Assessing the Quality of Care for Patients With Acute Myocardial Infarction in China

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ABSTRACT

There is a wide practice gap between optimal care and actual care for patients with acute myocardial infarction (AMI) in China. Indicators of quality of care for AMI patients have already been developed by a modified Delphi process. Our aim was to assess the association between those indicators and in-hospital mortality in AMI patients. We hypothesized that an association exists between quality-of-care indicators and in-hospital mortality in AMI patients. Based on the data of 2128 AMI patients at 20 tertiary hospitals in Heilongjiang Province from January 1, 2009 to October 31, 2010, we estimated the compliance rates of indicators. Association between indicators and in-hospital mortality was assessed using hierarchical generalized linear models. Among 2128 patients, 163 (7.66%) died during their hospital stay. The compliance rates were 71.6%, 41.3%, 82.5%, 63.5%, 80.4%, 5.1%, 28.9%, and 41.2% for the use of aspirin, β -blocker, clopidogrel, angiotensin-converting enzyme inhibitor, statin, thrombolytic, percutaneous coronary intervention, and coronary angiography, respectively. Aspirin, clopidogrel, angiotensin-converting enzyme inhibitor, statin, and percutaneous coronary intervention were significantly associated with in-hospital mortality after adjustment for potential confounding factors. We found some disparities between guidelines and clinical practice for AMI patients in China and a significant association between indicators and in-hospital mortality. Our findings are potentially helpful for assessing and improving the quality of care for AMI patients in China.

Introduction

Acute myocardial infarction (AMI), commonly known as a heart attack, is a main component of cardiovascular diseases and a serious health problem worldwide.^{1,2} It occurs when blood stops flowing properly to a portion of the heart and the heart muscle is injured because it is not receiving enough oxygen. With the aging population, the mortality and morbidity of AMI have greatly increased in China recently. Meanwhile, China's economic system, which used to be managed by the central government, has changed to a market-oriented system of health care. Only a small proportion of AMI patients can afford the high-cost therapies. To cope with this issue, the State Council has promulgated the New Rural Cooperative Medical Scheme to improve medical services for Chinese residents. As those changes have emerged in China in recent decades, it is important to assess the quality of care for AMI patients in contemporary medical practice settings.³ To assist the assessment of the quality of care, clinical practice guidelines have recommended quality indicators. These indicators can

be used to identify adverse outcomes and guide priorities for improving patient care. Several previous studies have shown that clinical guidelines with clinical indicators are useful for assessing the quality of care.^{4–6} A study in 2006 reported that the compliance rates according to indicators were associated with in-hospital mortality, which was 6.31% for the lowest-adherence group and 4.15% for the highest-adherence group.⁷

In recent years, the treatment of AMI has been redefined with the incorporation of evidence from multiple large-scale clinical trials. These guidelines provide recommendations for the use of evidence-based therapies to reduce morbidity and mortality.^{8–10} Despite the fact that considerable attention has been paid to the development and dissemination of the national guidelines for the management of AMI, up to now there still has been no integrated quality-improvement evaluation study in China. In previous studies, only outcome indicators (eg, hospital mortality, 30-day mortality) were chosen for measurement of quality of care. The processes of care have been overlooked. Based on the data from hospitals, quality indicators for the Chinese health care system have already been developed to guide diagnosis and treatments.¹¹ For those indicators to be useful for accurately measuring the quality of care, each indicator must be strongly associated with patient outcomes.^{12,13}

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In general, it is well accepted that quality indicators in AMI are associated with prognosis. Several studies have focused on quality of care, but some of them showed inconsistent results regarding the association between recommended indicators and health outcomes.^{14–17} Furthermore, patient quality of care depends on a number of factors, such as age, sex, race, status at admission, and physician specialty. The consistency between guidelines and actual care of AMI patients in China is not clear, especially as to what extent these recommended interventions are associated with mortality and readmission.

In this study, we aimed to assess the association between indicators and in-hospital mortality for AMI patients and to evaluate the effect of highly predictive indicators.

