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Journal:	*BMJ Open*
Manuscript ID	bmjopen-2020-039757
Article Type:	Original research
Date Submitted by the Author:	24-Apr-2020
Complete List of Authors:	Zheng, Xianghui; Second Affiliated Hospital of Harbin Medical University Zhang, Maomao; Second Affiliated Hospital of Harbin Medical University Zheng, Yang; Second Affiliated Hospital of Harbin Medical University Zhang, Yongxiang; Second Affiliated Hospital of Harbin Medical University Wang, Junnan; Jilin University Second Hospital, Cardiology Zhang, Ping; Beijing Tsinghua Changgung Hospital Yang, Xuwen; Tianjin Chest Hospital, Tianjin Cancer Hospital Li, Shan; The Affiliated Hospital of Qingdao University Ding, Rong jing; Peking University People's Hospital, Department of cardiology Siqin, Gaowa; Inner Mongolia People's Hospital Hou, Xinyu; Second Affiliated Hospital of Harbin Medical University Chen, Liangqi; Second Affiliated Hospital of Harbin Medical University Zhang, Min; Second Affiliated Hospital of Harbin Medical University Sun, Yong; Key Laboratories of Education Ministry for Myocardial Ischemia Mechanism and Treatment, 2nd Affiliated Hospital of Harbin Medical University, Cardiology Wu, Jian; Second Affiliated Hospital of Harbin Medical University, Yu, Bo; Key Laboratories of Education Ministry for Myocardial Ischemia Mechanism and Treatment, 2nd Affiliated Hospital of Harbin Medical University, Cardiology
Keywords:	Myocardial infarction < CARDIOLOGY, REHABILITATION MEDICINE, Coronary heart disease < CARDIOLOGY

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Quality indicators for cardiac rehabilitation after myocardial infarction in China: a consensus panel and a national questionnaire

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Abstract

Objectives: Cardiac rehabilitation (CR) improves medical outcomes after myocardial infarction (MI), but it is underutilized in China. The purpose of this study was to develop a set of quality indicators (QIs) to improve clinical practices and confirm measurability and outcome of the developed indicators for CR in post-MI Chinese patients.

Design and setting: The QIs are developed by expert consensus panel through face-to-face meetings. Further, the 5 indicators most in need of improvement were selected through the national questionnaire. Finally, the completion rate and feasibility of the indicators were verified by the patients with MI.

Participants: 17 professionals for the consensus panel and 89 individuals in CR for the national questionnaire.

Results: A review of 17 eligible articles generated 26 potential indicators among which 18 were selected by a consensus panel after careful evaluation. A nationwide survey by telephone or WeChat identified 5 indicators most in need of improvement as 'automatically referring all eligible patients at the time of discharge', 'recommending CR in discharge guidance' and 'prescribing exercise based on assessment of physical fitness', 'full time staff for educating patients about CR', 'assessment and education of patients regarding coronary disease risk factors'. A multicenter practice test (n=165) revealed that median performance of the proposed indicators was 43.1% (9.9-86.1%) in post-MI patients of the university hospitals.

Conclusions: The consensus panel identified a comprehensive set of QIs for CR for post-MI patients. A nationwide questionnaire survey revealed the indicators that need immediate attention to improve the quality of CR. Although, the practice test confirmed measurability of the proposed indicators in clinical practice, the performance needed to be improved.

Keywords

cardiac rehabilitation, quality indicators, myocardial infarction, a consensus panel, a national questionnaire

Strengths and limitations of this study

This is the first study proposing an immediate improvement of CR QIs via a nationwide survey and instituting improvement guidelines for CR in China.

The completion rate and feasibility of the developed indicators were revealed by a multicenter practice test.

The consensus panel may lead to a biased selection of indicators.

The national questionnaire was not distributed to all regions and cardiac rehabilitation centers in the country.

Introduction

Acute myocardial infarction (AMI) is highly prevalent globally, and the leading cause of mortality and adult disability. Currently, the annual mortality rate due to myocardial infarction (MI) is less than 10%, but among the survivors, 20% suffer a relapse within the first year.[1] A cardiovascular disease report published in 2017 stated that in China, with the aging population, the mortality rate of AMI, which increases exponentially after 40 years of age, is on the rise from 2002 to 2015. Thus, an estimated 2.5 million Chinese with a history of MI impose a substantial personal

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and societal burden. A recent study shows that 41.5% of MI patients are unable to work by 12 months after AMI.[2]

Cardiac rehabilitation (CR), a comprehensive secondary prevention program measure, is geared to improve quality of life and promote longevity in patients with heart diseases. CR plays an equally important role as medication to improve outcomes in post-MI patients. Large-scale randomized trials and systematic reviews have established the positive impact of CR, and its significant role in reducing morbidity and mortality in post-MI patients.[3-5] Other known benefits of CR include improvement in exercise capacity and quality of life, and positive effects on coronary endothelial function, blood pressure, and insulin resistance, and fibrinolytic state and inflammatory markers.[6-10] There exists a strong and linear association between the number of CR sessions and long-term outcomes in post-MI. Studies indicated a 1% drop in mortality rate per CR session.[11 12] CR is the Class I recommendation for patients with MI from the American Heart Association (AHA) and the American College of Cardiology Foundation (ACCF). [13]

CR programs remain clinically underused, and participation in CR remains dismally low world over. The rate of CR participation generally ranges between 6.6% and 53.5% in the USA.[14] CR was used only in 13.9% of patients hospitalized for AMI and 31.0% after coronary artery bypass graft surgery.[14] The results of a European survey revealed an average participation rate of 44.9%, in patients with coronary heart disease, with the highest participation rate of 85.4% in Lithuania, and the lowest rate (0.0%) in Greece.[15] Only 34% of Canadian patients with indications participated in CR.[16] A review of medical records of 1330 AMI patients revealed only 30.5% participation between December 2017 and September 2018 at a university hospital in China that vigorously carried out CR programs. However, most hospitals currently do not carry out CR programs, and other medical institutions also are far below the participation rate of 30.5%. Besides, adherence to evidence-based performance measures of CR is also suboptimal in China. Therefore, effective strategies to increase enrollment and adherence to CR are urgently needed.

Quality improvement means improving health care, and systems of care delivered by individual physician. Quality indicators (QIs) provide direction and specific methods for quality improvement. A study on ICU patients showed that a multifaceted quality improvement intervention improved the adoption of care practices.[17] And there was a significant improvement in patients with acute ischemic stroke by a multifaceted quality improvement intervention.[18] In addition, many countries, such as the USA, Japan, and Canada have developed QIs for improving CR but are lacking in the Chinese context. Implementation of QIs can increase the participation and adherence over longer-term in post-MI patients. For example, a two-year study showed a significant increase in the percentage of enrollment in CR with a series of quality improvement interventions, including policy change, a 7-minute video describing the benefits of CR, and incentives.[19] A randomized controlled trial revealed that early appointments within 10 days of hospital discharge improved CR attendance almost by 3-folds versus standard appointments after 35 days.[20]

Besides, there are also some gaps in the effectiveness of CR in China. Increasing participation is an important goal for successful implementation of CR programs, which could decrease morbidity and mortality due to MI. The aim of this study was to describe candidate QIs and test their feasibility and applicability to improve the participation and the completing effect of CR in post-MI Chinese patients.

Methods

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Indicator development

Databases including PubMed, CINAHL Ebsco, and Embase were searched for eligible articles published till August 2018 using keywords cardiac rehabilitation, quality indicator, myocardial infarction, MeSH terms, and Emtree headings. By reading the title, abstract and text, only articles published in English and providing QIs for CR were included. The collected QIs were further divided into two domains: improving the rate of participation and adherence to CR and the effect of completing the CR.

Consensus panel

The consensus panel consisted of 15-20 individuals, with a maximum of 2 individuals selected from each CR center. Members were selected upon meeting the following criteria: (1) at least 1 year of experience in CR; (2) leader of a local CR program; (3) committed to the construction of CR; (4) agree to participate in a face-to-face meeting on quality improvement of CR. Two authors (XZ and YZ) assessed qualifications of the members and disagreements were resolved by discussion or the third author (JW). Members were responsible for scoring the collected indicators based on their experience and finally determine the QIs for CR in MI patients in China. And the member's responsibility is to score the collected indicators based on their own experience, and finally determine the QIs for CR in patients with MI in China.

National questionnaire

A questionnaire based survey was conducted nationwide either by telephone or WeChat. Participants included cardiologists, nurses, physical therapists, clinical psychologists, registered dietitians and health follow-up staff, all from established cardiac rehabilitation centers with at least 1 year of experience in CR. The participants were asked to select 3 out of the 26 candidate QIs that required urgent improvement with the purpose of selecting the top 5 QIs that required immediate improvement in China.

Practice test

A practice test was performed to review the adaptability of each QI before implementation due to the differences in healthcare systems and social circumstances. And also, to assess the completion rate of the proposed indicators selected by the consensus panel. Inclusion criteria of patients were: (1) history of AMI; (2) participation in Ⅰ and Ⅱ phase CR at all the 5 teaching hospitals (Beijing Tsinghua Changgung Hospital, the Second Hospital of Jilin University, Tianjin Chest Hospital and Affiliated Hospital of Qingdao University and the Second Affiliated Hospital of Harbin Medical University) between September 3, 2018 and October 31, 2019. They had made out whether the cardiac rehabilitation center completed the proposed indicators. The patients did not answer if they could not decide or understand the question. There were no ethical issues associated with the questionnaire.

Scoring method and selection criteria

The candidate indicators generated from the literature were scored on a ten-point scale. Scoring criteria were based on four aspects: evidence-based, feasibility of implementation, validity, reliability, which need to be judged according to the clinical experience of the consensus panel. Indicators with >7 points and considered to be significant to the improvement in CR quality indicators were included in the study. Indicators with <7 and >5 points were not considered for this study, and indicators <5 points were excluded. A QI was considered acceptable for improving the quality of CR in post-MI Chinese patients based on its average score. Meanwhile, participants in the CR program were asked to select the three most important QIs. The top 5 most important

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indicators were selected based on the participants' ratings. Also, participants could suggest new QIs outside of those mentioned in the questionnaire.

Data collection and analysis

Two authors (XZ and YZ) were responsible for data collection and cross checking. Mean score of each indicator was calculated as: the sum of all participants' ratings/ the number of participants. And median performance of QIs was calculated as: number of times the indicator was met/ the number of participants (excluding participants who did not fill in) x100.

Results

Collection of QIs

A review of the literature identified 203 articles, and after perusing the titles and abstracts, 176 were excluded as they were not related to QIs for CR. After careful examination, 17 articles were found to be eligible to be included.[14, 19-34] A list of 26 potential indicators including 16 about improving the rate of participation and adherence to CR and 10 on the effect of completing the CR was created (Supplementary Table 1). A flowchart of the literature search and selection of eligible articles is shown in Supplementary Figure 1.

The consensus panel and proposal of QIs for CR in post-MI patients

The consensus panel including 17 cardiologists from 12 CR centers individually rated each indicator on a ten-point scale questionnaire. The rating of each indicator is shown in Supplementary Figure 2 and 3. After careful evaluation, only indicators with an average score >7 that could improve the quality of CR in China were accepted (Figure 1). Finally, a total of 18 QIs were selected and divided into two domains: (1) improving participation and adherence and (2) completion effect of CR (Table 1).

National questionnaire and top five indicators for imminent improvement

A nationwide telephonic or WeChat survey involving 89 people from 4 municipalities and 18 provinces in China was carried out with a response rate of 100%. And 89 participants included 21 cardiologists, 15 nurses, 18 physical therapists, 11 clinical psychologists, 13 registered dietitians and 11 health follow-up staff. Each participant selected three indicators considered to be critical to improve post-MI CR in China (Figures 2 and 3). Results showed that the five most important indicators were 'automatically referring all eligible patients at the time of discharge', 'recommending CR in discharge guidance' and 'prescribing exercise based on assessment of physical fitness', 'full time staff for educating patients about CR', 'assessment and education of patients regarding coronary disease risk factors' (Table 2) with score ratios of 47.2%, 38.2 %, 28.1%, 25.8% and 19.1%, respectively.

Practice test

A practice test was performed on 165 patients with MI enrolled in the study revealed a median performance of 43.1% (9.9-86.1%). Indicators with high performance (minimum to maximum 72.1–86.1%) were 'assessment and education of patients on tobacco and alcohol consumption', 'recommending CR in discharge guidance'. There were also several low performing indicators (minimum to maximum 9.9–29.7%), including 'holding multidisciplinary conferences', 'frequency of CR registration and recommendation as indicators for assessing the performance of doctor', 'immediate reservation of CR for referral patients', 'providing patients with written invitations and program brochures' (Table 1).

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Discussion

In this study, 26 indicators generated from 17 articles were assessed as candidate QIs for CR. Out of the 26, 18 QIs were selected by a Chinese multidisciplinary consensus panel and divided into two domains based on participation and adherence, and outcomes. The findings of the nationwide questionnaire could guide clinical quality improvement. Although the barriers to CR participation in China may differ from those in other countries, the pilot test showed the feasibility and applicability of all the 18 QIs in the Chinese context., which also were generally unsatisfactory completion of indicators.

To our knowledge, this is the first study proposing an immediate improvement of CR QIs via a nationwide survey and instituting improvement guidelines for CR in China. Although in its infancy, CR in China had developed rapidly, from 6 centers in 2012 to currently about 500. This unbalanced development of CR in China is similar to that in the USA and worrisome as there is no health insurance for CR. Hence, better implementation of CR is imperative, given the current situation. We consider that QI development is a time-efficient and resource-saving approach.[32] In many countries, the promotion of CR is inseparable from the quality of life improvement. For example, the USA has effectively used QIs to increase CR participation from 20% to 70%.[21] Similarly, Canada has developed indicators to promote the all-round development of CR,[24] and Japan also has proposed QIs for improving the quality of CR after acute coronary syndrome (ACS).[27] In this study, we propose QIs for the improvement of CR in China by the recommendations reported in these previous studies.

CR is in its early stages of development in China. Given the uneven development of CR, the consensus panel selected QIs for improving participation and adherence that were basic, practical and in line with the current status of CR in the country. For example, we found that 'recommending CR in discharge guidance' was a key way for patients to know the importance and necessity of CR and 'automatically referring all eligible patients at the time of discharge' was the best way to increase participation in CR. Other suitable QIs were 'full time staff for educating patients about CR' and 'liaison staff for CR'. Besides, the study revealed QIs necessary for the completion effect of CR in China, such as 'assessment and education of patients regarding coronary disease risk factors', 'assessment and education of patients about dietary habits', 'prescribing exercise based on physical fitness'. It is worth mentioning that the completion rate of 'holding multidisciplinary conferences' is very low in the practice test, but the implementation of this indicator can help patients with multiple diseases to recover better. Moreover, how to measure the completion rate of the proposed QIs is important. Firstly, relevant QIs should be recorded in electronic medical records. And questionnaire survey on the implementation of QIs in patients with MI on discharge and after CR. In addition, relevant medical staff are measured in practice by self-assessment scale and others assessment scale.

It is also important to understand the barriers to appropriate CR including lack of health awareness, inadequate policy, insufficiency of CR, lack of better healthcare system and care discontinuity. Gary et al. reported that older females from low socioeconomic status, with poor education, self-efficacy, multiple comorbidities and unable to communicate in English were more likely not to participate in CR.[28] Enrollment to the CR program is affected by many healthcare system related factors, including lack of referral, limited facilitation of enrollment after referral, lack of programs that serve specific geographic areas and low-income communities, and gender-dominated programs.[35] In this study, we proposed improvement indicators that would overcome these barriers to the successful

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implementation of CR.

In short, application of these indicators would standardize and improve the quality of CR in China. During the course of the study, two more supplementary indicators-extending the hospital rehabilitation time and strengthening the application of traditional Chinese sports, such as Taiji and Baduanjin in CR were pointed out that warrant further discussion. This study provides significant guidance for the development of cardiac rehabilitation in our country. Nevertheless, further studies are needed to evaluate the validity, reliability and feasibility of these indicators.

Study limitation

There are many limitations in our study. First, we retrieved the literature through a public database, hence, there was a possibility of publication bias. Second, there might be investigation bias rooted in that the participants of the consensus panel were all cardiologists and the national questionnaire was not distributed to all regions and cardiac rehabilitation centers in the country. In addition, to assess the measurability and completeness of the proposal indicators, we included post-MI patients who already had participated in Ⅰ and Ⅱ phase CR in the clinical practice test. Consequently, we found that the performance of the proposed indicators was high.

Conclusion

In this study, a consensus panel identified 18 candidate indicators to improve the quality of CR in patients with MI in China. A nationwide survey revealed the 5 indicators that required imminent improvement to facilitate better enrollment in CR programs in the country. Moreover, a practice test on MI patients confirmed the feasibility and completeness of the developed indicators. The test also revealed that holding multidisciplinary conferences and better communication between referral physician and patient about CR can improve the performance of the CR program in clinics. Application of the proposed indicators would improve the quality of care through CR in post-MI Chinese patients.

Acknowledgements

The authors are grateful to the members of the consensus panel and the staff who participated in the national questionnaire.

Author contribution

All authors contributed to conception and design of the work. XZ and YZheng contributed to analysis and interpretation. JWu, YZhang, JWang, PZ, XY, SL, RD, GS, BY and YS contributed to acquisition of data. XZ and MaoZ drafted the manuscript. MinZ, XH and LC critically revised the manuscript. All authors reviewed and agrees to the final version.

Funding

This work was supported by the National Key R&D Program of China (Grant no. 2016YFC1301100), the National Natural Science Foundation of China (Grants no. 81670373, 81670459 and 81771946), and the Key Laboratory of Myocardial Ischemia, Harbin Medical University, Ministry of Education (KF201806 to X.Z., KF201716 to Y.Z., KF201822 to L.C.).

Competing interests

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None declared.

Patient consent for publication

Not required.

Ethics approval

Ethical approval and patient consent were not required. Analyses were based on anonymised data.

Provenance and peer review

Not commissioned; externally peer reviewed.

Data sharing statement

No additional data are available.

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Figure Legends

Figure 1. Mean of all indicators from the consensus panel. A. The mean of domain 1: improving participation and adherence of CR. B. The mean of domain 2: completion effect of CR.

Figure 2. Regional distributions of the national questionnaire. Blue represented the areas surveyed, while white did not.

Figure 3. Indicators from the national questionnaires that needed to immediate improvement (blue).

Supplementary Figure 1. Flow chart of the literature search.

Supplementary Figure 2. Rating distribution of domain 1 candidate indicators. The X-axis indicates individual indicator evaluation by the panel. The Y-axis indicates the number of panel members who scored the indicator.

Supplementary Figure 3. Rating distribution of domain 2 candidate indicators. The X-axis indicates individual indicator evaluation by the panel. The Y-axis indicates the number of panel members who scored the indicator.

Table Legends

Table 1. The proposal quality indicators and percentage scores for cardiac rehabilitation of patients with myocardial infarction.

Table 2. Top 5 quality indicators that need to improve.

Supplemental Table 1. Candidate quality indicators for CR of patients with MI.

