Association between process indicators and in-hospital mortality among patients with chronic heart failure in China

Rong Fu¹, Jing Xiang¹, Han Bao¹, Zhiqiang Wang², Yupeng Wang¹, Yongjie Chen¹, Huimin Zhang¹, Dan Liu¹, Meina Liu¹

1 Department of Biostatistics, Public Health College, Harbin Medical University, Harbin, P.R. China
2 School of Medicine, the University of Queensland, Room 817, Health Sciences Building, Royal Brisbane & Women’s Hospital, Herston, QLD 4029, Australia

Correspondence: Meina Liu, Public Health College, Harbin Medical University, 157 Baojian Road, Harbin City, Heilongjiang Province, 150081, P.R. China, Fax: +86 (0) 86 0451 87502831, e-mail: liumeina369@163.com

Background: Quality indicators for Chinese patients with chronic heart failure (CHF) have been developed. However, little is known about the compliance with quality indicators and the association between process indicators and in-hospital mortality in China. Methods: Data from 1862 CHF admissions between 1 January 2009 and 31 October 2010 at 20 tertiary hospitals in Heilongjiang Province were analyzed. Hierarchical generalized linear models were used to examine the association between six process indicators and in-hospital mortality in eligible patients. Results: The in-hospital mortality for the 1862 patients was 4.7%. The compliance with six process indicators were: evaluation of left ventricular function, 66.4%; angiotensin-converting enzyme inhibitor (ACEI)/angiotensin receptor blocker (ARB), 54.9%; diuretic, 86.2%; beta-blocker, 45.1%; aldosterone-receptor antagonist, 64.0%; and warfarin, 17.1%. Rates of compliance at the hospital level varied from 0 to 100%. After the adjustment for confounding factors, evaluation of left ventricular function, ACEI/ARB and aldosterone receptor antagonist were significantly associated with in-hospital mortality ([OR, 0.55; 95% CI, 0.33–0.93; P = 0.027], [OR, 0.33; 95% CI, 0.12–0.94; P = 0.040] and [OR, 0.35; 95% CI, 0.13–0.98; P = 0.046], respectively). Conclusions: There are considerable gaps between guidelines and clinical practice and variations across hospitals for the treatment of patients with CHF. Evaluation of left ventricular function, ACEI/ARB and aldosterone receptor antagonist will reduce the risk of in-hospital mortality. The association of other process indicators with clinical outcomes remain to be established.

Introduction

Chronic heart failure (CHF) is one of the serious public health issues in China. An epidemiological survey throughout 10 Chinese provinces revealed that 0.9% of residents aged 35–74 years old had been diagnosed as CHF. This accounts for 20% hospitalization and 40% death of cardiovascular diseases which are the leading cause of death in Chinese residents except cancer. The morbidity and costs associated with treating CHF patients are likely to increase over the next decade due to the aging of the population. Optimal quality of care may reduce the huge burden of morbidity, mortality and health care expenditures. Professional societies, government agencies, accreditation organizations and insurers in Western countries are all involved in efforts to assess and improve quality of care in hospital settings. In order to optimize the quality of care for Chinese patients, CHF-specific quality indicators suited to the Chinese health-care system have been identified, which lay the groundwork for future initiatives aimed at assessing and improving quality of care.

The process indicators were developed based on the assumption that clinical practice complying with evidence-based therapies by hospitals can reduce the likelihood of adverse outcomes among patients. It is intended to assess the quality of care delivered by Chinese health-care providers and serve as the criteria of pay for performance with these indicators. Therefore, it is especially important that each process indicator is evidence-based and has significant impact on patient outcomes.

Although the scientific evidence of current performance measures is strong, existing studies have shown inconsistent associations between clinical care processes and outcomes. Several studies have suggested that higher compliance with quality indicators is associated with a lower risk of mortality and readmission. However, the associations between American College of Cardiology/American Heart Association performance measures and early mortality have been not reported except that angiotensin-converting enzyme inhibitor (ACEI) or angiotensin receptor blocker (ARB) at discharge have been found to be associated with 60–90-day post-discharge mortality or rehospitalization. An analysis of data from a university hospital in Louisiana even shown that compliance with the Joint Commission on Accreditation of Healthcare Organization performance measures would increase the risk of readmission.

