Clinical Communication

Incidence of acute kidney injury during the perioperative period in the colorectal division of surgery - Retrospective study

INTRODUCTION AND BACKGROUND

Acute kidney injury (AKI) commonly occurs following cardiac surgery but is also seen in colorectal surgeries.[1] This may have a detrimental impact on cost, duration of hospital stay and mortality. Kidney disease improving global outcomes (KDIGO) defines AKI by an absolute increase in creatinine, ≥0.3 mg/dL within 48 h or by a 50% increase in creatinine from a baseline within 7 days, or a urine volume <0.5 mL/kg/h minimum duration of 6 hours.[1]There have been several studies on AKI during the hospital stay in major abdominal surgery.[2-4] However, studies on AKI developed after colorectal surgery are limited.[5-7] The incidence is 4.8-11.8%.[6]

This study aims to assess the kidney function from preoperative to postoperative period. In addition, it also evaluates the incidence and risk factors of AKI in the first 7 days after surgery in a cohort of patients undergoing major colorectal surgery. Notable secondary outcomes include hypotension and reduced urinary output in the post-anaesthetic care unit (PACU), medical complications in hospital, in-hospital mortality and time until discharge.

METHODS

Ethics approval was obtained from Central Adelaide Local Health Network Human Research Ethics Committee (Ref no HREC/18/CALHN/510). This retrospective single centre study involved all open/laparoscopic colorectal procedures performed at The Queen Elizabeth Hospital from June 2016 to June 2018. The biochemical and patient data were collected from the hospital electronic system during this period.

The patients who were enrolled in this study were the patients who had general anaesthesia with propofol, fentanyl and rocuronium with endotracheal intubation. They were aged 18 years and above undergoing elective/emergency or laparoscopic/open procedures. Patients with no renal parameters, chronic kidney disease, transplanted kidney, renal replacement therapy, multiple surgeries in the same admission were excluded.

AKI was defined as having a post-op to pre-op creatinine ratio ≥1.5 or a glomerular filtration rate (GFR) ≤0.8 on either Day 1 or Day 7 postoperatively.

Medical complications were defined as cardiopulmonary compromise during hospital stay requiring intensive care unit (ICU) admission.

Statistical analysis plan

Sample size analysis was not performed at commencement of study.

A Table 1 was constructed with descriptive statistics as appropriate.

Univariate binary logistic regressions were performed for AKI at Day 1 or Day 7 vs various potential predictors. Those potential predictors with *P* value <0.2 were included in an initial multivariable model, and backwards elimination was performed until all *P* values were less than 0.05.

Table 1: Demographic patient characteristics

Patient characteristics	Frequency (%)
Age (yrs), mean (SD)	56.8 (19.7)
Female	395 (52.4)
Weight (Kgs), mean (SD)	78.2 (20.6)
Comorbidities	
Hypertension	251 (33.3)
Diabetes	117 (15.5)
IHD	55 (7.3)
Hypercholesterolemia	90 (11.9)
Hyperlipidaemia	31 (4.1)
COPD	41 (5.4)
GORD	137 (18.2)
Heart failure	9 (1.2)
ASA category	
1	140 (18.6)
2	303 (40.3)
3	261 (34.7)
4	46 (6.1)
5	2 (0.3)
Pre-existing kidney disease	123 (16.6)
Operation type	
Laparoscopy	410 (54.4)
Laparotomy	339 (45.0)
Lap to Laparotomy	5 (0.7)
Operation elective/emergency	
Elective	492 (65.3)
Emergency	262 (34.8)

Cross tabulations were then performed for AKI vs operation variables, with associated Fisher's exact tests or Chi square tests.

The statistical software used was SAS 9.4 (SAS Institute Inc., Cary, NC, USA).

RESULTS

Out of 779 patients 25 did not satisfy the inclusion criteria. Descriptive statistics of patient demographics and perioperative variables are demonstrated in Tables 1 and 2. The incidence of AKI in our retrospective study was 6.9%.