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Table 1 The proposal quality indicators and percentage scores for cardiac rehabilitation of patients with myocardial infarction

Indicators	Numerator/ denominator	Performance %
Domain 1: Improving participation and adherence of CR		
QI-1: recommending CR in discharge guidance	142/165	86.1
QI-2: automatically referring all eligible patients at the time of discharge	56/163	34.4
QI-3: full time staff for educating patients about CR	72/162	44.4
QI-4: providing patients with written invitations and program brochures	49/165	29.7
QI-5: liaison staff for CR	51/161	31.7
QI-6: providing patients with written invitations and program brochures	49/165	29.7
QI-7: immediate reservation of CR for referral patients	31/164	18.9
QI-8: registering of CR before discharge	67/162	41.4
QI-9: frequency of CR registration and recommendation as indicators for assessing the performance of doctor	28/153	18.3
Domain 2: completing effect of CR		
QI-1: assessment and education of patients regarding coronary disease risk factors	79/165	47.9
QI-2: communication between referral physician and patient about CR	95/157	60.5
QI-3: assessment and education of patients about dietary habits	81/165	49.1
QI-4: assessment and treatment of psychological status	85/165	51.5
QI-5: assessment and education of patients on tobacco and alcohol consumption	119/165	72.1
QI-6: prescribing exercise based on assessment of physical fitness	86/165	52.1
QI-7: reassessment of exercising capacity	71/165	43.0
QI-8: education on the importance of adherence to prescribed medication	91/165	55.2
QI-9: holding multidisciplinary conferences	16/162	9.9

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Table 2 Top 5 quality indicators that need to improve

Indicators	Numerator/ denominator	Importance (%)
Top 1: automatically referring all eligible patients at the time of discharge	42/89	47.2
Top 2: recommending CR in discharge guidance	34/89	38.2
Top 3: prescribing exercise based on assessment of physical fitness	25/89	28.1
Top 4: full time staff for educating patients about CR	23/89	25.8
Top 5: assessment and education of patients regarding coronary disease risk factors	17/89	19.1

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Figure 1

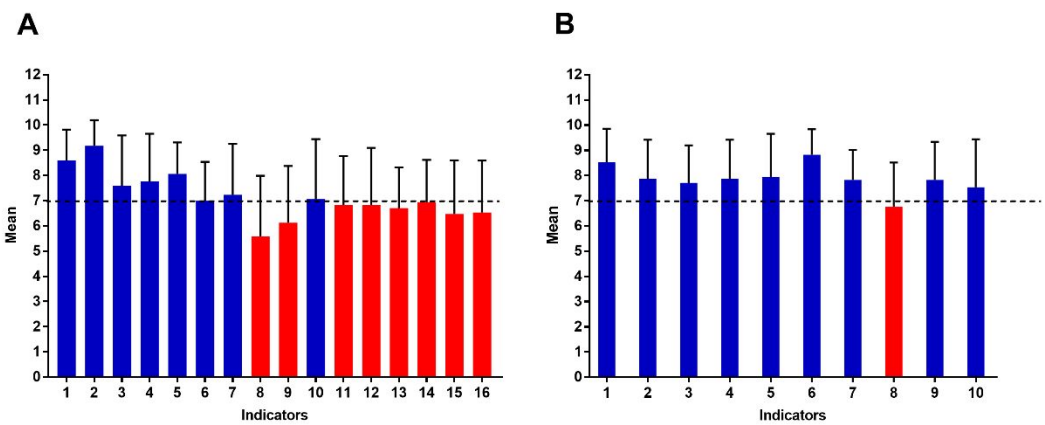

Figure 1. Mean of all indicators from the consensus panel. A. The mean of domain 1: improving participation and adherence of CR. B. The mean of domain 2: completion effect of CR.

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Figure 2

Figure 2. Regional distributions of the national questionnaire. Blue represented the areas surveyed, while white did not.

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Figure 3

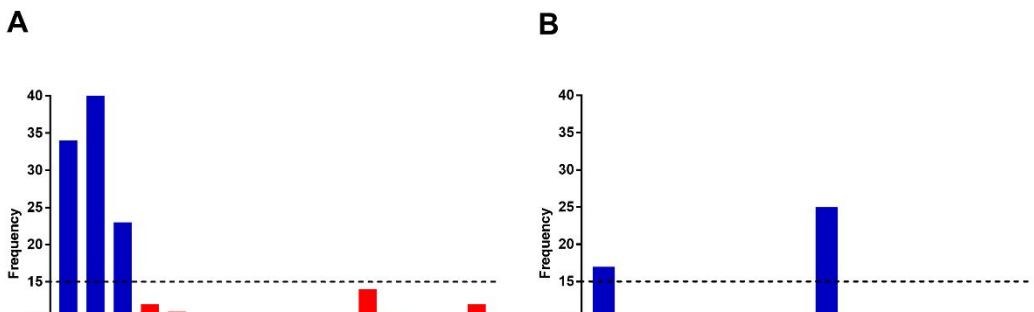

Figure 3. The national questionnaire. Indicators from the national questionnaires that needed to immediate improvement (blue).

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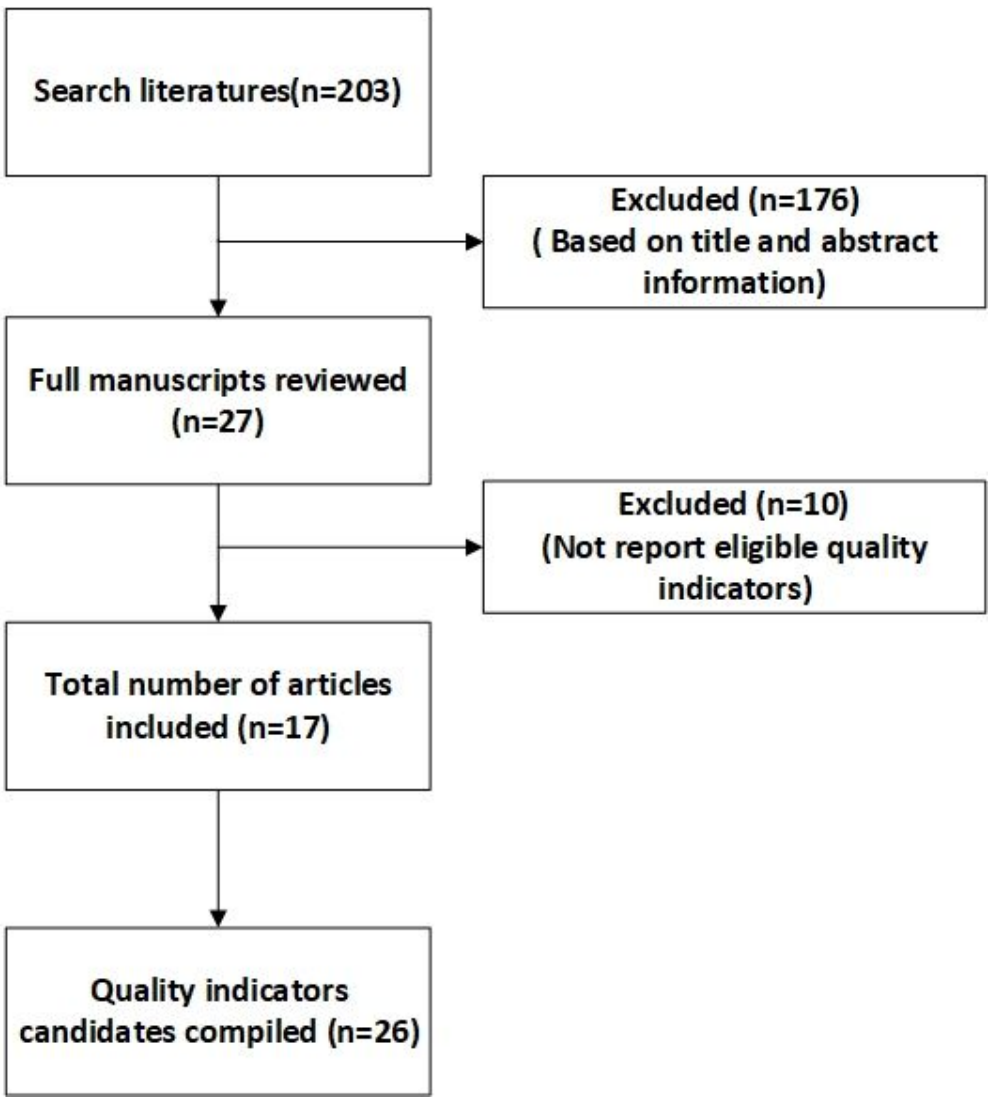
Supplementary Figure 1



Supplementary Figure 1. Flow chart of the literature search.

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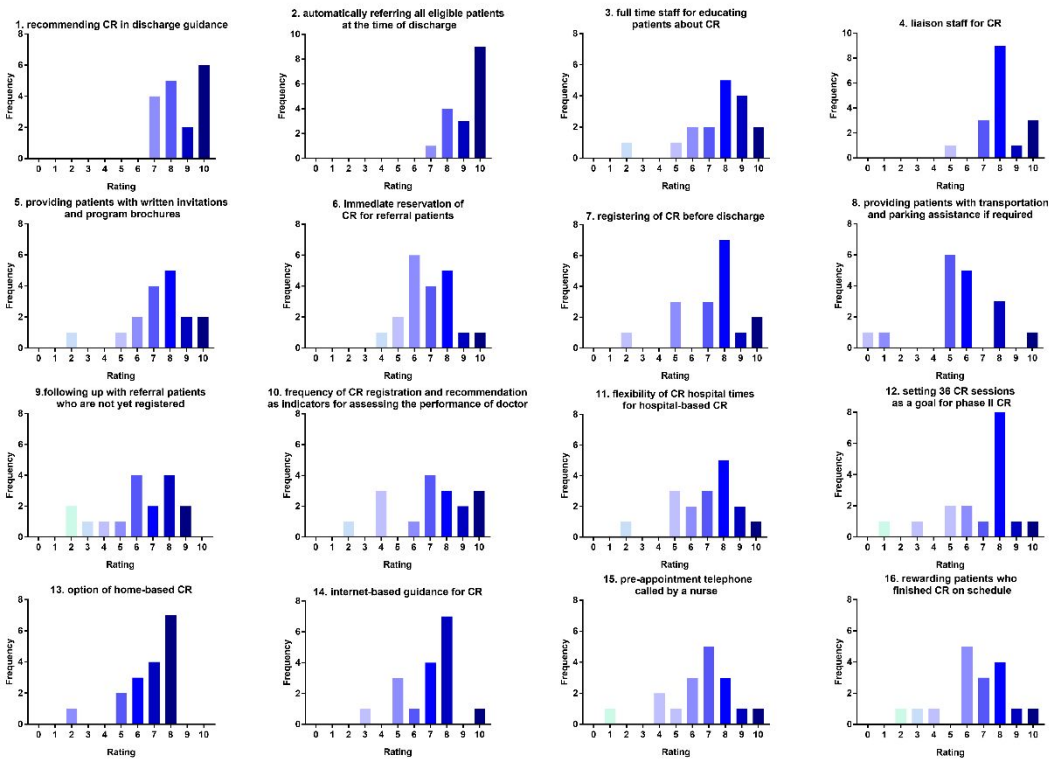
Supplementary Figure 2



Supplementary Figure 2. Rating distribution of domain 1 candidate indicators. The X-axis indicates individual indicator evaluation by the panel. The Y-axis indicates the number of panel members who scored the indicator.

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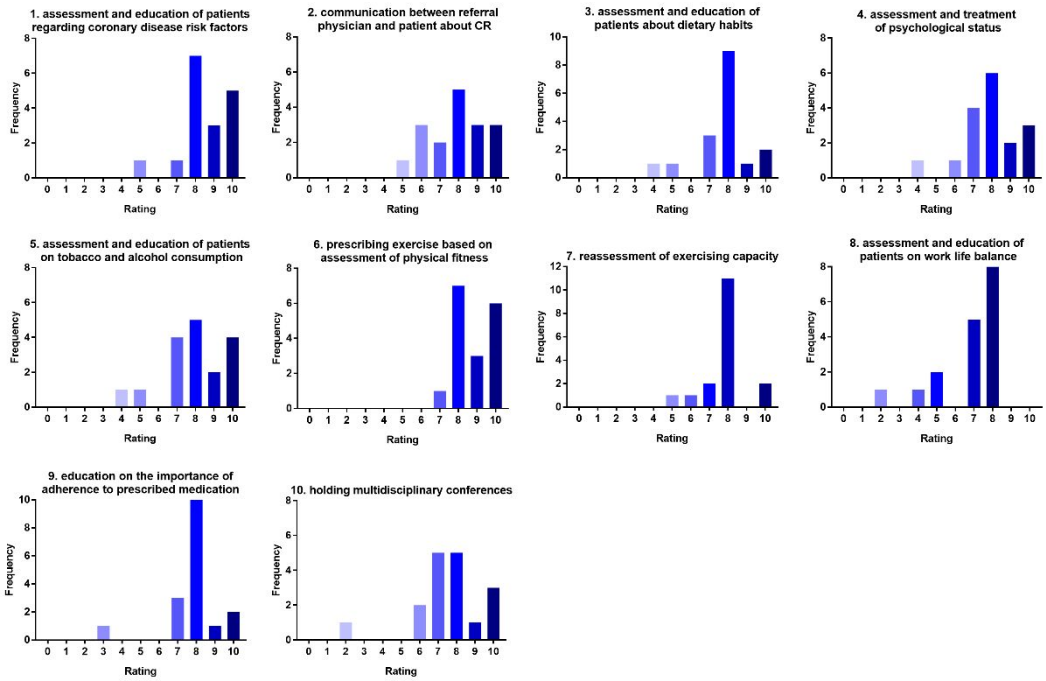
Supplementary Figure 3



Supplementary Figure 3. Rating distribution of domain 2 candidate indicators. The X-axis indicates individual indicator evaluation by the panel. The Y-axis indicates the number of panel members who scored the indicator.

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Supplemental Table 1 Candidate quality indicators for CR of patients with MI

Indicators
Domain 1: Improving participation and adherence of CR
QI-1: recommending CR in discharge guidance
QI-2: automatically referring all eligible patients at the time of discharge
QI-3: full time staff for educating patients about CR
QI-4: liaison staff for CR
QI-5: providing patients with written invitations and program brochures
QI-6: immediate reservation of CR for referral patients
QI-7: registering of CR before discharge
QI-8: providing patients with transportation and parking assistance if required
QI-9: following up with referral patients who are not yet registered
QI-10: frequency of CR registration and recommendation as indicators for assessing the performance of doctor
QI-11: flexibility of CR hospital times for hospital-based CR
QI-12: setting 36 CR sessions as a goal for phase II CR
QI-13: option of home-based CR
QI-14: internet-based guidance for CR
QI-15: pre-appointment telephone called by a nurse
QI-16: rewarding patients who finished CR on schedule
Domain 2: completion effect of CR
QI-1: assessment and education of patients regarding coronary disease risk factors
QI-2: communication between referral physician and patient about CR
QI-3: assessment and education of patients about dietary habits
QI-4: assessment and treatment of psychological status
QI-5: assessment and education of patients on tobacco and alcohol consumption
QI-6: prescribing exercise based on assessment of physical fitness
QI-7: reassessment of exercising capacity
QI-8: assessment and education of patients on work life balance
QI-9: education on the importance of adherence to prescribed medication
QI-10: holding multidisciplinary conferences

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BMJ Open

Quality indicators for cardiac rehabilitation after myocardial infarction in China: a consensus panel and practice test

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2020-039757.R1
Article Type:	Original research
Date Submitted by the Author:	03-Aug-2020
Complete List of Authors:	Zheng, Xianghui; Second Affiliated Hospital of Harbin Medical University Zhang, Maomao; Second Affiliated Hospital of Harbin Medical University Zheng, Yang; Second Affiliated Hospital of Harbin Medical University Zhang, Yongxiang; Second Affiliated Hospital of Harbin Medical University Wang, Junnan; Jilin University Second Hospital, Cardiology Zhang, Ping; Beijing Tsinghua Changgung Hospital Yang, Xuwen; Tianjin Chest Hospital, Tianjin Cancer Hospital Li, Shan; The Affiliated Hospital of Qingdao University Ding, Rong jing; Peking University People's Hospital, Department of cardiology Siqin, Gaowa; Inner Mongolia People's Hospital Hou, Xinyu; Second Affiliated Hospital of Harbin Medical University Chen, Liangqi; Second Affiliated Hospital of Harbin Medical University Zhang, Min; Second Affiliated Hospital of Harbin Medical University Sun, Yong; Key Laboratories of Education Ministry for Myocardial Ischemia Mechanism and Treatment, 2nd Affiliated Hospital of Harbin Medical University, Cardiology Wu, Jian; Second Affiliated Hospital of Harbin Medical University, Yu, Bo; Key Laboratories of Education Ministry for Myocardial Ischemia Mechanism and Treatment, 2nd Affiliated Hospital of Harbin Medical University, Cardiology
Primary Subject Heading:	Cardiovascular medicine
Secondary Subject Heading:	Cardiovascular medicine
Keywords:	Myocardial infarction < CARDIOLOGY, REHABILITATION MEDICINE, Coronary heart disease < CARDIOLOGY

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Quality indicators for cardiac rehabilitation after myocardial infarction in China: a consensus panel and practice test

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Abstract

Objectives: Cardiac rehabilitation (CR) improves outcomes after myocardial infarction (MI), but it is underutilized in China. The purpose of this study was to develop a set of quality indicators (QIs) to improve clinical practices and to confirm the measurability and performance of the developed QIs for CR in Chinese patients after MI.

Design and setting: The QIs were developed by an Chinese expert consensus panel during in-person meetings. The 5 QIs most in need of improvement were selected using a national questionnaire. Finally, the completion rate and feasibility of the QIs were verified by patients with MI at university hospitals in China.

Participants: Seventeen professionals participated in the consensus panel, 89 personnel in the field CR participated in the national questionnaire, and 165 patients with MI participated in the practice test.

Results: A review of 17 eligible articles generated 26 potential QIs, among which 17 were selected by the consensus panel after careful evaluation. The 17 QIs were divided into two domains: (1) improving participation and adherence and (2) CR process standardization. Nationwide telephone and WeChat surveys identified the 5 QIs most in need of improvement. A multicenter practice test (n=165) revealed that the median performance value of the proposed QIs was 43.1% (9.9-86.1%) according to post-MI patients.

Conclusions: The consensus panel identified a comprehensive set of QIs for CR in post-MI patients. A nationwide questionnaire survey revealed the QIs that need immediate attention to improve the quality of CR. Although practice tests confirmed the measurability of the proposed QIs in clinical practice, the implementation of the QIs needs to be improved.

Keywords

cardiac rehabilitation, quality indicators, myocardial infarction, consensus panel, national questionnaire

Strengths and limitations of this study

This is the first study proposing immediate improvement in CR QIs on the basis of the results of a nationwide survey and instituting improvement guidelines for CR in China.

The completion rate and feasibility of the developed QIs were revealed by a multicenter practice test.

The composition of the consensus panel may have resulted in bias in the selection of QIs.

The national questionnaire was not distributed to all regions and CR centers in the country.

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Introduction

Acute myocardial infarction (AMI) is highly prevalent globally and the leading cause of mortality and adult disability.[1] Currently, the annual mortality rate due to myocardial infarction (MI) is less than 10%, but up to 20% suffer experience relapse within the first year.[2] A cardiovascular disease report published in 2017 stated that in China, due to the aging population, the mortality rate of acute myocardial infarction (AMI), which increases exponentially after 40 years of age, increased from 2002 to 2015.[3] Only 55.9% of Chinese patients return to work within 12 months after AMI.[4] Thus, an estimated 2.5 million Chinese people with a history of MI represent a substantial healthcare burden.

