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## **Risk Factors of Contrast-Associated Acute Kidney Injury in Patients with Acute Coronary Syndrome after Primary Percutaneous Coronary Intervention**

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### **Abstract**

**Background:** There are many risk factors that increase the rate of contrast-associated acute kidney injury in patients with acute coronary syndrome such as type of medication, dose of contrast agent used during angiography and emergency coronary intervention. Pre-existing chronic kidney disease, diabetes, older age, heart failure, hemodynamic instability, anemia, and concomitant medications have not been fully and individually studied in patients with acute coronary syndromes. Therefore, we conducted research to determine the rate of acute kidney injury after contrast administration and risk factors to better serve the prevention and treatment of acute kidney injury in patients with the acute coronary syndrome.

**Materials and Methods:** There were 181 patients with

acute coronary syndrome who received emergency coronary intervention at Dong Nai General Hospital from October 2022 to July 2023. This is a cohort, prospective study.

**Results:** There were 21 cases (11.6%) of contrast-associated acute kidney injury, average age  $59.2 \pm 12.3$ , 79.6% of men. In univariate analysis, we noted that contrast medium volume ( $p=0.038$ ), reduced left ventricular ejection fraction ( $p<0.001$ ) and Mehran score ( $p<0.001$ ) are factors that affect the incidence of contrast-associated acute kidney injury. However, upon multivariate analysis, only Mehran score ( $p<0.001$ ) was associated with contrast-associated acute kidney injury, OR=13 (95% CI 4-35).

**Conclusions:** Mehran score was an independent risk factor for contrast-induced acute kidney injury.

**Keywords:** Contrast-Associated Acute Kidney Injury, Acute Coronary Syndrome, Risk Factor, Mehran Score

### **1. Introduction**

Currently, cardiovascular disease is increasingly common and is the leading cause of death in the world. The number of global cardiovascular disease cases increased from 271 million in 1990 to 523 million in 2019. Number of cardiovascular deaths was 12.1 million people in 1990, increasing to 18.6 million people in 2019 <sup>[1]</sup>. The majority of patients with acute coronary syndrome must undergo emergency coronary intervention treatment immediately after hospitalization using contrast agents. With the increase in coronary intervention procedures, acute kidney injury after contrast injection is a matter of concern. In addition to its advantages in diagnosis and treatment, contrast agents also have their adverse effects. Statistics show that acute kidney injury after contrast injection is the third most common cause of acute kidney injury in inpatients. The rate of acute kidney injury after contrast injection in stable patients with normal kidney function is very low, about 3%. In patients with pre-existing chronic kidney disease or emergency conditions, the rate of acute kidney injury after contrast injection ranges from 12-27% and increases to 50% in high-risk patients <sup>[2]</sup>. According to some studies, the mortality rate in patients with acute kidney injury after contrast injection ranges from 7% - 34%, much higher than the group of patients without acute kidney injury <sup>[3]</sup>. A study at Nguyen Tri Phuong Hospital and Tam Duc Heart Hospital in 2017 showed that the rate of acute kidney injury after contrast injection in patients with emergency coronary intervention was 21.3% <sup>[4]</sup>. There are many risk factors that increase the rate of acute kidney injury after contrast injection in patients with acute coronary syndrome. Therefore, we conducted the study "Risk factors of acute kidney injury after contrast injection in patients with acute coronary syndrome undergoing emergency coronary intervention". with the following objectives:

1. Determine the rate of acute kidney injury after contrast injection in patients with acute coronary syndrome undergoing emergency coronary intervention.

- Determine risk factors for acute kidney injury after contrast injection in patients with acute coronary syndrome undergoing emergency coronary intervention.

## 2. Materials and Methods

### 2.1 Research subjects:

**2.1.1 Study population:** All patients with acute coronary syndrome received emergency coronary intervention at Dong Nai general hospital.

**2.1.2 Sample selection criteria:** All patients ≥ 18 years old with acute coronary syndrome undergoing emergency coronary intervention at the Cardiovascular Intervention Department of Dong Nai General Hospital from October 2022 to July 2023.

**2.1.3 Exclusion criteria:** Failure to obtain serum creatinine samples at hours 24 and 72 after emergency coronary intervention, death within 72 hours after emergency coronary intervention without kidney damage Acute, end-stage kidney disease, undergoing dialysis, previous kidney transplant, pregnant.

