Changes in ST segment elevation myocardial infarction hospitalisations in China from 2011 to 2015

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ABSTRACT

Objective Access to acute cardiovascular care has improved and health services capacity has increased over the past decades. We assessed national changes in (1) patient characteristics, (2) in-hospital management and (3) patient outcomes among patients presenting with ST segment elevation myocardial infarction (STEMI) in 2011–2015 in China.

Methods In a nationally representative sample of hospitals in China, we created two random cohorts of patients in 2011 and 2015 separately. We weighted our findings to estimate nationally representative numbers and assessed changes from 2011 to 2015. Data were abstracted from medical charts centrally using standardised definitions.

Results While the proportion of patients with STEMI among all patients with acute myocardial infarction decreased over time from 82.5% (95% CI 81.7 to 83.3) in 2011 to 68.5% (95% CI 67.7 to 69.3) in 2015 (p<0.0001), the weighted national estimate of patients with STEMI increased from 210 000 to 380 000. The rate of reperfusion eligibility among patients with STEMI decreased from 49.3% (95% CI 48.1 to 50.5) to 42.2% (95% CI 41.1 to 43.4) in 2015 (p<0.0001); ineligibility was principally driven by larger proportions with prehospital delay exceeding 12 hours (67.4%–76.7%, p<0.0001).

Among eligible patients, the proportion receiving reperfusion therapies increased from 54% (95% CI 52.3 to 55.7) to 59.7% (95% CI 57.9 to 61.4) (p<0.0001). Crude and risk-adjusted rates of in-hospital death did not differ significantly between 2011 and 2015.

Conclusions In this most recent nationally representative study of STEMI in China, the use of acute reperfusion increased, but no significant improvement occurred in outcomes. There is a need to continue efforts to prevent cardiovascular diseases, to monitor changes in in-hospital treatments and outcomes, and to reduce prehospital delay.

INTRODUCTION

Over the past two decades in China access to acute cardiovascular care has improved and health services capacity has increased. Insurance reform began in 2003 and achieved the goal of minimum universal coverage by 2011.1 This period was also marked by an increasing burden of acute cardiovascular events and a focus on effective in-hospital management strategies. In response, several guideline updates for acute myocardial infarction (AMI) care were released during this period.2 3

Dynamic changes also occurred in the epidemiology and quality of care for ST segment elevation myocardial infarction (STEMI) hospitalisations in China between 2001 and 2011.4 Although a previous study found marked improvements in use of primary percutaneous coronary intervention (pPCI) as well as adjunctive STEMI therapies, the overall reperfusion rate and patient outcomes had not changed.4

The focus of healthcare reform in China has evolved from increasing access to care and expanding capacity to improving efficiency and quality of acute cardiovascular care.5 In this latest iteration of the China Patient-Centered Evaluative Assessment of Cardiac
Events (PEACE) Retrospective AMI Study, we report
data from 2015 to evaluate changes in patient charac-
teristics, presentations, use of guideline-based therapies
and outcomes. Our focus is to determine whether the
improvements in quality of care observed from 2001 to
2011 have continued and whether outcomes changed,
and to identify areas for improvement.
Accordingly, our aims were to assess national changes
among patients presenting with STEMI in 2011 and 2015
in (1) patient characteristics (demographic, cardiovascular
risk factors, medical history, clinical characteristics), (2) in-hospital management (use of recommended
treatments, procedures and diagnostic tests, and inappro-
priate use of non-evidence-based treatments), and (3) patient outcomes (in-hospital and 7-day mortality and complications).