Compared with most discharge indicators and follow-up indicators of other organizations, Chinese quality indicators for CHF patients mainly consist of recommended interventions during the hospital stay. The differences reflect the actual health care conditions in China. The State Council has conducted health-care system reform to improve medical security of Chinese people. As the government increased investments to health care, the proportion of individual health expenditure in the total health expenditure decreased from 60.0% in 2001 to 34.9% in 2011. However, the reimbursement policies mainly cover inpatients but outpatient treatment will be paid by patients themselves. Therefore, the use of recommended interventions during the hospital stay has become the focus of quality of care measurement in China. Furthermore, the follow-up mechanism of China was incomplete as the results revealed that it was difficult to access patient data after discharge. To date, there is little knowledge about the degree of compliance with recommended interventions in CHF care and limited available data about whether complying with those
interventions will reduce the risk of mortality in China. In this study, we assessed the quality of care for CHF patients and examined the association between process indicators and in-hospital mortality using the data from the medical records of patients admitted in 20 tertiary hospitals in China. This study will provide evidence for improving the quality of care for CHF patients.

Methods

Quality indicators

Six process indicators and one outcome indicator were assessed. The descriptions of each indicator included the denominator which was the patients eligible for an intervention with no contraindications to that intervention and the numerator which was the eligible patients who actually received the recommended intervention, as follows:

1. Evaluation of left ventricular function: **Denominator**: CHF patients; **Numerator**: CHF patients with documentation in the hospital record that left ventricular function was assessed before arrival, or during hospitalization, or was planned for after discharge.

2. ACEI/ARB: **Denominator**: CHF patients with left ventricular systolic dysfunction (LVSD) and without contraindications to ACEI or ARB (e.g., allergy to ACEI, aortic stenosis, bilateral renal artery stenosis, renal dysfunction, hyperkalemia); **Numerator**: Patients who were prescribed an ACEI during hospital stay or patients with contraindications to ACEI who were prescribed an ARB during hospital stay.

3. Diuretic: **Denominator**: CHF patients with fluid retention and without contraindications to diuretic (e.g., gout, liver dysfunction, renal dysfunction, electrolyte disturbance, hypotension); **Numerator**: Patients who were prescribed a diuretic during hospital stay.

4. Beta-blocker: **Denominator**: CHF patients with LVSD and without contraindications to beta-blocker (e.g., heart rate <60 beats min⁻¹, conduction system disease, hypotension, asthma, severe obstructive lung disease); **Numerator**: Patients who were prescribed a beta-blocker during hospital stay.

5. Aldosterone receptor antagonist: **Denominator**: Moderate or severe CHF patients with LVSD and without contraindications to aldosterone receptor antagonist (e.g., hypotension, hyperkalemia, renal dysfunction); **Numerator**: Patients who were prescribed an aldosterone receptor antagonist during hospital stay.

6. Warfarin: **Denominator**: CHF patients with atrial fibrillation and without contraindications to warfarin (e.g., bleeding episode, liver dysfunction, renal dysfunction, hypertension, allergy to warfarin); **Numerator**: Patients who were prescribed warfarin during hospital stay.

7. In-hospital mortality: **Denominator**: CHF patients; **Numerator**: Patients who died during hospital stay.

The compliance rates with process indicators were calculated as the number of eligible patients who actually received the recommended intervention (Numerator) divided by the total number of eligible patients for that intervention (Denominator). The crude in-hospital mortality was defined as the percentage of patients who died during hospital stay.

Data source

This was a retrospective study of patients who were admitted in 20 tertiary hospitals of Heilongjiang Province in Northeast China between 1 January 2009 and 31 October 2010. To be eligible for the research, patients had to be hospitalized with an episode of worsening heart failure as the primary cause for admission or with heart failure symptoms during hospitalization in which heart failure was the primary discharge diagnosis, according to International Classification of Diseases, Tenth Revision codes I50.001, I50.003, I50.004, I50.103, I50.105–I50.107, I50.902, I50.905–I50.910, I50.912, I50.951 and I50.952. The database managers in each hospital de-identified medical records by removing names, addresses and telephone numbers of patients before we abstracted the data. Every patient was identified by a unique medical record number. One hundred patients within each hospital were randomly selected after all available medical records from that hospital were sorted by medical record numbers, and all medical records were used if a hospital had fewer than 100 records. Four trained data collectors used standardized definitions to abstract patient data. Patient variables included demographic characteristics, addiction (e.g., smoking, drinking), medical history (had or not), clinical presentation (e.g., status at admission, admission diagnosis, heart rate), therapies, associated main contraindications to therapies and in-hospital outcome (e.g., mortality, length of stay). To ensure the reliability of data, two collectors abstracted the same discharge record. The inter-collector consistency was assessed at the end of each day. When the agreement rate fell below 95%, the record was reviewed the next day.

