

Mild Renal Insufficiency and Attributable Risk of Adverse In-hospital Outcomes in Patients with ACS from the Improving Care for Cardiovascular Disease in China (CCC) Project

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Research Article

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Abstract

Background: Renal insufficiency (RI) is a frequent comorbidity among patients with acute coronary syndrome (ACS). We aimed to evaluate the attributable risk associated with mild RI for the in-hospital outcomes in patients with ACS.

Methods: The Improving Care for Cardiovascular Disease in China-ACS (CCC-ACS) Project was a collaborative study of the American Heart Association and the Chinese Society of Cardiology. A total of 92509 inpatients with a discharge diagnosis of ACS were included. The attributable risk was calculated to investigate the effect of mild RI ($eGFR\ 60-89\ ml/min \cdot 1.73m^2$) on major adverse cardiovascular events (MACE) during hospitalization.

Results: The average age of these ACS patients was 63 years, and 73.9% were men. The proportion of patients with mild RI was 36.17%. After adjusting for other possible risk factors, mild RI was still an independent risk factor for MACE in ACS patients. In the ACS patients, the attributable risk of $eGFR\ 60-89ml/min \cdot 1.73m^2$ to MACE was 8.96%, 5.59% of $eGFR\ 45-59\ ml/min \cdot 1.73m^2$, 5.31% of $eGFR\ 30-44\ ml/min \cdot 1.73m^2$, and 4.03% of $eGFR < 30\ ml/min \cdot 1.73m^2$.

Conclusion: Compared with moderate to severe RI, mild RI has higher attributable risk to MACE during hospitalization in Chinese ACS population.

Background

In 2018, an estimated 11 million Chinese were affected by coronary heart disease (CHD) [1]. The aging population and increasing prevalence of cardiovascular disease risk factors [2, 3] will lead to a growing burden of CHD [4, 5]. The population affected by CHD is predicted to increase to 22.6 million by 2030 [6]. The mortality rate of CHD in China reached 1.39 million in 2013 [7].

It is generally believed that hypertension, diabetes, smoking and hyperlipidemia are the risk factors for CHD [8–10]. In addition, renal insufficiency (RI) is also one of the important risk factors for CHD [11]. Many studies had shown that in the patients with CHD, worse renal function was an independent predictor for short- and long-term prognosis [12–14]. However, the impact of mild RI on adverse in-hospital outcomes is not clear, and there are few studies about it. The information about the attributable risk associated to mild RI in patients with ACS for MACE is scarce too. Therefore, the purpose of the present study is to evaluate the influence of mild RI on the in-hospital outcomes in patients with ACS.

Methods

Research design

Details of the design and methodology of the CCC-ACS project have been published [15]. Briefly, it is a national, hospital-based quality improvement project with an ongoing database, aiming to increase adherence to ACS guidelines in China and to improve patient outcomes. It was launched in 2014 as a collaborative initiative of the American Heart Association (AHA) and Chinese Society of Cardiology (CSC). 240 hospitals were recruited representing the diversity of ACS care in hospitals in China, including 160 tertiary hospitals and 80 secondary hospitals. Clinical data were collected via a web-based data collection platform (Oracle Clinical Remote Data Capture, Oracle Corporation). Trained data abstractors entered the data elements abstracted from medical charts. Eligible patients were consecutively reported to the CCC-ACS database for each month before the middle of the following month. Around 5% of reported cases were randomly selected and compared with the original medical records. An audit by a third party was performed to ensure that cases were reported consecutively rather than selectively. This research has been registered in <https://clinicaltrials.gov> (NCT02306616).

Research population

A total of 92509 inpatients with ACS, identified based on their principal diagnosis at discharge, were enrolled from 240 hospitals across China from November 2014 to December 2019. Based on the $eGFR$, all the patients were further divided into $\geq 90\ ml/min \cdot 1.73m^2$ group, $60-89\ ml/min \cdot 1.73m^2$ group, $45-59\ ml/min \cdot 1.73\ m^2$ group, $30-44\ ml/min \cdot 1.73\ m^2$ group and $< 30\ ml/min \cdot 1.73\ m^2$ group. Institutional review board approval was granted for the aggregate data set for research and quality improvement by the Ethics Committee of Beijing Anzhen Hospital, Capital Medical University. No informed consent was required.

Definition of mild RI

Mild RI is defined as $eGFR\ 60-89\ ml/min \cdot 1.73m^2$.

Definition of in-hospital outcomes

Major adverse cardiovascular events (MACE) were defined as a combination of death, heart failure, cardiac arrest, and cardiac shock.

