Design of A Nationwide Registry-Research-Education Project for Quality Improvement: The China Heart Failure Surgery Registry (China-HFSR)

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Abstract

Background: The case of cardiovascular surgeries for patients with heart failure (HF) patients is likely to increase in the future. However, little is known about its current status in the Asia Pacific Region. The China-HFSR is a national project that aims to timely obtain real-world knowledge about the cardiac surgeries in HF patients, provide the platform for clinical research, and finally properly guide the subsequent administrative measures and the effort for quality improvement efforts in China. This paper reports on the design of this database and provides an overview of the participating sites.

Methods: We established a network of participating sites with an adult cardiac surgery volume of more than 100 operations per year. Heart failure patients with reduced ejection fraction (EF, <50%) are included. Clinical data, treatments, outcomes and follow up data are collected at local centers electronically, with a standardized set of variables and standard definitions, and rigorous control on data quality.

Results: In total, 13,234 patient records from 94 hospitals were submitted from January 2012 to December 2016. The mean age of patients was 58.0 ± 11.0 years with 26.9% female and the mean preoperative EF was 42.3 ± 5.4%. Coronary artery bypass surgery is the leading procedure (61.2%, 8,090/13,234) and 90% patients (11,904/13,234) received on-pump surgery with median bypass time in 116 minutes. The overall complication rate was 10.2% (1,345/13,234) and in-hospital mortality rate was 4.1% (541/13,234). The median hospital stay was 23 days. Re-intubation (2.7%, 363/13,234), renal failure (2.2%, 294/13,234) and re-operation (3.0%, 397/13234) were the most common complications.

Conclusion: China-HFSR provides a comprehensive insight into the clinical features of cardiac surgery in HF patients in China. As the database continues to expand, it will facilitate future research projects, establish benchmarking standards, and identify potential areas for prevention and quality improvements.

Background

In the past decades, China has heralded a rapid increase in the cases of cardiac operations. In the mean while, heart failure (HF) represents a great global burden of public health and it was the only chronic disease that keeps increasing. There are 4.5 million HF patients in China with 200,00 new cases per year.[1] The overall cost of HF in 2012 was estimated at $108 billion while it cost China 5.4 billion, occupying the first place in middle income countries. [2] Patients undergoing cardiac surgery with HF were at a higher risk. We assumed that the cardiac surgeries in HF will pose a great challenge for the public health systems in China. Given the imbalance of economic development among regions, the lack of a standardized surgeon training system and the heterogeneity between East Asia and western countries, there has been increasing critical concern over the national database of cardiac surgical care in HF patients has been raised.

Therefore, the China National Center for Cardiovascular Diseases (NCCD) and Fuwai Hospital launched China-HFSR registry with other elite cardiac centers. The specific aims of the study were as follows:

1. To obtain the real-world information and outcomes of Chinese surgical patients with HF.
2. To continuously monitor the appropriateness of the practice, performance and quality of medical care.
3. To improve quality care, we report and provide feedback on performance to participating sites.
4. To evaluate the trends of patient characteristics and outcomes.
5. To estimate the cost of medical care.
6. To set up a national platform and nationwide infrastructure to multicenter research, surgeon and patient education.

Methods

Overview of study Design

China-HFSR is a nationwide, multicenter and observational registry study that is currently underway in China. We send collaborate invitations to hospitals which have an adult cardiac surgery volume over 100. According to geographic and administrative division, we divided China Mainland into 7 regions. Based on the 2013 ACCF/AHA HF guideline[3] and 2014 China HF guideline,[4] we retrospectively collected the medical record of patients received cardiac surgery with documented HF with EF<50% for the first stage work. Then we will prospectively collect the data including those HF patients with preserved EF and perform the follow-up by trained physicians.

This study was approved by the institutional review board at Fuwai Hospital (approval number 887) and written informed consent was provided by participants. The China-HFSR study group maintains the institutional review board-approved protocol that describes methods used to protect the privacy of patients and maintain confidentiality of data collected. The data is anonymous and omits private information.

