Examining the utility of routine perioperative hemoglobin monitoring in patients undergoing radical nephrectomy

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ABSTRACT

Introduction: Patients undergoing radical nephrectomy (RN) are often admitted with protocolized bloodwork for several days following their operation, yet the clinical value of serial hemoglobin (Hgb) measurements has not been established. This can lead to unnecessary costs and can prolong patient stay, despite the absence of an intervention based on these lab values. This study sought to examine perioperative Hgb values and identify those patients at high risk of bleeding requiring intervention, as well as those patients who are unlikely to require further monitoring.

KEY MESSAGES

- The current practice of routine daily postoperative bloodwork may result in over-investigation, increasing costs and prolonging length of stay.
- In patients with minimal perioperative change in hemoglobin with high preoperative levels, rates of bleeding complications are low.
- Investigations prompted by clinical parameters identify patients having postoperative complications.
- Those at higher risk for bleeding complications include patients with low preoperative hemoglobin, advanced age, and higher blood loss.

Methods: Patient and perioperative factors were retrospectively examined for a cohort of 259 radical nephrectomy patients from 2015–2021 in Atlantic Canada. Postoperative Hgb values and transfusion rates were recorded. A multivariate logistic regression analysis was performed to identify variables associated with requiring a blood transfusion.

Results: Overall, 31 (12%) patients required a blood transfusion in the postoperative period. Median estimated blood loss (EBL) was 150 ml (interquartile range [IQR] 100–300), with a median Hgb change of 15 g/L (IQR 9–22 g/L) from preoperative to postoperative day 1 (POD1). In patients with a Hgb loss of ≤15 g/L (n=131), transfusion was only required in four of these

patients (3.1%). Among those with a POD1 Hgb >100 g/L (n=199), only four (2%) required transfusion. These patients were identified to be having complications based on hemodynamic instability. Factors found to be associated on multivariate regression analysis with higher transfusion risk were age and intraoperative EBL, while higher preoperative Hgb was found to be associated with a lower transfusion risk.

Conclusions: In patients who have a reassuring POD1 Hgb value, with a drop of <15 g/L or an absolute value of >100 g/L, consideration can be made towards discontinuing routine Hgb testing in the absence of a clinical indication. Age, blood loss, and preoperative Hgb are factors that may affect a patient's overall risk of transfusion.

INTRODUCTION

In patients with localized renal cell carcinoma (RCC), surgical excision is the gold standard of treatment, with the goal of maximizing oncologic control while minimizing nephron loss[1]. In the current surgical landscape of increased pressure for operative time and reduced bed availability, enhanced recovery after surgery (ERAS) protocols are being implemented throughout urology to streamline the postoperative period[2–4]. These protocols have been shown to reduce length of stay while preserving quality of care[5–7]. Many surgical specialities are beginning to look at perioperative optimization through reduction of unnecessary blood tests, and urology is no exception[8–12]. Identification of patients at low risk of complications is crucial to avoid unnecessary intervention while also preserving perioperative outcomes.

After undergoing a nephrectomy, patients commonly receive routine bloodwork for several days to monitor their hemoglobin (Hgb) levels. Many institutions have protocolized pre-printed order sets that typically include several days of routine blood draws, a tradition that lacks evidence to support its use. These routine lab tests can result in unnecessary investigations as well as increased costs, without benefit to overall outcomes and prolonging length of stay[13,14]. Murphy et al[15] and Kholi et al[13] have demonstrated that most patients experiencing a complication will do so on a clinical basis, calling into question the benefit of routine labs in patients experiencing an uncomplicated course.

This study examines postoperative Hgb values and transfusion rates in patients undergoing nephrectomy to elucidate the clinical utility of routine bloodwork monitoring. In addition, we sought to identify clinical and patient risk factors that may predispose patients to require a postoperative blood transfusion.

METHODS

At a single Canadian institution, we retrospectively identified all patients who underwent open or laparoscopic radical nephrectomy (RN) for a renal mass presumed to be RCC between 2015 - 2021. Patients were excluded if the nephrectomy was performed for a nonfunctional kidney, renal trauma, age < 18 years of age, or infectious complications. Ethics approval was obtained by

the local institutional health research ethics board. Patient and demographic characteristics were recorded, as well as postoperative factors including successive Hgb values, complications, and length of stay.