Definition of other Variables

The ACS classification was based on the primary diagnosis at discharge in the medical record. Non-ST-segment elevation ACS was defined as non-ST-segment elevation myocardial infarction (STEMI) or unstable angina. Hypertension was defined as having a history of hypertension, receiving

antihypertensive therapy, or having a systolic blood pressure \geq 140mmHg or diastolic blood pressure \geq 90mmHg at admission. Diabetes mellitus was defined as having a previous or new diagnosis of diabetes mellitus, receiving oral hypoglycemic drug therapy or insulin therapy, or having a HbA1C \geq 6.5%. Hyperlipidemia was defined as having a history of hyperlipidemia, receiving lipid-lowering drugs, or having a serum LDL-C \geq 1.8mmol/L at admission. Current smoking was defined as smoking in the preceding 1 year according to the medical records of the patients.

The baseline eGFR was calculated using the Modification of Diet in Renal Diseases (MDRD) equation for Chinese patients: eGFR (mL/min) = $1.73m^2 \times SCr (mg/dl)^{-1.234} \times Age^{-0.179}$ (x 0.79 for women) [16].

All the laboratory testing values were the values tested the first time after admission.

Statistical methods

Continuous variables with normal distribution were presented as mean \pm standard deviation, and ANOVA analysis was used for univariate comparison. On the other hand, those with non-normal distribution were represented as median and interquartile range, and Wilcoxon-Mann-Whitney test was used for univariate comparison. The categorical variables were reported as number of cases and percentages, and the chi-square test was used for univariate comparison. A multivariate logistic regression model was used to determine the association between the eGFR and in-hospital outcomes by controlling for potential confounders. Candidate adjustment factors included age, history of hypertension, diabetes mellitus, heart failure, atrial fibrillation, stroke, previous PCI or CABG, ACS type, heart failure at admission, cardiogenic shock at admission, cardiac arrest at admission, Killip class at admission, systolic pressure at admission, taking antiplatelet drugs before admission, taking β -blocker before admission and taking ACEI/ARB before admission, HB at admission, LDL-C at admission. The attributable risk (AR) was calculated using the method described by Bruzzi P [17] to investigate the effect of mild RI on MACE during hospitalization.

$$AR \% = PE \times (mOR-1) / PE \times (mOR-1) + 1$$

PE= probability of exposure of disease

For data with missing values lower than 15%, the sequential regression multiple imputation method implemented by IVEware software version 0.2(Survey Research Center, University of Michigan, Ann Arbor, MI, USA) was used to imputed the missing values.

SPSS software version 22.0 (IBM Inc, Armonk, NY, USA) was used to analyze the data. For all analyses, P \leq 0.05 was considered as statistically significant.

Results

Patients' characteristics

This study included 92509 ACS patients from 240 hospitals across China. The clinical characteristics of these patients are summarized in Table 1. The average age of these ACS patients was 63 years, and 73.9% of them were men.

The percentages of patients with eGFR \geq 90 ml/min \cdot 1.73m 2 , 60-89 ml/min \cdot 1.73m 2 , 45-59 ml/min 1.73 m 2 , 30-44 ml/min 1.73 m 2 and < 30 ml/min 1.73 m 2 were 45.95%, 36.17%, 9.06%, 5.38% and 3.43%, respectively. The comparison results were shown in Table 1. With the decrease of eGFR, the proportion of STEMI decreased gradually, while the proportion of NSTE-ACS increased gradually. The proportion of patients with hypertension, diabetes mellitus, heart failure, previous heart myocardial and previous stroke increased gradually, while the proportion of patients with hyperlipidemia and LDL-C level decreased gradually. With the decrease of eGFR, the proportion of patients with taking β -blockers, antiplatelet drugs and statins before admission increased, while the proportion of patients with taking ACEI/ARB decreased when the eGFR \leq 60 ml/min \cdot 1.73m 2 . With the decrease of eGFR, the proportion of patients undergoing coronary angiography and PCI decreased significantly after admission, while the severity of coronary artery lesions in patients undergoing angiography increased gradually.

Compared to the patients with STEMI, patients with NSTE-ACS had a higher proportion of RI: the percentages of patients with 60-89 ml/min \cdot 1.73m 2 , 45-59 ml/min 1.73 m 2 , 30-44 ml/min 1.73 m 2 and < 30 ml/min 1.73 m 2 in STEMI patients were 34.95%, 8.65%, 4.89% and 2.73%, respectively, while those in NSTE-ACS patients were 38.00%, 9.68%, 6.26% and 4.49%, respectively. (Figure 1) Compared to the patients with STEMI, the proportion of previous MI, hypertension, diabetes, previous stroke, previous PCI or CABG, use of β -blocker and ACEI/ARB before admission were increased in patients with NSTE-ACS.(Additional file1: Table S1)

