Original Article

Evaluating the necessity of postoperative day 1 labs following laparoscopic radical nephrectomy (LRN)

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Background: Standard postoperative care following laparoscopic radical nephrectomy (LRN) typically includes routine blood tests. Recent studies have assessed the safety of omitting routine postoperative labs in minimally invasive surgeries to reduce hospital costs. Our primary objective was to evaluate if routine postoperative day 1 (POD1) labs were necessary following LRN.

Methods: We evaluated 650 consecutive LRN performed by a single surgeon. Patients on dialysis or that previously had a renal transplant were excluded from the study. Our final analysis included 478 LRN. We examined POD1 labs of potassium (K), sodium (Na), and hemoglobin (Hgb) and their associations to preoperative and postoperative outcomes. Abnormal K at POD1 was defined as less than 3.5 mEq/L or greater than 5.0 mEq/L. Abnormal Na at POD1 was defined as less than 135 mEq/L or more than 145 mEq/L. Abnormal Hgb at POD1 was defined as POD1 Hgb less than 8 g/dL or POD1 Hgb 3.0 g/dL or more decrease from preoperative Hgb.

Results: One or more abnormal POD1 labs were observed in 32.4% (155/478) patients. Sixty-five patients had abnormal Hgb, 57 had abnormal Na, and 53 had abnormal K. Preoperative patient factors associated with abnormal labs included older age [odds ratio (OR) 0.461; 95% confidence interval (CI): 0.26–0.809], higher Charlson comorbidity index (CCI) (OR 1.671; 95% CI: 1.036–2.7), and increased intraoperative blood loss (OR 1.213; 95% CI: 1.069–1.39; all $P<0.05$). Intraoperative variables such as longer operative time and complications were not significantly associated with abnormal labs ($P>0.05$).

Conclusions: Abnormal labs on POD1 following LRN were found in 32.4% of patients. POD1 lab tests appear to be needed following LRN in older patients with more comorbidities.

Keywords: Laparoscopic radical nephrectomy (LRN); outpatient; postoperative day one (POD1 labs)

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Introduction

Laparoscopic radical nephrectomy (LRN) has evolved as the gold standard in treating localized renal cell carcinoma after it was first introduced in 1991 (1). This minimally invasive approach has improved perioperative outcomes including shorter hospitalizations, faster recovery time, and reducing intraoperative blood loss (2,3). Some studies have evaluated the feasibility of LRN as an ambulatory procedure in patients that have met specific criteria (4-6). Azawi *et al.* found that 92% of their patients were safely

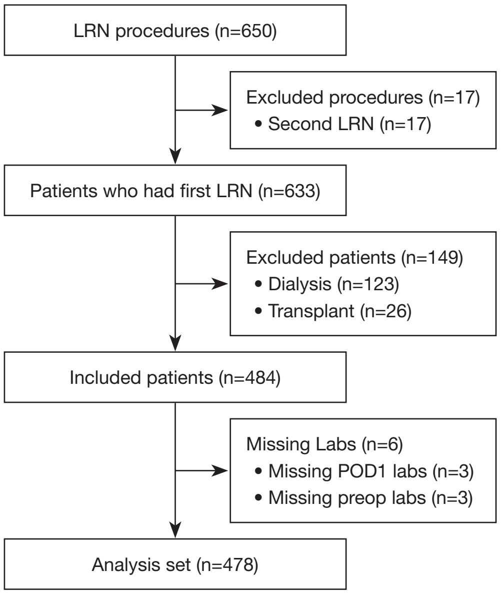

Figure 1 Patient flow diagram. Dialysis and transplant patients along with patients who had more than one LRN were excluded. POD1, post-operative day one; LRN, laparoscopic radical nephrectomy.

discharged within a few hours post-LRN (7). Standard care following LRN is to obtain postoperative day one (POD1) labs. The necessity of routine postoperative labs has become a growing interest in recent studies in order to reduce hospital costs without sacrificing the quality of care (8,9). A previously published study found that POD1 labs following robotic-assisted partial nephrectomy (RAPN) were necessary (10). As literature has evaluated the success of LRN as an outpatient procedure, this is the first study to our knowledge that examines the necessity of POD1 labs after LRN. Therefore, our primary outcome was to analyze the necessity of obtaining routine POD1 labs following LRN by specifically analyzing abnormalities in hemoglobin (Hgb), sodium (Na), and potassium (K). We present this article in accordance with the STROBE reporting checklist (available at https://tau.amegroups.com/article/view/10.21037/tau-24-250/rc).