Data collection

The data elements collected in the China-HFSR were developed and determined through the discussion of the Scientific committee and Executive and Steering Committee. Data including patient demographics surgery details, medical history, clinical presentation, physical examination, laboratory and imaging results, medications, clinical events and costs were collected. Trained physicians collected and reviewed the follow-up data in person at clinic visit or by telephone call. All variables’ definition were comparable to those of The Society of Thoracic Surgeons National Cardiac Database (STS NCD) and metadata was created under the Clinical Data Interchange Standards Consortium standards for merging among international databases.[5]

Data were collected through a web-based electronic data capture system by local investigators at each participating site. Training for data collection was conducted by the coordinating center. If the participating site was equipped with structured electronic medical record system, it is also acceptable for sites to
export and import data automatically instead of by manual submission under the premise of quality and safety. Real-time automatic logic and range check on the completeness and validity of the data were integrated in the system. The data will be automatically rejected if any component of the required mandatory data elements is missing or any of the validation rules of logic are not met. Two reviewers from the data processing center abstracted a random sample of 5-10% of medical records through on-site auditing annually to compare with the information from the original records. When a disagreement occurred, physicians and surgeons will adjudicate the disagreement to determine the correct final value after discussion.

Statistical analysis

Descriptive statistics were calculated on baseline characteristics and in-hospital outcomes, P-value was not available. We used Kolmogorov-Smirnov to test normal distribution of continuous variables, those conformed to normal distribution were presented as mean ± standard deviation, whereas those did not conformed to normal distribution were presented as median and quartile. Categorical variables were shown as frequency and percentage. All statistical analysis was performed using SPSS version 22.0 (IBM Corp., Armonk, NY).

Results

Hospital Characteristics

Collaboration was made in 94 cardiac centers (Additional file1: Table S1). The geographic locations of the participating sites are shown in Figure1. Among the participant centers, 90.4% (85/94) were academic hospitals, 11.7% (11/94) were specialty hospitals, 13.8% (13/94) were military hospitals, and only 1.1% (1/94) were private hospitals. Overall, China-HFSR had seven hospitals from North-eastern region, 21 from Northern region, 27 from Eastern region, 14 from the Central region, eight from South region, 11 from South-western region, and six from North-western region. Detail information of hospitals is presented in (Table.1). Moreover the median heart failure surgery volume of Southern region was nine whereas Eastern was 21.

Baseline Characteristics

From January 2012 to December 2016, 13,234 patients had been enrolled. The detail of Baseline characteristics were shown in Table 2. The mean age was 58.0 ± 11.0 years with 26.9% female and the mean preoperative EF was 42.3 ± 5.4. Most patients were in NYHA class II(29.2%) or III(51.0%). Multiple cardiovascular risk factors were prevalent, 44.3% patients have smoking history and 15.3% have smoking history 2 weeks before admission. The prevalence of hyperlipidaemia and hypertension were 39.1% and 22.1% respectively. Coronary artery disease (CAD) history was common, 25.4% patients have previous myocardial infarction, 39.6% patients have triple vessel disease and 8.5% patients have previous percutaneous transluminal coronary angioplasty.

Perioperative treatment

In HF patients with reduced EF, all kinds of coronary artery bypass surgeries (CABG) were the most common surgery types. Overall, 48.0% patients received isolated CABG and 27.1% patients received isolated valve surgery. CABG combine valve surgery (including combine other surgery) was performed in 8.1% patients (Table 3). 90% patients received on-pump surgery, with median bypass time in 116 minutes. Urgent and emergency surgery was rare (3.6%).

In medication, the β-blockers and angiotensin-converting enzyme inhibitor (ACEI) or angiotensin receptor blockers (ARB) prescription at discharge were 57.4% and 22.0% respectively(Table 3). Perioperative life supporting devices had already begun to be used in China, with 7.0% patients received intro-aortic balloon pump (IABP) and 0.3% patients received extracorporeal membrane oxygenation (ECMO), while the postoperative use were 5% and 0.3% respectively.

Outcomes

Overall complication rate was 10.2% and mortality was 4.1%. Median in-hospital-stay was 23 days (Table 4). Re-intubation (2.7%), renal failure (2.2%) and re-operation (3.0%) were the most common complications.