METHODS
Data source and study design
The design of the China PEACE-Retrospective AMI Study had been previously described. In addition to a nationally
representative sample of patients admitted for AMI
in China during 2011, which was created in the China
PEACE-Retrospective AMI Study, we also included a
more recent sample of patients admitted in 2015 from
the same nationally representative hospital cohort, using
the same random sampling process (online supplemental
methods).
In the first stage, we created a sample of hospitals
that are representative of hospitals in China, excluding
military hospitals, prison hospitals, specialised hospitals
without a division for cardiovascular disease and hospita-
tals for traditional Chinese medicine. We stratified the
sample by five economic geographical regions (online
supplemental methods). In the second stage, using
systematic random sampling procedures we selected
patients with AMI from the local hospital database of
each sampled hospital (online supplemental methods).
Discharges with AMI were identified according to the
International Classification of Diseases-Clinical Modi-
fication codes, including versions 9 (410.xx) and 10 (I21.xx), when available, or through principal diagnosis
terms noted at discharge. Data were collected by central
abstraction of medical charts with use of standardised
data definitions. At each sampling stage, data quality
was monitored by random auditing of 5% of the medical
records, with overall variable accuracy exceeding 98%. A
waiver of patients’ written consent was approved since it
was not feasible to approach patients hospitalised several
years ago in a retrospective study. All collaborating hospi-
tals accepted the central ethics approval except for five
hospitals, which obtained local approval from internal
ethics committees (online supplemental methods).
Participants
Only patients with a definite discharge diagnosis of
STEMI were included in the study sample. The diagnosis
of STEMI was determined by the combination of clinical
discharge diagnosis terms and ECG results and validated
by review of ECGs from randomly selected records by a
cardiologist not involved in data abstraction. We treated
left bundle branch block as a STEMI equivalent.
We excluded all patients whose STEMI occurred during
the course of the hospitalisation because STEMI during
hospitalisation could be considered one severe and rare
complication of other clinical conditions (ie, coronary
artery bypass graft and trauma), so the treatment could
be very different, making it difficult to measure quality
of care. For the analysis of treatments, procedures and
tests, we excluded patients who had transferred in from
other hospitals or who had a length of stay of 24 hours
or shorter. For the analysis of in-hospital outcomes, we
excluded patients who were transferred in from another
hospital because we sought to characterise patients
admitted directly to the hospital. We also excluded
patients who were discharged alive within 24 hours because they may
have left against medical advice and there was very little
time for treatment.
Patient-level characteristics
Variables included patient-level characteristics (age, sex,
cardiovascular risk factors, medical history and clinical
characteristics at admission), defined as documentation
on the admission notes, discharge diagnosis or positive
laboratory test results (total cholesterol >5.18 mmol/L or
low-density lipoprotein ≥3.77 mmol/L, or high-density
lipoprotein <1.04 mmol/L in men or <1.30 mmol/L in
women).
Quality metrics
We assessed use of treatments recommended by the
2010 China National Guideline for STEMI, which were
consistent with those recommended by the guidelines
in the USA. These treatments included reperfusion
therapy, aspirin within 24 hours of admission, clopidogrel
or ticagrelor within 24 hours of admission, β blockers
within 24 hours of admission, ACE inhibitors or angio-
tensin receptor blockers during hospital admission, and
statins during hospital admission. We excluded patients
with documented contraindications (online supplemental
methods). We also assessed use of magnesium
sulfate (a treatment with no documented survival benefits
in the setting of STEMI), traditional Chinese medicine,
other procedures and tests. We included the seven main
categories of traditional Chinese medicine used for coro-
nary heart disease (online supplemental methods). We
did not include some care processes (eg, door-to-balloon
time and counselling for smoking cessation) due to inad-
quate documentation on the medical records.
We compared patients’ in-hospital outcomes with
three measures: death, death or withdrawal from treat-
ment due to terminal status at discharge (referred to
as treatment withdrawal), and composite complications
Coronary artery disease

including death, treatment withdrawal, reinfarction, cardiogenic shock, ischaemic stroke or congestive heart failure, defined in online supplemental methods). Treatment withdrawal is common in China due to reluctance of many patients to die in the hospital. The Chinese Government uses in-hospital death or treatment withdrawal as a quality measure for hospitals. Cardiologists in the coordinating study centre adjudicated the clinical status of patients who withdrew from treatment using medical records.

Statistical analysis
We examined patient characteristics, treatments, tests, procedures and crude rates of outcomes across different study years using the \( \chi^2 \) test for categorical variables and the Mann-Whitney test for continuous variables. We used percentages with 95% CI to describe categorical variables and median with IQR to describe continuous variables. We used multiple imputation for missing age values. To estimate nationally representative numbers of hospitalisations for 2011 and 2015, we applied sampling weights proportional to the inverse sampling fraction of hospitals within each stratum and the sampling fraction of patients within each hospital.