In-hospital outcomes

The proportion of in-hospital mortality was 1.7%, heart failure in hospital was 8.0%, cardiogenic shock in hospital was 2.6%, and cardiac arrest in hospital was 1.6% in all the ACS patients. Moreover, the proportion of MACEs were 7.0%, 13.6%, 25.1%, 35.4%, and 46.7% in patients with eGFR \geq 90ml/min \cdot 1.73m 2 , 60-89 ml/min \cdot 1.73m 2 , 45-59 ml/min 1.73 m 2 , 30-44 ml/min 1.73 m 2 and < 30 ml/min 1.73 m 2 respectively. With the decrease of eGFR, the proportion of in-hospital mortality, heart failure, cardiac arrest and cardiogenic shock increased gradually. (Figure 2).

Compared to the patients with STEMI, patients with NSTE-ACS had a higher proportion of all-cause death, cardiac arrest, cardiogenic shock, heart failure were decreased.(Additional file1: Table S2)

Relationship between eGFR and MACE

To evaluate the association between eGFR and MACE, logistic regression analyses were performed in the ACS population. In univariate logistic regression analysis, a significantly higher risk of the MACEs was observed in patients with RI. After adjusting for confounders in the multivariate logistic regression model, patients with eGFR 60-89 ml/min·1.73m², 45-59 ml/min·1.73m², 30-44 ml/min·1.73m² and \geq 30 ml/min·1.73m² had a 1.3-fold(OR, 1.27; 95% CI, 1.19-1.35), 1.7-fold(OR, 1.65; 95% CI, 1.52-1.80), 2.0-fold(OR, 2.04; 95% CI, 1.85-2.26) and 2.2-fold(OR, 2.23, 95% CI, 1.98-2.50) increased risk of MACEs compared to patients with eGFR \geq 90 ml/min·1.73m². (Table 2)

In order to explore the relationship between eGFR and MACE in different types of ACS, subgroup analysis was performed based on STEMI and NST-ACS population respectively. In the patients with STEMI, after adjusted for confounders in the multivariate logistic regression model, patients with eGFR 60-89 ml/min·1.73m², 45-59 ml/min·1.73m², 30-44 ml/min·1.73m² and \geq 30 ml/min·1.73m² had a 1.2-fold(OR, 1.25; 95% CI, 1.16-1.34), 1.6-fold(OR, 1.56; 95% CI, 1.40-1.73), 1.9-fold(OR, 1.92; 95% CI, 1.70-2.17) and 2.4-fold(OR, 2.38, 95% CI, 2.05-2.76) increased risk of MACEs compared to patients with eGFR \geq 90 ml/min·1.73m². (Table 3) In the patients with NST-ACS, after adjusting for confounders in the multivariate logistic regression model, patients with eGFR 60-89 ml/min·1.73m², 45-59 ml/min·1.73m², 30-44 ml/min·1.73m² and \geq 30 ml/min·1.73m² had a 1.4-fold(OR, 1.41; 95% CI, 1.25-1.59), 2.0-fold(OR, 12.01; 95% CI, 1.72-2.34), 2.6-fold(OR, 2.57; 95% CI, 2.18-3.04) and 2.7-fold(OR, 2.69, 95% CI, 2.23-3.24) increased risk of MACEs compared to patients with eGFR \geq 90 ml/min·1.73m². (Table 3)

The attributable risk of eGFR for MACE

In all the ACS patients, the attributable risk of eGFR 60-89 ml/min·1.73m² was 8.96%, 5.59% of eGFR 45-59 ml/min·1.73m², 5.31% of eGFR 30-44 ml/min·1.73m², and 4.03% of eGFR \geq 30 ml/min·1.73m². (Table 2)

According to the results of regression analysis, we calculated the attributable risk of MACE in STEMI and NST-ACS population with different eGFR stratification. In the patients with STEMI, the attributable risk of eGFR 60-89 ml/min·1.73m² was 8.00%, 4.59% of eGFR 45-59 ml/min·1.73m², 4.22% of eGFR 30-44 ml/min·1.73m², and 3.63% of eGFR \geq 30 ml/min·1.73m². In the patients with NSTE-ACS, the attributable risk of eGFR 60-89 ml/min·1.73m² for MACE was 15.50%, 9.73% of eGFR 45-59 ml/min·1.73m², 9.84% of eGFR 30-44 ml/min·1.73m², and 7.58% of eGFR \geq 30 ml/min·1.73m².(Table 3)

Discussion

In this large, hospital-based registry for patients with ACS, eGFR was significantly associated with the risk of MACE during hospitalization. Moreover, the attributable risk of mild RI to MACE was higher than that of moderate to severe RI, which is especially obvious in patients with NSTE-ACS.