Methods

Data Source and Study Population

The patient information was collected from 20 tertiary hospitals in Heilongjiang Province of China between January 1, 2009 and October 31, 2010. All patients selected for this study were hospitalized with AMI as the primary reason for admission. Every patient was assigned a unique medical-record number because some information, such as names, addresses, and telephone numbers, was removed in the record database before it was obtained by researchers. Standardized procedures were used by 6 well-trained data collectors to retrieve required data on demographic characteristics, health habits (eg, smoking and drinking), medical history (had or not), clinical presentation (eg, status at admission, admission diagnosis, clinical examination), therapies, associated main contraindications to therapies, and in-hospital outcome (eg, mortality, rehospitalization). The consistency between different data collectors' abstraction for the same questionnaire was assessed at the end of each day. When the agreement was <95%, the data were reabstracted the next day to ensure the reliability of data.

For hospitals with >150 AMI patients, we randomly selected 150 patients in each hospital; for hospitals with <150 AMI patients, all patients were selected. Among 2203 patients, we excluded 10 patients because they were age <18 years and 65 patients because they had stayed <1 day in hospital. Therefore, 2128 patients were included in the final analysis of this study. Each indicator was determined according to whether a patient was eligible for it and if he or she actually received it.

Quality Indicators

The association between 8 process indicators and in-hospital mortality was assessed. Each indicator was clearly defined. The compliance rate can be calculated with the denominator as the number of patients eligible for an intervention without any contraindications to it and the numerator as the number of patients who actually received the recommended intervention. Detailed denominator and numerators for different indicators are as follows:

1. Aspirin. Denominator: AMI patients without contraindications to aspirin (eg, active bleeding before hospital arrival or allergy to aspirin). Numerator:

Patients with AMI who received aspirin within 3 hours after hospital arrival.

2. β -Blocker. Denominator: AMI patients without contraindications to β -blocker (eg, heart rate <60 bpm, systolic blood pressure [SBP] <100 mm Hg, moderate or severe left-heart failure, peripheral circulation hypoperfusion). Numerator: Patients with AMI who received β -blocker within 12 hours after hospital arrival.
3. Clopidogrel. Denominator: AMI patients without contraindications to clopidogrel (eg, SBP <100 mm Hg, allergy to angiotensin-converting enzyme inhibitor [ACEI], severe liver damage, bilateral renal artery stenosis). Numerator: Patients with AMI who received clopidogrel within 12 hours after hospital arrival.
4. Angiotensin-converting enzyme inhibitor. Denominator: AMI patients without contraindications to ACEI (eg, allergy to ACEI, aortic stenosis, bilateral renal artery stenosis, renal dysfunction, hyperkalemia). Numerator: Patients with AMI who were prescribed an ACEI during their hospital stay.
5. Statin. Denominator: AMI patients without contraindications to statin (eg, active liver disease, liver dysfunction, renal dysfunction, allergy to statin). Numerator: Patients with AMI who were prescribed a statin during their hospital stay.
6. Thrombolytic. Denominator: AMI patients with ST-segment elevation or left bundle branch block on electrocardiogram, fibrinolytic therapy within 12 hours after onset, and age <75 years, and without contraindications to thrombolytic (eg, suspected aortic dissection, recent surgical operation). Numerator: Patients with AMI who received thrombolytic within 30 minutes of hospital arrival.
7. Primary percutaneous coronary intervention (PCI). Denominator: AMI patients without contraindications to PCI (eg, patients who received fibrinolytic therapy or coronary artery stenosis <50%). Numerator: Patients with AMI who received PCI intervention during their hospital stay.
8. Coronary angiography. Denominator: AMI patients without contraindications to coronary angiography (eg, uncontrolled hypertension, uncontrolled heart insufficiency, acute myocarditis, allergy to coronary angiography). Numerator: Patients with AMI who received coronary angiography examination during their hospital stay.
9. In-hospital mortality. Denominator: AMI patients. Numerator: Patients who died during their hospital stay.

The compliance rate for each indicator was calculated as the number of eligible patients who actually received the recommended intervention divided by all patients eligible for it. In-hospital mortality was defined as the percentage of patients who died during their hospital stay.

Statistical Analysis

We calculated the medians (interquartile ranges) for continuous variables that were not normally distributed,

and numbers (percentages) for categorical variables. The minimum, 25th percentile, 50th percentile, 75th percentile, and maximum were calculated for each process indicator across the 20 hospitals. In addition to the quality of care delivered itself, the outcome also might be influenced by patient characteristics, so we performed multivariate logistic analysis to calculate the standardized in-hospital mortality rate. The risk-adjustment factors included age, medical history (had or not before), status at hospital admission (dangerous, urgent, or general), renal disease (had or did not have at admission), cerebral infarction, electrolyte imbalance, arrhythmia, SBP (≥ 140 or < 140 mm Hg), and type of AMI (ST-segment elevation MI [STEMI] or non-STEMI).