We did multilevel logistic regressions accounting for clustering of patients within hospitals. We included year 2015 as key explanatory variable, while adjusting for patients’ demographics (age and sex), risk factors or medical history (hypertension, diabetes, current smoker, previous myocardial infarction, previous coronary heart disease and previous stroke), and clinical characteristics at admission (chest discomfort, cardiac arrest, acute stroke, heart rate and systolic blood pressure). The dependent variables were in-hospital death, in-hospital death or treatment withdrawal, and in-hospital composite complications. We transformed continuous variables (eg, age, heart rate and systolic blood pressure) into categorical variables according to clinically meaningful cut-off values. We report OR and 95% CI from the multilevel logistic regression related to the year indicators. In view of the small decrease in length of hospital stay over time, a sensitivity analysis was performed using 7-day outcomes using the same approach as for in-hospital outcomes. We also repeat outcome analyses using a sample of patients that includes patients transferred in from other facilities.

All comparisons were two-sided, with statistical significance defined as p<0.05. Statistical analysis was done with SAS V.9.2 software and R V.3.0.2.

Patient and public involvement
This research was done without patient or public involvement.

RESULTS
Demographical and clinical characteristics
During 2011 and 2015, we identified 21167 patients with AMI, including 15807 patients with STEMI, in 166 hospitals in China (figure 1A, online supplemental figure S1). The absolute number of STEMI hospitalisations increased from 7696 in 2011 to 8111 in 2015 (figure 1A). Applying sample weighting showed the number of patients hospitalised with STEMI increased from 0.21 million in 2011 to 0.38 million in 2015 (figure 1B). In our sample, the proportion of patients with STEMI among all patients with AMI decreased from 82.5% (95% CI 81.7 to 83.3) in 2011 to 68.5% (95% CI 67.7 to 69.3) in 2015 (p<0.0001; online supplemental figure S1).

Figure 1
Number of patients by year and condition. (A) Number of patients in PEACE-Retrospective AMI Study. (B) Weighted number of patients in China. To estimate nationally representative numbers of hospitalisations for 2011 and 2015, we applied sampling weights proportional to the inverse sampling fraction of hospitals within each stratum and the sampling fraction of patients within each hospital to account for differences in the sampling fraction for 2011 in all analyses. AMI, acute myocardial infarction; NSTEMI, non-ST segment elevation myocardial infarction; PEACE, China Patient-Centered Evaluative Assessment of Cardiac Events; STEMI, ST segment elevation myocardial infarction.
Among patients with STEMI, the prevalence of diabetes and dyslipidaemia increased (p<0.001), the prevalence of smoking decreased (p<0.05), and the prevalence of hypertension did not change (p=0.1; table 1). In 2015, 51.7% of patients had hypertension, 22.4% had diabetes, 79.5% had dyslipidaemia and 35.2% were current smokers (table 1). The proportion of patients with a medical history of myocardial infarction decreased from 10.6% in 2011 to 7% in 2015, while a medical history of coronary heart disease and percutaneous coronary intervention became more prevalent (p<0.01; table 1).

Between 2011 and 2015, the median time between symptom onset and hospital admission increased from 12 hours (IQR 3–72) to 24 hours (IQR 4–96) (p<0.0001; table 1). In 2015, 56.9% (95% CI 55.7 to 58) of patients had a long prehospital delay, defined as >12 hours between symptom onset and admission (online supplemental table S2). The prevalence of left bundle branch block on admission decreased, while the prevalence of cardiogenic shock, acute stroke and tachycardia (defined as heart rate >110 beats per minute) increased (p<0.05; table 1). The median Mini-Global Registry of Acute Coronary Events scores did not change significantly between 2011 and 2015 (table 1).

Among all patients with STEMI, the rate of reperfusion eligibility decreased from 49.3% (95% CI 48.1 to 50.5) in 2011 to 42.2% (95% CI 41.1 to 43.4) in 2015 (p<0.0001; online supplemental table S3). Among ineligible patients, ineligibility was principally driven by increased prevalence of long prehospital delay (online supplemental table S4).