The subjects of this study were patients with ACS. In the present study, we found the proportion of patients with eGFR < 90 ml / min · 1.73m² was 54.05%, and the proportion of patients with mild RI (eGFR 60-89 ml / min · 1.73m²) was 36.17%. This was similar to the foreign literature report: in a study including 20604 patients with ACS in New Zealand, 53.3%, 23.3%, 1.7% and 1.4% of patients combined with CKD stages 2, 3, 4 and 5 respectively [18]. In other studies with relative small sample size, the proportion of ACS patients with RI is also similar [19, 20]. It can be seen that the proportion of patients with RI is large in ACS population and which is mainly mild RI.

The present study also found that RI was an independent risk factor for MACE during hospitalization, and there was a gradual correlation between them. In the multivariate regression analysis, the odds ratio(95% CI) of MACE in the patients with 60-89 ml/min·1.73m², 45-59 ml/min·1.73m², 30-44 ml/min·1.73m² and \geq 30 ml/min·1.73m² were 1.27, 1.65, 2.04 and 2.23. We can see from this data that the worse the renal function in the patients with ACS, the higher risk of MACE during hospitalization, which is consistent with the foreign literature reports [13, 21]. Therefore, we always pay more attention to the ACS patients with severe RI in clinical work, while often ignore the ACS patients with mild RI.

However, it also can be seen from the data of the present study that only the slightly decrease of eGFR (60-89 ml / min · 1.73m²) in the patients with ACS, the risk of MACE increased 1.272 times compared to those with normal renal function (eGFR \geq 90ml / min·1.73m²). Smith GL et al. followed up 118753 patients with AMI for 10 years. They found that even mild impairment of renal function (eGFR66-74 ml/min·1.73 m²) could increase 10-year mortality risk of patients to 10% compared to patients with normal renal function [22]. Other studies with relatively small sample size also found that mild RI was related to the short-term and long-term prognosis in ACS patients [22-24]. However, only regression analysis was used to analyze the relationship between mild RI and prognosis of ACS patients in these studies. And this was not be reported in previous literature that used attributable risk to reveal the relationship between mild RI and hospital outcomes in ACS population. Attributable risk is reflected in the total chance of a disease (or death) in the population exposed to a certain factor, the part that really attributable to the exposure factor. The public health significance of this index is that for the exposed population, if the exposure factors are eliminated, the number of morbidity (or death) per unit population can be reduced. In the present study, the attributable risk of eGFR 60-89ml/min·1.73m² was 8.96%, eGFR 45-59 ml/min·1.73m² was 5.59%, eGFR 30-44 ml/min·1.73m² was 5.31% and eGFR \geq 30 ml/min·1.73m² was 4.03%. That is to say, among the ACS patients, 8.96% of MACE during hospitalization was caused by mild RI. It can be seen that in the ACS population in the present study, although the risk of MACE during hospitalization with mild RI was lower than that of

moderate and severe RI, its attributable risk is far greater than that of moderate and severe RI. The occurrence of this phenomenon is attributed to the proportion of patients with mild RI far greater than that of patients with moderate and severe RI. This suggests that we should pay more attention to ACS patients and their prognosis even with mild RI.

We even found that in the NSTE-ACS population, the attributable risk of eGFR 60–90 ml/min·1.73m² to MACE during hospitalization was as high as 15.5%. While that is 8% in patients with STEMI. This is related to the relatively high percentage of mild RI and a higher OR value of mild RI to MACE in NSTE-ACS population. In the present study, the proportion of STEMI patients with RI compared with NST-ACS patients with RI was 51.14% vs 58.43%. Moreover, 34.95% of patients with STEMI had mild RI, while that of NST-ACS patients was 38%. It can be seen that patients with NSTE-ACS are more likely to have a poor basic renal function than patients with STEMI. In other words, once ACS occurs in patients with chronic kidney disease (CKD), the type of ACS is more likely to be NSTE-ACS than STEMI, which is similar to Gupta's conclusion [13]. They analyzed 3187404 patients. In the ACS subgroup, the percentages of STEMI in non CKD, CKD and ESRD patients were 34.5%, 22.3% and 16.6% respectively, while the percentages of NSTE-ACS were 65.5%, 77.7% and 83.4%. The occurrence of this phenomenon may be related to the presence of microinflammation, vascular calcification caused by abnormal bone metabolism, etc in patients with RI, which leads to the progression of chronic invasive plaque of coronary artery and eventually lead to chronic obstruction [25, 26].

