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Intraoperative Hypotension and Acute Kidney Injury in Non-Cardiac Surgery at Providence Sacred Heart 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 aims to describe the risk factors and rates of AKI following IOH at various absolute mean arterial blood pressure (MAP) thresholds for specified durations of time among adults undergoing non-cardiac surgery at Providence Sacred Heart Medical Center (PSHMC).

Methods

- PSHMC approved this retrospective, observational evidence-based project and deemed exempt by the Institutional Review Board from human subjects testing
- Inclusion Criteria: Adults undergoing general anesthesia for non-cardiac surgery at PSHMC 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 ($1-\beta=0.80$, $\alpha=0.05$, $Df=1$, $W=0.06$)
- PSHMC sponsor 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 on PSHMC designated computers

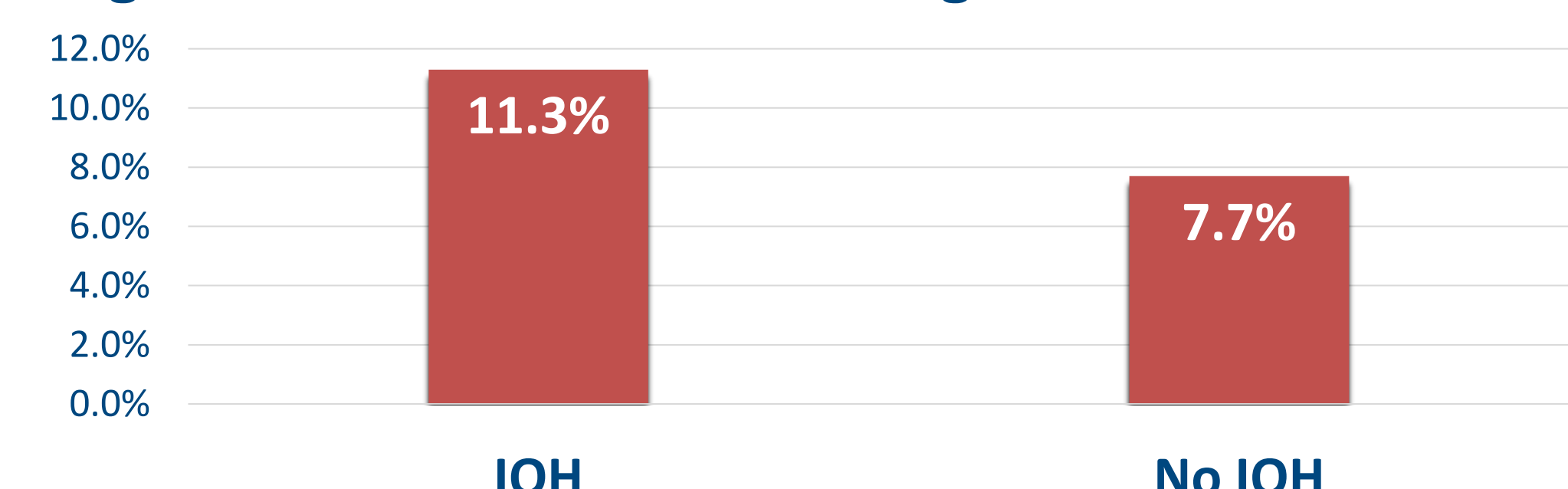
Findings

Table 1. Demographic and Clinical Characteristics

Characteristic	sCr (n=4,603)*		Missing sCr (n=50,788)		P
	Count	Percent	Count	Percent	
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/m ²)	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* at PSHMC



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

Table 2. Rates of AKI at PSHMC

Frequent MAP Cases (n=3,507)*			AKI (n=310)			Wesselink RR/OR/HR**
MAP	Time (min)	n (%)	n (%)	RR	P	
<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
<50	≥ 20	194 (6%)	30 (16%)	1.83	0.001	3.5
	≥ 1	743 (21%)	91 (11%)	1.37	0.008	1.2
	≥ 5	388 (11%)	50 (13%)	1.55	0.003	1.2
<45	≥ 10	145 (4%)	26 (16%)	1.82	0.002	2.3
	≥ 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 minutes
**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
Overall rate of postoperative AKI at PSHMC is 8.9%
When MAP < 60 for ≥ 10 minutes, AKI risk increases from 7.7% to 11.3%

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 PSHMC 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

Project findings revealed that 8.3% of patients had both pre- and postoperative serum creatinine results to evaluate for AKI. Of this study population (n=4,603), 8.9% experienced postoperative AKI. The literature reports rates of AKI to be 5-7.5%.⁵ Risk for AKI increased from 7.7% to 11.3% among patients exposed to MAPs less than 60mmHg for at least 10 minutes (RR 1.48, 95% CI [1.19-1.84], $p < 0.001$). According to the literature, AKI risk increases with the duration and severity of IOH exposure.⁵

In a fully adjusted model, IOH, ASA 4 or greater, history of chronic kidney disease, baseline eGFR less than 60 ml/min/1.73m², and vascular surgery were identified as independent risk factors for AKI at PSHMC.

Exploring AKI rates and risk factors at PSHMC helps identify potential areas of anesthesia practice improvement and informs further research surrounding AKI. As blood pressure is a modifiable risk factor for AKI, limiting IOH exposure may mitigate end organ damage and improve patient outcomes.

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