### Use of treatments, procedures and diagnostic tests

After exclusion of 630 patients transferred in from other facilities and 1416 patients with length of stay ≤24 hours, 13761 patients with STEMI were included in the analysis of treatments, procedures and tests (online supplemental figure S1).

Use of troponin tests increased from 63.1% (95% CI 62 to 64.3) in 2011 to 80.0% (95% CI 79.1 to 80.9) in 2015 (p<0.0001; table 2). Use of other cardiac enzyme tests decreased between 2001 and 2015 (p<0.0001; table 2). Use of echocardiography increased from 63.1% (95% CI 61.9 to 64.2) in 2011 to 72.1% (95% CI 71 to 73.1) in 2015 (p<0.0001; table 2).

Among patients eligible for reperfusion, the proportion receiving reperfusion therapies increased from 54.0% (95% CI 52.3 to 55.7) in 2011 to 59.7% (95% CI 57.9 to 61.4) in 2015, in which use of pPCI increased from 21.1% (95% CI 19.7 to 22.5) to 33.7% (95% CI 32.1 to 35.4) and use of fibrinolytic therapy decreased from 32.9% (95% CI 31.3 to 34.5) to 25.9% (95% CI 24.4 to 27.5) (p<0.01; table 2). Meanwhile, the prehospital delay of patients who received reperfusion therapy was longer in 2015 than in 2011 (3 hours (IQR 2–6) vs 3 hours (IQR 2–5), p<0.0001).

Use of statins and use of clopidogrel or ticagrelor increased between 2011 and 2015 (p<0.0001; table 2). Use of ACE inhibitors or angiotensin receptor blockers

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**Table 1** Characteristics of patients with STEMI in 2011 and 2015

<table>
<thead>
<tr>
<th>Variable</th>
<th>2011 (n=7696)</th>
<th>2015 (n=8111)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Demographics</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age (years)</td>
<td>65 (55–75)</td>
<td>65 (55–74)</td>
<td>0.9</td>
</tr>
<tr>
<td>Women</td>
<td>2247 (29.2)</td>
<td>2311 (28.5)</td>
<td>0.3</td>
</tr>
<tr>
<td><strong>Cardiovascular risk factors</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypertension</td>
<td>3890 (50.5)</td>
<td>4197 (51.7)</td>
<td>0.1</td>
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<tr>
<td>Diabetes</td>
<td>1558 (20.2)</td>
<td>1818 (22.4)</td>
<td>0.0009</td>
</tr>
<tr>
<td>Dyslipidaemia</td>
<td>4843 (62.9)</td>
<td>6452 (79.5)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Current smoker</td>
<td>2854 (37.1)</td>
<td>2853 (35.2)</td>
<td>0.01</td>
</tr>
<tr>
<td><strong>Clustering of risk factors</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥3</td>
<td>1612 (20.9)</td>
<td>2027 (25)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>2</td>
<td>2878 (37.4)</td>
<td>3360 (41.4)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>1</td>
<td>2357 (30.6)</td>
<td>2275 (28)</td>
<td>0.0044</td>
</tr>
<tr>
<td>None</td>
<td>849 (11)</td>
<td>449 (5.5)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td><strong>Medical history</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Myocardial infarction</td>
<td>814 (10.6)</td>
<td>569 (7)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Coronary heart disease</td>
<td>1568 (20.4)</td>
<td>1897 (23.4)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>PCI</td>
<td>180 (2.3)</td>
<td>251 (3.1)</td>
<td>0.004</td>
</tr>
<tr>
<td>Coronary artery bypass graft</td>
<td>21 (0.3)</td>
<td>14 (0.2)</td>
<td>0.2</td>
</tr>
<tr>
<td>Stroke</td>
<td>897 (11.7)</td>
<td>1022 (12.6)</td>
<td>0.07</td>
</tr>
<tr>
<td><strong>Clinical characteristics</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Symptom onset to admission (hours)</td>
<td>12 (3–72)</td>
<td>24 (4–96)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Chest discomfort</td>
<td>7118 (92.5)</td>
<td>7478 (92.2)</td>
<td>0.5</td>
</tr>
<tr>
<td>Left bundle branch block</td>
<td>97 (1.3)</td>
<td>65 (0.8)</td>
<td>0.0044</td>
</tr>
<tr>
<td>Cardiac arrest</td>
<td>125 (1.6)</td>
<td>104 (1.3)</td>
<td>0.07</td>
</tr>
<tr>
<td>Cardiogenic shock</td>
<td>508 (6.6)</td>
<td>630 (7.8)</td>
<td>0.005</td>
</tr>
<tr>
<td>Acute stroke</td>
<td>83 (1.1)</td>
<td>217 (2.7)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td><strong>Heart rate (beats per minute)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;50</td>
<td>384 (5)</td>
<td>306 (3.8)</td>
<td>0.0002</td>
</tr>
<tr>
<td>50–110</td>
<td>6917 (89.9)</td>
<td>7278 (89.7)</td>
<td>0.8</td>
</tr>
<tr>
<td>&gt;110</td>
<td>395 (5.1)</td>
<td>527 (6.5)</td>
<td>0.0003</td>
</tr>
<tr>
<td>Heart rate</td>
<td>76 (65–89.5)</td>
<td>78 (66–90)</td>
<td>0.0009</td>
</tr>
<tr>
<td><strong>Systolic blood pressure (mm Hg)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;90</td>
<td>408 (5.3)</td>
<td>430 (5.3)</td>
<td>&gt;0.9</td>
</tr>
<tr>
<td>90–139</td>
<td>4658 (60.5)</td>
<td>5017 (61.9)</td>
<td>0.09</td>
</tr>
<tr>
<td>≥140</td>
<td>2630 (34.2)</td>
<td>2664 (32.8)</td>
<td>0.08</td>
</tr>
<tr>
<td><strong>Mini-GRACE risk score</strong></td>
<td>142 (122–160)</td>
<td>141 (120–160)</td>
<td>0.06</td>
</tr>
</tbody>
</table>