Discussion

China-HFSR represents a unique, large-scale, national, contemporary and long-term registry project. A registry-research-education multicenter platform for surveillance, research and quality improvement was established. Through the China-HFSR, it is possible that real-world patient characteristics, practice care, cost and outcomes in China could compare with other countries. We will get information on medical performance at the patient level, surgeon level, hospital level and region level in the cardiac surgery with HF across China.

The surgery volume was 13,234 in 5 years. This number was significantly less than those developed countries represented by the United States.[6] The overall mortality (4.1%) was at a comparable level of performance with other countries[6–8] but patient in China was at a relatively young age and only 33.5% of patients have EF ≤ 40%. In consideration of the rapidly increasing HF population and large proportion of moderate-severe ventricular dysfunction patient[9], the surgical care remain insufficient with lack of capability in treating critically ill patients.

The high prevalence of cardiovascular risk factors such as smoking, diabetes mellitus, hypertension and hyperlipidaemia calls for more concerns. Compare with the past, HF patients receive cardiac surgeries are aging with more comorbid risk factors, lower EF and more serious atherosclerosis. Under the double pressure of aging and various cardiovascular risk factors, the cardiovascular prevention and care in China might face enormous challenges.[1] Hence there is an urgent need for a large-scale multicenter registry study based on Chinese population to promote work on care improvement and prevention.

CABG was performed in sixty percent of patient and a quarter of patients have previous myocardial infarction. We can infer that myocardial damage caused by CAD was the leading cause of HF patients need surgical intervention These results highlight the prevention of CAD as the vital part of HF prevention in
Compared with western countries, the prescription of perioperative evidence-based medication, like β-blockers and ACEI/ARB, was insufficient in China. The use of beta-blockers and ACEI/ARB in OPTIMIZE-HF were both more than 80%[10]; the use of ACEI/ARB in EuroHeart Failure Survey II was 80.2% and beta-blockers was 61.4%[11]. Evidence-based medications have been proven to improve the outcomes of HF patients. All patients without contraindications should receive the guideline recommended therapies. [12] With the clinician-level effort through care quality feedback and scientific support, we will be able to help improve care quality.

In perioperative life supporting device, the use of IABP has become common but ECMO is still rare. As far as our knowledge, a variety of centers in China have not equipped with ECMO. Moreover, the implantation of ventricular assist devices has been performed in a very few centers only recently. The limitation on these life saving technologies will holding us from rescuing perioperative severe HF cases. Generalizing extracorporeal life assistant devices and explore the critical technique needs further research in the Chinese population.

During the past decades, cardiac surgeries in China have undergone a rapid but imbalanced development. Two hospitals have a volume of more than 10,000 cases per year but over 70% of sites have a volume of no more than 200 cases per year, mainly in congenital cardiac surgeries.[1] There are more cardiac centers in the North, East and central region. Those regions are the political and economic center of China and most of Chinese population is concentrated in these more developed regions. Regional variation will lead to variation in quality of care. We hope this nationwide monitor, feedback and research-education system can continuously improve quality in China. The experience of improving quality in remote regions might be a reference for policy makers in other developing countries or areas.

We will extend the scope of the CCSR database in the future and invite more hospitals participating in our network and gradually become a representative high quality database from the developing countries. Many middle- and low-income countries have not yet established national or regional registries. Our experience has the potential to help investigators in these countries. In addition, we are expecting potential opportunities to cooperate with international peers by merge data from different sources for further studies in cardiac surgery in HF patients.

There are several strengths of the China-HFSR. One of which is that diverse representing group of hospitals covering all regions across Mainland China participated in our study, thus making the population in the registry representative of different regions and different economic levels. These hospitals can adequately reflect the real-world status of cardiac surgery in HF patients in Mainland China. We also collect the costs during hospitalization to analyze the cost-effectiveness and burden for surgical patients.