Cardiac rehabilitation (CR), a comprehensive secondary prevention framework, aims to improve overall quality of life as well as morbidity and mortality in patients with heart disease. CR has a pivotal role along with timely reperfusion strategies and optimized lifestyle and pharmacological therapies in the contemporary approach to post-MI patients.[5] Previous data, including randomized trials and systematic reviews, have established the positive impact of CR and its significant role in reducing morbidity and mortality in post-MI patients.[6-8] Other known benefits of CR include improvements in exercise capacity and quality of life and positive effects on coronary endothelial function, blood pressure, insulin resistance, and inflammatory markers.[9-12] There is a strong association between the number of CR sessions and long-term post-MI outcomes, with different studies reporting the importance of compliance with these programs with regard to cardiac events.[13] [14] Given these data, CR is considered a class I recommendation for post-MI patients by the American Heart Association, the American College of Cardiology and the European Society of Cardiology.[15]

CR programs are clinically underutilized, and participation in CR is dismally low worldwide.[16-18] The rate of CR participation generally ranges between 6.6% and 53.5% in the USA. [18] CR was utilized by only 13.9% of patients hospitalized for AMI and 31.0% of patients after coronary artery bypass graft surgery.[18] The results of a European survey revealed an average participation rate of 44.9% in patients with coronary heart disease, with the highest participation rate (85.4%) in Lithuania and the lowest rate (0.0%) in Greece.[17] Only 34% of Canadian patients with indications participated in CR.[16] At present, there are no data on the CR participation rate in China. In addition, adherence to evidence-based CR performance measures is suboptimal in China. Therefore, effective strategies to increase enrollment and adherence to CR are urgently needed.

Quality improvement is characterized by improvements in health care and systems of care delivered by individual physicians. Quality indicators (QIs) provide direction and specific methods for quality improvement. A study involving intensive care unit (ICU) patients showed that a multifaceted quality improvement intervention improved the adoption of care practices.[19] A multifaceted quality improvement intervention resulted in significant improvement in hospital personnel adherence to evidence-based performance measures evaluating the care of patients with acute ischemic stroke.[20] The European Association of Preventive Cardiology (EAPC) has defined minimal and optimal cardiovascular rehabilitation standards to increase the quality of cardiovascular

rehabilitation programs.[21] In addition, many countries, such as the USA, Japan, and Canada, have developed QIs for improving CR, but QIs are lacking in China. Implementation of QIs can increase long-term participation and adherence by post-MI patients. For example, a two-year study reported a significant increase in enrollment in CR after the implementation of a series of quality improvement interventions, including policy changes, a 7-minute video describing the benefits of CR, and incentives.[22] The early utilization of a cardiac access clinic resulted in an unprecedented (~3-fold) increase in the number of ST-elevation myocardial infarction (STEMI) patients participating in CR.[23] A randomized controlled trial also revealed that early appointments within 10 days of hospital discharge improved CR attendance by approximately 3-fold compared with standard appointments after 35 days.[24]

CR plays an important role in reducing mortality in patients with MI, improving patient quality of life and reducing China's economic burden.[25-27] Cardiovascular rehabilitation process standardization in China needs to be improved. Increasing participation is an important goal for the successful implementation of CR programs, which could decrease morbidity and mortality due to MI. The aim of this study was to describe candidate QIs and test their feasibility and applicability, as well as to improve the CR participation and compliance rates in Chinese post-MI patients.

Methods

Quality indicator development

Databases including PubMed, CINAHL Ebsco, and EMBASE were searched for eligible articles published through August 2018 using the keywords cardiac rehabilitation, quality indicator, and myocardial infarction; MeSH terms; and Emtree headings. Two authors (XZ and MZ) conducted the literature review by first reading titles and abstracts and then reading the full text of potential articles. Articles from the search results were included if the following conditions were met: (1) the study provided QIs for CR and (2) the study was published in English. The compiled QIs were further divided into two domains: improving the CR participation and adherence rates and standardizing CR processes. Any disagreement about study inclusion was resolved by a third author (JWu).

Consensus panel

The consensus panel consisted of 17 individuals, with a maximum of 2 individuals from each CR center. Members were selected upon meeting the following criteria: (1) the individual had at least 1 year of experience in CR; (2) the individual held a position as a leader of a regional CR program; (3) the individual was committed to the advancement of CR; and (4) the individual agreed to participate in an in-person meeting to discuss CR quality improvement. Two authors (XZ and YZheng) assessed the qualifications of the members, and disagreements were resolved by consensus or the third author (JWu). Members were responsible for scoring the collected QIs based on their experience and determining the final QIs for CR in MI patients in China.

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Scoring method and selection criteria

The candidate QIs generated from the literature were scored on a ten-point scale. Scoring criteria were based on four aspects: whether they were evidence-based, the feasibility of implementation, their validity, and their reliability. The QIs were judged according to the clinical experience of the consensus panel. The four criteria were used to generate one score. QIs that received scores >7 and considered to be significant in the improvement of CR QIs were included in the study. QIs with <7 but >5 points were not considered in this study, and QIs with <5 points were excluded. A QI was considered acceptable for improving the quality of CR in post-MI Chinese patients based on its average score.

National questionnaire

A questionnaire-based survey was conducted nationwide by either telephone or WeChat (a communication tool in China). Participants included cardiologists, nurses, physical therapists, clinical psychologists, registered dietitians and follow-up staff caring for CR patients who met the following criteria: (1) working in an established cardiac rehabilitation center; and (2) at least 1 year of experience in CR. JWu and YZhang conducted a questionnaire-based survey on the participants. The participants were asked to select 3 out of 26 candidate QIs that they felt required urgent improvement to allow the selection of the top 5 QIs that required immediate improvement in China. The top 5 most important QIs were determined based on the frequency selected by the participants. Additionally, participants could suggest new QIs outside of those mentioned in the questionnaire.

Practice test

A practice test was administered to review the adaptability of each QI before implementation due to differences in healthcare systems and social circumstances, such as the size of the CR center and patient education, to assess the completion rate of the proposed QIs selected by the consensus panel. The patient inclusion criteria were as follows: (1) a history of AMI; (2) completion of phase Ⅰ and Ⅱ CR at one of the 5 teaching hospitals (Beijing Tsinghua Changgung Hospital, the Second Hospital of Jilin University, Tianjin Chest Hospital and Affiliated Hospital of Qingdao University and the Second Affiliated Hospital of Harbin Medical University) between September 3, 2018 and October 31, 2019; and (3) consent to participate in the study. Patients filled out an 18-question questionnaire about proposed QIs and evaluated whether the CR center implemented the proposed QIs. The patients did not answer if they were unsure or did not understand the question. In addition, the consensus panel unanimously agreed that a score greater than 70% was considering good performance a score less than 30% was considered poor performance. The questionnaire was approved by the ethics committees of the 5 teaching hospitals.

Patient and public involvement

Patients were not involved in the development of the research question, outcome measure and study design.

Data collection and analysis

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Two authors (XZ and YZ) were responsible for data collection and cross checking. The mean score of each QI was calculated as the sum of all participants' ratings/number of participants. The median performance of QIs was calculated as follows: number of times the QI was achieved/number of participants (excluding participants who did not answer)×100.

Results

Collection of QIs

A review of the literature identified 203 articles, and after screening the titles and abstracts, 176 were excluded, as they were not related to QIs for CR. After full-text screening, 17 articles were eligible and subsequently included. [22 24 28-42] A list of 26 potential QIs, including 16 regarding improvement of the CR participation and adherence rates and 10 regarding the effects of completing CR, was generated (Supplementary Table 1). A flowchart of the literature search and selection of eligible articles is shown in Supplementary Figure 1.

The consensus panel and proposal of QIs of CR in post-MI patients

The consensus panel included 17 experts in the field of CR from 12 CR centers (Supplementary Table 2). Seventeen experts who met the inclusion criteria were cardiologists and individually rated each QI on a ten-point scale. The rating of each QI is shown in Supplementary Figures 2 and 3. After careful evaluation, only QIs with an average score >7 that could potentially improve the quality of CR in China were accepted (Figure 1). Finally, a total of 17 QIs were selected and divided into two domains: (1) improving participation and adherence and (2) standardizing CR processes (Table 1). There were two more supplementary indicators: extending the hospital rehabilitation time and strengthening the application of traditional Chinese sports.

National questionnaire and top five QIs for imminent improvement

Eighty-nine professionals met the national survey participation criteria; among them, 65 people participated in a telephone survey, and 29 people participated in a WeChat survey. The survey response rate was 100%. The 89 participants from 4 municipalities and 18 provinces in China included 21 cardiologists, 15 nurses, 18 physical therapists, 11 clinical psychologists, 13 registered dietitians and 11 health follow-up staff. Each participant selected three QIs considered critical to improve post-MI CR in China (Figures 2 and 3). The results showed that the five most important QIs were ‘automatically referring all eligible patients at the time of discharge’, ‘recommending CR in discharge guidance’, ‘prescribing exercise based on an assessment of physical fitness’, ‘employing full-time staff for educating patients about CR’, and ‘assessment and education of patients regarding coronary disease risk factors’ (Table 2), with score ratios of 47.2%, 38.2%, 28.1%, 25.8% and 19.1%, respectively.

Practice test

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The practice test was completed by 165 patients who met the inclusion criteria, and no patients refused to participate in the study (30 patients from Beijing Tsinghua Changgung Hospital, 30 patients from the Second Hospital of Jilin University, 34 patients from Tianjin Chest Hospital, 30 patients from Affiliated Hospital of Qingdao University and 41 patients from the Second Affiliated Hospital of Harbin Medical University). The results revealed a median performance value of 43.1% (9.9-86.1%). The QIs that achieved good performance (minimum to maximum 72.1-86.1%) were 'assessment and education of patients on tobacco and alcohol consumption' and 'recommending CR in discharge guidance'. There were also several low-performing QIs (minimum to maximum 9.9-29.7%), including 'holding multidisciplinary meetings, 'frequency of CR registration and recommendation as QIs for assessing doctor performance', 'immediate enrollment in CR for referral patients', and 'providing patients with written invitations and program brochures' (Table 1).

Discussion

In this study, 26 QIs generated from 17 articles were assessed as candidate QIs for CR. Out of the 26 QIs, 17 were selected by a Chinese multidisciplinary consensus panel and divided into two domains based on participation and adherence and outcomes. The findings of the nationwide questionnaire could guide clinical quality improvement. The practice test showed the feasibility and applicability of all 17 QIs in the Chinese context.

To our knowledge, this is the first study proposing an immediate improvement in CR QIs on the basis of the results of a nationwide survey and the implementation of improvement guidelines for CR in China. However, although still in its infancy, CR in China has developed rapidly. According to data published by the Chinese Society of Rehabilitation Medicine (CARM), the number of CR centers has increased from 6 in 2012 to more than 500 currently. This unbalanced development of CR in China is similar to that in the USA and is worrisome, as health insurance does not cover CR. Hence, the improved implementation of CR programs is imperative, given the current situation. We consider that QI development is a time-efficient and resource-saving approach.[43] In many countries, CR is strongly associated with quality of life improvement. For example, the USA has effectively implemented QI monitoring to increase the CR participation rate.[28] Similarly, Canada has developed QIs to promote the broad development of CR programs,[31] and Japan has also proposed QIs to assess improvements in the quality of CR after acute coronary syndrome (ACS).[33] Moreover, the EAPC described QIs to assess improvements in CR process standardization in Europe.[21] In this study, we propose QIs to promote the improvement of CR in China considering the recommendations reported in these previous studies.

CR is still in the early phase of development in China. Given the uneven distribution of CR programs, the consensus panel selected QIs to promote improvements in participation and adherence that were simple, practical and in line with the current status of CR in the country. For example, we found that 'recommending CR in discharge guidance' was key in emphasizing the importance and necessity of CR, and 'automatically referring all eligible patients at the time of discharge' was the best way to increase participation in CR. Other suitable QIs were 'employing full-time staff for

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educating patients about CR' and 'employing CR liaison staff'. In addition, the study revealed QIs that are necessary for CR process standardization in China, such as 'assessment and education of patients regarding coronary disease risk factors', 'assessment and education of patients about dietary habits', and 'prescribing exercise based on physical fitness'. It is worth mentioning that the completion rate of 'holding multidisciplinary meetings' was very low in the practice test, but the implementation of this QI can improve recovery in patients with multiple diseases. Moreover, measuring the completion rate of the proposed QIs is important. First, relevant QIs should be recorded in electronic medical records. A questionnaire survey about the implementation of QIs in patients with MI at discharge and after CR was conducted. In addition, relevant medical staff should be evaluated in practice by self-assessment and other assessment scales.

It is also important to understand the barriers to appropriate CR, including lack of health awareness, inadequate policies, insufficiency of CR, lack of healthcare system support and care discontinuity. Gary et al. reported that older females with a low socioeconomic status, with a low education level, with poor self-efficacy, with multiple comorbidities and who were unable to communicate in English were more likely to not participate in CR.[35] Enrollment in the CR program is affected by many healthcare system-related factors, including lack of referral, limited facilitation of enrollment after referral, lack of programs that serve specific geographic areas and low-income communities, and gender-dominated programs.[44] In this study, we proposed QIs that would overcome these barriers and aid in the successful implementation of CR.

During the course of the study, two additional supplementary indicators, 'extending the hospital rehabilitation time' and 'strengthening the application of traditional Chinese exercise', were added. Tai Chi Chuan practice was associated with a VO_2 peak increase in patients with MI.[45] Baduanjin exercise therapy in post-MI patients reverses adverse left ventricular (LV) remodeling and improves clinical outcomes.[46] Therefore, traditional Chinese exercises, such as Tai Chi Chuan and baduanjin, may constitute effective forms of CR in patients with MI.

In summary, the application of these QIs would help standardize and improve the quality of CR in China. This study provides significant guidance for the development of CR in our country. Nevertheless, further studies are needed to evaluate the validity, reliability and feasibility of these QIs.

Study limitations

There are many limitations in our study. First, in the quality indicator development section of the methods, we retrieved the literature from public databases; hence, there is a possibility of publication bias. Second, investigation bias may exist because the consensus panel participants were all cardiologists and the national questionnaire was not distributed to all regions and CR centers in the country. These factors may also lead to bias in the results of the practice test due to the absence of data from nonteaching hospitals, the relatively small sample size and the lack of data concerning baseline characteristics of the patients. Moreover, to assess the measurability and completeness of

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the proposed QIs, only patients who participated in CR programs were selected to complete the practice test. As such, data from those who did not participate in these programs were not available.

Conclusion

In this study, a consensus panel identified 17 candidate QIs to assess improvements in the quality of CR in patients with MI in China. A nationwide survey revealed the 5 QIs that required imminent improvement to facilitate increased enrollment in CR programs in the country. Moreover, a practice test administered to MI patients confirmed the feasibility and completeness of the developed QIs. The test also revealed that holding multidisciplinary meetings and improving communication between referral physicians and patients about CR can improve the performance of the CR program in clinics. Application of the proposed QIs would improve the quality of CR care in Chinese post-MI patients.

Acknowledgments

The authors are grateful to the members of the consensus panel, the staff who participated in the national questionnaire, and the patients who completed the practice test.

Author contribution

All authors contributed to conception and design of the work. XZ and YZheng contributed to analysis and interpretation. JWu, YZhang, JWang, PZ, XY, SL, RD, GS, BY and YS contributed to acquisition of data. XZ and MaoZ drafted the manuscript. MinZ, XH and LC critically revised the manuscript. All authors reviewed and agrees to the final version.

Funding

This work was supported by the National Key R&D Program of China (Grant no. 2016YFC1301100), the National Natural Science Foundation of China (Grants no. 81670373, 81670459 and 81771946), and the Key Laboratory of Myocardial Ischemia, Harbin Medical University, Ministry of Education (KF201806 to X.Z., KF201716 to Y.Z., KF201822 to L.C.).

Competing interests

None declared.

Patient consent for publication

Patients and/or the public were involved in the design, or conduct, or reporting, or dissemination plans of this research. Refer to the Methods section for further details.

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Ethics approval

The study was approved by the ethics committee of Beijing Tsinghua Changgung Hospital, the Second Hospital of Jilin University, Tianjin Chest Hospital and Affiliated Hospital of Qingdao University and the Second Affiliated Hospital of Harbin Medical University. This study is part of a registered study of ClinicalTrials.gov NCT03528382.

Provenance and peer review

Not commissioned; externally peer reviewed.

Data sharing statement

No additional data are available.

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Figure Legends

Figure 1. Mean of all the indicators identified by the consensus panel. A. The mean of domain 1: improving CR participation and adherence. B. The mean of domain 2: CR process standardization.

Figure 2. Regional distributions of the national questionnaire. Blue represents the areas surveyed, while white represents areas not surveyed.

Figure 3. Quality indicators from the national questionnaires that were identified as needing immediate improvement (blue).

Supplementary Figure 1. Flow chart of the literature search process.

Supplementary Figure 2. Rating distribution of domain 1 candidate quality indicators. The X-axis indicates individual indicator evaluation by the panel. The Y-axis indicates the number of panel members who scored the indicator.

Supplementary Figure 3. Rating distribution of domain 2 candidate indicators. The X-axis indicates individual indicator evaluation by the panel. The Y-axis indicates the number of panel members who scored the quality indicator.

Table Legends

Table 1. The proposed quality indicators and their percentage scores for CR in patients with MI.

Table 2. Top 5 quality indicators that were identified as needing improvement.

Supplementary Table 1. Candidate QIs to improve CR in patients with MI.

Supplemental Table 2. Information about professionals of the consensus pane.

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Table 1 The proposal quality indicators and percentage scores for cardiac rehabilitation of patients with myocardial infarction

Quality Indicators	Numerator/ denominator	Performance %
Domain 1: Improving CR participation and adherence		
QI-1: recommending CR in discharge guidance	142/165	86.1
QI-2: automatically referring all eligible patients at the time of discharge	56/163	34.4
QI-3: employing full-time staff for educating patients about CR	72/162	44.4
QI-4: providing patients with written invitations and program brochures	49/165	29.7
QI-5: employing liaison staff for CR	51/161	31.7
QI-6: immediate enrollment in CR for referral patients	31/164	18.9
QI-7: enrollment in CR before discharge	67/162	41.4
QI-10: frequency of CR enrollment and recommendation as indicators for assessing doctor performance	28/153	18.3
Domain 2: CR process standardization		
QI-17: assessment and education of patients regarding coronary disease risk factors	79/165	47.9
QI-18: communication between referral physician and patient about CR	95/157	60.5
QI-19: assessment and education of patients about dietary habits	81/165	49.1
QI-20: assessment and treatment of psychological issues	85/165	51.5
QI-21: assessment of and education of patients about tobacco and alcohol consumption	119/165	72.1
QI-22: prescribing exercise based on an assessment of physical fitness	86/165	52.1
QI-23: reassessment of exercise capacity	71/165	43.0
QI-25: education about the importance of adherence to prescribed medication	91/165	55.2
QI-26: holding multidisciplinary meetings	16/162	9.9

These are the QIs with a rating ≥7, with the same numbers as those in Supplementary Table 1.