Data are median (IQR) or n (%), for which n is the number of patients in the study sample and % is a nationally representative rate. GRACE, Global Registry of Acute Coronary Events; PCI, percutaneous coronary intervention; STEMI, ST segment elevation myocardial infarction.

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(table S1). Between 2011 and 2015, the median age of patients and the proportion of women did not change (table 1). In 2015, the median age was 65 years (IQR 55–74) and 28.5% of patients were women (table 1).
Coronary artery disease

decreased (p<0.0001; table 2). Use of magnesium sulfate increased (p<0.001) and use of traditional Chinese medicine did not significantly change (p=0.2; table 2). Use of coronary angiography during hospitalisation increased (p<0.0001; table 2).

In-hospital and 7-day outcomes

After exclusion of 630 patients transferred in from other facilities, 2281 patients transferred out to other facilities and 132 patients discharged alive within 24 hours, 12764 patients with STEMI were included in the analysis of in-hospital and 7-day outcomes (6472 in year 2011 and 6292 in year 2015; online supplemental figure S1).

The median length of stay decreased from 11 days (IQR 7–15) to 10 days (IQR 7–13) (p<0.0001; online supplemental table S5). Crude rates of in-hospital death were unchanged between 2011 and 2015 (p=0.9; online supplemental table S5). Adjustment for patient demographic and clinical characteristics in the multi-level logistic regression model did not differ significantly between 2011 and 2015 with respect to death, treatment withdrawal or complications during hospitalisation (p>0.05; figure 2). Adjusted outcomes calculated with a 7-day timeframe showed similar results as the in-hospital analysis (figure 3). With the inclusion of 630 patients transferred in from other facilities, adjusted in-hospital outcomes and 7-day outcomes remained similar to the main analyses (online supplemental figures S2 and S3).
DISCUSSION
In this nationally representative retrospective study in China, our findings had implications for measuring and improving quality of care for STEMI. First, the number of AMI hospitalisations doubled from 2011 to 2015. Although the proportion of those with STEMI decreased,

**Figure 2** Adjusted in-hospital outcomes for patients with STEMI. Adjusted OR of 1 shows no difference from year 2011. We included 12,764 patients (6,472 in year 2011 and 6,292 in year 2015). We excluded 630 patients transferred in from other facilities, 2,281 patients transferred out to other hospitals at any timepoint and 132 patients discharged alive within 24 hours. C=0.774 for mortality, C=0.793 for death or treatment withdrawal, and C=0.694 for composite complications. STEMI, ST segment elevation myocardial infarction.