Highlight box

Key findings

- Postoperative day one (POD1) labs following laparoscopic radical nephrectomy (LRN) are necessary in older patients with higher risk factors.
- The majority of patients from our cohort experienced normal postoperative labs. Most patients who had mild electrolyte abnormalities did not require medical intervention.

What is known and what is new?

- Recent studies have evaluated the safety of eliminating postoperative blood tests in minimally invasive surgeries to reduce hospital expenses.
- To our knowledge, this is the first study to evaluate the necessity of POD1 labs following LRN.

What is the implication, and what should change now?

- These findings can help physicians decide if postoperative labs are necessary in patients without potential risk factors.

Methods

Study cohort

The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the Institutional Review Board of Mayo Clinic (No. 12-004921) and individual consent for this retrospective analysis was waived. A total of 650 consecutive LRNs performed from July 2007 to January 2023 by a single surgeon were retrospectively reviewed. *Figure 1* shows the patient flow diagram. We excluded patients that had an LRN previously performed (n=17), transplant (n=26), and dialysis (n=123) patients. We also excluded patients that had missing preoperative (n=3) and postoperative day one (n=3) labs. A total of 478 LRN were included in the final analysis. Our primary outcomes were one or more abnormal labs (Na, K, Hgb) on POD1 excluding Cr.

Data collection

Study data were collected and managed using REDCap electronic data capture tools hosted at our institution. The following data was collected on REDCAP: patient characteristics [age, sex, race, body mass index (BMI), Charlson comorbidity index (CCI) (11), diabetes (DM), and hypertension], intraoperative variables [intraoperative complications, estimated blood loss (EBL), total operative time, Clavien-Dindo complications (12)], postoperative information [length of stay (LOS), prolonged LOS defined as ≥3 days (13), readmission within 30 days, tumor characteristics (tumor size obtained from the pathology report where available, tumor kidney side), and labs prior to LRN and POD1 (Hgb, Na, and K).

Laboratory definitions

All POD1 labs were obtained following LRN. Abnormal POD1 Na labs were described as <135 or >145 mEq/L (9,10). Abnormal POD1 K labs were defined as <3.5 or >5.0 mEq/L. Abnormal K was additionally defined as severe hypokalemia (<3.0 mEq/L), mild hypokalemia (3.0–3.4 mEq/L), mild hyperkalemia (5.1–5.4 mEq/L), moderate hyperkalemia (5.5–5.9 mEq/L), and severe hyperkalemia (6.0 mEq/L or higher) (9). Abnormal Hgb labs were described as POD1 Hgb <8 g/dL or POD1 Hgb ≥3.0 g/dL decrease from preoperative Hgb (9,10). Acute kidney injury (AKI) on POD1 was defined as one of the following 3 stages: Stage I baseline Cr at POD1 was 1.5–1.9 times preoperative Cr or ≥0.3 mg/dL increment from preoperative to POD1.26 Stage II POD1 Cr was 2.0–2.9 times preoperative Cr. Stage III POD1 Cr was ≥3.0 times preoperative Cr or POD1 Cr of 4.0 mg/dL or more (10).

Statistical analysis

All statistical analyses were performed using R version 4.2.2 (R Foundation for Statistical Computing, Vienna, Austria). Categorical characteristics were reported as the frequency and percentage of patients. Continuous characteristics were reported as the sample median and interquartile range (IQR). To evaluate our primary outcome, we estimated the proportion of patients who had one or more abnormal laboratory values on POD1 with a 95% confidence interval (CI) for a single proportion using the score method. We also used logistic regression models to examine which preoperative and intraoperative characteristics were associated with having abnormal labs. All statistical tests were two-sided. P<0.05 was considered statistically significant without adjustment for multiple testing. Given the large number of tests performed, the possibility of a type I error (i.e. false positive finding) should be considered when interpreting the results.