Study population

Between 1 January 2009 and 31 October 2010, 1887 patients were entered into the study population. We excluded 5 patients who were younger than 18 years and 20 patients who left hospital without clinician admission. The remaining 1862 patients were included in this study. We identified patients who were eligible for each recommended intervention as the denominator and those who had actually received the intervention as the numerator to assess the hospital quality of care according to that process indicator.

Statistical analysis

Medians (interquartile ranges) for continuous variables, and numbers (percentages) for categorical variables were reported. The minimum, 25th, 50th, 75th and maximum values were calculated for each process indicator across 20 hospitals. Because in-hospital outcome might have also been influenced by patient characteristics in addition to the quality of care delivered, multivariate analysis was performed to calculate standardized in-hospital mortality for each hospital, with adjustment for confounding factors such as age, medical history (had or not), status at hospital admission (dangerous, urgent or general), renal disease (e.g., renal dysfunction, chronic renal failure), liver disease (e.g., hepatitis, cirrhosis, liver damage), hypertension, low sodium syndrome and length of stay.

The association between each process indicator and in-hospital mortality was assessed using a univariate and a multivariate analysis with in-hospital outcome (death or survival) as the dependent variable and compliance with a process indicator (yes or no) as the independent variable. Patient characteristics were adjusted for as potential confounding factors in the multivariate analysis. The confounding factors varied for different process indicators.

In all the multivariate analyses, the confounding factors were first selected with a stepwise selection procedure by a multivariate logistic model. The P value of 0.05 was used for entry in, and 0.10 was used for retention in the model during the selection process. Accounting for the hierarchical nature of the study population (patients clustered within hospitals), we reestimated the regression coefficients of the independent variable using hierarchical generalized linear model (HGLM) with a logit link. The confounding factors identified by stepwise strategy were further manually selected in the HGLM and P < 0.15 was considered as acceptable level to sufficiently adjust for confounding factors. The model intercept was initially entered as random coefficient in all the HGLMs, and only eligible patients were included in each of these analyses. The C statistics (area under receiver operating characteristic curve) was estimated to evaluate the goodness of fit for the HGLMs.
All statistical analyses were conducted using SAS software version 9.2. A two-sided \( P < 0.05 \) was established as the level of statistical significance for all tests.

## Results

### Baseline and clinical characteristics

Table 1 shows baseline and clinical characteristics for the overall population. Median age at hospital admission was 70 years, and 51.6% of admitted patients were male. Of 1862 patients, 74.1% patients had a history of disease before hospitalization and 4.9% patients were recorded as dangerously ill at hospital admission. Most of the patients admitted to the hospitals had coronary heart disease (70.9%), arrhythmia (51.9%), hypertension (51.5%) and respiratory disease (41.3%). The overall median heart rate and length of hospital stay were 88 beats min\(^{-1}\) and 11 days, respectively.

### Performance and variation

In aggregate, 1237 (66.4%) of 1862 CHF patients were evaluated for left ventricular function. An ACEI/ARB was provided in 352 (54.9%) of 641 eligible patients. Of 1678 eligible patients, 1446 (86.2%) patients received a diuretic during their hospital stay. In total, 503 patients were considered eligible for treatment with beta-blockers, but only 227 (45.1%) patients received that treatment. An aldosterone receptor antagonist was given in 412 (64.0%) of 644 eligible patients. Only 86 (17.1%) of 502 eligible patients were prescribed warfarin. Of the six process indicators, the compliance rate with diuretic was highest and warfarin was lowest.

Eighty-seven (4.7%) of 1862 patients died during the hospital stay. The \( C \) statistics for in-hospital mortality HGLM was 0.80. Standardized in-hospital mortality across 20 hospitals ranged from 2.6 to 7.6%. The variation in standardized in-hospital mortality was associated with in-hospital mortality. Patients receiving these interventions had a 45, 67 and 65% relative-reduced risk of in-hospital mortality, respectively. The other three process indicators were not significantly associated with in-hospital mortality. The \( C \) statistics for these multivariate HGLMs ranged from 0.75 to 0.86.