The current study has the following limitations: (1) Because cardiologists usually avoid to do coronary angiography in patients with RI because of a high risk. Therefore, the population for assessing the severity of coronary artery lesions in our study, may not be represented all the ACS patients. (2) Because the data in our study are obtained from CCC-ACS database, which does not include the data of calcium and phosphorus metabolism, inflammation, the current study couldn't adjust the impact of the above factors on the short-term outcomes in patients with ACS. (3) The outcome of our study was limited to hospital events and follow-up data were not available.

Conclusion

In conclusion, the present study is the largest sample study for the ACS population in China. It is suggested that the mild decline of eGFR is an independent risk factor for the poor short-term prognosis in ACS patients. Moreover, the attributable risk of mild RI is far greater than that of moderate and severe RI in ACS patients with short prognosis during hospitalization, which is especially in NSTE-ACS patients. Therefore, in clinical work, the prevention of cardiovascular disease is not only limited to moderate and severe RI, but also start from those with early RI.

Declarations

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Authors' contributions

HC, FBX, DZ, CSM and JL designed the study; FBX, NY, LJY, GQW, WJB, YCH, JL and NY cleaned up the data; FBX analyzed the data; FBX and HC wrote the manuscript. All authors reviewed and edited the manuscript. All authors read and approved the final manuscript.

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Availability of data and material

The datasets analyzed during the current study are not publicly available because of intellectual property rights, but are available from the Prof. Dong Zhao on reasonable request.

Ethics approval and consent to participate

Institutional Review Board approval was granted for this research by the Ethics Committee of Beijing Anzhen Hospital, Capital Medical University. (reference number of approval: 2014018). No informed consent was required.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests in relation to this work.

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Tables

Table 1 Baseline characteristics of ACS patients

	Total n=92509	eGFR≥90ml/min·1.73m ² n=42508, 45.95%	eGFR60-89 ml/min·1.73m ² n=33462, 36.17%	eGFR45-59 ml/min·1.73m ² n=8383, 9.06%	eGFR30-44 ml/min·1.73m ² n=4980, 5.38%	eGFR≤ 30 ml/min·1.73m ² n=3176, 3.43%	P value
Male gender	68370±73.9	34036±80.1	23995±71.7	5462±65.2	3005±60.3	1872±64.1	0.001
Age(years)	63.21±12.45	59.57±10.36	67.46±11.01	71.20±10.85	72.47±11.39	71.50±11.74	0.001
ACS type							
STEMI	55574±60.1	27154±63.9	19425±58.1	4809±57.4	2667±53.6	1519±47.8	0.001
NSTE-ACS	36933±39.9	15352±36.1	14.37±41.9	2574±42.6	2313±46.4	1657±52.2	
Previous MI	7561±8.2	2743±6.5	2896 (8.7)	883±10.5	591±11.9	448±14.1	0.001
Previous PCI or CABG	7744±8.4	2984±7.0	3110 ±9.3	804±9.6	508±10.2	338±10.6	0.001
Family history of CAD	2481±2.7	1354±3.2	825 (2.5)	159±1.9	78±1.6	65±2.0	0.001
Previous AF	2229±2.4	409±1.0	963 (2.9)	376±4.5	283±5.7	198±6.2	0.001
Hypertension	61096±65.3	25677 ±60.4	22873 (68.4)	6194±73.9	3774±75.8	2578±81.2	0.001
Hyperlipidemia	79418±85.9	37122 (87.3)	28639 (85.6)	7036±83.9	4124±82.8	2497±78.6	0.001
Diabetes	27582±29.8	11896±28.0	9468 (28.3)	2842±33.9	1949±39.1	1427±44.9	0.001
Previous stroke	8387±9.1	2640±6.2	3348 (10.0)	1128±13.5	763±15.3	508±16.0	0.001
Previous heart failure	2070±2.2	296 ±0.7	769 (2.3)	370±4.4	312±6.3	323±10.2	0.001
Cigarette smoking	40334±43.6	22059 ±51.9	13229 (39.5)	2718±32.4	1482±29.8	846±26.6	0.001
Statins before admission	16304±17.6	6817±16.0	6184 (18.5)	1553±18.5	1043±20.9	707±22.3	0.001
Antiplatelet drugs before admission	22659±24.5	9602±22.6	8556 (25.6)	2187±26.1	1369±27.5	945±29.8	0.001
β-blocker before admission	8873±9.6	3599±8.5	3449±10.3	876±10.4	534±10.7	415±13.1	0.001
ACEI/ARB before admission	9696±10.5	3662±8.6	3819±11.4	1146±13.7	674±13.5	395±12.4	0.001
Heart failure on admission	6610±7.1	1545±3.6	2449 (7.3)	1046±12.5	845±17.0	725±22.8	0.001
Cardiac arrest on admission	1449±1.6	455 ±1.1	529 (1.6)	197±2.3	165±3.3	103±3.2	0.001
Cardiogenic shock on admission	2592±2.7	625 ±1.5	856 (2.6)	426±5.1	356±7.1	239±7.5	0.001
SBP on admission (mmHg)	130.7±23.5	130.1±22.0	131.2±23.5	130.4±25.5	130.0±27.5	133.2±29.4	0.001
DBP on admission (mmHg)	78.3±14.4	79.8±14.0	77.6±14.0	76.3±15.2	75.3±15.7	75.9±16.6	0.001
HR on admission (bpm)	77.5±16.2	76.6±14.6	77.1±16.2	79.2±18.8	81.3±20.3	82.6±20.7	0.001
Killip class≥3	9656 (10.4)	2301 ±5.4	2575 (10.7)	1551±18.5	1210±24.3	1019±32.1	0.001
eGFR on admission (ml/min·1.73m ²)	88.0 (68.3-99.8)	100.8±95.3-107.8	78.8±70.3-85.1	53.55 (49.50-56.90)	38.83 (34.88-42.13)	21.06 (13.97-26.00)	0.001

