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In-Hospital Incidence of Acute Kidney Injury Among Patients of Acute Coronary Syndrome Who Have Transient Hypotension in Catheterization Laboratory

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[1-3,4,5] Substantial contributions to the conception or design of the work; or the acquisition, analysis, Proof reading, critical revision of the manuscript for important intellectual content, [3]Statistical Analysis, [4]Active participation in active methodology

Funding Source: None

Conflict of Interest: None

Received: July 01, 2023

Accepted: Nov 29, 2023

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ABSTRACT

Objective: To determine in-hospital incidence of acute kidney injury among patients of acute coronary syndrome who have transient hypotension in catheterization laboratory.

Methodology: A prospective hospital-based study was conducted at National Institute of Cardiovascular Disease (NICVD), Karachi from October 2022 to March, 2023. All adult patients admitted with acute coronary syndrome and underwent percutaneous coronary intervention within 72 hours of admission and experienced transient hypotension during procedure, normal renal function before procedure, age between 18 years to 75 years, and both males and females were included in this study. Baseline and clinical data were collected, and all statistical tests were conducted with a level of significance (p-value) of <0.05 using SPSS Version 22.0.

Results: The total cohort size consisted of 290 patients. Prevalence of acute kidney injury was more common in patients with STEMI 57(19.6%) followed by NSTEMI 18(6.2%), and UA 8(2.7%) but there is an insignificant association among them, p = 0.71. On multivariate binominal analysis, males (OR = 2.49), rural residents (OR = 0.25), hypertensives (OR = 2.18), diabetics (OR = 9.37), hyperlipidemia (OR = 3.85), and patients with LVEF <50% (OR = 6.34) were more likely to develop acute kidney injury (p = <0.05).

Conclusion: In this study, majority of the patients experienced acute kidney injury and prevalence in our study is higher than previously conducted studies. Among all risk factors, LVEF <50%, type 2 diabetes mellitus, and hyperlipidemia were most prevalent risk factors of AKI.

Keywords: Acute coronary syndrome, Percutaneous coronary intervention, acute kidney injury, transient hypotension.

Cite this article as: Malik F, Ali A, Ullah R, Arain ZI, Mansoor B, Iqbal M. In-Hospital Incidence of Acute Kidney Injury Among Patients of Acute Coronary Syndrome Who Have Transient Hypotension in Catheterization Laboratory. Ann Pak Inst Med Sci. 2023; 19(4):451-456. doi. 10.48036/apims.v19i4.988.

Introduction

Acute coronary syndrome (ACS) is an umbrella term used to denote patients suffering from either unstable angina (UA), non-ST segment elevation myocardial infarction (NSTEMI), and/or ST-segment elevation myocardial infarction (STEMI).[1] Its prevalence is continue on the rise in developed and developing countries including Pakistan.[2] According to recent data, the age adjusted prevalence of IHD/ACS is 7354.1 per 100,000 and more than 19 million deaths occur annually.[3] Unfortunately, epidemiological studies on larger scale in Pakistan are still lacking but a previously published study has shown prevalence of coronary artery disease (CAD) in low-middle income countries was 13.63% and in Pakistan it was 15.31%. [4]

Patients with ACS if arrive at hospital on time, they should undergo invasive strategies such as coronary angiography/angioplasty to open the vessel and save the myocardium. In a 61 months follow-up study conducted by Yilmaz S and colleagues[5] have shown that patients who

receive early invasive strategy had lower mortality rates as compared to those who did not. Unfortunately, sometimes, this treatment comes with certain unfavorable outcome particular in high-risk patients such as, old age, patients with mechanical complications, late arrival at hospital, type 2 diabetes mellitus (DM) and/or multivessel disease.[6,7]

Acute kidney injury (AKI) is amongst the most common unfavorable outcome observed in patients treated with invasive strategy, caused by intravenous application of contrast media. In a previously conducted study by Weferling M and colleagues[8] have shown prevalence of AKI was 5.3% in ACS patients undergoing percutaneous coronary intervention (PCI) but data is limited regarding incidence of AKI in ACS patients being treated with invasive strategy and experience transient hypotension during the procedure. That is why this study aims to determine in-hospital incidence of acute kidney injury among patients of ACS who had transient hypotension in catheterization laboratory.