Table 2: The biochemical, perioperative variables with complications and mortality

Clinical parameters	Frequency (%)
Preop creatinine, Median (IQR*)	75 (63, 90)
Postop D1 creatinine, Median (IQR)	70 (55, 88)
Postop D7 creatinine, Median (IQR)	68 (53, 87)
Preop GFR, Median (IQR)	88 (70, 90)
Postop D1 GFR, Median (IQR)	90 (70, 90)
Postop D7 GFR, Median (IQR)	90 (70, 90)
Acquired kidney injury	52 (6.9)
Intraoperative variables	
Intraoperative hypotension	331 (43.9)
Vasoactive drug use	438 (58.1)
Bloods used	41 (5.4)
Intraop urine output (ml), Median (IQR)	245 (140, 550)
Intraop urine output (ml), adequate	208 (81.3)
Intraop urine output (ml), low	48 (18.8)
Fluids used	
Colloid	3 (0.4)
Crystalloid	598 (79.7)
Crystalloid and colloid	148 (19.7)
None	1 (0.1)
Volume of fluid used (Litre)	
0	6 (0.8)
1	357 (47.4)
2	220 (29.2)
3	114 (15.1)
4	27 (3.6)
5	14 (1.9)
6	7 (0.9)
7	5 (0.7)
8	1 (0.1)
9	3 (0.4)
Volume of albumin used, Median (IQR)	1000 (500, 1000)
PACU hypotension	48 (6.4)
PACU decreased urine output	33 (4.4)
Duration of surgery in minutes, Median (IQR)	157 (97, 239)
Postoperative complications	253 (33.6)
Medical complications	289 (38.3)
In -hospital mortality	22 (2.9)
Discharge time in days, Median (IQR)	6 (2, 11)

*IQR=Interquartile range; PACU=Post anaesthesia care unit; GFR=glomerular filtration rate

Odds ratios (OR), 95% CI, comparison and *P* values are presented in Table 3. The final multivariable binary logistic regression model is presented in Table 4. There is a significant association between AKI at Day 1 or Day7 and ASA category, adjusting for PACU decreased urine output (*P* value <0.0001). For every one unit increase in ASA category, the odds of developing AKI are multiplied by 2.7 (OR = 2.7, 95% CI: 1.8, 4.0). If the patient has decreased urine output in PACU, their odds of developing AKI are 2.7 times that of patients with adequate urine output (OR = 2.7, 95% CI: 1.1, 6.5).

There is a significant association between AKI and diabetes (*P* = 0.0120). Similarly, this was also observed between AKI and hypertension (*P* = 0.0200).

Patients with diabetes and hypertension were almost twice more likely to develop an AKI as compared to non-diabetics and non-hypertensives with occurrence of AKI being (15% vs 7.4%) and (12.1% vs 6.6%), respectively.

The 30-day mortality rate in patients with associated AKI was 7.7% compared with 2.2% in patients with no AKI. The median discharge time was found to be 3 days longer in patients with AKI (Median Interquartile range (IQR)) = 10 (5, 19.5) for patients with AKI and 7 (4,12) for patients without AKI).

DISCUSSION

This retrospective study showed significant association between AKI at Day 1 or Day7 and PACU decreased urine output. AKI is associated with medical morbidity and mortality, prolonged hospital stay, and higher hospital costs.[6]

Hypertension was deemed a major risk factor evidential by the Kheterpal study.[3]Thirty-day mortality after colorectal cancer (CRC) surgery ranged from 6.7% to 42%.[3,8] In our database, the 30-day patient mortality was 7.7% with AKI vs with 2.2% with no AKI. There was no difference in incidence of AKI in patients with heart failure, ischemic heart disease, hypercholesterolemia, chronic pulmonary airway disease or reflux disorders.