The primary outcome was the incidence of patients requiring blood transfusions following a post-operative day 1 (POD1) Hgb drop of ≤ 15 g/L. The secondary outcome was to examine patient and clinical factors associated with requiring a postoperative blood transfusion. Univariable and multivariable logistic regression were used to create a model to identify patient and tumour factors that were associated with blood transfusion. Variables that were found to be significant on univariable analysis were used to inform the multivariate analysis. Statistical significance was defined at *p*-value < 0.05, with odds ratios (OR) and 95% confidence intervals (95%CI) recorded for each outcome.
All statistical analyses were performed using SPSS version 28.

RESULTS

Overall, 259 patients were identified who met inclusion criteria. The median age of the cohort was 65 (IQR 58-73) years with renal mass diameter of 7 cm (IQR 5.5-9.1). Laparoscopic procedures were performed in 179 patients (69.1%) with 80 patients (30.9%) receiving open nephrectomy. Most patients had a clinical stage ≤ T2bN0M0 (64.8%). Median length of stay was 3 days (IQR 2-5) and total number of CBCs per patient was 4 (IQR 2-5), with 1312 overall CBC draws. Descriptive statistics are included in Table 1.

Overall, 31 (12%) patients required a blood transfusion based on postoperative bloodwork. For all patients, 95 units of blood were transfused. Median intraoperative estimated blood loss (EBL) was 150 ml (IQR 100-300) The median preoperative Hgb was 132 g/L (IQR 117-145). The median loss of Hgb from preop to POD1 was 15 g/L (IQR 9-22 g/L). The median Hgb loss on POD1 for those who went on to require transfusion was 24 g/L (IQR 11-27 g/L). In those patients with an initial Hgb drop of < 15 g/dL, only 3.1% (4/131) required a blood transfusion in their subsequent hospital stay. Two patients overall (0.8%) required an operative takeback for a bleed, and no patients required IR intervention for a bleed.

When undergoing an uncomplicated operation (no inadvertent injury, no conversion to open from laparoscopic surgery) for clinical stage ≤ T2b, 3/104 (2.9%) of patients required transfusion. These patients are described more in detail in Table 2. There were 199 patients with a Hgb value > 100 g/L on POD1, only 4 of which (2%) required subsequent transfusion. All 4 of these patients experienced a complicated postoperative course. Their clinical descriptions can be found in Table 3.

Using multivariate logistic regression, age in years (OR = 1.083, 95% CI 1.018 – 1.152, *p*=0.011) and intraoperative EBL in ml (OR = 1.003, 95% CI 1.002 – 1.005, *p* = <0.001) were found to be statistically significantly associated with postoperative transfusion rates, while preoperative Hgb value in g/L (OR = 0.945, 95% CI 0.919 – 0.972, *p* = <0.001) was found to be protective when all factors entered in the analysis were held constant. Multivariate logistic regression specifics can be found in Table 4.

DISCUSSION

In this retrospective cohort of patients undergoing RN, 12% of patients required a blood transfusion, a rate comparable to the literature [16]. However, patients who had minimal change in their Hgb values from preop to postop (<15 g/L) had a postoperative transfusion rate of only 3.1%. Likewise, there are low transfusion rates (2%) for those with a POD1 Hgb > 100 g/L. This suggests that those patients with reassuring bloodwork based on these values on POD1 can be considered for discontinuing further daily bloodwork draws in the absence of a clinical indication. In addition, there were low rates of blood transfusion in patients with lower stage (≤ T2b) and uncomplicated operations. This is an implicitly understood finding inherent to medicine in general – patients with complications and complex disease are more likely to need more attentive care. This is further outlined by the regression model, where patients with more EBL (i.e., complex ORs) and advanced age are more likely to require blood transfusions.
Out of the patients who required a blood transfusion despite a POD1 Hgb > 100 g/L or Hgb drop < 15 g/L (described in Table 3**)**, all of them initially developed hemodynamic instability as a hallmark of the complication they were experiencing. This further suggests that even those patients who develop a complication despite reassuring bloodwork will be identified by clinical parameters that will prompt additional investigation. This study, among others[13–15], would point towards clinically-prompted investigations for patients, as opposed to routine postoperative laboratory investigations. The majority of patients who experience a bleed will likely do so in the first 24-48 hours, which will be apparent based on vital signs, patients' symptoms, urine output, and clinical acumen of the treating physician[17]. All patients in this study that required a blood transfusion after a reassuring POD1 Hgb value were experiencing complications that would have prompted investigation of their own accord.