Methodology

This study was conducted in the Department of Cardiology, unit of invasive cardiology, National Institute of Cardiovascular Diseases (NICVD), Karachi for a period of six months from October 2022 to March, 2023 through a convenience sampling technique. In this study we have included all adult patients admitted with ACS and underwent PCI within 72 hours of admission and experienced transient hypotension during procedure, normal renal function before procedure, age between 18 years to 75 years, and both males & females. Patients with known renal function impairment, pregnant women, patients who already had PCI/CABG, patients who with cardiogenic shock or hypotension at the time of admission or before commencement of procedure, acute decompensated heart failure (ADH), valvular heart disease (VHD), known cardiomyopathy, and patients who refused to participate in this study were excluded from this study.

All the admitted patients planned for coronary intervention were given standard care. To prevent from contrast-induced nephropathy (CIN), patients were hydrated with 0.9% normal saline 12 hours before and after procedure. Radial access for PCI was the preferred method performed in majority of the patients (n 288) while only 8 patients were intervened through femoral access. While performing PCI through radial access we gave a radial cocktail consisting of 2.5mg of verapamil, 100µg of nitroglycerin, and 5,000 units of heparin. Twelve patients experienced transient minor vagal reaction and managed with bolus dose of 0.9% normal saline before commencement of the procedure. But we did not excluded those patients from the study as their episode was due to drug induced and also it was occurred before the procedure and become normal when the procedure started.

The diagnosis of AKI was made based on the renal function test at the time of admission and after procedure. Acute kidney injury was labeled when patient's serum creatinine increased ≥1.5 folds (50%) from the baseline value. Transient hypotension was defined as, systolic blood pressure ≤80mmHg and diastolic blood pressure ≤60mmHg during PCI and last not more than 10 minutes and become normal without inotropic support.

Data collection were started after briefing the study's objectives to the patients'/accompanied attendants. Approval from ethical review committee board was taken before commencement of the study. Structured questionnaire was used to collect the relevant data. Baseline data included; age, gender, weight, height, body mass index (BMI), social class, ethnicity, area of residence, marital status, comorbid conditions, and addiction habit. Clinical data includes; left ventricular ejection fraction, indication of PCI, systolic & diastolic blood pressure, pre & post-catheterization laboratory investigations (urea, creatinine, and eGFR), presence or absence of transient hypotension, and presence or absence of acute kidney injury.

Data analysis were performed on quantitative and qualitative variables. Mean±SD was calculated for continuous variables while frequencies and percentages were calculated for categorical variables. A two sided chi-square/fisher's exact test was used to compare categorical data and independent *t*-test was used to compare the means between groups. A Hosmer-Lemeshow test was performed to check the model's goodness of fit. Binary logistic regression analysis was performed to observe the risk factors associated with AKI among patients experienced transient hypotension during PCI. All statistical tests were conducted with a level of significance (*p*-value) of <0.05. SPSS Version 22.0 (IBM, Armonk, New York, USA) was used for all statistical analyses.

Results

The total cohort size consisted of 290 patients of ACS who had transient episode of hypotension in the coronary catheterization (cath) laboratory (lab). Table I shows baseline and clinical characteristics of study participants.

doi. 10.48036/apims.v19i4.988

Table I: Baseline and Clinical Characteristics of Study Participants.