HbA1C(%)	6.1±5.6-7.2	6.0 (5.6-7.3)	6.0 (5.6-7.0)	6.2 (5.7-7.3)	6.3 (5.7-7.6)	6.4(5.8-7.6)	≤0.001
HB on admission (g/L)	137.84±19.40	136.0±20.5	135.0±19.3	129.7±20.6	124.7±22.0	113.5±25.6	≤0.001
TC (mmol/L)	4.43±1.23	4.51±1.24	4.39±1.21	4.37±1.25	4.32±1.29	4.24±1.36	≤0.001
TG (mmol/L)	1.44 (1.02-2.14)	1.52±1.07-2.26	1.38±0.98-2.02	1.38±0.97-2.03	1.38(0.95-2.09)	1.42(1.02-2.11)	≤0.001
LDL-C (mmol/L)	2.69 (2.08-3.35)	2.71 (2.12-3.35)	2.63 (2.05-3.27)	2.60 (2.00-3.25)	2.55 (1.95-3.24)	2.43 (1.82-3.13)	≤0.001
HDL-C (mmol/L)	1.01 (0.85-1.22)	1.03 (0.86-1.24)	1.05 (0.87-1.26)	1.04 (0.86-1.27)	1.03 (0.85-1.27)	1.00 ≤0.80-1.23	≤0.001
Undergoing CA	74241 (80.3)	36514 (85.9)	26821 (80.2)	6050 (72.2)	3196±64.2	1660 (52.3)	≤0.001
Undergoing PCI	63852±69.0	32026 ±75.3	22799 (68.1)	5070±60.5	2611±52.4	1346±42.4	≤0.001
Coronary artery lesions							
One-vessel lesion	42416(57.1)	22254±60.9	14695 (54.8)	3143 (51.9)	1558 (48.7)	766 (46.1)	≤0.001
multi-vessel lesions	27946(37.6)	12789±35.0	10545 (39.3)	2497 (41.3)	1381 (43.2)	734 (44.2)	≤0.001
Left main vessel lesions	3879±5.2	1471±4.1	1581 (5.9)	410±6.8	257±8.0	160±9.6	≤0.001

Values are mean±SD, median(interquartile range, IQ), or n (%).

CKD: chronic kidney disease; eGFR: estimated glomerular filtration rate; ACS: acute coronary syndrome; STEMI: ST-elevation myocardial infarction; NSTEMI: Non-ST elevation myocardial infarction; UA: Unstable angina pectoris; PCI: percutaneous coronary intervention; CABG: coronary artery bypass grafting; SBP: systolic blood pressure; DBP: diastolic blood pressure; HR: heart rate; ACEI: Angiotensin Converting Enzyme Inhibitors; ARB: Angiotensin receptor antagonist; FBG: fasting blood glucose; HbA1C: glycated hemoglobin; HB: Hemoglobin; TG: triglyceride; TC: total cholesterol; LDL-C: low-density lipoprotein cholesterol; HDL: high-density lipoprotein cholesterol.