In-hospital outcome (death or survival) was the dependent variable, and each process indicator (yes or no) was an independent variable separately. When different indicators were analyzed, the corresponding confounding factors varied. First, the confounding factors for each indicator were selected by a multivariate logistic model with a stepwise selection. The *P* value of 0.10 was used for entry in and 0.15 was used for retention in the model during selection. Considering the clustering effect of the population within hospitals, the hierarchical generalized linear model (HGLM) with a logit link was used to estimate the regression coefficients. Different confounding factors that were selected by the first step for each indicator were then chosen in the HGLM model, and *P* < 0.15 was taken as an acceptable level for sufficient adjustment. For each indicator, only the eligible patients were included in the analyses. All statistical analyses were conducted using SAS software version 9.1 (SAS Institute Inc., Cary, NC). A 2-sided *P* < 0.05 was considered as the level of statistical significance.

Results

Clinical Characteristics

Table 1 shows the clinical characteristics of the patients. Of 2128 patients, 34.02% were women and the median age was 63 years. A total of 64.14% of the patients had a history of disease before hospitalization, and 63.82% of the patients had an urgent condition for hospital admission. Approximately half of the patients had hypertension (42.20%); other major historical diseases were cerebral infarction (12.03%), coronary disease (11.56%), and diabetes mellitus (17.29%).

Compliance Measurements

A total of 592 of 827 patients (71.58%) with AMI actually received aspirin within 3 hours of hospital arrival. A β -blocker was provided in 498 of 1207 eligible patients (41.26%), whereas clopidogrel was supplied to 1647 of 1997 eligible patients (82.47%). Of 2010 patients who were recommended an ACEI, only 733 patients (36.47%) actually received it during their hospital stay. Statin had a high compliance rate, with 1606 of 1997 eligible patients (80.42%) receiving a statin. Conversely, only 45 of 875 patients (5.14%) who were eligible for a thrombolytic actually received it. A total of 1968 patients were considered suitable for treatment with PCI, but only 568 (28.86%) patients received it. For

Table 1. Baseline and Clinical Characteristics of the Patients

Characteristics	Overall Population
Female sex	724 (34.02)
Age, y	63 (55–73)
Han ethnicity	2070 (97.27)
Smoker	827 (38.86)
Drinker	376 (17.66)
Status at admission	
Dangerous	338 (15.88)
Urgent	1358 (63.82)
General	432 (20.30)
Medical history	1365 (64.14)
Cerebral infarction	256 (12.03)
HF	1 (0.05)
Renal disease	16 (0.75)
Liver disease	12 (0.56)
Hyperlipidemia	16 (0.75)
COPD	35 (1.64)
Coronary disease	246 (11.56)
Myocardosis	10 (0.47)
Rheumatic heart disease	5 (0.23)
Valvular disease	1 (0.05)
Hypertension	898 (42.20)
DM	368 (17.29)
GI ulcers	33 (1.55)
Malignant tumor	14 (0.66)
Abbreviations: COPD, chronic obstructive pulmonary disease; DM, diabetes mellitus; GI, gastrointestinal; HF, heart failure; IQR, interquartile range.	
Data are presented as n (%) or median (IQR).	

coronary angiography, 315 of 764 eligible patients (41.23%) received this procedure. Among the 8 process indicators, the compliance rate was highest for clopidogrel and lowest for the thrombolytic.

Of the 2128 patients, 163 (7.66%) died during their hospital stay. After adjustment for confounding factors (eg, sex, age, status at admission, medical history, smoking, drinking), the standardized in-hospital mortality rate ranged from 4.5% to 9.8% across 20 hospitals. Across all hospitals, the standardized median compliance rates for different indicators were as follows: aspirin, 70.23% (range, 35.05%–86.46%); β -blocker, 36.00% (range, 13.29%–56.4%); clopidogrel, 78.74% (range, 46.64%–100.0%); ACEI, 36.08% (range, 16.78%–63.65%); statin, 80.87% (range, 33.82%–91.55%); thrombolytic, 4.46% (range, 1.70%–16.62%); PCI, 33.89% (range, 2.28%–84.68%);