Results

Table 1 summarizes patient characteristics found in our cohort including patients with any abnormal or normal POD1 labs for Hgb, Na, and K. We found that 32.4% (155/478) patients had one or more abnormal labs on POD1 for Hgb, Na, or K. Patients with abnormal POD1 labs had a median age of 69 years (IQR, 61 to 77 years), median BMI of 29 kg/m^2 (IQR, 25 to 34 kg/m^2), a median LOS of 2 days (IQR, 2 to 3 days), and a median tumor size of 5 cm (IQR, 4 to 6 cm). The median tumor size in our total cohort is 6 cm (IQR, 4 to 8 cm).

The frequencies of abnormal individual labs are presented in *Table 2*. Sixty-five (13.6%) patients had abnormal Hgb labs; 10 patients (2.1%) had POD1 Hgb <8 g/dL, and 55 patients (11.5%) had a decrease in postoperative Hgb from baseline Hgb ≥3 units. Eleven of these patients had their labs repeated. Nine (1.9%) patients with abnormal Hgb labs required a blood transfusion. Seven patients had hemodynamic instability and 2 patients had symptomatic anemia.

Fifty-seven (11.9%) patients had abnormal Na labs; 52 (10.9%) patients had hyponatremia and 5 (1.0%) patients had hypernatremia. Ten hyponatremic patients were treated with IV fluids while others had dietary recommendations. Fifty-three (11.1%) patients had abnormal K labs; 12 patients developed mild hypokalemia while 28 patients developed mild hyperkalemia. Eleven patients had moderate hyperkalemia. Hypokalemic patients were treated with oral K agents while hyperkalemic patients were treated with loop diuretics. Four patients with moderate hyperkalemia had an electrocardiogram (EKG) performed and all EKGs came back normal.

Table 3 shows a multivariable analysis of factors associated for each POD1 abnormal lab with age, sex, and CCI being adjusted. Factors such as elevated CCI [+3, odds ratio (OR) 1.671; 95% CI: 1.036–2.7, P=0.04] were associated with impacting any abnormal Hgb, K, or Na POD1 labs. Patients with Na abnormalities were significantly older (+20 years, OR: 0.461; 95% CI: 0.26–0.809, P=0.007) and patients with Hgb abnormalities were associated with a higher EBL (+200 mL, OR 1.213; 95% CI: 1.069–1.39, P=0.003).

Discussion

LRN has advanced as the gold standard in treating T1–T2 tumors, reducing the risks of postoperative complications along with shorter LOS (1,14). Standard protocol following LRN is to obtain blood tests, specifically evaluating abnormalities in Hgb, Na, and K. This is the first study that acknowledges the necessity of POD1 labs post-LRN. We found that 32.4% of our patients had one or more abnormal POD1 labs. Patients with certain preoperative factors such as older age, higher CCI, and larger tumor size increased