Table 2 Attributable risk of MACE in different renal function in all the ACS patients

	Unadjusted			Adjusted			
	OR	95%CI	P	OR*	95%CI	P	AR
eGFR ≥90 ml/min·1.73m ²	ref			ref			
60-89 ml/min·1.73m ²	1.82	1.73-1.92	≤0.001	1.27	1.19-1.35	≤0.001	8.96%
45-59 ml/min·1.73m ²	3.18	2.97-3.41	≤0.001	1.65	1.52-1.80	≤0.001	5.59%
30-44 ml/min·1.73m ²	4.62	4.28-4.99	≤0.001	2.04	1.85-2.26	≤0.001	5.31%
≤30 ml/min·1.73m ²	6.06	5.55-6.61	≤0.001	2.23	1.98-2.50	≤0.001	4.03%

MACE: major adverse cardiovascular events

ACS: acute coronary syndrome

eGFR: estimated glomerular filtration rate

* ORs were adjusted for age, history of hypertension, diabetes mellitus, heart failure, atrial fibrillation, stroke, previous PCI or CABG; ACS type, heart failure at admission, cardiogenic shock at admission, cardiac arrest at admission, Killip class at admission, systolic pressure at admission, taking antiplatelet drugs before admission, taking β-blocker before admission and taking ACEI/ARB before admission, HB at admission, LDL-C at admission.

Table 3 Attributable risk of MACE in different renal function in STEMI and NSTEMI-ACS patients

		STEMI patients			NSTE-ACS patients		
		Adjusted OR (95% CI)	P	AR	Adjusted OR* (95% CI)	P	AR
eGFR \geq 90 ml/min·1.73m ²	ref				ref		
60-89 ml/min·1.73m ²	1.25	1.16-1.34	0.001	8.00%	1.41	1.25-1.59	0.001 15.50%
45-59 ml/min·1.73m ²	1.56	1.40-1.73	0.001	4.59%	2.01	1.72-2.34	0.001 9.73%
30-44 ml/min·1.73m ²	1.92	1.70-2.17	0.001	4.22%	2.57	2.18-3.04	0.001 9.84%
<30 ml/min·1.73m ²	2.38	2.05-2.76	0.001	3.63%	2.69	2.23-3.24	0.001 7.58%

MACE: major adverse cardiovascular events

STEMI:ST segment elevated myocardial infarction

NSTE-ACS:non-ST segment elevated acute coronary syndrome

eGFR: estimated glomerular filtration rate

* ORs were adjusted for age, history of hypertension, diabetes mellitus, heart failure, atrial fibrillation, stroke, previous PCI or CABG, ACS type, heart failure at admission, cardiogenic shock at admission, cardiac arrest at admission, Killip class at admission, systolic pressure at admission, taking antiplatelet drugs before admission, taking β-blocker before admission and taking ACEI/ARB before admission, HB at admission, LDL-C at admission