As we attempt to optimize patient length of stay in our strained healthcare system, identification of those patients at highest risk of complications is crucial. Berger[2] and Ravivarapu[18] attempted to study this in cohort populations, looking at readmission and complication rates for those patients with early discharges. Unfortunately, this study suffers a retrospective bias; those patients discharged early did well postoperatively and will likely continue to do well. Azawi[6] looked at a small cohort of patients undergoing laparoscopic nephrectomy (n = 50), and found that out of those who were successful same-day discharges (92%), none required readmission to hospital. An alternative perspective is provided by Myers[19] in a cohort of patients undergoing robotic partial nephrectomy, who had high incidence of abnormal POD1 laboratory values and transfusions based on these values. Although a partial nephrectomy cohort is fundamentally at higher bleeding risk, the results support stratifying patients based on their POD1 bloodwork. It is difficult to support the idea of a same-day, or even 1-day nephrectomy based on these studies as well as the data presented here, yet it is hypothesis-generating.

Although this is a cohort of patients undergoing both laparoscopic and open nephrectomy, regression modelling did not demonstrate surgical approach as a predictive factor.

This is surprising, as intuitively patients will often require longer open procedures for complex disease.

This study is not without limitations. By nature, a retrospective cohort may have confounding factors not identified or accounted for in the analysis. The decision to order a transfusion can be subjective; although "strict" criteria exist, patients may occasionally have a blood transfusion triggered by symptoms, past cardiovascular history, overall trend of bloodwork or vital signs changes. These variations in practice can make prediction of transfusions somewhat difficult at the patient level. In addition, there are a small percentage of patients who received an intraoperative blood transfusion, skewing the results of their Hgb value on POD1. Intraoperative blood transfusions were performed at the discretion of the treating anesthetist, based on hemodynamics, ongoing blood loss, and communication with the surgeon.

CONCLUSIONS

This retrospective analysis demonstrates a low rate of blood transfusion for patients undergoing RN for renal cell carcinoma who have an initially stable post-operative serum Hgb level. Age, EBL, and preoperative hemoglobin values are all factors in consideration of the overall bleeding risk. Bloodwork prompted by clinical indications rather than routine bloodwork can reduce unnecessary blood draws, costs, anxiety, and prolonged length of stay.

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FIGURES AND TABLES

Table 1. Clinical and demographic findings for patients undergoing radical nephrectomy (N=259)		
Age, median years (IQR)	65 (58–73)	
Gender		
Male	173 (66.8%)	
Female	86 (33.2%)	
BMI, median (IQR)	30.1 (26.2–34.7)	
Comorbidities, percentage		
Smoker	107 (41.3%)	
Diabetic	55 (21.2%)	
Hypertension	160 (61.8%)	
On ACE or ARB	121 (46.7%)	
ASA score, percentage		
1	6 (2.3%)	
2	159 (61.4%)	
3	89 (34.4%)	
4	4 (1.5%)	
Renal mass biopsy	45 (17.4%)	
Preoperative Hgb, median g/L (IQR)	132 (117–145)	
Renal mass diameter, median cm (IQR)	7.0 (5.5–9.1)	
OR time, median mins (IQR)	126 (101–174)	
EBL, median ml (IQR)	150 (100–300)	
Change in Hgb preop-postop, median g/L (IQR)	-15 (-22 to -9)	
Total # of CBCs, median (IQR)	4 (2–5)	
Length of stay, median days (IQR)	3 (2–5)	
Tstage	Clinical stage	Pathologic stage
T1a	20 (7.7%)	19 (7.3%)
T1b	80 (30.9%)	36 (13.9%
T2a	53 (20.5%)	14 (5.4%)
T2b	32 (12.4%	4 (1.5%)
T3+	72 (27.8%)	180 (69.5%)
M1 disease	17 (6.6%)	
Surgical approach		
Laparoscopic	179 (69.1%)	
Open	80 (30.9%)	
Laterality		
Left	114 (44.0%)	
Right	145 (56.0%)	
Clavien complications		
None	190 (73.4%)	
Grade 1	22 (8.5%)	

Grade 2	31 (12.0%)
Grade 3	11 (4.2%)
Grade 4	4 (1.5%)
Grade 5	1 (0.4%)
Final histology	
Clear-cell	194 (74.9%)
Papillary	18 (6.9%)
Chromophobe	15 (5.8%)
Oncocytoma	11 (4.2%)
Other	20 (7.7%)
Overall transfusion rate	31 (12%)
Uncomplicated OR and ≤T2b	104 (40.2%)
Transfused in uncomplicated disease	3/104 (2.9%)
Transfused after POD0 if initial Hgb drop ≤15 g/L	4/131 (3.1%)
Transfused after POD0 if initial Hgb >100 g/L	4/199 (2.0%)

ACE: angiotensin-converting enzyme inhibitor; ARB: angiotensin receptor blocker; ASA: American Society of Anesthesiologists; BMI: body mass index; CBC: complete blood cell count; EBL: estimated blood loss; IQR: interquartile range; POD: postoperative day; Hgb: hemoglobin; OR: operating room.