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Table 2 Top 5 quality indicators that need improvement

Indicators	Numerator/ denominator	Importance (%)
Top 1: automatically referring all eligible patients at the time of discharge	42/89	47.2
Top 2: recommending CR in discharge guidance	34/89	38.2
Top 3: prescribing exercise based on an assessment of physical fitness	25/89	28.1
Top 4: employing full-time staff for educating patients about CR	23/89	25.8
Top 5: assessment and education of patients regarding coronary disease risk factors	17/89	19.1

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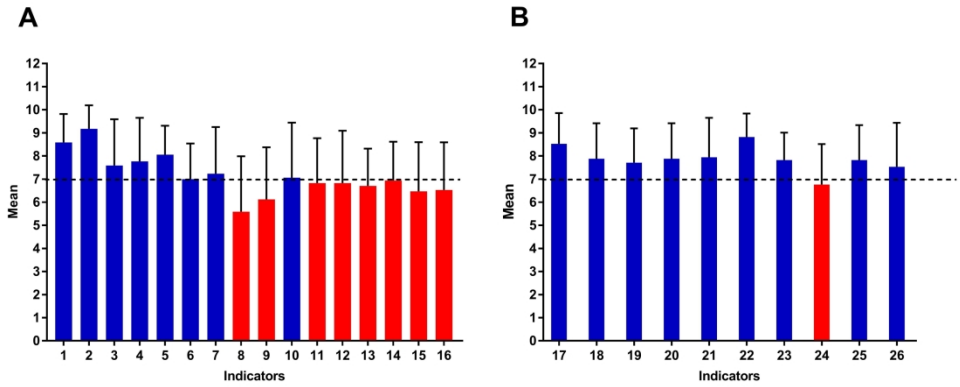

Mean of all the indicators identified by the consensus panel. A. The mean of domain 1: improving CR participation and adherence. B. The mean of domain 2: CR process standardization.

259x109mm (300 x 300 DPI)

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Regional distributions of the national questionnaire. Blue represents the areas surveyed, while white represents areas not surveyed.

254x190mm (300 x 300 DPI)

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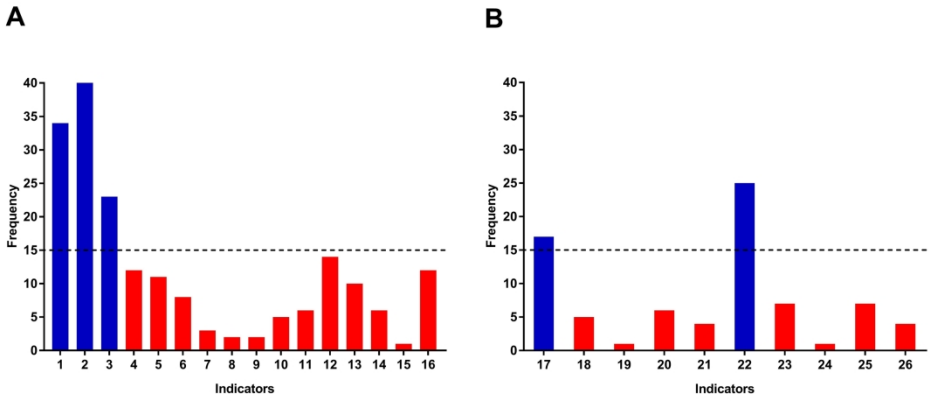

Quality indicators from the national questionnaires that were identified as needing immediate improvement (blue).

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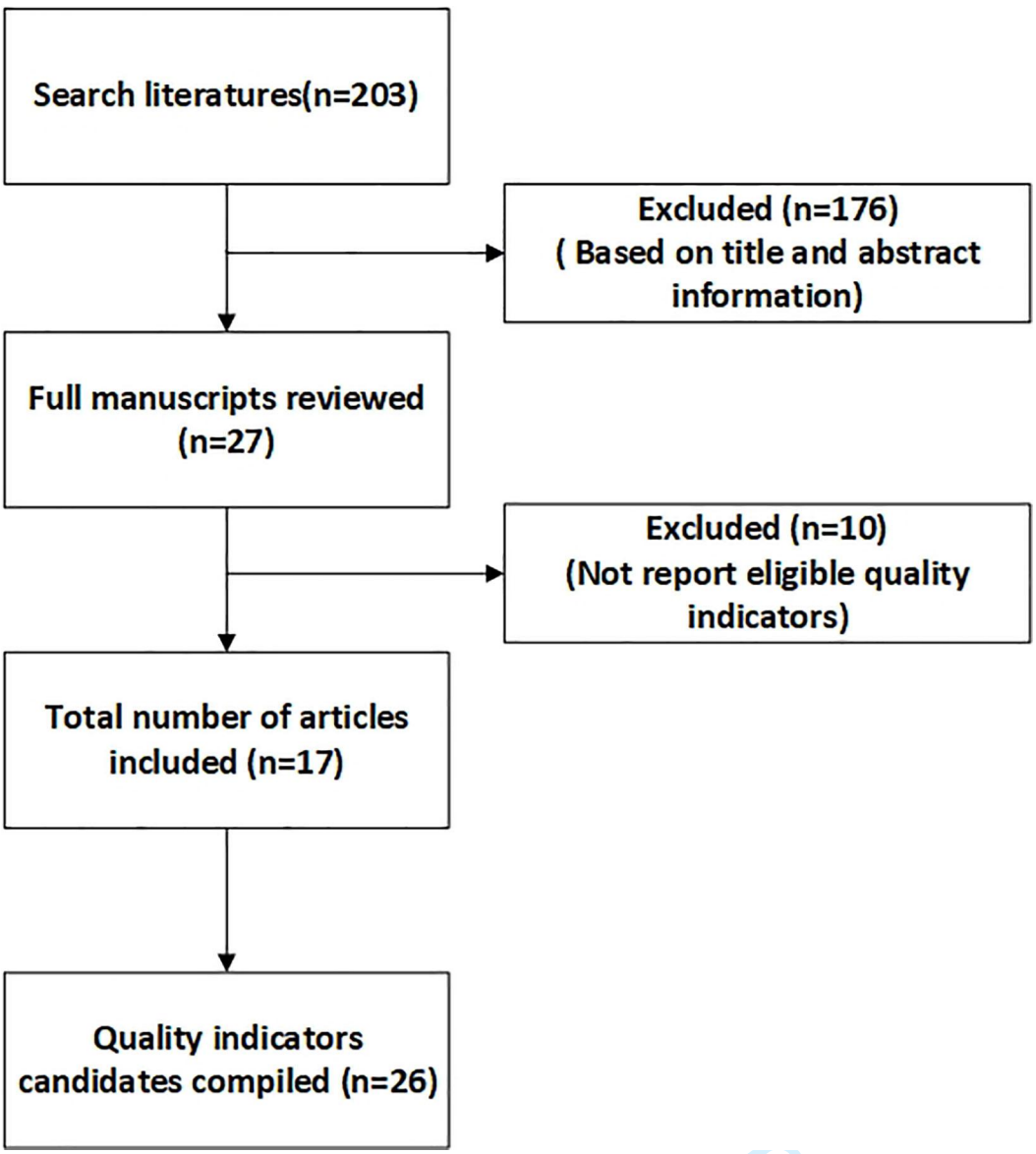
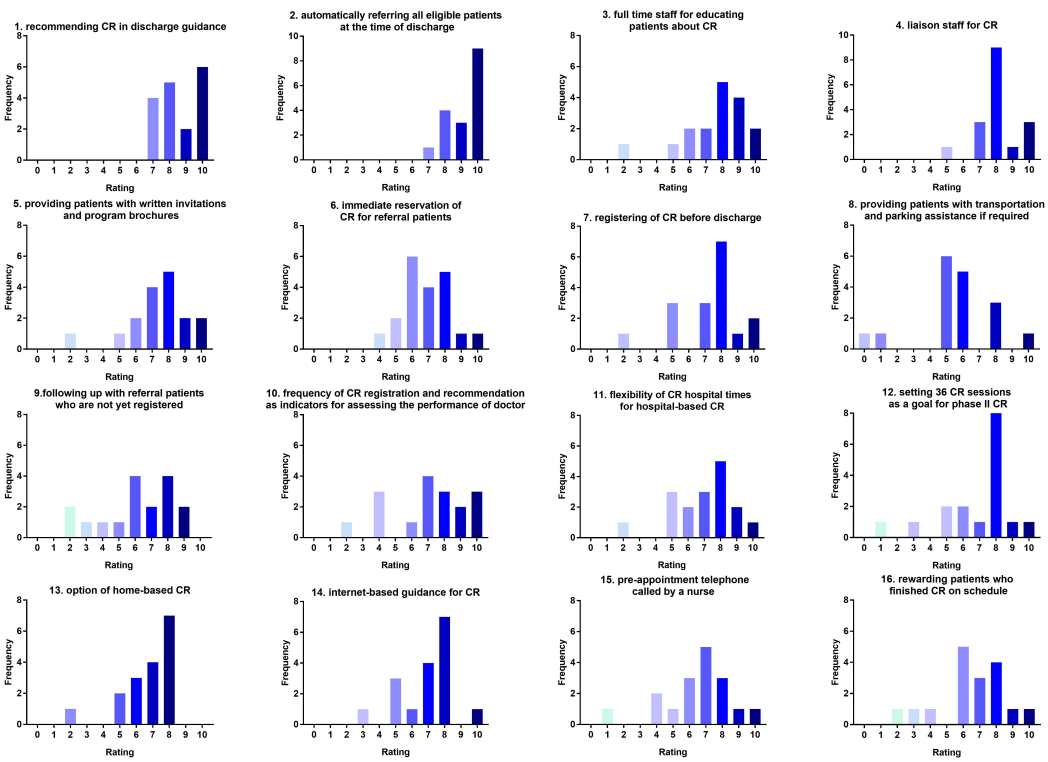
Supplementary Figure 1. Flow chart of the literature search process.



Supplementary Figure 2. Rating distribution of domain 1 candidate quality indicators. The X-axis indicates individual indicator evaluation by the panel. The Y-axis indicates the number of panel members who scored the indicator.



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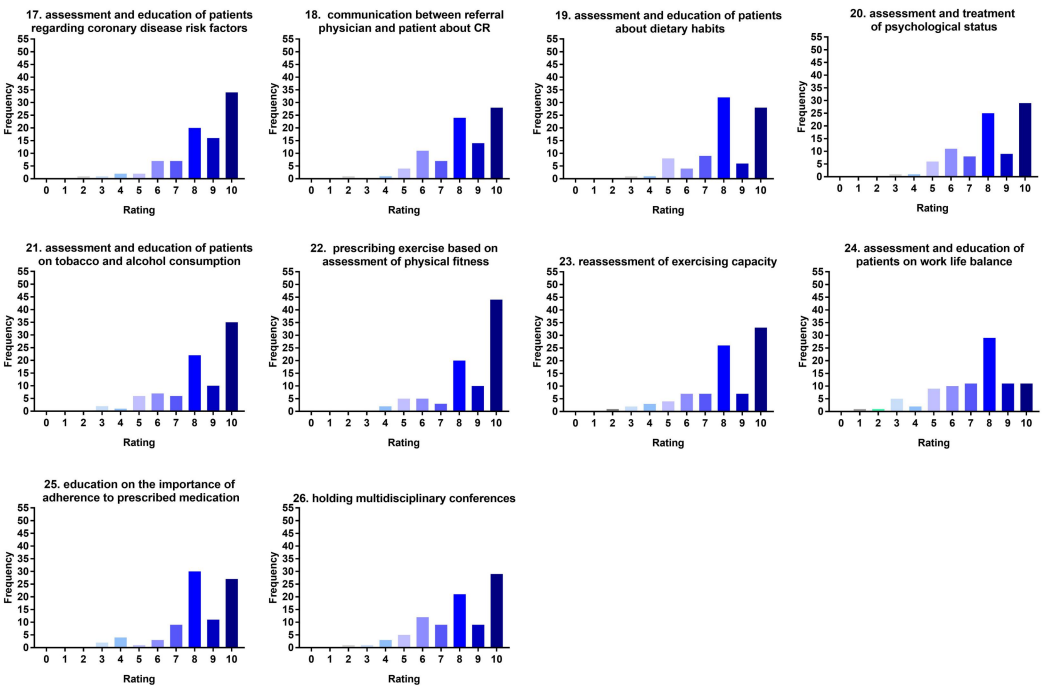
Supplementary Figure 3. Rating distribution of domain 2 candidate indicators. The X-axis indicates individual indicator evaluation by the panel. The Y-axis indicates the number of panel members who scored the quality indicator.



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Supplemental Table 1 Candidate quality indicators for cardiac rehabilitation in patients with myocardial infarction

Quality Indicators	Reference
Domain 1: Improving CR participation and adherence	
QI-1: recommending CR in discharge guidance	28, 38
QI-2: automatically referring all eligible patients at the time of discharge	28, 34, 35, 36, 38, 39, 40
QI-3: employing full-time staff for educating patients about CR	28, 38
QI-4: providing patients with written invitations and program brochures	35
QI-5: employing CR liaison staff	35
QI-6: immediate enrollment in CR for referral patients	24, 29, 31, 36, 37
QI-7: enrollment in CR before discharge	35
QI-8: providing patients with transportation and parking assistance if required	35
QI-9: following up with referral patients who are not yet registered	35
QI-10: frequency of CR registration and recommendation as indicators for assessing doctor performance	22
QI-11: flexibility of CR times for hospital-based CR	28, 35
QI-12: setting 36 CR sessions as a goal for phase II CR	22, 42
QI-13: option of home-based CR	28
QI-14: internet-based guidance for CR	41
QI-15: preappointment telephone reminder by a nurse	32
QI-16: rewarding patients who finish CR on schedule	22, 30
Domain 2: Process standardization of CR	
QI-17: assessment and education of patients regarding coronary disease risk factors	31 , 33, 36
QI-18: communication between referral physician and patient about CR	33
QI-19: assessment and education of patients about dietary habits	33
QI-20: assessment and treatment of psychological issues	31, 33
QI-21: assessment and education of patients about tobacco and alcohol consumption	31, 33
QI-22: prescribing exercise based on an assessment of physical fitness	31, 33, 36
QI-23: reassessment of exercise capacity	33
QI-24: assessment of and education about patient work-life balance	33
QI-25: education about the importance of adherence to prescribed medication	33
QI-26: holding multidisciplinary meetings	33

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Supplemental Table 2 Information about professionals of the consensus panel.

Experts of the consensus panel	Cardiac rehabilitation centres
Xuwen Yang	Tianjin Chest Hospital, Tianjin Cancer Hospital, Tianjin
Yuanhui Liu	Guangdong Provincial People's Hospital, Guangzhou, Guangdong Province
Gaowa Siqin	Inner Mongolia People's Hospital, Inner Mongolia
Shumei Zhang	Inner Mongolia People's Hospital, Inner Mongolia
Junnan Wang	the Second Hospital of Jilin University, Changchun, Jilin Province
Yinjun Li	the Fourth Hospital of Shenyang, Shenyang, Liaoning Province
Jian Zhang	General Hospital of Northern Theater Command, Shenyang, Liaoning Province
Cheng Liu	General Hospital of Northern Theater Command, Shenyang, Liaoning Province
Guihua Li	The Second Hospital of Dalian Medical University, Dalian, Liaoning Province
Chuanfen Liu	Peking University People's Hospital, Beijing
Rongjing Ding	Peking University People's Hospital, Beijing
Jian Wu	the Second Affiliated Hospital of Harbin Medical University, Harbin, Heilongjiang Province
Yongxiang Zhang	the Second Affiliated Hospital of Harbin Medical University, Harbin, Heilongjiang Province
Qiaoyu Ren	Heilongjiang Agricultural Reclamation Sanjiang People's Hospital, Jiamusi, Heilongjiang Province
Shibo Wang	Heilongjiang Agricultural Reclamation Sanjiang People's Hospital, Jiamusi, Heilongjiang Province
Ying Xin	Harbin Second Hospital, Harbin, Heilongjiang Province
Jing Yao	Hegang People's Hospital, Hegang, Heilongjiang Province

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BMJ Open

Quality indicators for cardiac rehabilitation after myocardial infarction in China: a consensus panel and practice test

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2020-039757.R2
Article Type:	Original research
Date Submitted by the Author:	12-Oct-2020
Complete List of Authors:	Zheng, Xianghui; Second Affiliated Hospital of Harbin Medical University Zhang, Maomao; Second Affiliated Hospital of Harbin Medical University Zheng, Yang; Second Affiliated Hospital of Harbin Medical University Zhang, Yongxiang; Second Affiliated Hospital of Harbin Medical University Wang, Junnan; Jilin University Second Hospital, Cardiology Zhang, Ping; Beijing Tsinghua Changgung Hospital Yang, Xuwen; Tianjin Chest Hospital, Tianjin Cancer Hospital Li, Shan; The Affiliated Hospital of Qingdao University Ding, Rong jing; Peking University People's Hospital, Department of cardiology Siqin, Gaowa; Inner Mongolia People's Hospital Hou, Xinyu; Second Affiliated Hospital of Harbin Medical University Chen, Liangqi; Second Affiliated Hospital of Harbin Medical University Zhang, Min; Second Affiliated Hospital of Harbin Medical University Sun, Yong; Key Laboratories of Education Ministry for Myocardial Ischemia Mechanism and Treatment, 2nd Affiliated Hospital of Harbin Medical University, Cardiology Wu, Jian; Second Affiliated Hospital of Harbin Medical University, Yu, Bo; Key Laboratories of Education Ministry for Myocardial Ischemia Mechanism and Treatment, 2nd Affiliated Hospital of Harbin Medical University, Cardiology
Primary Subject Heading:	Cardiovascular medicine
Secondary Subject Heading:	Cardiovascular medicine
Keywords:	Myocardial infarction < CARDIOLOGY, REHABILITATION MEDICINE, Coronary heart disease < CARDIOLOGY

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Quality indicators for cardiac rehabilitation after myocardial infarction in China: a consensus panel and practice test

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Abstract

Objectives: Cardiac rehabilitation (CR) improves outcomes after myocardial infarction (MI), but it is underutilized in China. The purpose of this study was to develop a set of quality indicators (QIs) to improve clinical practices and to confirm the measurability and performance of the developed QIs for CR in Chinese patients after MI.

Design and setting: The QIs were developed by a Chinese expert consensus panel during in-person meetings. The 5 QIs most in need of improvement were selected using a national questionnaire. Finally, the completion rate and feasibility of the QIs were verified by a group of MI survivors at university hospitals in China.

Participants: Seventeen professionals participated in the consensus panel, 89 personnel the field of CR participated in the national questionnaire, and 165 MI survivors participated in the practice test.

Results: A review of 17 eligible articles generated 26 potential QIs, among which 17 were selected by the consensus panel after careful evaluation. The 17 QIs were divided into two domains: (1) improving participation and adherence and (2) CR process standardization. Nationwide telephone and WeChat surveys identified the 5 QIs most in need of improvement. A multicenter practice test (n=165) revealed that the mean performance value of the proposed QIs was 43.1% (9.9-86.1%) according to post-MI patients.

Conclusions: The consensus panel identified a comprehensive set of QIs for CR in post-MI patients. A nationwide questionnaire survey revealed the QIs that need immediate attention to improve the quality of CR. Although practice tests confirmed the measurability of the proposed QIs in clinical practice, the implementation of the QIs needs to be improved.