Table 2. Variation in Compliance With Indicators Across 20 Hospitals

Indicators	Min	25th Percentile	50th Percentile	75th Percentile	Max
AMI-1	35.05	53.38	70.23	80.53	86.46
AMI-2	13.29	31.39	36.00	43.76	56.41
AMI-3	46.64	72.95	78.74	84.84	100.00
AMI-4	16.78	28.78	36.08	40.78	63.65
AMI-5	33.82	73.14	80.87	86.91	91.55
AMI-6	1.70	2.33	4.46	7.73	16.62
AMI-7	2.28	24.28	33.89	41.22	84.68
AMI-8	1.97	29.85	39.89	54.57	100.00

Abbreviations: ACEI, angiotensin-converting enzyme inhibitor; AMI, acute myocardial infarction; AMI-1, aspirin; AMI-2, β -blocker; AMI-3, clopidogrel; AMI-4, ACEI; AMI-5, statin; AMI-6, thrombolytic; AMI-7, PCI; AMI-8, coronary angiography; Max, maximum; Min, minimum; PCI, percutaneous coronary intervention. Data are presented as percentages.

and coronary angiography, 39.89% (range, 1.97%–100.00%; Table 2).

Association Between Process Indicators and Outcome

The crude and adjusted odds ratios (ORs) with 95% confidence intervals for the association between process indicators and in-hospital mortality are shown in Table 3. The numbers of patients for different indicators were different because of different numbers of eligible patients. For 7 out of 8 indicators, patients who survived had a better compliance rate than those who died: aspirin, 73.28% vs 48.2%; β -blocker, 42.00% vs 26.32%; clopidogrel, 83.17% vs 72.99%; ACEI, 37.61% vs 20.30%; statin, 81.82% vs 60.61%; PCI, 30.46% vs 8.90%; and coronary angiography, 42.68% vs 15.00%. Therefore, patients who had received the recommendations for therapy were more likely to survive than patients who did not during their hospital stay. In univariate analysis, the association between PCI and mortality was the strongest (OR: 4.59), which suggested that patients who did not receive PCI had 4.59 $\times$ the risk of dying of those patients who received it. After adjustment for confounding factors, only 5 indicators were still found to be significantly associated with in-hospital mortality, and aspirin became the largest risk factor (OR: 3.07). β -Blocker, thrombolytic, and coronary angiography were not considered as predictive indicators.

Discussion

The quality of care for AMI patients has been assessed in other countries, showing that using quality indicators is effective in improving health services.^{18–20} Unlike the indicators provided by the American College of Cardiology and the American Heart Association (ACC/AHA), which comprised only process indicators, this study included additional outcome and structural indicators based on the theoretical framework of Donabedian medical quality system.^{21,22}

Each process indicator should be clearly defined for the purpose of assessment. Some indicators, such as aspirin and thrombolytic, have time restrictions, whereas others such as PCI do not have such restrictions.^{23,24} Many eligible patients cannot afford PCI due to its high cost. Coronary angiography is also very expensive, but for a definitive diagnosis and risk stratification, we still recommend it as a process indicator. As a higher compliance rate indicates a better quality of care, when all eligible patients actually received the intervention, the compliance rate should reach 100%. However, considering the fact that sometimes contraindications to a therapy are not always documented, the Canadian Cardiovascular Outcomes Research Team recommended benchmark values as <100%.¹² To accurately assess the quality of care accurately, valid and realistic benchmarks are required.²⁵

The 3 indicators (aspirin, β -blocker, and thrombolytic) used in our study had already been recommended by the ACC/AHA as first-line treatments for practice guidelines. These indicators were found to be effective in reducing in-hospital mortality for patients with AMI in multicenter clinical trials. However, the compliance rates were much less than the target level, with 90% as the lowest benchmark.²⁶ Except for clopidogrel and statin, other indicators all demonstrated poor compliance rates, indicating that the quality of care for AMI patients in these 20 hospitals needs to be improved. Compliance rates varied substantially among those hospitals, indicating that the deficiencies should be identified and actions taken to improve the quality of care.^{27,28}

As the lowest-compliance indicator in this study, the thrombolytic was rarely recommended by physicians. In these tertiary hospitals, physicians were inclined to recommend interventional treatments to patients.²⁴ Considering the fact that patients visiting these tertiary hospitals were at high risk, PCI was preferable to thrombolytic, according to the guidelines. Meanwhile, a higher compliance rate for PCI resulted in a further lower rate for thrombolytic. Therefore, it is reasonable to combine PCI with thrombolytic as a new process indicator for measuring reperfusion therapy in China.