### 2.2 Research Methods:

**2.2.1 Study design:** Cohort, prospective.

Sample size: sample size calculation formula according to objective 1: determine the rate of acute kidney injury after contrast agent injection.

$$n = Z_{1-\alpha/2}^2 \frac{p(1-p)}{d^2}$$

In which: p = 21% of the rate of acute kidney injury after contrast injection in patients with acute coronary syndrome undergoing emergency coronary intervention, based on research by authors Pham Van Bui and Nguyen Quang Dung 1/ 2014-3/2015 at Nguyen Tri Phuong Hospital and Tam Duc Heart Hospital<sup>[4]</sup>.

d = 0.07 is the marginal error of the estimate. Number n = 1,962 x 0.21 x 0.79/0.072 = 131 people.

Sample size calculation formula according to objective 2: determine risk factors for acute kidney injury after contrast injection.

$$n = \frac{\left( Z_{1-\frac{\alpha}{2}} \sqrt{2\bar{P}(1-\bar{P})} + Z_{1-\beta} \sqrt{P_1(1-P_1) + P_2(1-P_2)} \right)^2}{(P_1 - P_2)^2}$$

In which: p1 = 24.1% rate of acute kidney injury after contrast injection in high-risk patient group, RR = 1.944 according to research by Narula A. *et al.* in 2014<sup>[5]</sup>.

$\bar{P} = \frac{P_1 + P_2}{2}$ ;  $p_2 = p_1 \times RR$ ;  $Z_{1-\alpha/2} = 1,96$ .  $Z_{1-\beta} = 1,28$ . Number n = 182 people. Select an overall sample size of 182 patients.

**2.2.2 Data analysis:** Data are processed using SPSS version 26 software. Quantitative variables are expressed as the mean ± standard deviation if belonging to a normal distribution or median and interquartile range of the value 25-75th percentile if not in normal distribution. Compare the

difference between two averages using the unpaired t test, Mann-Whitney U test. Qualitative variables are displayed by frequency (percentage). Compare the difference between 2 proportions using the 2-tailed  $\chi^2$  test; Fisher's exact test for 2x2 tables with 20% of cells with expected frequency < 5. Univariate and multivariate binary logistic regression analysis between contrast-induced acute kidney injury and qualitative or non-qualitative variables normal distribution. The differences are statistically significant when p < 0.05.

## 3. Results

During the research period from October 2022 to July 2023 at Dong Nai General Hospital, we collected 181 patients who met the selection criteria and had no exclusion criteria for the study.

### 3.1 Characteristics of the study population

The average age in the study was 59.2 ± 12.3 years old, the youngest patient was 23 years old, the oldest patient was 90 years old. Male/female ratio: 3.9.

### 3.2 Clinical characteristics

There were 120 smoking patients in the study, accounting for the majority at 66.3%. There were 42 patients with anemia before admission, a rate of 23.2%. The rate of hypertension in the study was 72.3% with 131 cases. The number of diabetic patients is less at 28.7%. There were 103 patients with lipid disorders, a rate of 56.9%. There were 28 cases of pre-existing kidney function impairment, a rate of 15.5%. Patients with previous myocardial infarction in this study accounted for only 2.8% with 5 cases. Patients with EF < 50% accounted for a higher proportion of 66.9%.

### 3.3 Laboratory

**Table 1:** Laboratory

Parameters	Mean ± Standard Deviation
Hemoglobin (g/dL)	13,81 ± 1,77
Hct (%)	41,78 ± 5,07
Glucose (mmol/L)	7,75 ± 3,54
Creatinine (µmol/L)	81,19 ± 35,92
Cholesterol(mmol/L)	5,61 ± 1,41
HDL-C (mmol/L)	1,23 ± 0,33
LDL-C (mmol/L)	3,49 ± 1,1
Triglyceride (mmol/L)	2,39 ± 1,96

Comment: Among the blood biochemical indexes, Cholesterol, HDL-C, LDL-C, and Triglyceride have an average value higher than the normal threshold.

### 3.4 Rate of contrast-induced acute kidney injury in patients with acute coronary syndrome undergoing emergency coronary intervention

In our study, there were 21 patients with contrast-induced kidney disease after the procedure, accounting for 11.6%.