Variables	Overall	Unstable angina	NSTEMI	STEMI	P value
	(N = 290)	(N = 26)	(N = 82)	(N = 182)	
			Mean±SD		
Age – years	61.74±11.28	62.85±8.14	61.77±10.68	61.57±11.95	0.86
Weight – kg	66.12±8.86	62.69±8.74	67.33±8.57	66.06±8.92	0.06
Height – cm	162.77±14.72	164.58±4.70	158.59±25.63	164.39±6.17	0.01
Systolic blood pressure (lowest) – mmHg	68.9±8.01	72.69±4.52	66.40±8.09	69.48±8.06	0.001
Diastolic blood pressure (lowest) - mmHg	49.26±7.42	52.69±4.52	46.22±6.83	50.13±7.59	<0.001
Urea (pre-cath) - mg/dL	36.66±6.87	36.35±2.91	37.21±6.22	36.46±7.48	0.69
Creatinine (pre-cath) - mg/dL	0.95±0.14	0.95±0.17	1.0±0.06	0.92±0.15	<0.001
eGFR (pre-cath) - mL/min/1.73m2	73.28±12.25	79.75±8.98	72.91±10.53	72.53±13.14	0.01
Urea (post-cath) - mg/dL	51.97±13.24	52.27±11.25	48.93±10.76	53.29±14.31	0.04
Creatinine (post-cath) - mg/dL	1.49±0.33	1.32±0.25	1.56±0.33	1.49±0.33	0.004
eGFR (post-cath) - mL/min/1.73m2	47.48±17.57	50.58±7.24	47.20±18.74	47.16±18.08	0.64
LVEF - %	45.55±10.36	55.01±5.36	50.33±8.72	38.47±15.44	<0.001
Gender			N (%)		
Male	197 (67.9)	7 (2.4)	59 (20.3)	131 (45.2)	<0.0001
Female	93 32.1)	19 (6.6)	23 (7.9)	51 (17.6)	
Education status					
Illiterate	42 (14.5)	0 (0)	5 (1.7)	37 (12.8)	
Primary	109 (37.6)	14 (4.8)	18 (6.2)	77 (26.6)	<0.0001
≥Secondary	139 (47.9)	12 (4.1)	59 (20.3)	68 (23.4)	
Socioeconomic status					
Lower	83 (28.6)	12 (4.1)	11 (3.8)	60 (20.7)	
Middle	163 (56.2)	14 (4.8)	43 (14.8)	106 (36.6)	<0.0001
Upper	44 (15.2)	0 (0)	28 (9.7)	16 (5.5)	
Ethnicity					
Urdu	98 (33.8)	7 (2.4)	23 (7.9)	68 (23.4)	
Sindhi	121 (41.7)	5 (1.7)	18 (6.2)	98 (33.8)	<0001
Pashto	31 (10.7)	14 (4.8)	6 (2.1)	11 (3.8)	
Balochi	40 (13.8)	0 (0)	35 (12.1)	5 (1.7)	
Area of residence					
Rural	134 (46.2)	12 (4.1)	25 (8.6)	97 (33.4)	
Urban	156 (53.8)	14 (4.8)	57 (19.7)	85 (29.3)	0.002
Marital status					
Single	16 (5.5)	0 (0)	0 (0)	16 (5.5)	
Married	274 (94.5)	26 (9.0)	82 (28.3)	166 (57.2)	0.004
Cigarette smoking	10 (3.4)	0 (0)	0 (0)	10 (3.4)	0.042
Comorbids					
Hypertension	178 (61.4)	14 (4.8)	65 (22.4)	99 (34.1)	0.003
Diabetes Mellitus	111 (38.3)	5 (1.7)	23 (7.9)	83 (28.6)	0.003
Hyperlipidemia	66 (22.8)	7 (2.4)	25 (8.6)	34 (11.7)	0.08
Presence of AKI	83 (28.62)	8 (2.7)	18 (6.2)	57 (19.6)	0.71

Statistically significant p value <0.05

AKI: Acute kidney injury

Most of the ACS patients had STEMI (n = 182, 62.75%) followed by NSTEMI (n = 82, 28.27%), and UN (n = 26, 8.96%). There is no difference among mean age of the study participants in these groups. Systolic & diastolic blood pressures were comparatively higher in patients with UA as compare to patients with NSTEMI or STEMI while pre & post cath urea and creatinine were lower in patients with UA as compared to patients with NSTEMI or STEMI, p <0.05. Hypertension and Type 2 DM were significantly prevalent among NSTEMI and STEMI group as compared to patients with UA, p <0.05. Overall prevalence of AKI was 28.62% (n = 82) and AKI was more prevalent among STEMI patients (n = 57, 19.6%).

