Intraoperative Hypotension and Acute Kidney Injury in Non-Cardiac Surgery at a Large Tertiary Care Medical Center

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Background

Acute kidney injury (AKI) is a serious postoperative complication that increases a patient's risk for both long and short-term morbidity and mortality.[1] Intraoperative hypotension (IOH) is an independent risk factor for AKI, [2-5] which can be readily modified by anesthesia providers.

This project aimed to describe the rate of and establish IOH as an independent risk factor for AKI among adults undergoing non-cardiac surgical cases at a large tertiary care medical center.

Methods

- An observational, retrospective, evidence-based practice project was conducted following facility approval
- IRB deemed exempt from human subjects review
- Inclusion Criteria: Adults undergoing general anesthesia for non-cardiac surgery from 2015-2019 with pre- and postoperative serum creatinine lab results to evaluate for AKI via KDIGO Criteria
- Exclusion Criteria: Obstetrics, Urology, Dialysis history
- The study group was further stratified by recorded MAP measurement intervals of ≤ 5 minutes to capture IOH
- An a-priori power analysis revealed 2,181 records would power results (1-β=0.80, α=0.05, Df=1, W=0.06)
- Securely extracted, deidentified, encrypted and stored data in a HIPAA compliant REDCap database
- Performed univariate, bivariate and multivariable analyses using Microsoft Excel, MedCalc and G*Power platforms

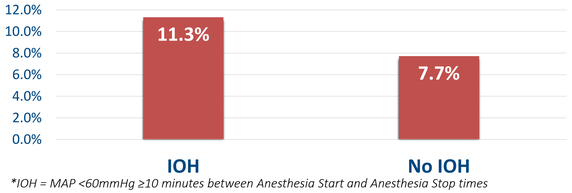
Findings

Table 1. Demographic and Clinical Characteristics

	sCr (n=4,603)*		Missing sCr (n=50,788)		
Characteristic	**Count**	**Percent**	**Count**	**Percent**	**P**
Male	2,474	54%	21,575	42%	<0.001
ASA 1	25	1%	3,098	6%	<0.001
ASA 2	678	15%	23,646	47%	<0.001
ASA 3	2,984	65%	20,181	40%	<0.001
ASA 4	692	15%	1,518	3%	<0.001
Heart Failure	517	11%	1,517	3%	<0.001
Diabetes	1,285	28%	6,454	13%	<0.001
Hypertension	2,610	57%	19,473	38%	<0.001
CAD	828	18%	4,528	9%	<0.001
CKD	1,115	24%	1,802	4%	<0.001
Stroke	978	21%	8,039	16%	<0.001
Elective Surgery	2,630	57%	41,246	81%	<0.001
Orthopedics	1,366	30%	12,684	25%	<0.001
General	1,185	26%	11,871	23%	<0.001
Vascular	654	14%	2,452	5%	<0.001
Neurology	408	9%	6,813	13%	<0.001
Other Service Line	990	21%	16,968	34%	
	Mean	**SD**	**Mean**	**SD**	
Age (years)	62.3	16.6	56.3	16.8	<0.001
Baseline eGFR	68.0	39.1	NA	NA	NA
	Median	**IQR**	**Median**	**IQR**	
BMI (kg/m²)	28.1	23.7-33.5	28.6	24.7-33.6	0.195
Case Duration**	129	89-192	120	85-167	<0.001

*sCr Records = pre- and postoperative serum creatinine values within 1 month and 1 week respectively
**Case Duration measured in minutes from Anesthesia Start to Stop
SD = Standard Deviation, IQR = 25-75% Interquartile Range, eGFR = mL/min/1.73m²
ASA = American Society of Anesthesiologists Physical Status Classification

Figure 1. Risk for AKI Following IOH*



*IOH = MAP <60mmHg ≥10 minutes between Anesthesia Start and Anesthesia Stop times

Table 2. Risk for AKI at Varying MAP Thresholds

Frequent MAP Cases (n=3,507)*			AKI (n=310)			Wesselink
MAP	**Time (min)**	**n (%)**	**n (%)**	**RR**	**P**	**RR/OR/HR****
<60	≥10	1,119 (32%)	127 (11%)	1.48	<0.001	1.8
	≥20	613 (17%)	71 (12%)	1.40	0.009	2.3
<55	≥1	1,265 (36%)	148 (11%)	1.38	0.003	1.2
	≥5	875 (25%)	102 (12%)	1.48	0.001	1.2
	≥10	408 (12%)	62 (13%)	1.63	0.003	2.3
	≥20	194 (6%)	30 (16%)	1.83	0.001	3.5
<50	≥1	743 (21%)	91 (11%)	1.37	0.008	1.2
	≥5	388 (11%)	50 (13%)	1.55	0.003	1.2
	≥10	145 (4%)	26 (16%)	1.82	0.002	2.3
<45	≥5	143 (4%)	23 (16%)	1.89	0.002	1.2
<40	≥1	197 (6%)	29 (13%)	1.51	0.025	3.8
Infrequent MAP Cases (n=1,096)* **			**100 (9.1%)**			
All Cases (n=4,603)			**410 (8.9%)**			

*Cases with MAP measurements recorded every 5 minu
**Risk for AKI findings from Wesselink et al. 2018 Systematic Review
***Cases with MAP measurements recorded > 5-minute intervals
n = Count, RR = Relative Risk, OR = Odds Ratio, HR = Hazard Ratio
Only reporting statistically significant findings (p < 0.05)
Overall rate of postoperative AKI at our tertiary center is 8.9%
Cases with IOH (MAP < 60 for ≥ 10 minutes) compared to cases without IOH had increased risks for AKI (RR1.47 [95% CI 1.18-1.92, p<0.001)

Low Risk RR/OR/HR = 1.0-1.3
Moderate Risk RR/OR/HR = 1.4-2.0
High Risk RR/OR/HR > 2.0

Table 3. Risk Factors Associated with AKI at in a Fully Adjusted Model*

Variable	OR	95% CI	P
MAP < 60mmHg ≥ 10 minutes	1.50	1.18-1.92	0.001
ASA 4+	1.55	1.13-2.13	0.007
Chronic Kidney Disease	1.36	1.03-1.80	0.029
Baseline eGFR < 60	5.00	3.49-7.16	<0.001
Vascular Service Line	1.56	1.13-2.16	0.007

*Only statistically significant findings listed (p<0.05). Fully adjusted model accounts for: Age>65 years, American Society of Anesthesiologists Physical Status (ASA) 4+, History of heart failure, diabetes, coronary artery disease, hypertension, chronic kidney disease, baseline eGFR< 60ml/min/1.73m², emergency and vascular surgery. AUC = 72%, OR = Odds Ratio, 95%CI = 95% Confidence Interval

Discussion

This evidence-based practice project established the incidence rate of postoperative AKI at 8.9% (table 2). Postoperative AKI risk was elevated with each IOH exposure threshold. A MAP less than 60 mmHg for at least 10 minutes was associated with a relative risk of 1.48 for AKI (95% CI [1.19-1.84], p<0.001).

In a fully adjusted model, IOH was identified as an independent risk factor for AKI (OR 1.50, 95% CI [1.18-1.92], p=0.001). Other statistically significant independent risk factors for AKI included ASA four or greater, history of chronic kidney disease, baseline eGFR less than 60 mL/min/1.73m2 and vascular surgery (table 3). Patients with AKI had significantly lower baseline eGFRs, increased rates of CKD and higher BMIs (table 1).

Describing the rate of and risk factors for AKI may precipitate heightened attention to prevention strategies and encourage quality improvement initiatives.

References

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