Keywords

cardiac rehabilitation, quality indicators, myocardial infarction, consensus panel, national questionnaire

Strengths and limitations of this study

This is the first study proposing immediate improvement in CR QIs on the basis of the results of a nationwide survey and instituting improvement guidelines for CR in China.

The completion rate and feasibility of the developed QIs were revealed by a multicenter practice test.

The composition of the consensus panel may have resulted in bias in the selection of QIs.

The national questionnaire was not distributed to all regions and CR centers in the country.

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Introduction

Acute myocardial infarction (AMI) is highly prevalent globally and a leading cause of mortality and adult disability.[1 2] Currently, the annual mortality rate due to myocardial infarction (MI) can be less than 10%, but up to 20% of patients can experience relapse within the first year.[3] A cardiovascular disease report published in 2018 stated that in China, due to the aging population, the mortality rate of AMI, which increases exponentially in rural areas, increased from 2002 to 2016.[4] Only 55.9% of Chinese patients return to work within 12 months after AMI.[5] Thus, an estimated 2.5 million Chinese people with a history of MI represent a substantial healthcare burden.[4]

Cardiac rehabilitation (CR), a comprehensive secondary prevention framework, aims to improve overall quality of life as well as morbidity and mortality in patients with heart disease.[6 7] CR has a pivotal role along with timely reperfusion strategies and optimized lifestyle and pharmacological therapies in the contemporary approach to post-MI patients.[8] Previous data, including randomized trials and systematic reviews, have established the positive impact of CR and its significant role in reducing morbidity and mortality in post-MI patients.[9-11] Other known benefits of CR include improvements in exercise capacity and quality of life and positive effects on coronary endothelial function, blood pressure, insulin resistance, and inflammatory markers.[12-16] There is a strong association between the number of CR sessions and long-term post-MI outcomes, with different studies reporting the importance of compliance with these programs with regard to cardiac events.[17 18] Given these data, CR is considered a class I recommendation for post-MI patients by the American Heart Association, the American College of Cardiology and the European Society of Cardiology.[19 20]

CR programs are clinically underutilized, and participation in CR is dismally low worldwide.[21-23] A data on CR present that a large majority of coronary patients have unhealthy lifestyles in terms of smoking, diet and sedentary behaviour in the EUROASPIRE V registry.[24] CR is available in only 111/203 (54.7%) countries globally.[25] A report described the rate of CR participation as ranging between 6.6% and 53.5% in the USA.[23] CR was utilized by only 13.9% of patients hospitalized for AMI and 31.0% of patients after coronary artery bypass graft surgery.[23] The results of a European survey revealed an average participation rate of 44.9% in patients with coronary heart disease, with the highest participation rate (85.4%) in Lithuania and the lowest rate (0.0%) in Greece.[22] Only 34% of Canadian patients with indications participated in CR.[21] At present, to the best of our knowledge, there are no data on the CR participation rate in China. In addition, adherence to evidence-based CR performance measures is suboptimal in China.[26] Therefore, effective strategies to increase enrollment and adherence to CR are urgently needed.

Quality improvement is characterized by improvements in health care and systems of care delivered by individual physicians.[27 28] Quality indicators (QIs) provide direction and specific methods for quality improvement.[29 30] A study involving intensive care unit patients showed that a multifaceted quality improvement intervention improved the adoption of care practices.[31] A multifaceted quality improvement intervention resulted in significant improvements in hospital personnel adherence to evidence-based performance measures evaluating the care of patients with

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acute ischemic stroke.[32] The European Association of Preventive Cardiology (EAPC) has defined minimal and optimal cardiovascular rehabilitation standards to increase the quality of cardiovascular rehabilitation programs.[33] In addition, many countries, such as the USA, Japan, and Canada, have developed QIs for improving CR, but QIs are lacking in China. Implementation of QIs can increase long-term participation and adherence by post-MI patients. For example, a two-year study reported a significant increase in enrollment in CR after the implementation of a series of quality improvement interventions, including policy changes, a 7-minute video describing the benefits of CR, and incentives.[34] The early utilization of a cardiac access clinic resulted in an unprecedented (~3-fold) increase in the number of ST-elevation myocardial infarction (STEMI) patients participating in CR.[35] A randomized controlled trial also revealed that early appointments within 10 days of hospital discharge improved CR attendance by approximately 3-fold compared with standard appointments after 35 days.[36]

CR can have an important role in reducing mortality in patients with MI, improving patient quality of life and reducing China's healthcare burden.[37-39] CR process standardization in China needs to be improved.[40] Increasing participation is an important goal for the successful implementation of CR programs, which could decrease morbidity and mortality due to MI. The aim of this study was to describe candidate QIs and test their feasibility and applicability, so as to provide potential future strategies to improve the CR participation and compliance rates in Chinese post-MI patients.

Methods

Quality indicator development

Databases including PubMed, CINAHL Ebsco, and EMBASE were searched for eligible articles published through August 2018 using the keywords cardiac rehabilitation, quality indicator, and myocardial infarction; MeSH terms; and Emtree headings. Two authors (XZ and MZ) conducted the literature review by first reading titles and abstracts and then reading the full text of potential articles. Articles from the search results were included if the following conditions were met: (1) the study provided QIs for CR and (2) the study was published in English. The compiled QIs were further divided into two domains: improving CR participation and adherence rates and standardizing CR processes. Any disagreement about study inclusion was resolved by a third author (JWu).

Consensus panel

The consensus panel consisted of 17 individuals, with a maximum of 2 individuals from each CR center. Members were selected upon meeting the following criteria: (1) the individual had at least 1 year of experience in CR; (2) the individual held a position as a leader of a regional CR program; (3) the individual was committed to the advancement of CR; and (4) the individual agreed to participate in an in-person meeting to discuss CR quality improvement. Two authors (XZ and YZheng) assessed the qualifications of the members, and disagreements were resolved by consensus or a third author (JWu). Members were responsible for scoring the collected QIs based on their

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experience and determining the final QIs for CR in post-MI patients.

Scoring method and selection criteria

The candidate QIs generated from the literature were scored on a ten-point scale. Scoring criteria were based on four aspects: whether they were evidence-based, the feasibility of implementation, their validity, and their reliability. The QIs were judged according to the clinical experience of the consensus panel. The four criteria were used to generate one score. QIs that received scores ≥7 and considered to be significant in the improvement of CR were included in the study. QIs with <7 but >5 points were not considered in this study, and QIs with <5 points were excluded. A QI was considered acceptable for improving the quality of CR in post-MI Chinese patients based on its average score.

National questionnaire

A questionnaire-based survey was conducted nationwide by either telephone or WeChat (a communication tool in China). Participants included cardiologists, nurses, physical therapists, clinical psychologists, registered dietitians and follow-up staff caring for CR patients (health managers who follow up patients via telephone etc.) who met the following criteria: (1) working in an established CR center; and (2) at least 1 year of experience in CR. JWu and YZhang conducted a questionnaire-based survey on the participants. The participants were asked to select 3 out of 26 candidate QIs that they felt required urgent improvement to allow the selection of the top 5 QIs that required immediate improvement in China. The top 5 most important QIs were determined based on the frequency selected by the participants. Additionally, participants could suggest new QIs outside of those mentioned in the questionnaire.

Practice test

A practice test was performed as to review the adaptability of each QI before implementation due to differences in healthcare systems and social circumstances, such as the size of the CR center and patient education, to assess the completion rate of the proposed QIs selected by the consensus panel. The patient inclusion criteria were as follows: (1) a history of AMI; (2) completion of phase Ⅰ and Ⅱ CR at one of the 5 teaching hospitals (Beijing Tsinghua Changgung Hospital, the Second Hospital of Jilin University, Tianjin Chest Hospital and Affiliated Hospital of Qingdao University and the Second Affiliated Hospital of Harbin Medical University) between September 3, 2018 and October 31, 2019; and (3) consent to participate in the study. Patients filled out an 18-question questionnaire about proposed QIs that was developed specifically for this study, and evaluated whether the CR center implemented the proposed QIs. The patients did not answer if they were unsure or did not understand the question. In addition, the consensus panel unanimously agreed that a score greater than 70% was considering good performance, whereas a score less than 30% was considered poor performance. The questionnaire was approved by the ethics committees of the 5 teaching hospitals.

Patient and Public Involvement

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Patient and public involvement Patients and the public were not involved in the design of the study.

Data collection and analysis

Two authors (XZ and YZ) were responsible for data collection and cross checking. The mean score of each QI was calculated as the sum of all participants' ratings/number of participants. The percentage scores of QIs was calculated as follows: number of times the QI was achieved/number of participants (excluding participants who did not answer) × 100. The mean performance is the average of the percentages of all quality indicators.

Results

Collection of QIs

A review of the literature identified 203 articles, and after screening the titles and abstracts, 176 were excluded, as they were not related to QIs for CR. After full-text screening, 17 articles were eligible and subsequently included.[34 36 41-55] A list of 26 potential QIs, including 16 regarding improvement of the CR participation and adherence rates and 10 regarding the effects of completing CR, was generated (Supplementary Table 1). A flowchart of the literature search and selection of eligible articles is shown in Supplementary Figure 1.

The consensus panel and proposal of QIs of CR in post-MI patients

The consensus panel included 17 experts in the field of CR from 12 CR centers (Supplementary Table 2). Seventeen experts who met the inclusion criteria were cardiologists and individually rated each QI on a ten-point scale. The rating of each QI is shown in Supplementary Figures 2 and 3. After careful evaluation, only QIs with an average score ≥7 that could potentially improve the quality of CR in China were accepted (Figure 1). Finally, a total of 17 QIs were selected and divided into two domains: (1) improving participation and adherence and (2) standardizing CR processes (Table 1). There were two more supplementary indicators: extending the hospital rehabilitation time and strengthening the application of traditional Chinese sports.

National questionnaire and top five QIs for imminent improvement

Eighty-nine professionals met the national survey participation criteria; among them, 60 people participated in a telephone survey, and 29 people participated in a WeChat survey. The survey response rate was 100%. The 89 participants from 4 municipalities and 18 provinces in China included 21 cardiologists, 15 nurses, 18 physical therapists, 11 clinical psychologists, 13 registered dietitians and 11 health follow-up staff. Each participant selected three QIs considered critical to improve post-MI CR in China (Figures 2 and 3). The results showed that the five most important QIs were ‘automatically referring all eligible patients at the time of discharge’, ‘recommending CR in discharge guidance’, ‘prescribing exercise based on an assessment of physical fitness’, ‘employing full-time staff for educating patients about CR’, and ‘assessment and education of patients regarding coronary disease risk factors’ (Table 2), with score ratios of 47.2%, 38.2%, 28.1%,

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25.8% and 19.1%, respectively.

Practice test

The practice test was completed by 165 patients who met the inclusion criteria, and no patients refused to participate in the study (30 patients from Beijing Tsinghua Changgung Hospital, 30 patients from the Second Hospital of Jilin University, 34 patients from Tianjin Chest Hospital, 30 patients from Affiliated Hospital of Qingdao University and 41 patients from the Second Affiliated Hospital of Harbin Medical University). The results revealed a mean performance value of 43.1% (9.9-86.1%). The QIs that achieved good performance (minimum to maximum 72.1-86.1%) were 'assessment and education of patients on tobacco and alcohol consumption' and 'recommending CR in discharge guidance'. There were also several low-performing QIs (minimum to maximum 9.9-29.7%), including 'holding multidisciplinary meetings, 'frequency of CR registration and recommendation as QIs for assessing doctor performance', 'immediate enrollment in CR for referral patients', and 'providing patients with written invitations and program brochures' (Table 1).

Discussion

In this study, 26 QIs generated from 17 articles were assessed as candidate QIs for CR. Out of the 26 QIs, 17 were selected by a Chinese multidisciplinary consensus panel and divided into two domains based on participation and adherence and outcomes. The findings of the nationwide questionnaire could guide clinical quality improvement. The practice test showed the feasibility and applicability of all 17 QIs in the Chinese context.

To our knowledge, this is the first study proposing an immediate improvement in CR QIs on the basis of the results of a nationwide survey and the implementation of improvement guidelines for CR in China. However, although still in its infancy, CR in China has developed rapidly. According to data published by the Chinese Society of Rehabilitation Medicine (CARM), the number of CR centers has increased from 6 in 2012 to more than 500 currently.[56] Hence, the improved implementation of CR programs is imperative, given the current situation. We consider that QI development is a time-efficient and resource-saving approach.[57] In many countries, CR is strongly associated with quality of life improvement. For example, the USA has effectively implemented QI monitoring to increase the CR participation rate.[41] Similarly, Canada has developed QIs to promote the broad development of CR programs,[44] and Japan has also proposed QIs to assess improvements in the quality of CR after acute coronary syndrome (ACS).[46] Moreover, the EAPC described QIs to assess improvements in CR process standardization in Europe.[33] In this study, we propose QIs to promote the improvement of CR in China considering the recommendations reported in these previous studies.

CR is still in the early phase of development in China.[40] Given the uneven distribution of CR programs, the consensus panel selected QIs to promote improvements in participation and adherence that were simple, practical and in line with the current status of CR in the country. For example, the present report suggests that 'recommending CR in discharge guidance' was key in emphasizing the

importance and necessity of CR, and 'automatically referring all eligible patients at the time of discharge' was one of the best way to increase participation in CR. Other suitable QIs were 'employing full-time staff for educating patients about CR' and 'employing CR liaison staff'. In addition, the study revealed QIs that are necessary for CR process standardization in China, such as 'assessment and education of patients regarding coronary disease risk factors', 'assessment and education of patients about dietary habits', and 'prescribing exercise based on physical fitness'. It is worth mentioning that the completion rate of 'holding multidisciplinary meetings' was very low in the practice test, but the implementation of this QI can improve recovery in patients with multiple diseases.[29 58 59] Moreover, measuring the completion rate of the proposed QIs is important.[60-62] Moreover, measuring the completion rate of the proposed QIs is important. There are some methods for measuring. First of all, QIs should be recorded in the medical record. In this way, the completion of the QIs can be checked in the medical record. Second, from the perspective of patients, a questionnaire about the implementation of QIs was conducted when the patients were discharged. In addition, relevant medical staff should be evaluated by self-assessment and other assessment scales.

It is also important to understand the barriers to appropriate CR, including lack of health awareness, inadequate policies, insufficiency of CR, lack of healthcare system support and inadequate professional guidelines and information systems.[63-65] Gary et al. reported that older females with a low socioeconomic status, with a low education level, with poor self-efficacy, with multiple comorbidities and who were unable to communicate in English were more likely to not participate in CR.[48] Enrollment in the CR program is affected by many healthcare system-related factors, including lack of referral, limited facilitation of enrollment after referral, lack of programs that serve specific geographic areas and low-income communities, and gender-dominated programs.[66] In this study, we proposed QIs that could aid in overcoming some of these barriers and also in the successful implementation of CR.

During the course of the study, two additional supplementary indicators, 'extending the hospital rehabilitation time' and 'strengthening the application of traditional Chinese exercise', were added. Tai Chi Chuan practice was associated with a VO_2 peak increase in patients with MI.[67] Baduanjin exercise therapy in post-MI patients reverses adverse left ventricular (LV) remodeling, inflammation curbing, extracellular matrix organization adjustment and improves clinical outcomes.[68 69] Baduanjin sequential therapy also appears to improve the quality of life in patients with AMI after percutaneous coronary intervention, with additional benefits of lowered abdominal circumference and body mass index and improved level of cardiac function.[70] Therefore, traditional Chinese exercises, such as Tai Chi Chuan and baduanjin, may constitute effective forms of CR in patients with MI.

In summary, the application of these QIs could help standardize and improve the quality of CR in China. This study provides guidance for the development of CR in our country. Nevertheless, further studies are needed to evaluate the validity, reliability and feasibility of these QIs, and whether improvements in these parameters can be associated with clinical benefits in this patient population.

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Study limitations

There are many limitations in our study. First, in the quality indicator development section of the methods, we retrieved the literature from public databases; hence, there is a possibility of publication bias. Second, investigation bias may exist because the consensus panel participants were all cardiologists and the national questionnaire was not distributed to all regions and CR centers in the country. The baseline characteristics for the professionals in the national questionnaire were also not present; and no specific calculation was performed in terms of sample size for the national questionnaire. These factors may also lead to bias in the results of the practice test due to the absence of data from nonteaching hospitals, the relatively small sample size and the lack of data concerning baseline characteristics of the patients (i.e. sex, age, marital status, cardiovascular risk factors, prior history of myocardial infarction, ST-segment or non-ST-segment elevation myocardial infarction, left ventricular ejection fraction, percutaneous coronary intervention, coronary artery bypass grafting, medication, etc.). Moreover, to assess the measurability and completeness of the proposed QIs, only patients who participated in CR programs were selected to complete the practice test. As such, data from those who did not participate in these programs were not available.

Conclusion

In this study, a consensus panel identified 17 candidate QIs to assess improvements in the quality of CR in post-MI patients in China. A nationwide survey revealed the 5 QIs that required imminent improvement to facilitate increased enrollment in CR programs in the country. Moreover, a practice test administered to MI survivors confirmed the feasibility and completeness of the developed QIs. The test also revealed that holding multidisciplinary meetings and improving communication between referral physicians and patients about CR can improve the performance of the CR program in clinics. Application of the proposed QIs could improve the quality of CR care in Chinese post-MI patients.

Acknowledgments

The authors are grateful to the members of the consensus panel, the staff who participated in the national questionnaire, and the patients who completed the practice test.

Author contribution

All authors contributed to conception and design of the work. XZ and YZheng contributed to analysis and interpretation. JWu, YZhang, JWang, PZ, XY, SL, RD, GS, BY and YS contributed to acquisition of data. XZ and MaoZ drafted the manuscript. MinZ, XH and LC critically revised the manuscript. All authors reviewed and agrees to the final version.

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Funding

This work was supported by the National Key R&D Program of China (Grant no. 2016YFC1301100), the National Natural Science Foundation of China (Grants no. 81670373, 81670459 and 81771946), and the Key Laboratory of Myocardial Ischemia, Harbin Medical University, Ministry of Education (KF201806 to X.Z., KF201716 to Y.Z., KF201822 to L.C.).

Competing interests

None declared.

Patient consent for publication

Patients and/or the public were involved in the design, or conduct, or reporting, or dissemination plans of this research. Refer to the Methods section for further details.

Ethics approval

The study was approved by the ethics committee of Beijing Tsinghua Changgung Hospital, the Second Hospital of Jilin University, Tianjin Chest Hospital and Affiliated Hospital of Qingdao University and the Second Affiliated Hospital of Harbin Medical University. This study is part of a registered study of ClinicalTrials.gov NCT03528382.

Provenance and peer review

Not commissioned; externally peer reviewed.

Data sharing statement

No additional data are available.

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Figure Legends

Figure 1. Mean of all the indicators identified by the consensus panel. A. The mean of domain 1: improving CR participation and adherence. B. The mean of domain 2: CR process standardization.

Figure 2. Regional distributions of the national questionnaire. Blue represents the areas surveyed, while white represents areas not surveyed.

Figure 3. Quality indicators from the national questionnaires that were identified as needing immediate improvement (blue).

Supplementary Figure 1. Flow chart of the literature search process.

Supplementary Figure 2. Rating distribution of domain 1 candidate quality indicators. The X-axis indicates individual indicator evaluation by the panel. The Y-axis indicates the number of panel members who scored the indicator.

