenous iron service. There was large variability of intraoperative transfusion thresholds in the context of gradual haemoglobin concentration reduction which persisted in all three cardiovascular disease categories but a clear trend toward reduced acceptance of lower haemoglobin concentrations with more severe cardiovascular disease (Fig. 1). Fifty-three percent of responders would allow the haemoglobin concentration to drop below 70 g L^{-1} before giving blood which drops to 14.7% and 5.1% in the context of stable ischaemic heart

Table 3 Outcome data. SD, standard deviation.

Patient characteristics	Summary measure						
	Total	Colorectal resection	Oesophagectomy	Gastrectomy	Liver resection	Pancreatic resection	Small bowel resection
Surgery thought to be curative at discharge, *n* (%)	370 (90.2)	210 (92.5)	27 (93.1)	20 (87.0)	57 (91.9)	40 (87.0)	16 (69.6)
Postoperative troponin measurements, *n* (%)							
0	368 (89.5)	210 (92.1)	23 (79.3)	20 (87.0)	57 (91.9)	37 (80.4)	21 (91.3)
1	33 (8.0)	13 (5.7)	5 (17.2)	2 (8.7)	3 (4.8)	8 (17.4)	2 (8.7)
2	9 (2.2)	4 (1.8)	1 (3.4)	1 (4.3)	2 (3.2)	1 (2.2)	0 (0.0)
3	1 (<1)	1 (<1)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Postoperative troponin elevation, *n* (%)	17 (4.1)	8 (44.4)	2 (33.3)	1 (33.3)	1 (20.0)	4 (44.4)	1 (50.0)
Length of stay (days), mean (SD)	11.3 (9.5)	10.4 (8.6)	19.3 (15.9)	9.3 (5.1)	10.9 (10.8)	13.2 (7.6)	9.0 (6.1)
Thirty-day acute hospital mortality, *n* (%)							
Alive	405 (98.8)	226 (99.6)	29 (100.0)	21 (91.3)	62 (100.0)	45 (97.8)	22 (95.7)
Died	5 (1.2)	1 (<1)	0 (0.0)	2 (8.7)	0 (0.0)	1 (2.2)	1 (4.3)

disease and recent acute coronary syndrome, respectively. Loss of circulatory volume as a result of haemorrhage and decreased oxygen carrying capacity were cited as the leading reasons to prescribe a blood transfusion. Immune modulation and cancer recurrence were the two highest rated clinician concerns on blood transfusion in this setting.

Discussion

Our results suggest that current guidance advocating restrictive transfusion practice is largely followed in UK patients undergoing surgery for abdominal malignancy, although there is some suggestion from our survey that the presence of coexisting cardiovascular disease would discourage this approach. Immune modulation and cancer recurrence were also highlighted as leading concerns regarding blood transfusion in this setting. Eighty-six percent of respondents indicated they would consider there to be equipoise to enable recruitment to a trial of restrictive *vs* liberal transfusion, although this number decreased to 56% if this included patients with evidence of coexisting cardiovascular disease.

Chronic anaemia is common in patients presenting for cancer surgery and in this study was predictive of the requirement for transfusion. Non-transfusion treatments for preoperative anaemia, such as intravenous iron are in widespread use although evidence to support their use remains equivocal.[17] Patients commonly receive red cell transfusions to increase haemoglobin concentration with the belief that this may increase oxygen delivery to the tissues, particularly to the myocardium, and improve clinical outcomes. Clinicians also believe this may prevent cardiac complications, improve mobilisation, reduce hospital stay, prevent readmissions, and ensure fitness for further treatments such as chemotherapy.[18 19] However, blood transfusion is also associated with risks including fluid overload, immunosuppression, and immunomodulatory effects which may increase infectious complications and potentially increase the risk of cancer recurrence.[3] Of particular concern to clinicians is cancer recurrence, although this is only supported by retrospective data.

Available evidence generally supports restrictive transfusion strategies in stable hospitalised adult patients,[20] but uncertainty exists for important patient subgroups, notably those with coexisting cardiovascular disease, surgical patients, and older adults. These patients are excluded from, or under-represented in, many of the large trials in this area. A systematic review and meta-analysis has suggested that patients with chronic cardiovascular disease experience higher rates of myocardial ischaemia and a trend towards higher mortality when managed with restrictive transfusion strategies.[15] Patients undergoing cancer surgery are increasingly older, multimorbid, and have coexisting cardiovascular disease and anaemia. Six relevant systematic reviews since 2015 considering the issue of transfusion have been published[15 21–25] relating directly to patients having surgery for hip fracture,[21 22 24 25] general surgery,[15 22] or in older adults.[23] The overall quality of the evidence is low, and these studies report inconsistent effects of restrictive transfusion strategies. Moreover, there is a range of transfusion triggers used by each study and no standard definition of a restrictive or liberal strategy. Lack of a consistent definition of restrictive and liberal transfusion is reflected in clinical guidelines.[4–7]

Diagnosis of myocardial injury after noncardiac surgery does not require ECG changes or clinical symptoms and differs from international consensus definitions of myocardial infarction. Although controversial, it is widely accepted that it occurs at least in part because of myocardial ischaemia and oxygen supply imbalance. It is well recognised that perioperative myocardial injury is common – as high as 18% in a recent large cohort study of patients undergoing noncardiac surgery. These patients also have significantly higher short- and long-term mortality and higher rates of complications and disability.[12–14] Therefore, strategies that reduce the incidence of myocardial injury may result in significant improvements in outcomes after surgery.