Table 1 Patient characteristics and outcomes

Characteristics	Total (N=478)	Abnormal POD1 Hgb, Na, or K (N=155)	Normal POD1 Hgb, Na, and K (N=323)
Age at surgery (years)			
Median (Q1, Q3)	67 (57, 75)	69 (61, 77)	67 (56, 74)
Sex, n (%)			
Female	189 (39.5)	69 (44.5)	120 (37.2)
Male	289 (60.5)	86 (55.5)	203 (62.8)
Race, n (%)			
Asian	6 (1.3)	2 (1.3)	4 (1.2)
Black/African American	29 (6.1)	8 (5.2)	21 (6.5)
White	432 (90.4)	141 (91.0)	291 (90.1)
Hispanic or Latino	4 (0.8)	1 (0.6)	3 (0.9)
Body mass index (kg/m^2)			
Median (Q1, Q3)	29 (26, 34)	29 (25, 34)	30 (26, 34)
Charlson comorbidity index, n (%)			
1	10 (2.1)	3 (1.9)	7 (2.2)
2	50 (10.5)	8 (5.2)	42 (13.0)
3	59 (12.3)	15 (9.7)	44 (13.6)
4	104 (21.8)	32 (20.6)	72 (22.3)
5	107 (22.4)	39 (25.2)	68 (21.1)
6	73 (15.3)	23 (14.8)	50 (15.5)
7	43 (9.0)	20 (12.9)	23 (7.1)
8	22 (4.6)	10 (6.5)	12 (3.7)
9	6 (1.3)	2 (1.3)	4 (1.2)
10	4 (0.8)	3 (1.9)	1 (0.3)
Diabetes, n (%)			
Yes	112 (23.4)	43 (27.7)	69 (21.4)
No	366 (76.6)	112 (72.3)	254 (78.6)
Hypertension, n (%)			
Yes	339 (70.9)	111 (71.6)	228 (70.6)
No	139 (29.1)	44 (28.4)	95 (29.4)
Intra-op complications, n (%)			
Yes	10 (2.1)	4 (2.6)	6 (1.9)
No	468 (97.9)	151 (97.4)	317 (98.1)
Estimated blood loss (mL)			
Median (Q1, Q3)	300 (100, 300)	300 (100, 300)	300 (100, 300)

Table 1 *(continued)*

Table 1 *(continued)*

Characteristics	Total (N=478)	Abnormal POD1 Hgb, Na, or K (N=155)	Normal POD1 Hgb, Na, and K (N=323)
Total operative time (min)			
Median (Q1, Q3)	144 (122, 185)	146 (121, 190)	143 (122, 184)
Post-op complication, n (%)			
Yes	79 (16.5)	36 (23.2)	43 (13.3)
No	399 (83.5)	119 (76.8)	280 (86.7)
Length of stay (days)			
Median (Q1, Q3)	2 (2, 3)	2 (2, 3)	2 (2, 3)
Length of stay ≥3 days, n (%)			
Yes	165 (34.5)	61 (39.4)	104 (32.2)
No	313 (65.5)	94 (60.6)	219 (67.8)
Readmission, n (%)			
Yes	84 (17.6)	34 (21.9)	50 (15.5)
No	394 (82.4)	121 (78.1)	273 (84.5)
Tumor kidney, n (%)			
Left	244 (51.0)	82 (52.9)	162 (50.2)
Right	234 (49.0)	73 (47.1)	161 (49.8)
Pathology tumor size (cm)			
Median (Q1, Q3)	6 (4, 8)	5 (4, 6)	6 (4, 8)

POD1, postoperative day one; Hgb, hemoglobin; Na, sodium; K, potassium.

their risk of developing abnormal labs. These findings suggest that POD1 labs following LRN are necessary for specific patients that need to be monitored. While creatinine was also assessed, it was not part of our primary analysis as AKI is a common incidence after LRN and does not prolong LOS (15,16). Among our patients, 60.5% (289/478) experienced stage 1 AKI based on KDIGO guidelines (17). Proper management of AKI involves liberal fluid therapy while monitoring urine output (18).

While LRN helps reduce the risks of intraoperative blood loss, it continues to be a common complication (19,20). Hgb abnormalities were observed in 13.6% (65/478) of our patients, in which 1.9% (9/478) of those patients required medical intervention by receiving a blood transfusion. Patient factors significantly associated with abnormal Hgb levels were a higher CCI and increased intraoperative blood loss. Teixeira *et al.* evaluated the necessity of postoperative blood tests following laparoscopic prostate surgery (21). A significant drop in Hgb levels was experienced by 4.8% (11/231) of their patients, with 1.7% (4/231) of their patients requiring a blood transfusion. Blood loss was significantly correlated to patients that experienced hemodynamic instability. Similarly in our cohort, seven patients that required a blood transfusion had hemodynamic instability. This was expected as our patients had underlying comorbidities such as coronary artery disease and hypertension. These results from both cohorts imply that while certain patients with specific risk factors may benefit from routine postoperative blood tests, it appears unnecessary for patients without these underlying factors.