Supplementary Figure 3. Rating distribution of domain 2 candidate indicators. The X-axis indicates individual indicator evaluation by the panel. The Y-axis indicates the number of panel members who scored the quality indicator.

Table Legends

Table 1. The proposed quality indicators and their percentage scores for CR in patients with MI.

Table 2. Top 5 quality indicators that were identified as needing improvement.

Supplementary Table 1. Candidate QIs to improve CR in patients with MI.

Supplemental Table 2. Information about professionals of the consensus pane.

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Table 1 The proposal quality indicators and percentage scores for cardiac rehabilitation of patients with myocardial infarction

Quality Indicators	Numerator/ denominator	Performance %
Domain 1: Improving CR participation and adherence		
QI-1: recommending CR in discharge guidance	142/165	86.1
QI-2: automatically referring all eligible patients at the time of discharge	56/163	34.4
QI-3: employing full-time staff for educating patients about CR	72/162	44.4
QI-4: providing patients with written invitations and program brochures	49/165	29.7
QI-5: employing liaison staff for CR	51/161	31.7
QI-6: immediate enrollment in CR for referral patients	31/164	18.9
QI-7: enrollment in CR before discharge	67/162	41.4
QI-10: frequency of CR enrollment and recommendation as indicators for assessing doctor performance	28/153	18.3
Domain 2: CR process standardization		
QI-17: assessment and education of patients regarding coronary disease risk factors	79/165	47.9
QI-18: communication between referral physician and patient about CR	95/157	60.5
QI-19: assessment and education of patients about dietary habits	81/165	49.1
QI-20: assessment and treatment of psychological issues	85/165	51.5
QI-21: assessment of and education of patients about tobacco and alcohol consumption	119/165	72.1
QI-22: prescribing exercise based on an assessment of physical fitness	86/165	52.1
QI-23: reassessment of exercise capacity	71/165	43.0
QI-25: education about the importance of adherence to prescribed medication	91/165	55.2
QI-26: holding multidisciplinary meetings	16/162	9.9

These are the QIs with a rating ≥7, with the same numbers as those in Supplementary Table 1.

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Table 2 Top 5 quality indicators that need improvement

Indicators	Numerator/ denominator	Importance (%)
Top 1: automatically referring all eligible patients at the time of discharge	42/89	47.2
Top 2: recommending CR in discharge guidance	34/89	38.2
Top 3: prescribing exercise based on an assessment of physical fitness	25/89	28.1
Top 4: employing full-time staff for educating patients about CR	23/89	25.8
Top 5: assessment and education of patients regarding coronary disease risk factors	17/89	19.1

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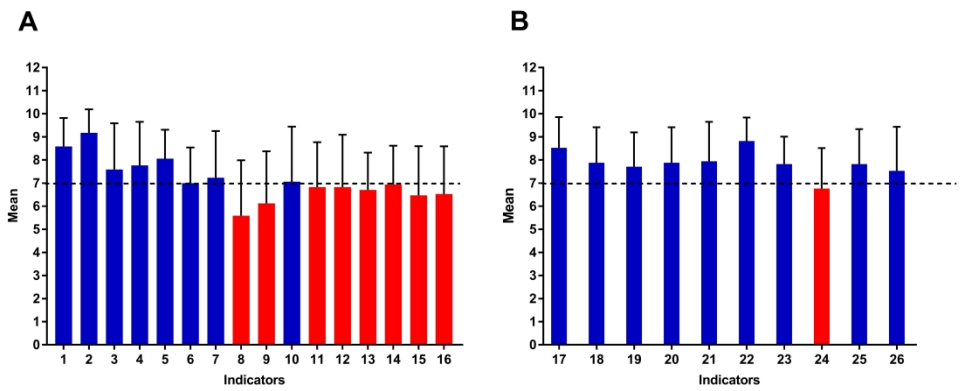

Mean of all the indicators identified by the consensus panel. A. The mean of domain 1: improving CR participation and adherence. B. The mean of domain 2: CR process standardization.

259x109mm (600 x 600 DPI)

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Regional distributions of the national questionnaire. Blue represents the areas surveyed, while white represents areas not surveyed.

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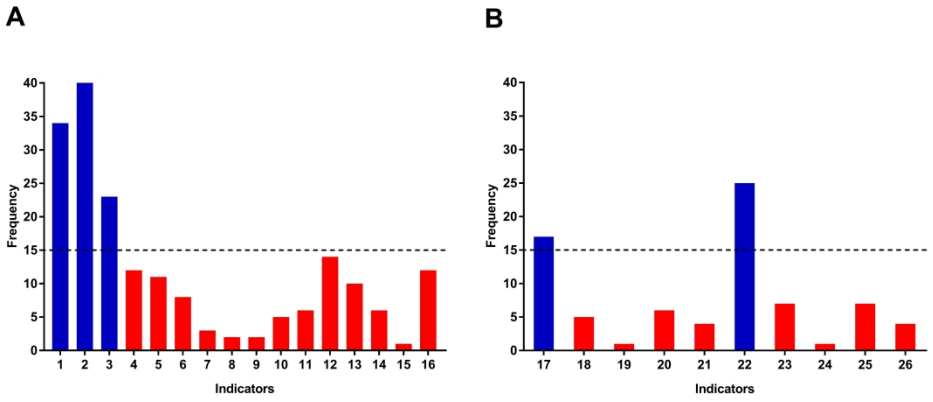

Quality indicators from the national questionnaires that were identified as needing immediate improvement (blue).

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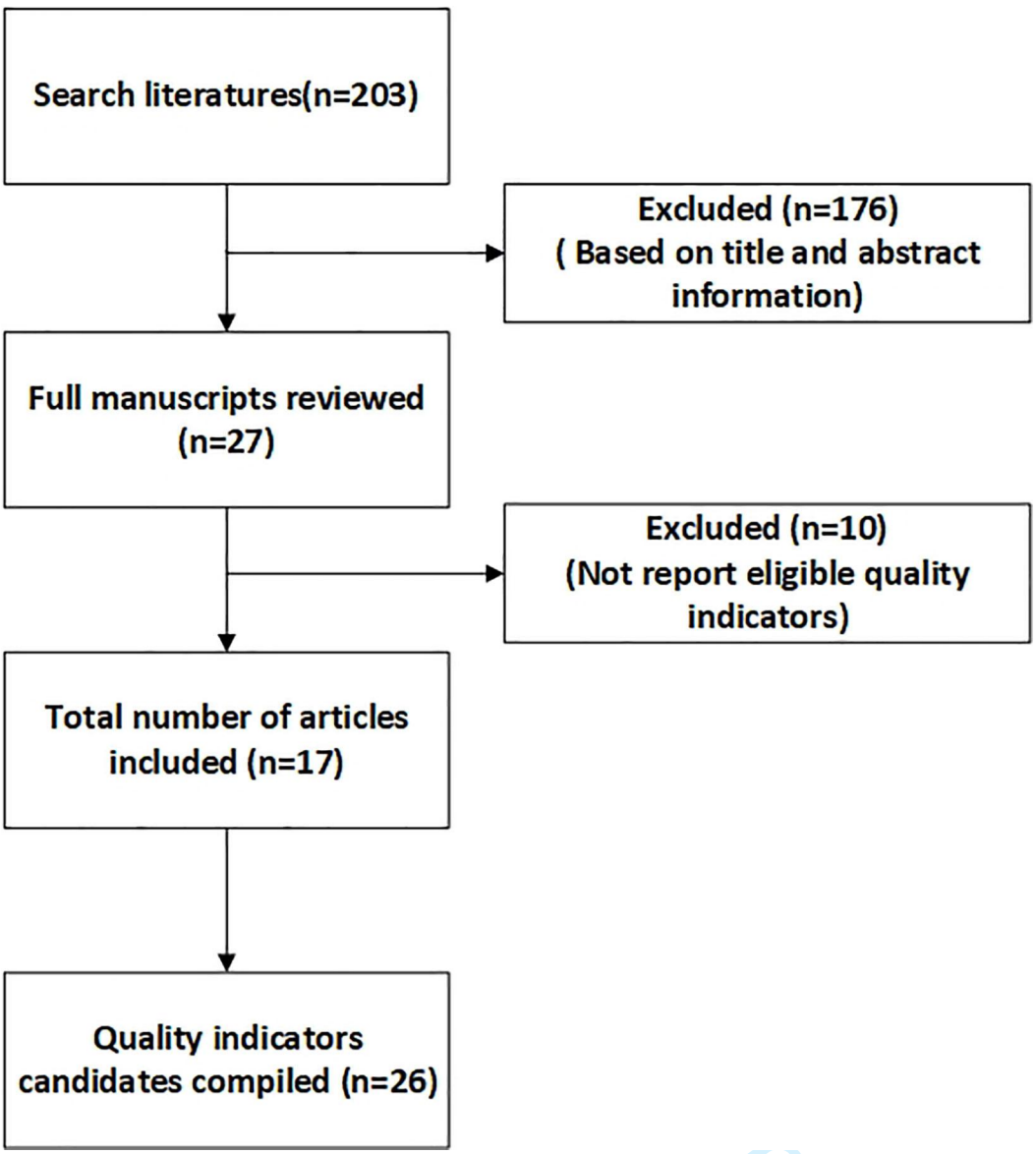
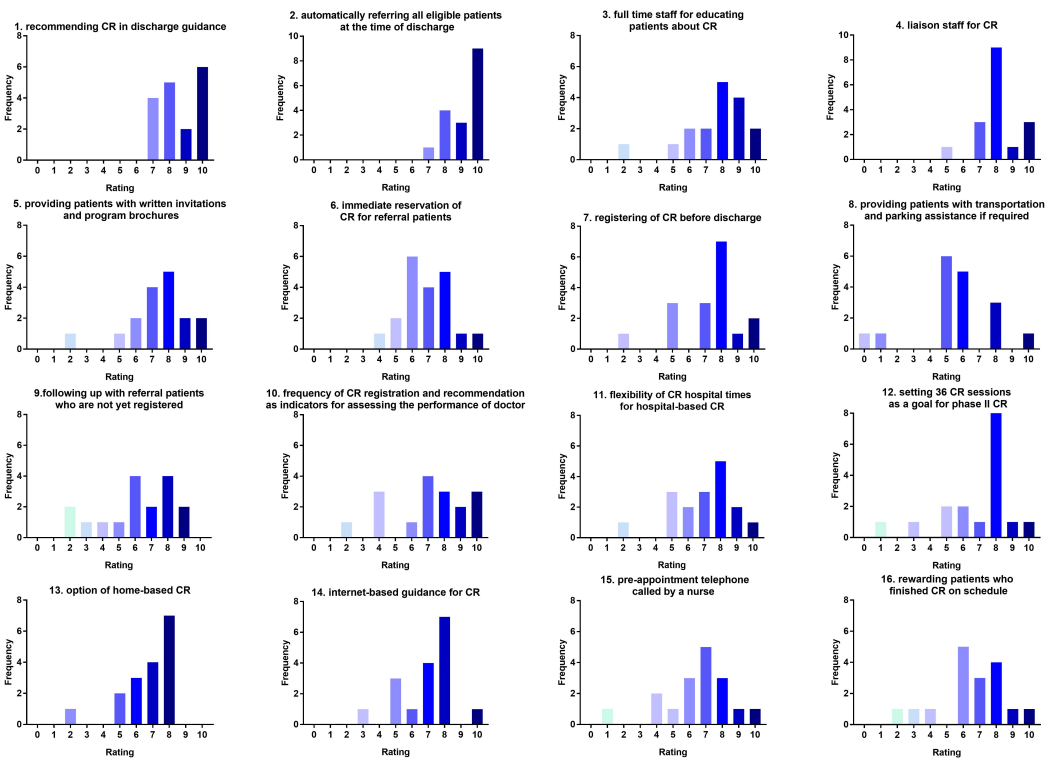
Supplementary Figure 1. Flow chart of the literature search process.



Supplementary Figure 2. Rating distribution of domain 1 candidate quality indicators. The X-axis indicates individual indicator evaluation by the panel. The Y-axis indicates the number of panel members who scored the indicator.



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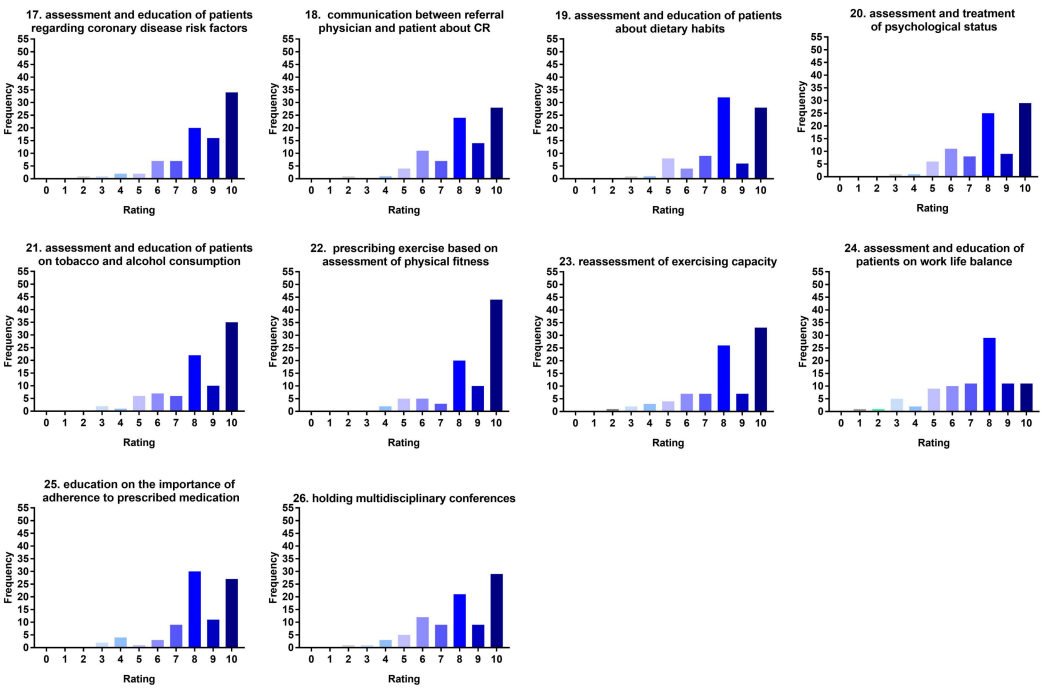
Supplementary Figure 3. Rating distribution of domain 2 candidate indicators. The X-axis indicates individual indicator evaluation by the panel. The Y-axis indicates the number of panel members who scored the quality indicator.



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Supplemental Table 1 Candidate quality indicators for cardiac rehabilitation in patients with myocardial infarction

Quality Indicators	Reference
Domain 1: Improving CR participation and adherence	
QI-1: recommending CR in discharge guidance	28, 38
QI-2: automatically referring all eligible patients at the time of discharge	28, 34, 35, 36, 38, 39, 40
QI-3: employing full-time staff for educating patients about CR	28, 38
QI-4: providing patients with written invitations and program brochures	35
QI-5: employing CR liaison staff	35
QI-6: immediate enrollment in CR for referral patients	24, 29, 31, 36, 37
QI-7: enrollment in CR before discharge	35
QI-8: providing patients with transportation and parking assistance if required	35
QI-9: following up with referral patients who are not yet registered	35
QI-10: frequency of CR registration and recommendation as indicators for assessing doctor performance	22
QI-11: flexibility of CR times for hospital-based CR	28, 35
QI-12: setting 36 CR sessions as a goal for phase II CR	22, 42
QI-13: option of home-based CR	28
QI-14: internet-based guidance for CR	41
QI-15: preappointment telephone reminder by a nurse	32
QI-16: rewarding patients who finish CR on schedule	22, 30
Domain 2: Process standardization of CR	
QI-17: assessment and education of patients regarding coronary disease risk factors	31 , 33, 36
QI-18: communication between referral physician and patient about CR	33
QI-19: assessment and education of patients about dietary habits	33
QI-20: assessment and treatment of psychological issues	31, 33
QI-21: assessment and education of patients about tobacco and alcohol consumption	31, 33
QI-22: prescribing exercise based on an assessment of physical fitness	31, 33, 36
QI-23: reassessment of exercise capacity	33
QI-24: assessment of and education about patient work-life balance	33
QI-25: education about the importance of adherence to prescribed medication	33
QI-26: holding multidisciplinary meetings	33

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Supplemental Table 2 Information about professionals of the consensus panel.

Experts of the consensus panel	Cardiac rehabilitation centres
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Shumei Zhang	Inner Mongolia People's Hospital, Inner Mongolia
Junnan Wang	the Second Hospital of Jilin University, Changchun, Jilin Province
Yinjun Li	the Fourth Hospital of Shenyang, Shenyang, Liaoning Province
Jian Zhang	General Hospital of Northern Theater Command, Shenyang, Liaoning Province
Cheng Liu	General Hospital of Northern Theater Command, Shenyang, Liaoning Province
Guihua Li	The Second Hospital of Dalian Medical University, Dalian, Liaoning Province
Chuanfen Liu	Peking University People's Hospital, Beijing
Rongjing Ding	Peking University People's Hospital, Beijing
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Quality indicators for cardiac rehabilitation after myocardial infarction in China: a consensus panel and practice test

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2020-039757.R3
Article Type:	Original research
Date Submitted by the Author:	25-Nov-2020
Complete List of Authors:	Zheng, Xianghui; Second Affiliated Hospital of Harbin Medical University Zhang, Maomao; Second Affiliated Hospital of Harbin Medical University Zheng, Yang; Second Affiliated Hospital of Harbin Medical University Zhang, Yongxiang; Second Affiliated Hospital of Harbin Medical University Wang, Junnan; Jilin University Second Hospital, Cardiology Zhang, Ping; Beijing Tsinghua Changgung Hospital Yang, Xuwen; Tianjin Chest Hospital, Tianjin Cancer Hospital Li, Shan; The Affiliated Hospital of Qingdao University Ding, Rong jing; Peking University People's Hospital, Department of cardiology Siqin, Gaowa; Inner Mongolia People's Hospital Hou, Xinyu; Second Affiliated Hospital of Harbin Medical University Chen, Liangqi; Second Affiliated Hospital of Harbin Medical University Zhang, Min; Second Affiliated Hospital of Harbin Medical University Sun, Yong; Key Laboratories of Education Ministry for Myocardial Ischemia Mechanism and Treatment, 2nd Affiliated Hospital of Harbin Medical University, Cardiology Wu, Jian; Second Affiliated Hospital of Harbin Medical University, Yu, Bo; Key Laboratories of Education Ministry for Myocardial Ischemia Mechanism and Treatment, 2nd Affiliated Hospital of Harbin Medical University, Cardiology
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Secondary Subject Heading:	Cardiovascular medicine
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Quality indicators for cardiac rehabilitation after myocardial infarction in China: a consensus panel and practice test

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Abstract

Objectives: Cardiac rehabilitation (CR) improves outcomes after myocardial infarction (MI), but it is underutilized in China. The purpose of this study was to develop a set of quality indicators (QIs) to improve clinical practices and to confirm the measurability and performance of the developed QIs for CR in Chinese patients after MI.

Design and setting: The QIs were developed by a Chinese expert consensus panel during in-person meetings. The 5 QIs most in need of improvement were selected using a national questionnaire. Finally, the completion rate and feasibility of the QIs were verified in a group of MI survivors at university hospitals in China.