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**Figure 3** Adjusted 7-day outcomes among patients with STEMI. Adjusted OR of 1 shows no difference from year 2011. We included 13,518 patients (6,715 in year 2011 and 6,803 in year 2015). We excluded 630 patients transferred in from other facilities, 1,527 patients transferred out to other hospitals within 7 days of admission and 132 patients discharged alive within 24 hours. C=0.773 for mortality and C=0.791 for death or treatment withdrawal. STEMI, ST segment elevation myocardial infarction.
the total number of patients with STEMI nearly doubled. Second, among patients with STEMI, the proportion of patients eligible for reperfusion decreased, primarily due to an increase in prehospital delay. Third, among those eligible for reperfusion, while significantly more received guideline-recommended therapy, substantial room for improvement remained. Fourth, among those receiving reperfusion therapy, we observed a continued shift away from fibrinolytic therapy towards pPCI. Finally, patient in-hospital outcomes did not improve between 2011 and 2015.

Regarding epidemiology, we note that from 2011 to 2015, non-ST segment elevation myocardial infarction (NSTEMI) cases as a proportion of all AMI cases increased, continuing the trend observed between 2001 and 2011. As we have previously reported, this is likely due to an increased use of sensitive biomarkers for myocardial injury in China,10 which would increase the diagnoses of NSTEMI,11 as well as a concomitant change in the Chinese population at risk of AMI.12 Despite increasing numbers of NSTEMI, the predominant AMI presentation in China continues to be STEMI, in contrast to high-income countries. This could be attributable to China’s comparatively higher rates of smoking and lower rates of use of preventive therapy (eg, aspirin, statins), which are factors more strongly associated with STEMI than NSTEMI.13-15 Similarly, this study found an increased proportion of patients with concomitant stroke in 2015, which might be explained by the unchanged or worsened prevalence of stroke-related risk factors, such as hypertension, diabetes and dyslipidaemia.16

We found processes of care improved, consistent with prior studies.17 18 For example, we found a notable increase in use of antiplatelet therapies, which may be attributable to the introduction of ticagrelor as a guideline-based medical therapy (GDMT) for AMI during the study period.19 However, obstacles remain, such as the persistent use of ineffective therapies such as magnesium sulfate, which had been shown to vary by hospital and physician characteristics in China.20 21 To improve the uptake of GDMT and other evidence-based processes in AMI care, a deeper understanding of the sources of practice variation is needed, many of which may be related to local and regional differences in resource allocation. Similarly, although the rate of cardiogenic shock increased over time, use of mechanical support devices such as intra-aortic balloon pump (IABP) decreased. This could be explained by a prior finding that in clinical practice in China, IABP is more often used as preventive implantation before pPCI and less often used for cardiogenic shock.22 Further, the Intraaortic Balloon Support for Myocardial Infarction with Cardiogenic Shock II (IABP-SHOCK II) trial results were published in 2012 and may have influenced clinical practice away from use of IABP for cardiogenic shock.23

Despite an increase in use of reperfusion therapies and guideline-based medications, we found no significant improvement in patient outcomes (in-hospital and 7-day mortality and complications) in 2015 compared with 2011. It is likely that there are multiple mechanisms for this finding. First, clinical outcomes may be confounded by variables not captured in this study. A prior study on geographical variation in China’s quality of care for STEMI reported a similar paradox. The western region, which had the best performance in processes of care, such as use of clopidogrel, ACE inhibitors/angiotensin receptor blockers and statins, had worse mortality than hospitals in the central region,21 which had worse performance on processes of care.24 However, second, we did find a decrease in the proportion of patients eligible for reperfusion on admission, with one of the drivers being increased prehospital delay, which may have masked the potential benefit of increased reperfusion rate among those eligible as observed at a cohort level. Further, we found that although marked shifts in acute reperfusion therapy occurred with a move from fibrinolysis to pPCI, among reperfused patients the time to reperfusion increased in 2015.