Table 2. Transfusion differences between simple and complex (clinical >T2, intraoperative complication, conversion, anesthetic instability) ORs

	Routine OR (n=104)	**Complex (n=155)**	**Significance**
Hgb loss (g/L)	-15.8 (±0.9)	-15.0 (±1.0)	p=0.416
EBL (ml)	185 (±19.5)	437 (±45.4)	p<0.001*
Transfusion rate	3 (2.9%)	28 (18.1%)	p<0.001*
Total CBCs (median)	3 (IQR 2–4)	5 (IQR 3–7)	p<0.001*
Laparoscopic	92 (88.5%)	87 (56.1%)	p<0.001*
Open	12 (11.5%)	68 (43.9%)	p<0.001*

*Significance. CBC: complete blood cell count; EBL: estimated blood loss; Hgb: hemoglobin; OR: operating room.

Table 3. Tumor size, blood loss, length of stay, and transfusion rates by operative approach		
	Laparoscopic (n=179)	**Open (n=80)**
Tumor size, median cm (IQR)	6.6 (5.2–8.3)	8.3 (6.0–11.0)
EBL, median ml (IQR)	100 (100–200)	400 (200–800)
Transfusion	9 (5%)	22 (27.5%)
Length of stay, days (IQR)	3 (2–3)	5 (4–7)

EBL: estimated blood loss; IQR: interquartile range.

Table 4. Outcomes of patients requiring blood transfusions following reassuring POD1 Hgb values					
Pt. ID#	**cStage**	**# of CBCs**	**LOS**	**Clinical findings**	**Complication**
Patients with Hgb >100 on POD1					
1.	T1bN0M0	18	5 days	Found to be tachypneic, hypotensive, low urine output.	Postoperative bleeding managed conservatively
2.	T2aN0M0	13	6 days	Hypotension refractory to fluids	Operative takeback for bleed at vein and artery staple line
Patients with Hgb drop <15 g/dL on POD1					
3.	T3aN0M0	33	31	Abnormal intraoperative ECG and tachycardia; multiple complications developed subsequent to this initial finding	PE found intraop based on ECG; anticoagulated and retroperitoneal hematoma; takeback for SBO, jejunopexy
4.	T1aN0M0	13	5	Bradycardic and hypotensive in PACU.	Postoperative bleeding managed conservatively
Patients with both Hgb drop <15 g/dL and Hgb >100 on POD1					
5.	T3aN0M0	37	22	Intraoperative instability, brought to ICU postop	Significant intraoperative bleeding requiring pressors; recovered in ICU but aspirated on floor, requiring reintubation; eventually developed multiorgan system failure

6.	T3aN0M0	16	9	Hypotension, tachycardia with new-onset Afib.	Intraoperative bowel injury managed by general surgery; developed GI bleed postoperatively with hemodynamic instability and Afib managed by GI

CBC: complete blood cell count; ECG: GI: gastrointestinal; ICU: intensive care unit; LOS: length of stay; PACU: post-anesthesia care unit; SBO: small bowel obstruction.

Table 5. Multivariate logistic regression identifying factors associated with postoperative blood transfusions when undergoing radical nephrectomy

Variable	**p**	**Odds ratio**
Age	0.011	1.083 (1.018–1.152)
Gender	0.553	0.685 (0.196–2.390)
Preoperative Hgb (g/L)	<0.001	0.945 (0.919–0.972)
EBL (ml)	<0.001	1.003 (1.002–1.005)
OR time (mins)	0.052	1.011 (1.000–1.023)
Laterality	0.089	2.939 (0.849–10.175)
Additional procedures at time of OR (RPLND, adrenalectomy)	0.191	2.700 (0.610–11.953)

EBL: estimated blood loss; Hgb: hemoglobin; OR: operating room; RPLND: retroperitoneal lymph node dissection.