The potential limitation is that any registry may not be fully representative of all patients and all hospitals. However, we believe our study can reflect the routine clinical practice of cardiac surgery in HF patients in China because of geographical and hospital-level diversity. And the representativeness of our database can be further improved by including more hospitals into the project. Second, the data were collected by each participating centers but not centrally collected, so the data completeness might be varied from time to time, and center to center. However we have gone through multiple ways including random sampling checking, sending staff to each center annually for auditing the data and training staff in participating centers to make sure the accuracy of data. Finally, because we were unable to link our data to the national database of death, we could only measure in-hospital outcomes but not a standardized 30-day outcome.[13] Nevertheless, the relatively long stay in China (median 23 days) permits a fairly long enough observation time.

**Conclusion**

China-HFSR has the potential to depict a panoramic picture of clinical practice of combined heart failure surgery in China. With the broad range of participating sites and high data quality, it can act as a national platform for monitoring cardiac surgery in HF patients in mainland China, facilitating research projects and identifying potential areas for quality improvements and health policy making.

**Abbreviations**

ACEI, angiotensin-converting enzyme inhibitor

ARB, angiotensin receptor blocker

CABG, coronary artery bypass surgery

CAD, coronary artery disease

ECMO, extracorporeal membrane oxygenation

EF, ejection fraction

HF: heart failure

IABP, intro-aortic balloon pump

NYHA, New York Heart Association

**Declarations**
Ethics approval and consent to participate:

This study was approved by the local institutional review board and ethics committee (institutional review board and ethics committee of Fuwai hospital, approval number 887) and informed consent was provided by participants.

Consent for publication:

Not applicable

Availability of data and materials:

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interest:

The authors declare that they have no competing interests.

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Authors’ contributions

S.H. conceived of the China-HFSR study and take responsibility for all aspects of it. S.H., H.T., X.H. and J.H. designed the study. H.T. wrote the first draft of the article, with further contributions from K.C., J.H. and S.L. H.T. did the statistical analysis. All authors read and approved the final manuscript.

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References

1. Hu S, Gao R, Liu L, Zhu M, Wang W, Wang Y, Wu Z, Li H, Gu D, Yang Y et al: Abstract of Report on Cardiovascular Diseases in China (2018). Chinese Circulation Journal 2019, 34(03):209-220.

2. Cook C, Cole G, Asaria P, Jabbour R, Francis DP: The annual global economic burden of heart failure. International journal of cardiology 2014, 171(3):368-376.

3. Yancy CW, Jessup M, Bozkurt B, Butler J, Casey DE, Jr., Drazner MH, Fonarow GC, Geraci SA, Horwich T, Januzzi JL et al: 2013 ACCF/AHA guideline for the management of heart failure: a report of the American College of Cardiology Foundation/American Heart Association Task Force on practice guidelines. Circulation 2013, 128(16):e240-327.

4. Chinese Society of Cardiology: 2014 CSC Guideline and Recommendation for the Diagnose and Management of Heart Failure. Chin J Cardiol 2014, 42(2):98-122.

5. Lamy A, Devereaux PJ, Prabhakaran D, Hu S, Piegas LS, Straka Z, Paolasso E, Taggart D, Lanas F, Akar AR et al: Rational and design of the coronary artery bypass grafting surgery off or on pump revascularization study: a large international randomized trial in cardiac surgery. American heart journal 2012, 163(1):1-6.

6. Keeling WB, Williams ML, Slaughter MS, Zhao Y, Puskas JD: Off-pump and on-pump coronary revascularization in patients with low ejection fraction: a report from the society of thoracic surgeons national database. The Annals of thoracic surgery 2013, 96(1):83-88: discussion 88-89.

7. Hamad MA, van Straten AH, Schonberger JP, ter Woorst JF, Martens EJ, van Zundert AA: Preoperative ejection fraction as a predictor of survival after coronary artery bypass grafting: comparison with a matched general population. Journal of cardiothoracic surgery 2010, 5:29.

8. Topkara VK, Cheema FH, Kesavaramanujam S, Mercando ML, Cheema AF, Namerow PB, Argenziano M, Naka Y, Oz MC, Esgir BC: Coronary artery bypass grafting in patients with low ejection fraction. Circulation 2005, 112(9 Suppl):I344-350.