Table II shows comparison of means between AKI and non-AKI patients. In univariate analysis, mean age difference (11.85 years), weight (4.64 kg), height (6.33 cm), systolic blood pressure (10.99 mmHg), diastolic

Table II: Unpaired t-test for the mean differences between AKI and Non-AKI patients (N = 290)

Parameters	AKI		Mean differences	p value	95% CI
	Yes	No			
	(n = 83)	(n = 207)			
Age – years	65.14±9.86	53.28±10.15	11.85±-1.29	<0.001	14.14, 9.31
Weight – kg	64.79±8.81	69.43±8.14	-4.64±-1.12	<0.001	14.44, 9.27
Height – cm	160.95±16.83	167.29±4.80	-6.33±-1.88	0.001	2.63, 10.03
Systolic blood pressure (lowest) - mmHg	65.75±5.95	76.75±7.04	-10.99±-0.81	<0.001	9.39, 12.60
Diastolic blood pressure (lowest) – mmHg	47.43±7.20	53.80±5.87	-6.36±-0.89	<0.001	4.60, 8.11
Urea (pre-cath) - mg/dL	35.15±6.45	40.43±6.32	-5.28±-0.83	<0.001	3.64, 6.92
Creatinine (pre-cath) - mg/dL	0.94±0.15	0.97±0.10	0.03±0.01	<0.001	0.00, 0.07
eGFR (pre-cath) - mL/min/1.73m2	71.78±12.79	77.04±9.95	-5.26±1.56	0.001	2.17, 8.33
Urea (post-cath) - mg/dL	54.46±14.07	45.75±8.14	8.71±1.64	<0.001	11.95, 5.47
Creatinine (post-cath) - mg/dL	1.65±0.24	1.09±0.10	0.55±0.07	<0.001	0.61, 0.50
LVEF - %	40.21±10.78	48.65±5.33	-8.44±5.45	<0.001	5.42, 13.43
eGFR (post-cath) - mL/min/1.73m2	38.13±9.76	70.78±8.85	-32.65±1.23	<0.001	30.22, 35.08

Statistically significant p value <0.05

AKI: Acute kidney injury; CI: confidence interval; eGFR: estimated glomerular filtration rate, LVEF: left ventricular ejection fraction

Table III: Risk factor distribution between AKI vs. non AKI patients. (N = 290)

Risk	AKI	Non-AKI	p value	Adjusted OR	95% CI	p value
	(N = 83)	(N = 207)				
	N (%)	N (%)				
Gender						
Male	59 (71.1)	138 (66.6)	0.49	1		
Female	24 (28.9)	69 (33.3)		2.49	1.11, 5.61	0.02
Education						
Illiterate	5 (6.02)	37 (12.8)	<0.001	1		
Primary	17 (20.4)	92 (31.7)		1.04	0.54, 2.0	0.88
≥Secondary	61 (73.4)	78 (26.9)				
Socioeconomic status						
Lower	12 (14.4)	71 (24.5)		1		
Middle	50 (60.2)	113 (39.0)	<0.001	0.56	0.31, 1.03	0.06
Upper	21 (25.3)	23 (7.9)				
Ethnicity						
Urdu	36 (43.3)	62 (21.4)		1		
Sindhi	20 (24.1)	101 (34.8)	<0.001	1.09	0.85, 1.40	0.49
Pashto	17 (20.4)	14 (4.8)				
Balochi	10 (12.04)	30 (10.3)				
Residence						
Urban	66 (79.51)	90 (31.0)	<0.001	1		
Rural	17 (20.4)	117 (40.3)		0.25	0.10, 0.61	0.002
Hypertension						
Yes	54 (64.06)	124 (59.9)	<0.001	1		
No	29 (34.9)	83 (40.09)		2.18	1.11, 4.28	0.02
Diabetes mellitus						
Yes	76 (26.2)	35 (16.9)	<0.001	1		
No	7 (2.4)	172 (83.09)		9.37	3.61, 24.33	<0.001
Hyperlipidemia						
Yes	42 (50.6)	24 (11.5)	0.53	1		
No	41 (49.3)	183 (88.4)		3.85	1.58, 9.35	0.003
LVEF - %						
≥50%	32 (38.5)	117 (56.5)	<0.001	1		
<50%	51 (61.4)	90 (43.4)		6.34	2.63, 11.42	<0.001