### Process-outcome link

Patients who survived were more likely to have received the evaluation of left ventricular function (67.4 \( \text{vs} \) 47.1%), prescription of ACEI/ARB (55.7 \( \text{vs} \) 30.0%) and aldosterone receptor antagonist (64.6 \( \text{vs} \) 42.1%). The unadjusted and risk-adjusted odds ratios (ORs) and 95% confidence intervals (CIs) for the association between process indicators and in-hospital mortality are presented in table 3. Of the six process indicators, compliance with evaluation of left ventricular function and prescription of ACEI/ARB for CHF patients with LVSD were predictive of in-hospital mortality in the univariate analysis. After the adjustment for confounding factors, the evaluation of left ventricular function, prescription of ACEI/ARB and aldosterone receptor antagonists were found to be associated with in-hospital mortality. Patients receiving these interventions had a 45, 67 and 65% relative-reduced risk of in-hospital mortality, respectively. The other three process indicators were not significantly associated with in-hospital mortality. The \( C \) statistics for these multivariate HGLMs ranged from 0.75 to 0.86.

### Discussion

The Institute of Medicine defined quality of care as ‘the degree to which health care services for individuals and populations increase the likelihood of desired health outcomes and are consistent with current professional knowledge.’\textsuperscript{22} Yet quantifying quality of care is an important and challenging process. Researchers have reached a...
consensus that quality indicators could provide a mechanism to detect strengths and weaknesses in existing clinical practice. Quality indicators are served as the foundation of improving the quality of care, thus it is in great demand that there be a link between the processes being measured and patient outcomes. If compliance with process indicators does not result in better outcomes, then medical resources will be misallocated, and stakeholders may be misinformed about quality of care.

The Canadian Cardiovascular Outcomes Research Team recommended benchmark values for process indicators which were set at <100%, in recognition of the fact that contraindications to a therapy were not always obtained in the indicator definitions. However, the compliance rates with process indicators in China were much less than the target levels. The compliance is maximal on prescribing diuretics (86.2%) and minimal on prescribing warfarin (17.1%). There were even large disparities in compliance with previous studies. An analysis of the Acute Decompensated Heart Failure National Registry (ADHERE) data found that the median compliance rates were 86.2% for evaluation of left ventricular function, 72.0% for ACEI/ARB and 24.0% for discharge instructions. Compliance rates for the same indicators were much less than the target levels. The compliance is maximal on prescribing diuretics and minimal on prescribing warfarin. Long-term therapy with beta-blockers could improve clinical symptoms and left ventricular function, and significantly reduce the risk of death and hospitalization. Within the hospitalization time frame, it may not be possible for beta-blockers to have obvious effect on clinical outcome in CHF patients. The use of warfarin could reduce the risk of systematic embolization and stroke for CHF patients with atrial fibrillation, but it revealed that the association with in-hospital mortality did not reach significance.

Several issues should be considered in the interpretation of the findings. First, obtaining such data was very difficult and expensive in China. Because electronic medical records have not been widely implemented, our research team members had to go to each hospital to collect data personally. Second, the structure of medical records was designed for administration purposes rather than the assessment of quality of care. This might have some impacts on the accuracy of the denominator (patients eligible for an intervention with no contraindications to that intervention) and numerator (eligible patients who actually received the recommended intervention). Some patients might have had contraindications for specified care but had not been documented, leading to overestimate of denominator. The reasons for nonuse of recommended therapy might not have been documented, resulting in the underestimate of denominator. Third, this study is observational that the process-outcome links do not prove causality. Finally, given the high mortality observed, we focused on short-term outcome during the hospital stay. However, the time frame during the hospital stay may not have been sufficient for assessing the effect of some therapies.

### Table 3: Univariate and multivariate process-outcome links for process indicators

<table>
<thead>
<tr>
<th>Quality indicators</th>
<th>Univariate</th>
<th>Multivariate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OR (95% CI)</td>
<td>P</td>
</tr>
<tr>
<td>CHF-1</td>
<td>41/87 (47.1)</td>
<td>1196/1775 (67.4)</td>
</tr>
<tr>
<td>CHF-2</td>
<td>6/20 (30.0)</td>
<td>346/621 (55.7)</td>
</tr>
<tr>
<td>CHF-3</td>
<td>60/66 (90.9)</td>
<td>1386/1612 (86.0)</td>
</tr>
<tr>
<td>CHF-4</td>
<td>7/14 (50.0)</td>
<td>220/489 (45.0)</td>
</tr>
<tr>
<td>CHF-5</td>
<td>8/19 (42.1)</td>
<td>404/625 (64.6)</td>
</tr>
<tr>
<td>CHF-6</td>
<td>2/15 (13.3)</td>
<td>84/487 (17.3)</td>
</tr>
</tbody>
</table>