9. Zhang J, Zhang Y: Multicenter, Prospective China Heart Failure Registry - Primary Analysis of Etiology, Clinical Characteristics and Treatment. Chinese Circulation Journal 2015(05):413-416.

10. Fonarow GC, Abraham WT, Albert NM, Gattis Stough W, Gheorghiade M, Greenberg BH, O’Connor CM, Pieper K, Sun JL, Yancy CW et al: Influence of a performance-improvement initiative on quality of care for patients hospitalized with heart failure: results of the Organized Program to Initiate Lifesaving Treatment in Hospitalized Patients With Heart Failure (OPTIMIZE-HF). Archives of internal medicine 2007, 167(14):1493-1502.

11. Nieminen MS, Brutsaert D, Dickstein K, Drexler H, Follath F, Hanjola VP, Hochadel M, Komajda M, Lassus J, Lopez-Sendon JL et al: EuroHeart Failure Survey II (EHFS II): a survey on hospitalized acute heart failure patients: description of population. European heart journal 2006, 27(22):2725-2736.

12. Fonarow GC, Abraham WT, Albert NM, Gattis WA, Gheorghiade M, Greenberg B, O’Connor CM, Yancy CW, Young J: Organized Program to Initiate Lifesaving Treatment in Hospitalized Patients With Heart Failure (OPTIMIZE-HF): rationale and design. American heart journal 2004, 148(1):43-51.

13. Drye EE, Normand SL, Wang Y, Ross JS, Schreiner GC, Han L, Rapp M, Krumholz HM: Comparison of hospital risk-standardized mortality rates calculated by using in-hospital and 30-day models: an observational study with implications for hospital profiling. Annals of internal medicine 2012, 156(1 Pt 1):19-
Tables

Table 1 Participating centers information.

|                              | Overall n=94 | Northeast n=7 | North n=21 | East n=27 | Central n=14 | South n=8 | Southwest n=11 | Northwes |
|------------------------------|--------------|---------------|------------|-----------|--------------|-----------|----------------|----------|
| Academic hospitals (%)      | 90.4         | 85.7          | 100        | 96.3      | 85.7         | 62.5      | 90.9           | 83.3     |
| Military hospitals (%)      | 13.8         | 14.3          | 14.3       | 7.4       | 0            | 25        | 36.4           | 16.7     |
| Private hospitals (%)       | 1.1          | 0             | 0          | 3.7       | 0            | 0         | 0              | 0        |
| Specialty hospitals (%)     | 11.7         | 14.3          | 19         | 7.4       | 14.3         | 12.5      | 9.1            | 0        |
| Median cardiac surgery beds, median (quartile) | 76(41,112) | 76(65,1325) | 42(26,76) | 76(75,98) | 170(39,220) | 61(31,108) | 76(76,128) | 52(45,76) |
| Median ICU beds, median (quartile) | 16(10,20)  | 16(15,21)     | 7(4,16)   | 16(16,20) | 22(10,33)   | 16(9,18) | 18(16,30)     | 14(8,16) |
| Median ratio of ICU to cardiac surgery beds, median (quartile) | 0.2(0.17,0.27) | 0.19(0.14,0.24) | 0.21(0.15,0.29) | 0.21(0.21,0.24) | 0.17(0.15,0.22) | 0.27(0.20,0.31) | 0.24(0.21,0.28) | 0.20(0.15) |
| Median annual HF surgery volume, median (quartile) | 16(6,30) | 19(7,31)      | 20(13,30) | 10(4,18)  | 21(10,41)   | 9(4,28)  | 15(12,28)     | 20(8,39) |