The incidence of AKI in our study was 6.9% as compared with 11.9% reported by Causey *et al*.[5] Although there is difference in the rate of AKI in elective surgery (3.38%), emergency surgery (12.99%) was

Table 3: Univariate binary logistic regression results for AKI at 1 Day or 7 Days vs various predictors

Predictor	Comparison	Odds Ratio (95% CI)*	Comparison *P* value	Global *P*
Pre-existing kidney disease	Yes vs No	1.41 (0.72, 2.73)		0.3128
Sex	Males vs Females	1.02 (0.58, 1.81)		0.9381
Hypertension	Yes vs No	1.95 (1.10, 3.46)		0.0218
Diabetes	Yes vs No	2.21 (1.18, 4.15)		0.0138
IHD	Yes vs No	1.81 (0.77, 4.25)		0.1743
Hypercholesterolemia	Yes vs No	1.39 (0.65, 2.98)		0.3946
Hyperlipidaemia	Yes vs No	0.87 (0.20, 3.77)		0.8468
COPD	Yes vs No	2.48 (1.04, 5.95)		0.0410
GORD	Yes vs No	0.97 (0.47, 2.00)		0.9344
Heart failure	Yes vs No	5.48 (1.33, 22.59)		0.0186
Operation type	Laparotomy vs Laparoscopy	2.09 (1.12, 3.90)		0.0205
Elective emergency	Emergency vs Elective	1.20 (0.66, 2.21)		0.5482
Intraop urine output	Low vs Adequate	0.95 (0.31, 2.95)		0.9330
Intraop hypotension_	Yes vs No	1.48 (0.83, 2.62)		0.1814
Vasoactive drug use	Yes vs No	2.30 (1.13, 4.68)		0.0220
Fluids used	Colloid vs Crystalloid/Colloid	3.82 (0.33, 44.45)	0.2839	0.1243
	Colloid vs Crystalloid	6.20 (0.55, 70.15)	0.1407	
	Crystalloid/Colloid vs Crystalloid	1.62 (0.87, 3.01)	0.1254	
Bloods used	Yes vs. No	1.17 (0.40, 3.44)		0.7703
PACU hypotension	Yes vs. No	2.35 (1.03, 5.34)		0.0413
PACU decreased urine	Yes vs. No	3.93 (1.67, 9.27)		0.0017
Postoperative complications	Yes vs No	2.38 (1.33, 4.25)		0.0034
Medical complication	Yes vs No	2.56 (1.40, 4.68)		0.0023
In-hospital mortality	Yes vs No	7.41 (2.92, 18.84)		<.0001
Age		1.04 (1.02, 1.06)		0.0003
Weight		1.00 (0.98, 1.01)		0.8549
ASA category		2.84 (1.92, 4.22)		<.0001
Duration of surgery		1.00 (1.00, 1.00)		0.5871
Duration of anaesthesia		1.00 (1.00, 1.00)		0.5470
Volume fluid used		1.11 (0.91, 1.36)		0.2847
Intraop urine output		1.00 (1.00, 1.00)		0.6794
Volume albumin used_		1.00 (1.00, 1.00)		0.1111
Discharge time		1.04 (1.02, 1.07)		0.0015

*Modelling the probability that AKI = "Yes"

Table 4: Final multivariable binary logistic model of AKI at Day 1 or Day 7 vs. significant predictors

Predictor	Comparison	Odds ratio (95% CI)	Global *P*
ASA category (continuous)		2.71 (1.82, 4.03)	<.0001
PACU decreased urine output	Yes vs. No	2.65 (1.08, 6.50)	0.0334

ASA=American Society of Anesthesiologists; PACU=Post anaesthesia Care Unit

associated with 3.8 times higher rate of AKI.[5] We did not find any difference in rates of AKI in elective vs emergency surgery.

Prolonged duration of surgery together with vasopressors use can potentially affect renal blood flow, however there was no increase in the AKI rates in longer surgeries or with the use of vasopressors in our study. Preoperative dehydration is associated with increased rates of postoperative AKI.[9]The preoperative use of concentrated glucose solutions in these patients has been reported to decrease postoperative complications in colorectal surgery.[9]Solanki *et al*. guidelines recommend the use of balanced salt solutions or albumin with the goal of adequate urine output for patients undergoing cytoreductive surgery.[10] Our study has not shown a difference in incidence of AKI based on the amount and type of fluids used; however, our study was retrospective with no strict protocol on liberal or restrictive use of fluids. Myles *et al*. reported that the restrictive fluids regimen was associated with a higher rate of AKI.[11]