CHF-1, Evaluation of left ventricular function; CHF-2, Angiotensin-converting enzyme inhibitor/Angiotensin receptor blocker; CHF-3, Diuretic; CHF-4, Beta-blocker; CHF-5, Aldosterone receptor antagonist; CHF-6, Warfarin; OR, odds Ratios; CI, confidence interval.

a: Adjusting for age, medical history, status at hospital admission, renal disease, liver disease, hypertension, low sodium syndrome and length of stay; C statistics: 0.80.
b: Adjusting for age, status at hospital admission and low sodium syndrome; C statistics: 0.75.
c: Adjusting for age, medical history, status at hospital admission, hypertension, low sodium syndrome and length of stay; C statistics: 0.82.
d: Adjusting for age, status at hospital admission, low sodium syndrome and length of stay; C statistics: 0.77.
e: Adjusting for age and length of stay; C statistics: 0.75.
f: Adjusting for sex, cerebral infarction and length of stay; C statistics: 0.86.
To more accurately profile healthcare providers and improve the quality of care for CHF patients, we will make further efforts to collect long-term outcomes, such as 1-year readmission or mortality to demonstrate the association with process indicators in future research in this area. The indicators will be updated on ongoing scientific evidence. Registry-based quality of care improvement initiative has been reported to be associated with substantial improvement in compliance with quality indicators and clinical outcomes for CHF patients. We will launch a collaborative initiative and recruit a group of hospitals to participate. Through the initiative, quality of care of participating hospitals will be tracked and compared. Hospitals can share effective strategies, which will help them to accelerate implementation of evidence-based therapies to narrow the gap with guidelines and decrease the variation in quality of care across hospitals.

Funding
This work was supported by the National Natural Science Foundation of China [70873031 and 81273183 to Meina Liu].

Conflicts of interest: None declared.

Key points
- Considerable gaps existed between guidelines and clinical practice among hospitals in China. The compliance is maximal on prescribing diuretics and minimal on prescribing warfarin.
- There were great variations in compliance with process indicators and in-hospital mortality across hospitals.
- After accounting for data clustering and adjusting for patient’s condition, evaluation of left ventricular function and prescription of ACEI/ARB and aldosterone receptor antagonist for CHF patients with LVSD were found to be associated with in-hospital mortality.
- The process indicators need to be further proved the association with long-term outcomes and updated on ongoing scientific evidence.
- A quality improvement initiative aimed to improve the quality of care for CHF patients is necessary.

References
9 Joint Commission on Accreditation of Healthcare Organizations. Core Measure Sets. Available at: http://www.jointcommission.org/assets/1/6/Heart%20Failure.pdf (4 May 2013, date last accessed).
Psychometric properties of the consumer quality index to assess shelter and community care services


Introduction

Despite the increasing social and academic interest in dealing with the problem of homelessness\(^1\) and intimate partner violence,\(^7\) little is known about the specific service priorities, and experiences of clients using shelter facilities for homeless people, youth and abused women. According to a literature study by Wolf, Luijtelaar, Jansen and Altena\(^3\) the few existing client satisfaction studies among homeless people and youth have all been conducted in the USA and have used instruments designed for other populations (e.g. medical patients). Macnee and McCabe\(^4\) have questioned the applicability of such instruments to homeless and abused women. According to a literature study by Wolf, Luijtelaar, Jansen and Altena\(^3\) the few existing client satisfaction studies among homeless people, homeless youth and abused women have with shelter and community care services. Methods: A pilot CQI questionnaire was constructed on the basis of literature study, focus group discussions with clients, concept mapping by clients and shelter workers, and a pre-pilot study. The pilot questionnaire was completed by 762 clients using shelter facilities for homeless people, homeless youth or abused women. Psychometric and multilevel analyses were performed to optimize the instrument and determine its validity, reliability and discriminative power. Results: The preparatory research had revealed seven primary focus topics, all of which were incorporated into the pilot questionnaire. Psychometric analyses resulted in four reliable scales, one of which applied only to clients in residential, day or night shelter programs. The final instrument consisted of 42 items for community care clients and 52 for clients using residential facilities, and day and night shelters; 32 and 42 such items pertained to client experiences. Conclusion: The consumer quality index for shelter and community care services (CQI-SCCS) is a valid, reliable instrument for assessing the quality of these services. It provides guidance to facilities in quality maintenance and improvement, and it is useful in determining quality differences in facilities for homeless people and homeless youth.