Strengths of this study include its prospective observational design and data collection across a range of NHS hospitals in the UK with a good cross section of regions and including Scotland, England, and Wales. Its results are therefore likely to reflect UK practice. Weaknesses include the noninterventional design and a relatively small cohort size, too small to allow the planned multivariate analysis. Finally, there was a preponderance of anaesthetists and critical care

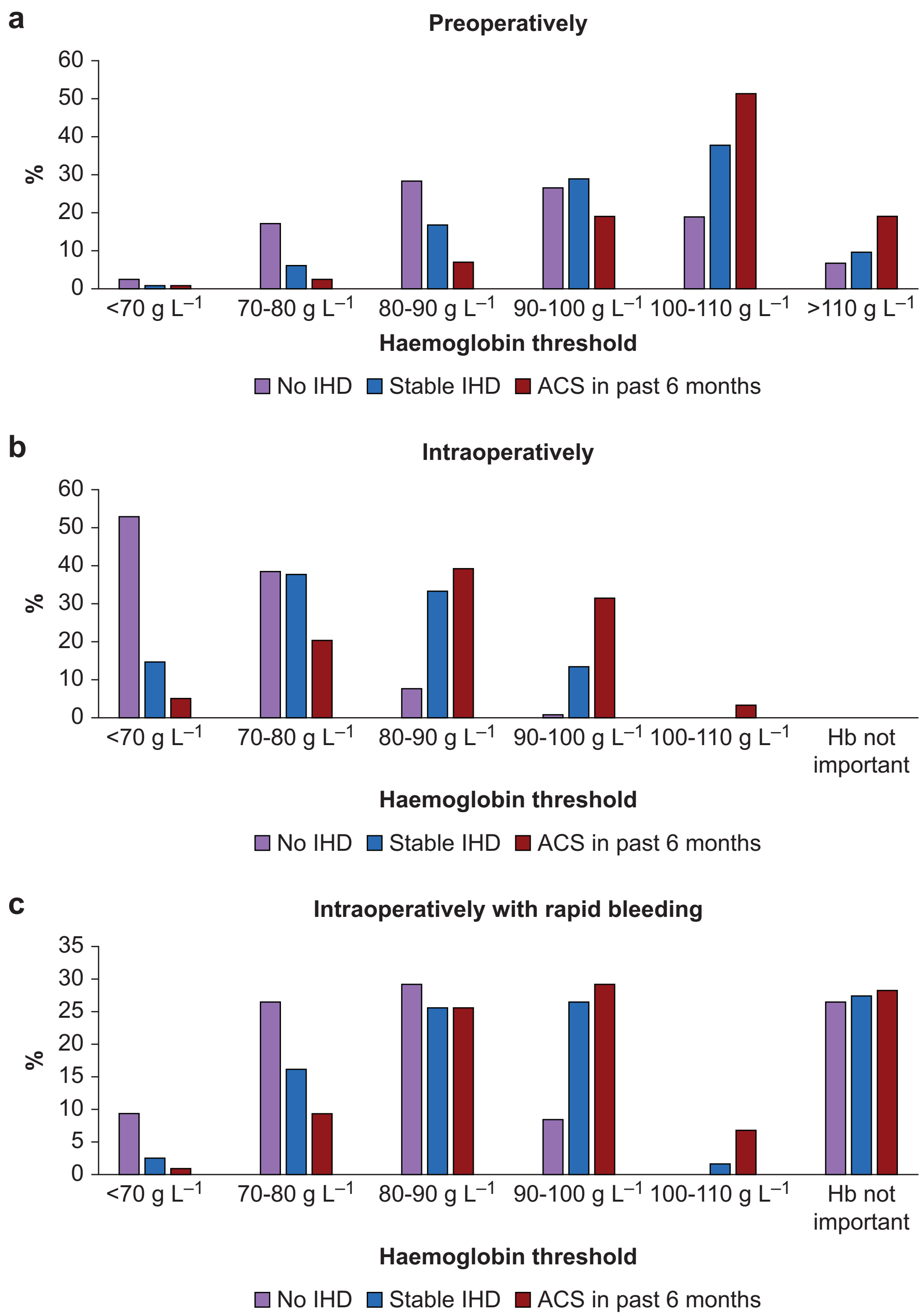

Fig 1. Survey responses to question, 'In a 59 year old man presenting for a large bowel cancer resection what is the Hb level that would prompt you to give a red cell transfusion … '. (a) Preoperatively. (b) Intraoperatively. (c) Intraoperatively with rapid bleeding. Hb, haemoglobin; ACS, acute coronary syndrome; IHD, ischameic heart disease.

physicians in the survey responses and so the views of surgeons and other relevant healthcare professionals may not have been as well represented.

The findings of this study suggest that restrictive transfusion practice is common in patients undergoing surgery for abdominal malignancy. However, uncertainty remains regarding the safety of this strategy, especially in patients with coexisting cardiac disease. Postoperative cardiac injury is common and further clinical trials of transfusion strategy in surgical patients, including those with coexisting cardiac disease would resolve this uncertainty and establish optimal transfusion thresholds for these patients. The planned RESULT-Hip (REStrictive versUs LIberaL Transfusion strategy on cardiac injury and death in patients undergoing surgery for

Hip Fracture) trial in the UK will examine transfusion threshold in patients undergoing surgery for hip fracture (ISRCTN 28818784) and the LIBERAL (Liberal Transfusion Strategy in Elderly Patients) study (NCT03369210) currently underway in Germany will address the same question in older adult patients having high risk noncardiac surgery. The results of our study would suggest equipoise exists for such a study to be carried out in major surgery for abdominal cancer in the UK.

Authors' contributions

All authors (including those listed in the Supplementary file) contributed to the design, data collection, interpretation of results, and manuscript preparation.

Declarations of interest

The authors declare that they have no conflicts of interest.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.bjao.2022.100032.

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