ICU indicates intensive care unit.
## Table 2
Baseline characteristics (n = 13,234)

|                              | Overall | EF ≤ 40% |
|------------------------------|---------|----------|
| Number of patients           | 13,234  | 4,446    |
| Age, mean ± SD               | 58.0 ± 11.0 | 58.1 ± 10.8 |
| Female,%                     | 26.9    | 21.6     |
| Smoking history,%            | 44.3    | 48.5     |
| Current smoker,%*            | 15.3    | 16.5     |
| Diabetes mellitus,%          | 21      | 22.9     |
| Hypertension,%               | 39.1    | 39.5     |
| Hyperlipaemia,%              | 22.1    | 24.1     |
| Renal failure,%              | 1.4     | 1.9      |
| COPD,%                       | 1.6     | 1.8      |
| Peripheral artery disease,%  | 2.9     | 3.5      |
| Stroke,%                     | 6.6     | 6.7      |
| Previous myocardial infarction,% | 25.4 | 30.7     |
| Prior PCI,%                  | 8.5     | 10.4     |
| Carotid disease,%            | 9.5     | 10.3     |
| Preoperative EF, mean ± SD   | 42.3 ± 5.4 | 36.0 ± 4.2 |
| NYHA Class                   |         |          |
| I,%                          | 11.1    | 10       |
| II,%                         | 29.2    | 26.1     |
| III,%                        | 51      | 52.3     |
| IV,%                         | 8.7     | 11.6     |
| Triple(%)                    | 39.6    | 43.7     |
| Cardiogenic Shock,%          | 0.3     | 0.5      |

COPD indicates chronic obstructive pulmonary disease, PCI, percutaneous coronary intervention; EF, ejection fraction; NYHA, New York Heart Association

**Current smoker** refers to smoking history in 2 week before admission.
Table 3
Perioperative treatment (n = 13,234)

|                          | Overall | EF ≤ 40% |
|--------------------------|---------|----------|
| Number of patients       | 13,234  | 4,446    |
| Surgery types            |         |          |
| Isolated CABG, %         | 48      | 50.5     |
| Isolated valve surgery, %| 27.1    | 24.4     |
| Others, %                | 0.6     | 0.7      |
| CABG + others, %         | 5.1     | 7.2      |
| Valve + others, %        | 11.1    | 8.1      |
| CABG + valve, %          | 6.7     | 7.4      |
| CABG + valve + others, % | 1.4     | 1.6      |
| Previous heart operation, %| 2.2    | 2.1      |
| Selective operation, %   | 96.4    | 96       |
| Median sternotomy, %     | 97.4    | 97.7     |
| On-pump, %               | 90      | 90.2     |
| CPB time, min, median (quartile) | 116(88,151) | 119(92,155) |
| IABP, %                  | 7       | 11.3     |
| Postoperative IABP, %    | 5       | 7.8      |
| ECMO, %                  | 0.3     | 0.5      |
| Postoperative, ECMO, %   | 0.3     | 0.4      |
| β-blockers at discharge, %| 57.4  | 60.2     |
| ACEI/ARB at discharge, % | 22      | 23.3     |

CABG indicates coronary artery bypass surgery; CPB, cardiopulmonary bypass; IABP, intra-aortic balloon pump; ECMO, extracorporeal membrane oxygenation; ACEI, angiotensin converting enzyme inhibitor; ARB, angiotensin receptor blocker

Table 4
In-hospital outcomes (n = 13,234)

|                          | Overall | EF ≤ 40% |
|--------------------------|---------|----------|
| Number of patients       | 13,234  | 4,446    |
| Complications, %         | 10.2    | 12.3     |
| Re-intubation, %         | 2.7     | 3.3      |
| Cardiac tamponade, %     | 0.5     | 0.6      |
| Myocardial infarction, % | 0.6     | 0.6      |
| Mediastinal infection, % | 0.9     | 0.9      |
| Stroke, %                | 0.5     | 0.5      |
| Renal failure*, %        | 2.2     | 3.3      |
| MODS, %                  | 1.8     | 2.5      |
| Reoperation, %           | 3       | 3.4      |
| Mortality, %             | 4.1     | 5.6      |
| Hospital stay, days, median (quartile) | 23(17,32) | 25(18,35) |

*Renal failure requiring dialysis.

MODS indicates multiple organ dysfunction syndrome

Figures
Figure 1

Geographic distribution of participating sites in China-HFSR. In total, 94 sites have participated in China-HFSR. Number after province names in figure indicates number of sites participated in China-HFSR. The image was created by EdrawMax Version 9.4.2 (Edraw software Ltd., Shenzhen, CN) Note: The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Research Square concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. This map has been provided by the authors.

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