### 3.5 Association between risk factors and contrast-induced acute kidney injury in patients with acute coronary syndrome undergoing emergency coronary intervention

**Table 2:** Univariate analysis of the association between risk factors and contrast-induced acute kidney injury

Variables	OR	KTC 95%	p
Age	1,005	0,952 - 1,062	0,845
Sex	0,962	0,113 - 8,166	0,972
Smoking	0,64	0,093 - 4,412	0,651
Hypertension	1,00	0 - 4	0,064
Diabetes Mellitus	0,914	0,166 - 5,025	0,917
Old Myocardial Infarction	0	0	0,999
Chronic Kidney Disease grade			
1			0,603
2	0,485	0,091 - 2,601	0,399
3a	1,808	0,043 - 75,411	0,756
3b	20,940	0,055 - 7939,3	0,315
4	7,224	0,005 - 10011,91	0,592
Hypotension using vasopressor	0,224	0,02 - 2,48	0,223
Creatinine on admission	0,993	0,964 - 1,023	0,654
Cholesterol	1,489	0,398 - 5,578	0,554
HDL-C	2,155	0,17 - 27,317	0,553
LDL-C	0,675	0,159 - 2,854	0,593
Triglyceride	1,167	0,832 - 1,635	0,371
Time of PCI	1,005	0,945 - 1,069	0,877
<b>Contrast Volume</b>	3,040	1,064 - 8,000	0,038
<b>LVEF &lt; 50%</b>	6,000	2,000 - 17,000	<0,001
Anemia	0,332	0,054 - 2,044	0,234
reduced kidney function	0,684	0,045 - 10,349	0,784
<b>Mehran score</b>	14	5,000 - 36,000	<0,001

Comment: When analyzing univariate, we noted that contrast medium volume ( $p=0.038$ ), reduced left ventricular ejection fraction ( $p<0.001$ ) and Mehran score ( $p<0.001$ ) are significant factors. Effects on acute kidney injury caused by contrast agents.

**Table 3:** Multivariate analysis of association between risk factors and contrast-induced acute kidney injury

Variables	OR	KTC 95%	p
Contrast Volume	1	0 - 7,000	0,082
LVEF < 50%	3,000	0 - 14,000	0,065
<b>Mehran score</b>	13	4,000 - 35,000	<0,001

Comment: After multivariate analysis, only Mehran score ( $p<0.001$ ) is related to PC-AKI, OR=13 (95% CI 4-35).

## 4. Discussion

### 4.1 Characteristics of the study population

The average age in the study was  $59.2 \pm 12.3$  years old, the youngest patient was 23 years old, the oldest patient was 90 years old, lower than the study by author Hoang Kim Linh ( $67 \pm 11, 2$ )<sup>[6]</sup>, Hoang Van Tu ( $68 \pm 10.9$ )<sup>[7]</sup> and similar to author Nguyen Duc Trung ( $61.2 \pm 16.4$ )<sup>[8]</sup>. The proportion of men in our study was higher than that of these authors. The time of onset of acute coronary syndrome in men was often earlier than in women, so it may affected the average age being younger than in other studies.

### 4.2 Clinical characteristics

Patients who smoked in the study were 66.3%, which can be explained by the fact that men make up the majority of the study population, and men had a higher smoking rate than women, so the overall smoking rate was high. The rate of hypertension in the study was 72.3%, similar to author Pham Van Bui's (73.4%)<sup>[4]</sup>, higher than Hoang Kim Linh's study (66.83%)<sup>[6]</sup> and lower than by Hoang Van Tu (82.7%)<sup>[7]</sup>. The number of diabetic patients in this study was 28.7%. Our results are similar to Hoang Van Tu (28.3%)<sup>[7]</sup>, higher than Hoang Kim Linh (23.8%)<sup>[6]</sup> and lower than Pham Van Bui's study (32.8%)<sup>[4]</sup>. The rate of lipid disorders in the study was 56.9%, higher than author Hoang Kim Linh