Participants: Seventeen professionals participated in the consensus panel, 89 personnel in the field of CR participated in the national questionnaire, and 165 MI survivors participated in the practice test.

Results: A review of 17 eligible articles generated 26 potential QIs, among which 17 were selected by the consensus panel after careful evaluation. The 17 QIs were divided into two domains: (1) improving participation and adherence and (2) CR process standardization. Nationwide telephone and WeChat surveys identified the 5 QIs most in need of improvement. A multicenter practice test (n=165) revealed that the mean performance value of the proposed QIs was 43.9% (9.9-86.1%) according to post-MI patients.

Conclusions: The consensus panel identified a comprehensive set of QIs for CR in post-MI patients. A nationwide questionnaire survey revealed was used to identify the QIs that need immediate attention to improve the quality of CR. Although practice tests confirmed the measurability of the proposed QIs in clinical practice, the implementation of the QIs needs to be improved.

Keywords

cardiac rehabilitation, quality indicators, myocardial infarction, consensus panel, national questionnaire

Strengths and limitations of this study

This is the first study proposing immediate improvement in CR QIs on the basis of the results of a nationwide survey and instituting improvement guidelines for CR in China.

The completion rate and feasibility of the developed QIs were revealed by a multicenter practice test.

The composition of the consensus panel may have resulted in bias in the selection of QIs.

The national questionnaire was not distributed to all regions and CR centers in the country.

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Introduction

Acute myocardial infarction (AMI) is highly prevalent globally and a leading cause of mortality and adult disability.[1 2] Currently, the annual mortality rate due to myocardial infarction (MI) is less than 10%, but up to 20% of patients experience relapse within the first year.[3] A cardiovascular disease report published in 2018 stated that in China, due to the aging population, the mortality rate of AMI, which is exponentially higher in rural areas, increased from 2002 to 2016.[4] Only 55.9% of Chinese patients return to work within 12 months after AMI.[5] Among the hospitalization expenses for cardiovascular and cerebrovascular diseases in 2016, AMI accounted for 19.085 billion yuan.[4] Thus, Chinese people with a history of MI represent a substantial healthcare burden.

Cardiac rehabilitation (CR), a comprehensive secondary prevention framework, aims to improve overall quality of life as well as morbidity and mortality in patients with heart disease.[6 7] CR has a pivotal role along with timely reperfusion strategies and optimized lifestyle and pharmacological therapies in the contemporary approach to post-MI patients.[8] Previous data, including randomized trials and systematic reviews, have established the positive impact of CR and its significant role in reducing morbidity and mortality in post-MI patients.[9-11] Other known benefits of CR include improvements in exercise capacity and quality of life and positive effects on coronary endothelial function, blood pressure, insulin resistance, and inflammatory markers.[12-16] There is a strong association between the number of CR sessions and long-term post-MI outcomes, with different studies reporting the importance of compliance with these programs with regard to cardiac events.[17 18] Given these data, CR is considered a class I recommendation for post-MI patients by the American Heart Association, the American College of Cardiology and the European Society of Cardiology.[19 20]

CR programs are clinically underutilized, and participation in CR is dismally low worldwide.[21-23] Notably, contemporary data from the EUROASPIRE V registry underscores the notion that many coronary patients have unhealthy lifestyles, namely in regards to smoking, diet and sedentary behaviour.[24] CR is available in only 111/203 (54.7%) countries globally.[25] A report described the rate of CR participation as ranging between 6.6% and 53.5% in the USA.[23] CR was utilized by only 13.9% of patients hospitalized for AMI and 31.0% of patients after coronary artery bypass graft surgery.[23] An European survey reported that less than half of the patients were advised to attend CR programs.[22] Only 34% of Canadian patients with the appropriate indications participated in CR.[21] At present, to the best of our knowledge, there are no data on the CR participation rate in China. In addition, adherence to evidence-based CR performance measures is suboptimal in China.[26] Therefore, effective strategies to increase enrollment and adherence to CR are urgently needed.

Quality improvement is characterized by improvements in health care and systems of care delivered by individual physicians.[27 28] Quality indicators (QIs) provide direction and specific methods for quality improvement.[29 30] A study involving intensive care unit patients showed that a multifaceted quality improvement intervention improved the adoption of care practices.[31] A multifaceted quality improvement intervention resulted in significant improvements in hospital

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personnel adherence to evidence-based performance measures evaluating the care of patients with acute ischemic stroke.[32] The European Association of Preventive Cardiology (EAPC) has defined minimal and optimal cardiovascular rehabilitation standards to increase the quality of cardiovascular rehabilitation programs.[33] In addition, many countries, such as the USA, Japan, and Canada, have developed QIs for improving CR, but QIs are lacking in China. Implementation of QIs can increase long-term participation and adherence by post-MI patients. For example, a two-year study reported a significant increase in enrollment in CR after the implementation of a series of quality improvement interventions, including policy changes, a 7-minute video describing the benefits of CR, and incentives.[34] The early utilization of a cardiac access clinic resulted in an unprecedented (~3-fold) increase in the number of ST-elevation myocardial infarction (STEMI) patients participating in CR.[35] A randomized controlled trial also revealed that early appointments within 10 days of hospital discharge improved CR attendance compared with standard appointments after 35 days.[36]

CR can play important roles in reducing mortality in patients with MI, improving patient quality of life and reducing China's healthcare burden.[37-39] CR process standardization in China needs to be improved.[40] Increasing participation is an important goal for the successful implementation of CR programs, which could decrease morbidity and mortality due to MI. The aim of this study was to describe candidate QIs and test their feasibility and applicability to provide a basis for future strategies to improve the CR participation and compliance rates in Chinese post-MI patients.

Methods

Quality indicator development

Databases including PubMed, CINAHL Ebsco, and EMBASE were searched for eligible articles published through August 2018 using the keywords cardiac rehabilitation, quality indicator, and myocardial infarction; MeSH terms; and Emtree headings. Two authors (XZ and MZ) conducted the literature review by first reading titles and abstracts and then reading the full text of potential articles. Articles from the search results were included if the following conditions were met: (1) the study provided QIs for CR and (2) the study was published in English. The compiled QIs were further divided into two domains: improving CR participation and adherence rates and standardizing CR processes. Any disagreement about study inclusion was resolved by a third author (JWu).

Consensus panel

The consensus panel consisted of 17 individuals, with a maximum of 2 individuals from each CR center. Members were selected upon meeting the following criteria: (1) the individual had at least 1 year of experience in CR; (2) the individual held a position as a leader of a regional CR program; (3) the individual was committed to the advancement of CR; and (4) the individual agreed to participate in an in-person meeting to discuss CR quality improvement. Two authors (XZ and YZheng) assessed the qualifications of the members, and disagreements were resolved by consensus or a third author (JWu). Members were responsible for scoring the collected QIs based on their

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experience and determining the final QIs for CR in post-MI patients.

Scoring method and selection criteria

The candidate QIs generated from the literature were scored on a ten-point scale. Scoring criteria were based on four aspects: whether they were evidence-based, the feasibility of implementation, their validity, and their reliability. The QIs were judged according to the clinical experience of the consensus panel. The four criteria were used to generate one score. QIs that received scores ≥7 and considered to be significant in the improvement of CR were included in the study. QIs with <7 but >5 points were not considered in this study, and QIs with <5 points were excluded. A QI was considered acceptable for improving the quality of CR in post-MI Chinese patients based on its average score.

National questionnaire

A questionnaire-based survey was conducted nationwide by either telephone or WeChat (a communication tool in China). Participants included cardiologists, nurses, physical therapists, clinical psychologists, registered dietitians and follow-up staff caring for CR patients (health managers who follow up patients via telephone etc.) who met the following criteria: (1) working in an established CR center; and (2) at least 1 year of experience in CR. J Wu and Y Zhang conducted a questionnaire-based survey with the participants. The participants were asked to select 3 out of 26 candidate QIs that they felt required urgent improvement to allow the selection of the top 5 QIs that required immediate improvement in China. The top 5 most important QIs were determined based on the frequency selected by the participants. Additionally, participants could suggest new QIs outside of those mentioned in the questionnaire.

Practice test

An practice test was performed as to review the adaptability of each QI before implementation due to differences in healthcare systems and social circumstances, such as the size of the CR center and patient education, to assess the completion rate of the proposed QIs selected by the consensus panel. The patient inclusion criteria were as follows: (1) a history of AMI; (2) completion of phase Ⅰ and Ⅱ CR at one of the 5 teaching hospitals (Beijing Tsinghua Changgung Hospital, the Second Hospital of Jilin University, Tianjin Chest Hospital and Affiliated Hospital of Qingdao University and the Second Affiliated Hospital of Harbin Medical University) between September 3, 2018 and October 31, 2019; and (3) consent to participate in the study. Patients filled out an 17-question questionnaire (Supplementary Table 1) about proposed QIs that was developed specifically for this study and evaluated whether the CR center implemented the proposed QIs. The patients did not answer if they were unsure or did not understand the question. In addition, the consensus panel unanimously agreed that a score greater than 70% was considering good performance, whereas a score less than 30% was considered poor performance. The questionnaire was approved by the ethics committees of the 5 teaching hospitals.

Patient and public involvement

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Patients and the public were not involved in the design of the study.

Data collection and analysis

Two authors (XZ and YZ) were responsible for data collection and cross checking. The mean score of each QI was calculated as the sum of all participants' ratings/number of participants. The percentage score for each QIs was calculated as follows: the number of times the QI was achieved/the number of participants (excluding participants who did not answer)×100. The mean performance was the average of the percentages of all quality indicators.

Results

Collection of QIs

A review of the literature identified 203 articles, and after screening the titles and abstracts, 176 were excluded, as they were not related to QIs for CR. After full-text screening, 17 articles were eligible and subsequently included.[34 36 41-55] A list of 26 potential QIs, including 16 regarding improvement of the CR participation and adherence rates and 10 regarding the standardization of the CR processes, was generated (Supplementary Table 2). A flowchart of the literature search and selection of eligible articles is shown in Supplementary Figure 1.

The consensus panel and proposal of QIs of CR in post-MI patients

The consensus panel included 17 experts in the field of CR from 12 CR centers (Supplementary Table 3). Seventeen experts who met the inclusion criteria were cardiologists and individually rated each QI on a ten-point scale. The rating of each QI is shown in Supplementary Figures 2 and 3. After careful evaluation, only QIs with an average score ≥7 that could potentially improve the quality of CR in China were accepted (Figure 1). Finally, a total of 17 QIs were selected and divided into two domains: (1) improving participation and adherence and (2) standardizing CR processes (Table 1). There were two more supplementary indicators: extending the hospital rehabilitation time and strengthening the application of traditional Chinese sports.

National questionnaire and top five QIs for imminent improvement

Eighty-nine professionals met the national survey participation criteria; among them, 60 people participated in a telephone survey, and 29 people participated in a WeChat survey. The survey response rate was 100%. The 89 participants from 4 municipalities and 18 provinces in China included 21 cardiologists, 15 nurses, 18 physical therapists, 11 clinical psychologists, 13 registered dietitians and 11 health follow-up staff. Each participant selected three QIs considered critical to improve post-MI CR in China (Figures 2 and 3). The results showed that the five most important QIs were ‘automatically referring all eligible patients at the time of discharge’, ‘recommending CR in discharge guidance’, ‘prescribing exercise based on an assessment of physical fitness’, ‘employing full-time staff for educating patients about CR’, and ‘assessment and education of

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patients regarding coronary disease risk factors' (Table 2), with score ratios of 47.2%, 38.2%, 28.1%, 25.8% and 19.1%, respectively.

Practice test

The practice test was completed by 165 patients who met the inclusion criteria, and no patients refused to participate in the study (30 patients from Beijing Tsinghua Changgung Hospital, 30 patients from the Second Hospital of Jilin University, 34 patients from Tianjin Chest Hospital, 30 patients from Affiliated Hospital of Qingdao University and 41 patients from the Second Affiliated Hospital of Harbin Medical University). The results revealed a mean performance value of 43.9% (9.9-86.1%). The QIs that achieved good performance (minimum to maximum 72.1-86.1%) were 'assessment and education of patients on tobacco and alcohol consumption' and 'recommending CR in discharge guidance'. There were also several low-performing QIs (minimum to maximum 9.9-29.7%), including 'holding multidisciplinary meetings, 'frequency of CR registration and recommendation as QIs for assessing doctor performance', 'immediate enrollment in CR for referral patients', and 'providing patients with written invitations and program brochures' (Table 1).

Discussion

In this study, 26 QIs generated from 17 articles were assessed as candidate QIs for CR. Out of the 26 QIs, 17 were selected by a Chinese expert consensus panel and divided into two domains based on participation and adherence and CR process standardization. The findings of the nationwide questionnaire could guide clinical quality improvement. The practice test showed the feasibility and applicability of all 17 QIs in the Chinese context.

To our knowledge, this is the first study proposing an immediate improvement in CR QIs on the basis of the results of a nationwide survey and the implementation of improvement guidelines for CR in China. However, although still in its infancy, CR in China has developed rapidly. According to data published by the Chinese Society of Rehabilitation Medicine (CARM), the number of CR centers has increased from 6 in 2012 to more than 500 currently.[56] Hence, the improved implementation of CR programs is imperative, given the current situation. We consider that QI development is a time-efficient and resource-saving approach.[57] In many countries, CR is strongly associated with quality of life improvement. For example, the USA has effectively implemented QI monitoring to increase the CR participation rate.[41] Similarly, Canada has developed QIs to promote the broad development of CR programs,[44] and Japan has also proposed QIs to assess improvements in the quality of CR after acute coronary syndrome (ACS).[46] Moreover, the EAPC described QIs to assess improvements in CR process standardization in Europe.[33] In this study, we propose QIs to promote the improvement of CR in China considering the recommendations reported in these previous studies.

CR is still in the early phase of development in China.[40] Given the uneven distribution of CR programs, the consensus panel selected QIs to promote improvements in participation and adherence that were simple, practical and in line with the current status of CR in the country. For example, the

present report suggests that 'recommending CR in discharge guidance' was key in emphasizing the importance and necessity of CR, and 'automatically referring all eligible patients 'at the time of discharge' was one of the best ways to increase participation in CR. Other suitable QIs were 'employing full-time staff for educating patients about CR' and 'employing CR liaison staff'. In addition, the study revealed QIs that are necessary for CR process standardization in China, such as 'assessment and education of patients regarding coronary disease risk factors', 'assessment and education of patients about dietary habits', and 'prescribing exercise based on physical fitness'. It is worth mentioning that the completion rate of 'holding multidisciplinary meetings' was very low in the practice test, but the implementation of this QI can improve recovery in patients with multiple diseases.[29 58 59] Moreover, measuring the completion rate of the proposed QIs is important.[60-62] There are some measurement methods. First, QIs should be recorded in the medical record. In this way, the completion of the QIs can be checked. Second, from the perspective of patients, a questionnaire about the implementation of QIs was conducted at discharge. Relevant medical staff should be evaluated by self-assessment and other assessment scales. In addition, clinical audits, a method of establishing whether healthcare is being provided in line with the relevant standards and identifying areas for improvements, should be performed.[63] CR programs could be improved by continuous assessment.[64]

It is also important to understand the barriers to appropriate CR, including lack of health awareness, inadequate policies, insufficiency of CR, lack of healthcare system support and inadequate professional guidelines and information systems.[65-67] Gary et al. reported that older females with a low socioeconomic status, with a low education level, with poor self-efficacy, with multiple comorbidities and without the ability to communicate in English were more likely to not participate in CR.[48] Enrollment in the CR program is affected by many healthcare system-related factors, including lack of referral, limited facilitation of enrollment after referral, lack of programs that serve specific geographic areas and low-income communities, and gender-dominated programs.[68] In this study, we proposed QIs that could aid in overcoming some of these barriers and also in the successful implementation of CR.

During the course of the study, two additional supplementary indicators, 'extending the hospital rehabilitation time' and 'strengthening the application of traditional Chinese exercise', were added. Tai Chi Chuan practice was associated with a VO_2 peak increase in patients with MI.[69] Baduanjin exercise therapy in post-MI patients reduced adverse left ventricular (LV) remodeling and was associated with beneficial effects in terms of inflammation and extracellular matrix organization.[70 71] Baduanjin sequential therapy also appeared to improve the quality of life in patients with AMI after percutaneous coronary intervention, with additional benefits of reducing the abdominal circumference and body mass index and improving the level of cardiac function.[72] Therefore, traditional Chinese exercises, such as Tai Chi Chuan and baduanjin, may constitute effective forms of CR in patients with MI.

In summary, the application of these QIs could help standardize and improve the quality of CR in China. This study provides guidance for the development of CR in our country. Nevertheless, further studies are needed to evaluate the validity, reliability and feasibility of these QIs and to

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determine whether improvements in these parameters are associated with clinical benefits in this patient population.

Study limitations

There are many limitations of our study. First, in the QI development section of the methods, we retrieved the literature from public databases; hence, there is a possibility of publication bias. Second, investigation bias may exist because the consensus panel participants were all cardiologists and the national questionnaire was not distributed to all regions and CR centers in the country. The baseline characteristics were not collected for the professionals in the national questionnaire, and no specific calculation was performed to determine the sample size needed for the national questionnaire. These factors may also lead to bias in the results of the practice test due to the absence of data from nonteaching hospitals, the relatively small sample size and the lack of data concerning baseline characteristics of the patients (i.e. sex, age, marital status, cardiovascular risk factors, prior history of myocardial infarction, ST-segment or non-ST-segment elevation myocardial infarction, left ventricular ejection fraction, percutaneous coronary intervention, coronary artery bypass grafting, medication, etc.). Moreover, to assess the measurability and completeness of the proposed QIs, only patients who participated in CR programs were selected to complete the practice test. As such, data from those who did not participate in these programs were not available.

Conclusion

In this study, a consensus panel identified 17 candidate QIs to assess improvements in the quality of CR in post-MI patients in China. A nationwide survey revealed the 5 QIs that required imminent improvement to facilitate increased enrollment in CR programs in the country. Moreover, a practice test administered to MI survivors confirmed the feasibility and completeness of the developed QIs. Application of the proposed QIs could improve the quality of CR care in Chinese post-MI patients.

Acknowledgments

The authors are grateful to the members of the consensus panel, the staff who participated in the national questionnaire, and the patients who completed the practice test. Our deepest gratitude goes to the reviewers and the editor for their careful work and thoughtful suggestions that have helped substantially improve the quality of this paper.

Author contribution

All authors contributed to the conception and design of the work. XZ and YZheng contributed to the analysis and interpretation. JWu, YZhang, JWang, PZ, XY, SL, RD, GS, BY and YS contributed to the acquisition of the data. XZ and MaoZ drafted the manuscript. MinZ, XH and LC critically revised the manuscript. All authors reviewed and agreed to the final version.

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Funding

This work was supported by the National Key R&D Program of China (Grant no. 2016YFC1301100), the National Natural Science Foundation of China (Grants no. 81670373, 81670459 and 81771946), and the Key Laboratory of Myocardial Ischemia, Harbin Medical University, Ministry of Education (KF201806 to X.Z., KF201716 to Y.Z., KF201822 to L.C.).

Competing interests

None declared.

Patient consent for publication

Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research. Refer to the Methods section for further details.