Prior studies vary in their reports of the prevalence of prehospital delay, with studies reporting from 8.6% to 34.1% of patients with STEMI in China present to the hospital >12 hours after symptom onset.25 26 Prehospital delay can be influenced by accessibility (eg, transportation or distance to hospitals), affordability and patient preferences, factors not captured by many quality of care studies including our study. Further, these three factors may vary across time and geography and interact with one another. For example, as transportation and affordability improve, some patients may choose to bypass local hospitals for more distant hospitals perceived to offer better care. Prior studies on patient choice have shown that for severe conditions, patients prefer large hospitals with advanced equipment and expert physicians.27-29 Regardless, this is a finding worthy of further indepth study, as timely reperfusion is key for optimal outcomes for STEMI. To reliably deliver good outcomes in time-bound STEMI care, a unified STEMI network is ideal with the involvement of physician societies, state governments, ambulance agencies and hospitals.

Our findings have important implications for practice and policy. Given the increasing number of STEMI hospitalisations, prevention of cardiovascular diseases remains a public health priority. To improve outcomes for patients with existing cardiovascular conditions, China has instituted several hospital-based initiatives, such as the establishment of national (and provincial) medical quality control centres to routinely measure the performance of local hospitals on major diseases, as well as healthcare alliance with vertical collaborations between hospitals of varied levels to facilitate dissemination of clinical knowledge and experiences.30 31 Efforts to improve reperfusion of eligible patients remain important. Prehospital delay in China is higher than in high-income countries.32-34 Studies have shown that 24% of Chinese patients with STEMI present without typical chest pain and often seek non-emergent medical care when no chest pain occurs,
which delays definitive treatment.33 35 This highlights the need to increase population awareness of the symptoms of myocardial infarction, especially atypical symptoms, and the importance of seeking timely care STEMI care; such efforts require involvement of physician societies, state governments, ambulance agencies and hospitals.36 37 In general, exploration of a broader range of care processes, beyond hospital treatment, would enhance quality improvement efforts.

The present study has several limitations. First, as a fixed cohort of hospitals that was representative in 2011, the China PEACE network’s 2015 iteration may not reflect the national increase in hospitals treating STEMI between 2011 and 2015. Second, the quality of our data depends on the accuracy and completeness of prior documentation and abstraction. Nevertheless, the standardised procedures for abstraction of medical records ensure the reliability of our results in the treatments and outcomes. Third, changes in the clinical characteristics, care and outcomes are likely to have occurred between 2015 and the present. However, our data remain the most recently available data that are nationally representative. Fourth, some quality metrics of STEMI care, such as door-to-balloon, were missing since they were not routinely documented on the medical records.

In conclusion, our study identifies several changes in patient characteristics, treatment patterns and outcomes for STEMI in China from 2011 to 2015. The overall number of STEMI hospitalisations has increased substantially even though the proportion of STEMI continues to reduce. Prehospital delay renders a larger proportion of patients eligible for reperfusion, highlighting an urgent need for improvement.38 39 Further, increasing reperfusion rates and use of pPCI have not translated to an improvement in mortality, which warrants further study.

The health system of China can benefit from an integrated data repository which delays definitive treatment.33 35 This highlights the need to increase population awareness of the symptoms of myocardial infarction, especially atypical symptoms, and the importance of seeking timely care STEMI care; such efforts require involvement of physician societies, state governments, ambulance agencies and hospitals.36 37 In general, exploration of a broader range of care processes, beyond hospital treatment, would enhance quality improvement efforts.

The present study has several limitations. First, as a fixed cohort of hospitals that was representative in 2011, the China PEACE network’s 2015 iteration may not reflect the national increase in hospitals treating STEMI between 2011 and 2015. Second, the quality of our data depends on the accuracy and completeness of prior documentation and abstraction. Nevertheless, the standardised procedures for abstraction of medical records ensure the reliability of our results in the treatments and outcomes. Third, changes in the clinical characteristics, care and outcomes are likely to have occurred between 2015 and the present. However, our data remain the most recently available data that are nationally representative. Fourth, some quality metrics of STEMI care, such as door-to-balloon, were missing since they were not routinely documented on the medical records.

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Coronary artery disease

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No data are available. The data underlying this article cannot be shared publicly due to the privacy of individuals who participated in the study.

Correction notice Since this article was first published online, the term infarction in the title has been corrected. It previously contained a typo.

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