The pathogenesis of postoperative AKI is complex and is affected by patient, anaesthetic and surgical factors. Patients with mechanical ventilation can constitute an additional mechanism for increased fluid loss. Surgery increases catabolic hormones and cytokines, leading to increased antidiuretic hormone secretion, which results in water retention, impairing fluid electrolyte homeostasis.[12] Patients on long-term ACE inhibitor

therapy are at a higher risk of developing post-operative renal dysfunction due to the loss of ability of the renin–angiotensin system to compensate for the decrease in renal perfusion.[12] Though renal blood flow may be decreased during pneumo-peritoneum, in our study there was no difference between laparoscopic and laparotomy incidence of AKI.

LIMITATIONS

Owing to this being a retrospective study, there are many confounding factors such as the lack of data on antibiotic usage, NSAIDs and contrast during inpatient stay. Future research on this topic should be encouraged to consolidate the data on AKI and to find ways to improve outcomes in this patient population.

CONCLUSION

Patients undergoing colorectal surgery are at significant risk of developing AKI in the immediate postoperative period. The presence of medical complications is associated with AKI, including in-hospital mortality. Hence, monitoring during the intraoperative and immediate postoperative period to detect early signs of renal insufficiency is recommended.

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Conflicts of interest
There are no conflicts of interest.

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REFERENCES

1. Kidney Disease: Improving Global Outcomes (KDIGO) Acute Kidney Injury Work Group. KDIGO clinical practice guideline for acute kidney injury. Kidney IntSuppl 2012;2:S1-138.
2. Abelha FJ, Botelho M, Fernandes V, Barros H. Determinants of post-operative acute kidney injury.Crit Care 2009;13:R79.
3. Kheterpal S, Tremper KK, Heung M, Rosenberg AL, Englesbe M, Shanks AM, *et al*. Development and validation of an acute kidney injury risk index for patients undergoing general surgery: Results from a national data set. Anesthesiology 2009;110:505-15.
4. Cho A, Lee J, Kwon G, Huh W, Lee HM, Kim YG, *et al*. Post-operative acute kidney injury in patients with renal cell carcinoma is a potent risk factor for new-onset chronic kidney disease after radical nephrectomy. Nephrol Dial Transplant 2011;26:3496-501.
5. Causey MW, Maykel JA, Hatch Q, Miller S, Steele SR. Identifying risk factors for renal failure and myocardial infarction following colorectal surgery. J Surg Res 2011;170:32-7.
6. Masoomi H, Carmichael JC, Dolich M, Mills S, Ketana N, Pigazzi A, *et al*. Predictive factors of acute renal failure in colon and rectal surgery. Am Surg 2012;78:1019-23.
7. Balakrishnan KP, Survesan S. Anaesthetic management and perioperative outcomes of cytoreductive surgery with hyperthermic intraperitoneal chemotherapy: A retrospective analysis. Indian J Anaesth 2018;62:188-96.
8. Morris EJ, Taylor EF, Thomas JD, Quirke P, Finan PJ, Coleman MP, *et al*. Thirty-day postoperative mortality after colorectal cancer surgery in England. Gut 2011;60:806-13.
9. Moghadamyeghaneh Z, Phelan MJ, Carmichael JC, Mills SD, Pigazzi A, Nguyen NT, *et al*. Preoperative dehydration increases risk of postoperative acute renal failure in colon and rectal surgery. J Gastrointest Surg 2014;18:2178-85.
10. Solanki SL, Mukherjee S, Agarwal V, Thota RS, Balakrishnan K, Shah SB, *et al*. Society of on coanaesthesia and perioperative care consensus guidelines for perioperative management of patients for cyto reductive surgery and hyperthermicintraperitoneal chemotherapy (CRS-HIPEC). Indian J Anaesth 2019;63:972-87.
11. Myles PS, Bellomo R, Corcoran T, Forbes A, Peyton P, Story D, *et al*.Restrictive versus liberal fluid therapy for major abdominal surgery. N Engl J Med 2018;378:2263-74.
12. Sear J. Kidney dysfunction in the postoperative period. Br J Anaesth 2005;95:20-32.

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