(44.66%)<sup>[6]</sup> and lower than Hoang Van Tu (77.2%)<sup>[7]</sup>. The average total cholesterol was  $5.61 \pm 1.41$  mmol/L, the average LDL-C and HDL-C were  $3.49 \pm 1.10$  and  $1.23 \pm 0.33$  mmol/L, respectively. Triglycerides have an average concentration of  $2.39 \pm 1.95$  mmol/L. The rate of anemic patients in our study was 23.2%, lower than that of authors Hoang Kim Linh (30.08%)<sup>[6]</sup>, Hoang Van Tu (29.9%)<sup>[7]</sup> and Pham Van Bui (39.7%)<sup>[4]</sup>; The WHO anemia standards include a note that normal Hb concentrations vary according to the patient's physiological status, possibly because the average age in our study is lower than those of these authors, so the rate of anemia is also lower. In this study, there were 5 patients who had had a myocardial infarction before, accounting for 2.8%, lower than that recorded by author Hoang Kim Linh (19%)<sup>[6]</sup>. If we use the standard ejection fraction to group, our rate of heart failure with reduced EF is higher than the study by authors Nguyen Duc Trung (25%)<sup>[8]</sup>, Pham Van Bui (9.1%)<sup>[4]</sup>.

### 4.3 Rate of contrast-induced acute kidney injury in patients with acute coronary syndrome undergoing emergency coronary intervention

The rate of acute kidney injury in our study is not different from Hoang Kim Linh<sup>[6]</sup> because the author collected cases of emergency coronary angiography and programs with or without coronary stent intervention at the Institute of Cardiology Vietnam Hoang Van Tu<sup>[7]</sup> study was conducted at a provincial hospital and routine isotonic fluid infusion was not performed, so the author's rate of acute kidney injury was higher than ours. Research by author Pham Van Bui<sup>[4]</sup> on 320 patients to survey the rate of kidney disease caused by contrast agents showed that in the group of patients who only had coronary angiography for diagnosis, this rate was 12%, in the group of acute coronary intervention. Study was 21.3% and in the program coronary intervention group was 10.3%<sup>[8]</sup>. Therefore, this rate in our study is also consistent with the literature that emergency coronary intervention can increase the rate of contrast-induced nephropathy.

### 4.4 Association between risk factors and contrast-induced acute kidney injury in patients with acute coronary syndrome undergoing emergency coronary intervention

The increase in complexity during coronary intervention procedures leads to an increase in the volume of contrast medium used, which is a risk factor for contrast-induced nephropathy. In our study, the average amount of contrast agent used per patient was  $106.01 \pm 26$  ml; in the group without acute kidney injury, it was  $106.18 \pm 26.27$  ml, in the group with acute kidney injury it was  $115.76 \pm 21.42$  ml and recorded a statistically significant difference with  $p < 0.05$ . For contrast-induced nephropathy, the factor of heart failure is mentioned because it leads to reduced blood flow to the kidneys, thereby weakening the ability to excrete contrast agents, increasing drug exposure time and damage to the kidneys. Renal tubular cells with tissue hypoxia. In this study, we found a difference in the rate of contrast-induced nephropathy between 2 groups of patients with  $EF \geq 50\%$  and  $EF < 50\%$ ,  $p < 0.001$ . The OR value is 8.436; 95% confidence interval 2,916 - 24,410. Our results are also similar to the comments of author Pham Van Bui<sup>[4]</sup>. The Mehran score is evaluated based on 8 factors: age > 75, diabetes, blood creatinine (or glomerular filtration rate),

number of contrast agents used, anemia, heart failure, hypotension and balloon placement. Aortic counterpulsation. Based on the total score of these risk factors, author Mehran classifies the risk as low (< 5 points), medium (from 6 - 10 points), high (from 11 - 16 points) and very high (> 16 points). Corresponds to a risk of contrast-induced nephropathy of 7.5%; 14%; 26.1% and 57.3%. In our study, the majority of 74.5% were low-risk Mehrans with scores below 5, medium-risk Mehrans 6 - 10 accounted for 16.5%, and high-risk 6.7%.

## 5. Conclusion

The rate of acute kidney injury after contrast injection in patients with acute coronary syndrome undergoing emergency coronary intervention is 11.6%. The independent risk factor for acute kidney injury after contrast injection in patients with acute coronary syndrome undergoing emergency coronary intervention is the Mehran score ( $p < 0.001$ ; OR= 13).

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