Statistically significant p value <0.05

AKI: Acute kidney injury; OR: odds ratio; CI: confidence interval, LVEF: left ventricular ejection fraction

blood pressure (6.36 mmHg), pre-cath urea (5.28 mg/dL), pre-cath creatinine (0.03 mg/dL), pre-cath eGFR (5.26 mL/min/1.73m^2), post-cath urea (8.71 mg/dL), post-cath creatinine (0.55 mg/dL), post-cath eGFR (32.65mL/min/1.73m^2), and LVEF (-8.44±5.45%) were statistically significant ($p < 0.05$).

On multivariate binominal analysis, males (OR = 2.49), urban residents (OR = 0.25), hypertensives (OR = 2.18), diabetics (OR = 9.37), hyperlipidemic (OR = 3.85), and LVEF <50% (OR = 6.34) patients were more likely to develop AKI ($p = <0.05$). (Table III)

Discussion

Acute kidney injury or renal impairment in patients undergoing percutaneous coronary intervention is the most important cause of in-hospital mortality. The overall prevalence of AKI without experiencing hypotension during PCI was 21.1% in a study conducted at Turkey [9] and 15.8% in a study conducted in New Zealand.[10] While another study from Turkey has shown lower prevalence of AKI (12.2%) when measured fractional pulse pressure after sheath insertion and before coronary intervention.[11] In a study conducted by Hooda F and colleagues have observed 4.5 times higher rates of in-hospital mortality in post-PCI AKI patients than post-PCI non-AKI patients.[12]

Previously published study conducted by Tsai TT and colleagues have observed prevalence of post-PCI associated AKI was approximately 7%.[13] The same prevalence (7.2%) was observed in another study from United Kingdom [14] and a slight higher prevalence (13%) was observed in a study conducted at the USA. [15] On the contrary, in our study, the prevalence of AKI in patients had transient episode of hypotension during PCI was 28.6%, which is almost 1.5 times higher than previously mentioned studies. The most important reason of higher prevalence of AKI in our study could be due older age population with multiple comorbid conditions, or possibly late arrival to the hospital. Another reason of higher prevalence of AKI is the lower cut-off value of serum creatinine (1.2 mg/dL) set to label the patients with AKI or presence of inflammation due to acute myocardial infarction and abrupt decrease in renal perfusion could be the underlying mechanisms because patients with cardiogenic shock and acute myocardial infarction are prone to renal damage.

During acute phase of ACS, cardiac insufficiency plays an important role in promoting the deterioration of renal functions, which may improve later on. On the other hands, Quinones and others found that more than 70% of the atherosclerotic plaque rupture events are iatrogenic and caused by PCI but, certain risk factors may contribute significantly than others.[16] In our study, risk factors such as age more than 65 years, weight less than 69 kg, systolic blood pressure less than 66 mmHg, and diastolic blood pressure less than 48 mmHg were more significantly associated with higher prevalence of AKI. However, patients with diabetes mellitus and hyperlipidemia had the highest risk of developing AKI, OR=9.37 and 3.85, respectively.

Findings from previously published studies[14, 16] are also in agreement with our study's findings. While a study conducted by Abdellatif EA and colleagues[15] have observed that diabetes mellitus was not an independent predictor of AKI. In their study, contrast volume more than 350 ml was associated with higher prevalence of AKI.

Study limitations: There are multiple limitations in this study that should be documented in future studies. Foremost importantly, this study was a single center study and the sample size is also small. Secondly, we did not included amount of contrast media used. That would may be the cause of higher prevalence of AKI in this study. Also, in this study we did not included severity of coronary artery disease and time taken in a single procedure. Lastly, serum creatinine should be observed and compare at the time of discharge so that true AKI patients can be observed.

Conclusion

In this study, majority of the patients experienced acute kidney injury and prevalence in our study is higher than previously conducted studies. Among all risk factors, LVEF <50%, type 2 diabetes mellitus, and hyperlipidemia were most prevalent risk factors of AKI.

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