Figures

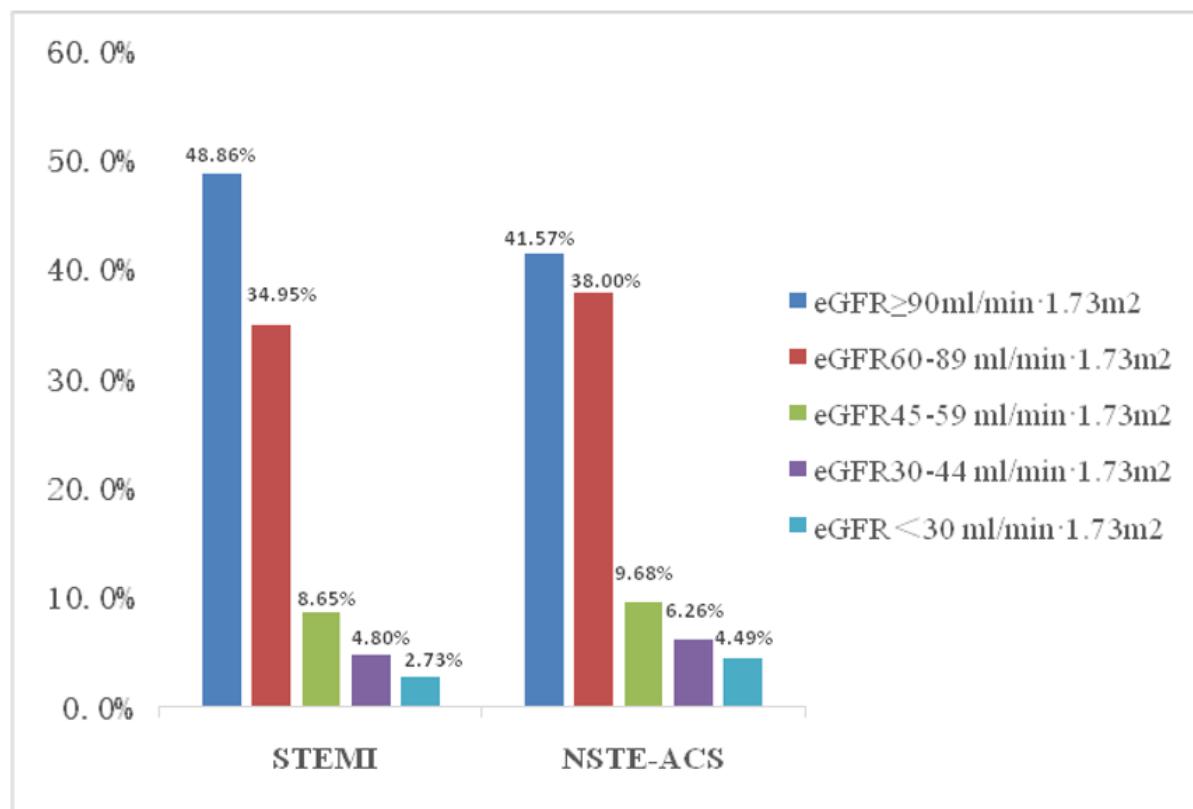


Figure 1

Percentage of different renal function in STEMI and NSTE-ACS patients eGFR: estimated glomerular filtration rate STEMI:ST-elevation myocardial infarction NSTE-ACS:Non-ST elevation acute coronary syndrome

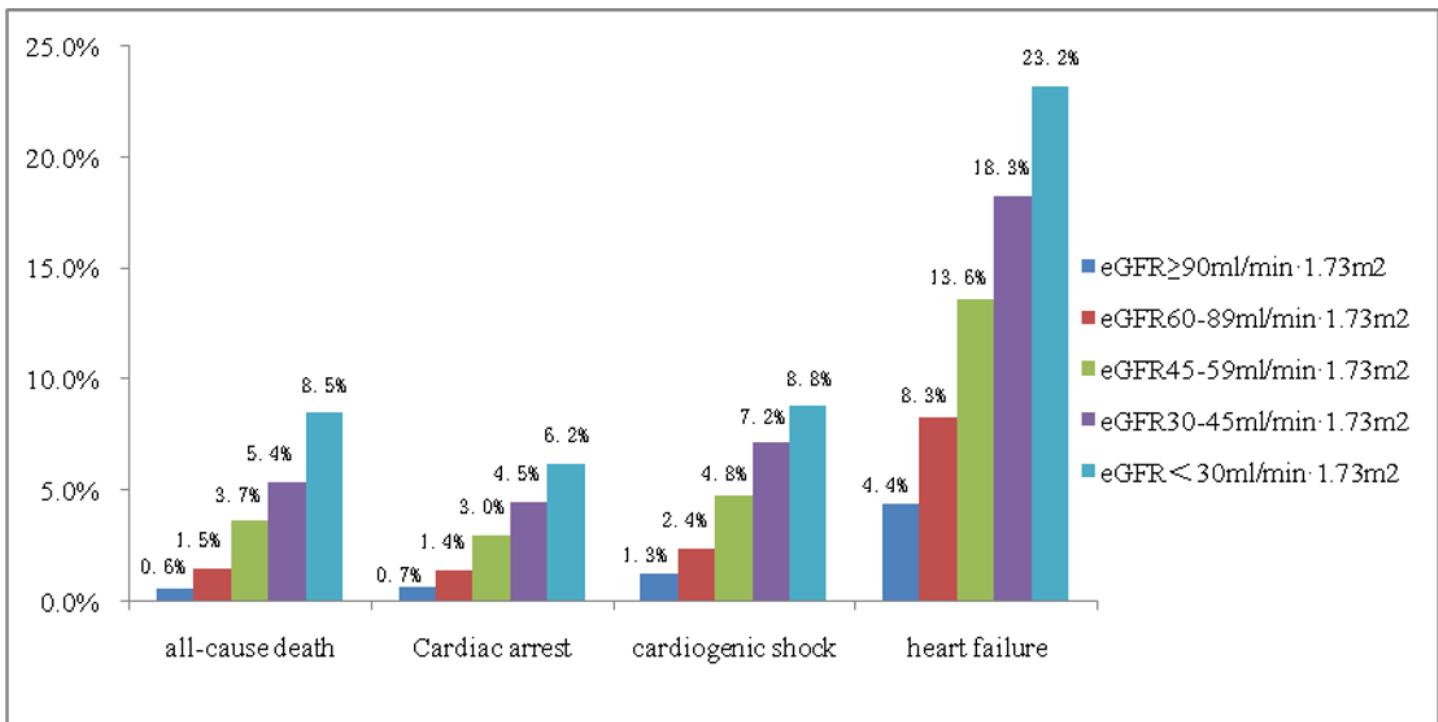


Figure 2

Incidence of MACE in patients with ACS under different renal functions eGFR: estimated glomerular filtration rate

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [TableS1.docx](#)
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