Study Limitations

As the first study to assess the association between process indicators and outcome for AMI patients in China, this study has some limitations. Although health services have been improved with increased investment by the Chinese government, only inpatients can benefit from the current reimbursement policies based on inpatient data rather than data after discharge. Because of incomplete follow-up mechanisms, we found it difficult to obtain validated data after discharge. Therefore, in contrast to other studies, quality indicators for AMI patients in China have always focused on the data during their hospital stay. Another limitation of our study was accuracy in denominators and numerators. The medical records in China are designed for administrative rather than assessment purposes, which makes it difficult to retrieve all useful information. Some patients refused a recommended treatment because of their financial situation, and the numerator could be

Table 3. Univariate and Multivariate Analysis of Process-Outcome Associations

Quality Indicators	Survival, N = 1965	Death, N = 163	Univariate		Multivariate	
			OR (95% CI)	P Value	OR (95% CI)	P Value
AMI-1 ^a	565/771 (73.28)	27/56 (48.21)	3.27 (1.72-6.22)	0.0010	3.07 (1.55-6.08)	0.0028
AMI-2 ^b	483/1150 (42)	15/57 (26.32)	2.02 (1.05-3.86)	0.0355	1.84 (0.94-3.6)	0.0745
AMI-3 ^c	1547/1860 (83.17)	100/137 (72.99)	1.94 (1.23-3.04)	0.0064	1.63 (1.02-2.6)	0.0436
AMI-4 ^d	706/1877 (37.61)	27/133 (20.3)	2.29 (1.42-3.7)	0.0017	2.29 (1.41-3.73)	0.0021
AMI-5 ^e	1526/1865 (81.82)	80/132 (60.61)	2.86 (1.87-4.38)	< 0.0001	2.77 (1.8-4.28)	0.0001
AMI-6 ^f	40/820 (4.88)	5/55 (9.09)	0.57 (0.19-1.78)	0.3076	0.7 (0.21-2.28)	0.5241
AMI-7 ^g	555/1822 (30.46)	13/146 (8.9)	4.59 (2.43-8.67)	< 0.0001	2.99 (1.56-5.72)	0.0024
AMI-8 ^h	309/724 (42.68)	6/40 (15)	4.26 (1.59-11.38)	0.0063	2.74 (0.96-7.83)	0.0585

Abbreviations: ACEI, angiotensin-converting enzyme inhibitor; AMI, acute myocardial infarction; AMI-1, aspirin; AMI-2, β -blocker; AMI-3, clopidogrel; AMI-4, ACEI; AMI-5, statin; AMI-6, thrombolytic; AMI-7, PCI; AMI-8, coronary angiography; CI, confidence interval; OR, odds ratio; PCI, percutaneous coronary intervention; SBP, systolic blood pressure.

Data are presented as n (%) unless otherwise indicated.

^aAdjusting for age, status at hospital admission, medical history, arrhythmia, SBP, and type of AMI. ^bAdjusting for sex, age, status at hospital admission, renal disease, SBP, and type of AMI. ^cAdjusting for age, status at hospital admission, medical history, arrhythmia, electrolyte imbalance, SBP, and type of AMI. ^dAdjusting for age, status at hospital admission, arrhythmia, SBP, and type of AMI. ^eAdjusting for age, status at hospital admission, medical history, arrhythmia, SBP, and type of AMI. ^fAdjusting for age, status at hospital admission, arrhythmia, SBP, and type of AMI. ^gAdjusting for age, status at hospital admission, medical history, arrhythmia, renal disease, electrolyte imbalance, SBP, and type of AMI. ^hAdjusting for sex, age, status at hospital admission, arrhythmia, cerebral infarction, SBP, and type of AMI.

underestimated. Additionally, some information about contraindications might be incorrectly recorded, leading to an overestimation of the denominator.

Conclusion

To better understand and to improve the quality of care for AMI patients in China, further studies including some tertiary hospitals in other cities, such as Beijing and Shanghai, should be conducted in the future. With data from other cities, we will be able to verify the findings of this study. As new medical treatments emerge, process indicators will also need to be modified to continuously optimize the quality of care. Meanwhile, we will attempt to follow up those discharged patients to investigate the association between process indicators and long-term outcomes.

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