The majority of patients in our cohort experienced normal Na and K levels. Most patients that experienced Na and K abnormalities were mild cases and did not require medical intervention. Medications, IV fluids, and dietary changes can help treat patients with these abnormalities (22).

Table 2 POD1 labs (N=478)

POD1 labs	N (%)
Hemoglobin	
POD1 Hgb (normal)	413 (86.4)
POD1 Hgb <8 g/dL (abnormal)	10 (2.1)
POD1 Hgb ≥3 unit decrease from preoperative Hgb value	55 (11.5)
Sodium	
POD1 Na <135 mEq/L (abnormal)	52 (10.9)
POD1 Na 135–145 mEq/L (normal)	421 (88.1)
POD1 Na >145 mEq/L (abnormal)	5 (1.0)
Potassium	
POD1 K <3.0 mEq/L (severe hypokalemia)	1 (0.2)
POD1 K 3.0–3.4 mEq/L (mild hypokalemia)	12 (2.5)
POD1 K 3.5–5.0 mEq/L	425 (88.9)
POD1 K 5.1–5.4 mEq/L (mild hyperkalemia)	28 (5.9)
POD1 K 5.5–5.9 mEq/L (moderate hyperkalemia)	11 (2.3)
POD1 K 6.0 or higher mEq/L (severe hyperkalemia)	1 (0.2)
Acute kidney injury at stage 1	
None	175 (36.6)
Acute kidney injury stage 1	289 (60.5)
Acute kidney injury stage 2	8 (1.7)
Acute kidney injury stage 3	6 (1.3)

POD1, postoperative day one; Hgb, hemoglobin; Na, sodium; K, potassium.

In our cohort, 10.9% developed hyponatremia which is commonly induced by surgical stress (23,24). Therefore, it does not typically pose for any potential concerns as it can be managed through intravenous (IV) saline fluids and dietary changes. Only three patients had moderate hyponatremia which was treated through IV fluids (22). Our study found that 5.9% developed mild hyperkalemia and 2.5% developed mild hypokalemia. Hypokalemic patients were treated with oral K agents while patients with hyperkalemia were given loop diuretics. Patients that develop postoperative arrhythmias can be associated with other underlying comorbidities, not specifically from electrolyte imbalances (25). All 4 EKG's conducted in our cohort to check for arrhythmias came back normal.

Ambulatory procedures, particularly minimally invasive surgeries, have gained popularity to help reduce hospital costs and enhance patient experience while minimizing unnecessary longer hospital stays (26). Geldmaker *et al.* found that POD1 labs were necessary in patients that received an RAPN (10). This interested us to evaluate POD1 labs using a laparoscopic nephrectomy series as we assumed we would find similar results. As advancements in LRN have significantly improved perioperative outcomes, it has been evaluated as a feasible outpatient procedure (4,5). Azawi *et al.* conducted a study that examined if laparoscopic nephrectomy was safe enough to be classified as an outpatient procedure (7). Postoperative care included pain control and early ambulation. Within 6 hours following LRN, 92% (46/50) of their cohort were discharged. Ragavan *et al.* conducted a similar study on evaluating various robotic-assisted laparoscopic surgeries, including 15 radical nephrectomies and 7 simple nephrectomies, as an outpatient procedure (6). They found that 100% (43/43) of their cohort were discharged on the same day. Patients in these two studies had to meet specific inclusion criteria. Hence, the ability to evaluate LRN as an outpatient procedure is ambiguous because this can change based on the patient selection in the cohort. Azawi *et al.* excluded patients that had heart comorbidities which minimized the risks of intraoperative blood loss and longer LOS. Our cohort had a median LOS of 2 days and excluded dialysis and transplant patients as they commonly require hospitalization and can have unpredictable lab results.

Two strengths in our study are all LRNs were performed by a single surgeon at a tertiary medical center and contain a large cohort. Our analysis is also limited due to its retrospective nature and not identifying the costs of each individual lab. Not all patients in our cohort with mild K and Na abnormalities required medical intervention as many of them stayed an additional day for observation. Therefore, it is essential for a physician's call of judgment in omitting POD1 labs in patients who are not associated with potential risk factors. As POD1 labs were necessary for a large number of patients in our cohort, this does not mean that all patients would be required to stay in the hospital overnight as they would be able to conduct bloodwork the following day after surgery.

Conclusions

POD1 lab tests appear to be required following LRN in older patients with more co-morbidities.

Table 3 Patient factors associated with abnormal postoperative day one labs following laparoscopic radical nephrectomy

Variable	Any abnormal Hgb, Na, or K (N=155)		Abnormal Hgb (N=65)		Abnormal Na (N=57)		Abnormal K (N=53)	
	OR (95% CI)	P value	OR (95% CI)	P value	OR (95% CI)	P value	OR (95% CI)	P value
Age (+20 years)	0.673 (0.451, 1.003)	0.052	1.073 (0.626, 1.874)	0.80	0.461 (0.26, 0.809)	0.007	0.732 (0.404, 1.337)	0.31
Male	1.141 (0.734, 1.788)	0.56	0.891 (0.5, 1.621)	0.70	1.285 (0.689, 2.483)	0.44	1.547 (0.801, 3.09)	0.20
BMI (+10 kg/m^2)	0.883 (0.676, 1.076)	0.31	0.769 (0.504, 1.071)	0.20	0.871 (0.576, 1.135)	0.46	0.994 (0.67, 1.248)	0.97
CCI (+3)	1.671 (1.036, 2.700)	0.04	1.613 (0.857, 2.948)	0.13	0.912 (0.434, 1.811)	0.80	2.062 (1.048, 3.945)	0.03
Diabetes	1.162 (0.706, 1.896)	0.55	0.671 (0.324, 1.314)	0.26	0.871 (0.576, 1.135)	0.46	0.994 (0.67, 1.248)	0.97
Hypertension	0.795 (0.502, 1.263)	0.33	0.677 (0.372, 1.257)	0.21	1.49 (0.723, 2.977)	0.27	1.417 (0.697, 2.81)	0.33
Right kidney side	0.926 (0.625, 1.371)	0.70	0.849 (0.497, 1.442)	0.55	1.054 (0.552, 2.09)	0.88	0.701 (0.353, 1.444)	0.32
Tumor size (+4 cm)	0.862 (0.604, 1.217)	0.41	0.773 (0.463, 1.249)	0.31	0.774 (0.436, 1.36)	0.38	1.541 (0.855, 2.815)	0.15
Intra-operative complications	1.187 (0.286, 4.43)	0.80	1.561 (0.227, 6.598)	0.59	0.969 (0.588, 1.553)	0.90	0.93 (0.532, 1.571)	0.79
Estimated blood loss (+200 mL)	1.076 (0.958, 1.211)	0.21	1.213 (1.069, 1.39)	0.003	1.561 (0.227, 6.663)	0.59	1.785 (0.249, 8.174)	0.50
Operating room times (+60 mins)	1.06 (0.857, 1.305)	0.59	1.254 (0.959, 1.62)	0.09	0.909 (0.692, 1.098)	0.42	1.024 (0.835, 1.19)	0.78

Multivariable analysis adjusted for age, sex, and CCI. Patients with multiple abnormal labs are counted once. Hgb, hemoglobin; Na, sodium; K, potassium; BMI, body mass index; CCI, Charlson comorbidity index.

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Footnote

Reporting Checklist: The authors have completed the STROBE reporting checklist. Available at https://tau.amegroups.com/article/view/10.21037/tau-24-250/rc

Data Sharing Statement: Available at https://tau.amegroups.com/article/view/10.21037/tau-24-250/dss

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Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://tau.amegroups.com/article/view/10.21037/tau-24-250/coif). D.D.T. is the Secretary of Southeastern Section of the American Urological Association. D.D.T. was an investigator for Grail, Inc. This included supplying tissue for analysis. D.D.T. was not personally compensated. D.D.T. was in investor in Auris Robotics greater than 36 months ago. The other authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the Institutional Review Board of Mayo Clinic (No. 12-004921) and individual consent for this retrospective analysis was waived.

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