Ethics approval

The study was approved by the ethics committee of Beijing Tsinghua Changgung Hospital, the Second Hospital of Jilin University, Tianjin Chest Hospital and Affiliated Hospital of Qingdao University and the Second Affiliated Hospital of Harbin Medical University. This study is part of a study registered in ClinicalTrials.gov NCT03528382.

Provenance and peer review

Not commissioned; externally peer reviewed.

Data sharing statement

No additional data are available.

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Figure Legends

Figure 1. Mean of all the indicators identified by the consensus panel. A. The mean of domain 1: improving CR participation and adherence. B. The mean of domain 2: CR process standardization.

Figure 2. Regional distributions of the national questionnaire. Blue represents the areas surveyed, while white represents areas not surveyed.

Figure 3. Quality indicators from the national questionnaires that were identified as needing immediate improvement (blue).

Supplementary Figure 1. Flow chart of the literature search process.

Supplementary Figure 2. Rating distribution of domain 1 candidate quality indicators. The X-axis indicates individual indicator evaluation by the panel. The Y-axis indicates the number of panel members who scored the indicator.

Supplementary Figure 3. Rating distribution of domain 2 candidate indicators. The X-axis indicates individual indicator evaluation by the panel. The Y-axis indicates the number of panel members who scored the quality indicator.

Table Legends

Table 1. The proposed quality indicators and their percentage scores for CR in patients with MI.

Table 2. Top 5 quality indicators that were identified as needing improvement.

Supplementary Table 1. The questionnaire used in the practice test.

Supplementary Table 2. Candidate QIs to improve CR in patients with MI.

Supplementary Table 3. Information about professionals in the consensus panel.

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Table 1 The proposed quality indicators and percentage scores for cardiac rehabilitation of patients with myocardial infarction

Quality Indicators	Numerator/ denominator	Performance %
Domain 1: Improving CR participation and adherence		
QI-1: recommending CR in discharge guidance	142/165	86.1
QI-2: automatically referring all eligible patients at the time of discharge	56/163	34.4
QI-3: employing full-time staff for educating patients about CR	72/162	44.4
QI-4: providing patients with written invitations and program brochures	49/165	29.7
QI-5: employing liaison staff for CR	51/161	31.7
QI-6: immediate enrollment in CR for referral patients	31/164	18.9
QI-7: enrollment in CR before discharge	67/162	41.4
QI-10: frequency of CR enrollment and recommendation as indicators for assessing doctor performance	28/153	18.3
Domain 2: CR process standardization		
QI-17: assessment and education of patients regarding coronary disease risk factors	79/165	47.9
QI-18: communication between referral physician and patient about CR	95/157	60.5
QI-19: assessment and education of patients about dietary habits	81/165	49.1
QI-20: assessment and treatment of psychological issues	85/165	51.5
QI-21: assessment of and education of patients about tobacco and alcohol consumption	119/165	72.1
QI-22: prescribing exercise based on an assessment of physical fitness	86/165	52.1
QI-23: reassessment of exercise capacity	71/165	43.0
QI-25: education about the importance of adherence to prescribed medication	91/165	55.2
QI-26: holding multidisciplinary meetings	16/162	9.9

These are the QIs with a rating ≥7, with the same numbers as those in Supplementary Table 2.

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Indicators	Numerator/ denominator	Importance (%)
Top 1: automatically referring all eligible patients at the time of discharge	42/89	47.2
Top 2: recommending CR in discharge guidance	34/89	38.2
Top 3: prescribing exercise based on an assessment of physical fitness	25/89	28.1
Top 4: employing full-time staff for educating patients about CR	23/89	25.8
Top 5: assessment and education of patients regarding coronary disease risk factors	17/89	19.1

Table 2 Top 5 quality indicators that need improvement

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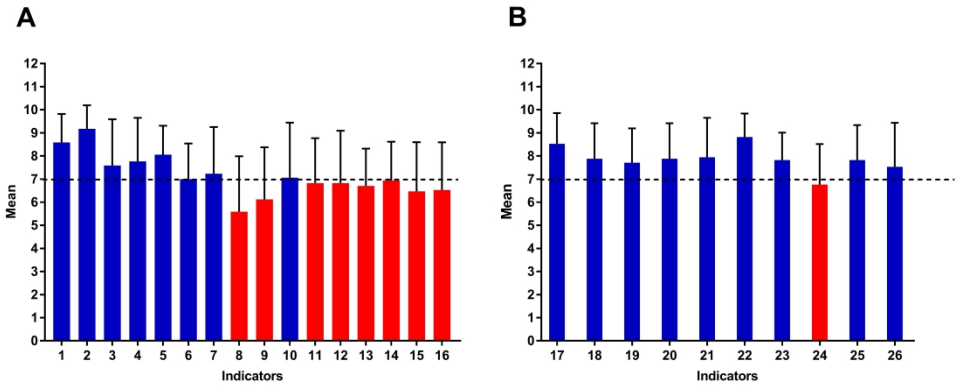

Mean of all the indicators identified by the consensus panel. A. The mean of domain 1: improving CR participation and adherence. B. The mean of domain 2: CR process standardization.

259x109mm (600 x 600 DPI)

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Regional distributions of the national questionnaire. Blue represents the areas surveyed, while white represents areas not surveyed.

254x190mm (300 x 300 DPI)

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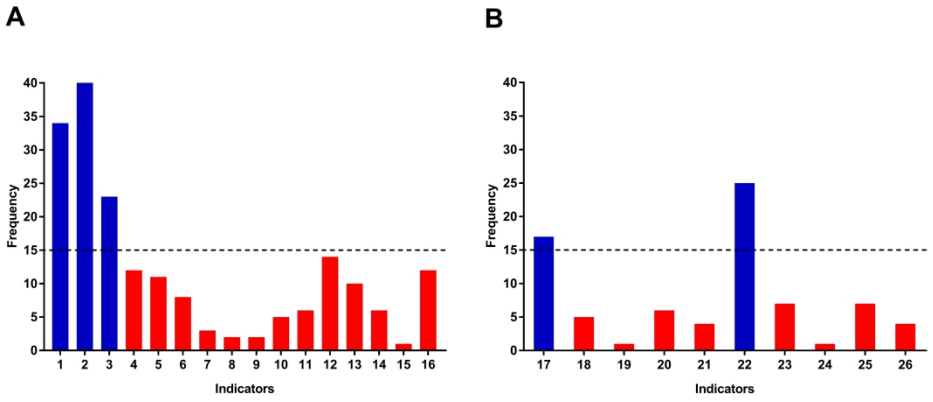

Quality indicators from the national questionnaires that were identified as needing immediate improvement (blue).

262x114mm (600 x 600 DPI)

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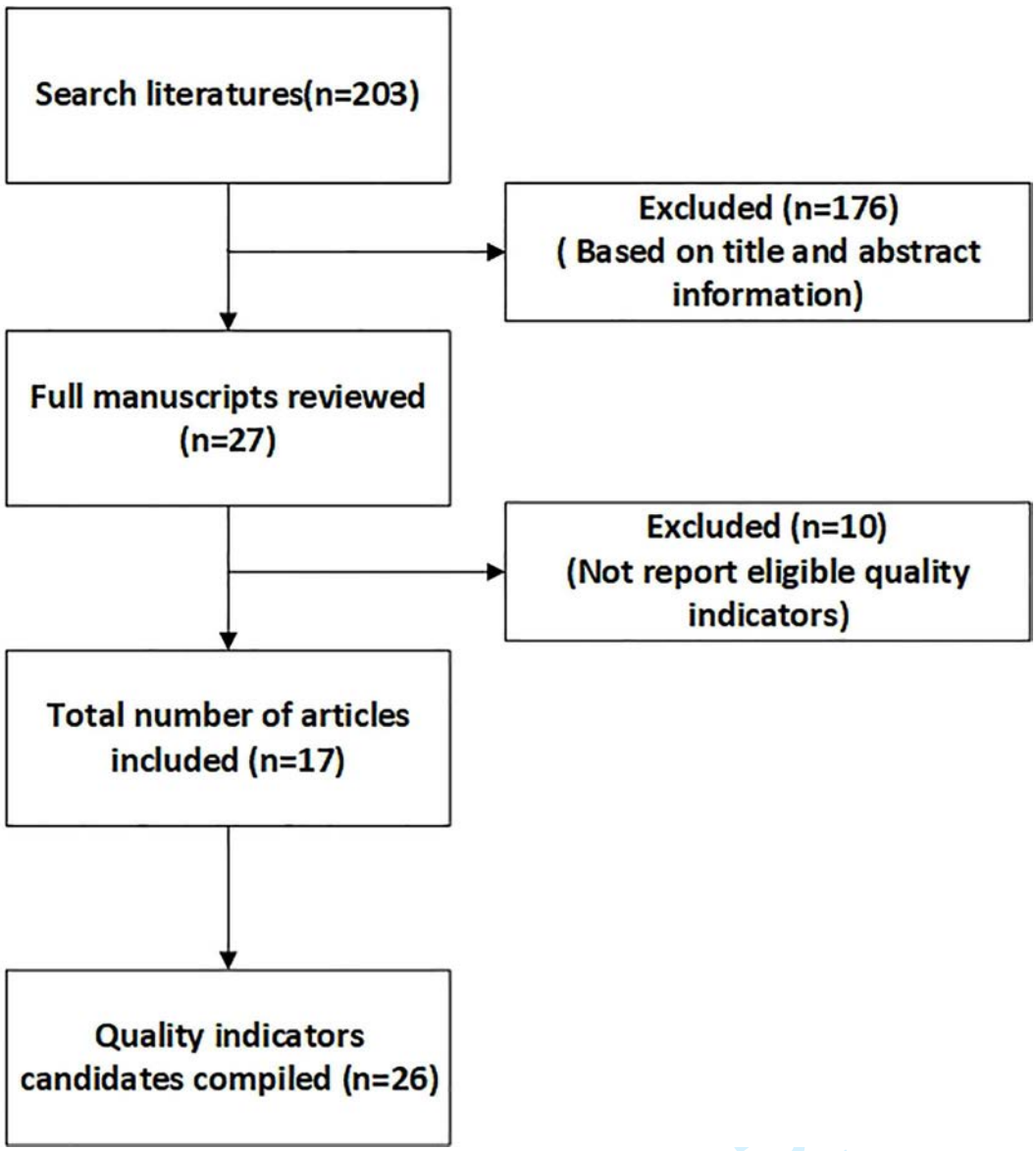
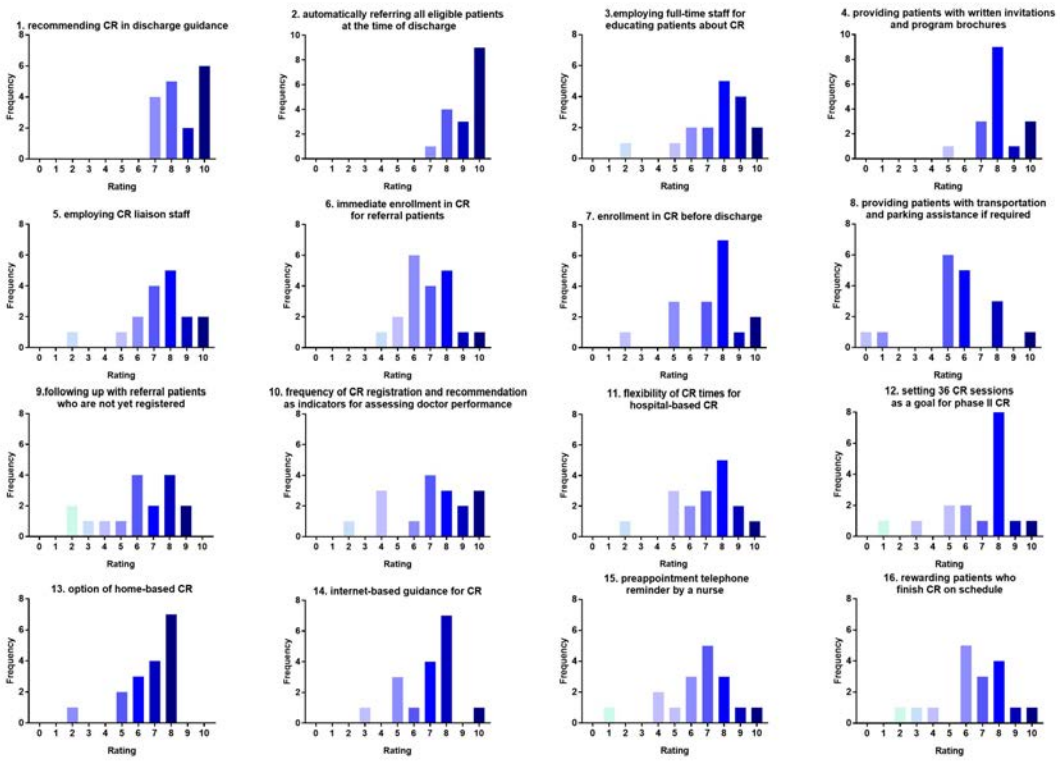
Supplementary Figure 1



Supplementary Figure 2



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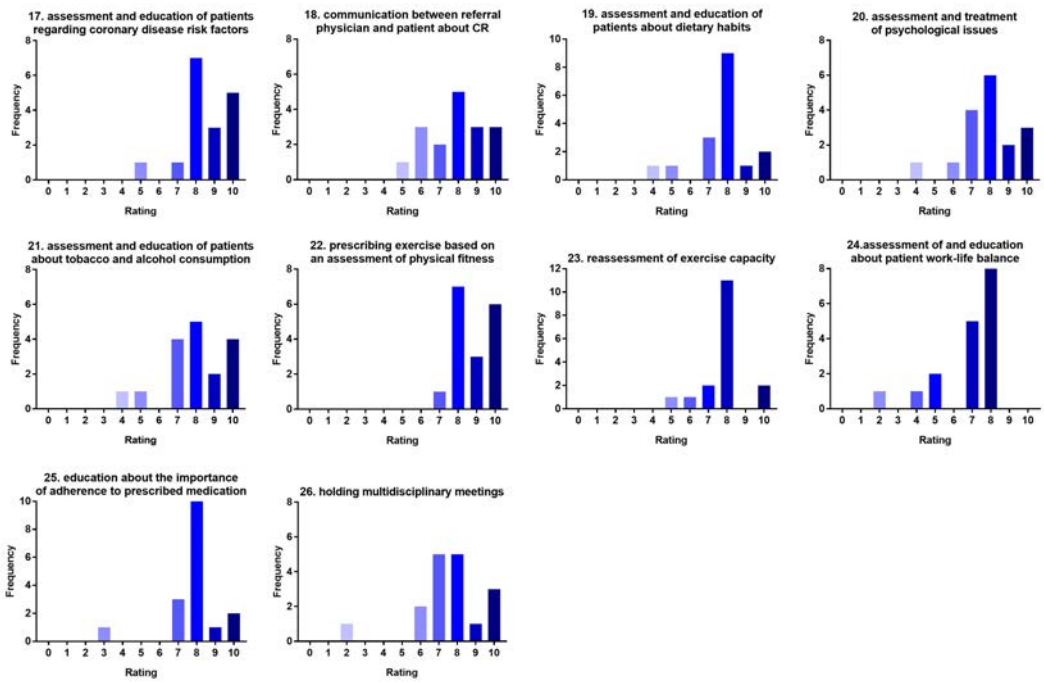
Supplementary Figure 3



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Supplementary Table 1. The questionnaire used in the practice test.

Optimization of the quality of CR questionnaire for patients with AMI in China		
Quality Indicators	**YES**	**NO**
Domain 1: Improving CR participation and adherence		
QI-1: recommending CR in discharge guidance		
QI-2: automatically referring all eligible patients at the time of discharge		
QI-3: employing full-time staff for educating patients about CR		
QI-4: providing patients with written invitations and program brochures		
QI-5: employing liaison staff for CR		
QI-6: immediate enrollment in CR for referral patients		
QI-7: enrollment in CR before discharge		
QI-10: frequency of CR enrollment and recommendation as indicators for assessing doctor performance		
Domain 2: CR process standardization		
QI-17: assessment and education of patients regarding coronary disease risk factors		
QI-18: communication between referral physician and patient about CR		
QI-19: assessment and education of patients about dietary habits		
QI-20: assessment and treatment of psychological issues		
QI-21: assessment of and education of patients about tobacco and alcohol consumption		
QI-22: prescribing exercise based on an assessment of physical fitness		
QI-23: reassessment of exercise capacity		
QI-25: education about the importance of adherence to prescribed medication		
QI-26: holding multidisciplinary meetings		
Please complete this questionnaire truthfully with regard to reporting whether the above QIs were implemented in the process of CR. If they were implemented, please fill in yes; otherwise, fill in no. Thank you very much for your participation and support. CR=cardiac rehabilitation, AMI=acute myocardial infarction, QIs=quality indicators.		

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Supplementary Table 2 Candidate quality indicators for CR in patients with MI

Quality Indicators	Reference
Domain 1: Improving CR participation and adherence	
QI-1: recommending CR in discharge guidance	28, 38
QI-2: automatically referring all eligible patients at the time of discharge	28, 34, 35, 36, 38, 39, 40
QI-3: employing full-time staff for educating patients about CR	28, 38
QI-4: providing patients with written invitations and program brochures	35
QI-5: employing CR liaison staff	35
QI-6: immediate enrollment in CR for referral patients	24, 29, 31, 36, 37
QI-7: enrollment in CR before discharge	35
QI-8: providing patients with transportation and parking assistance if required	35
QI-9: following up with referral patients who are not yet registered	35
QI-10: frequency of CR registration and recommendation as indicators for assessing doctor performance	22
QI-11: flexibility of CR times for hospital-based CR	28, 35
QI-12: setting 36 CR sessions as a goal for phase II CR	22, 42
QI-13: option of home-based CR	28
QI-14: internet-based guidance for CR	41
QI-15: preappointment telephone reminder by a nurse	32
QI-16: rewarding patients who finish CR on schedule	22, 30
Domain 2: Process standardization of CR	
QI-17: assessment and education of patients regarding coronary disease risk factors	31 , 33, 36
QI-18: communication between referral physician and patient about CR	33
QI-19: assessment and education of patients about dietary habits	33
QI-20: assessment and treatment of psychological issues	31, 33
QI-21: assessment and education of patients about tobacco and alcohol consumption	31, 33
QI-22: prescribing exercise based on an assessment of physical fitness	31, 33, 36
QI-23: reassessment of exercise capacity	33
QI-24: assessment of and education about patient work-life balance	33
QI-25: education about the importance of adherence to prescribed medication	33
QI-26: holding multidisciplinary meetings	33

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Supplementary Table 3 Information about professionals of the consensus panel.

Experts of the consensus panel	Cardiac rehabilitation centres
Xuwen Yang	Tianjin Chest Hospital, Tianjin Cancer Hospital, Tianjin
Yuanhui Liu	Guangdong Provincial People's Hospital, Guangzhou, Guangdong Province
Gaowa Siqin	Inner Mongolia People's Hospital, Inner Mongolia
Shumei Zhang	Inner Mongolia People's Hospital, Inner Mongolia
Junnan Wang	the Second Hospital of Jilin University, Changchun, Jilin Province
Yinjun Li	the Fourth Hospital of Shenyang, Shenyang, Liaoning Province
Jian Zhang	General Hospital of Northern Theater Command, Shenyang, Liaoning Province
Cheng Liu	General Hospital of Northern Theater Command, Shenyang, Liaoning Province
Guihua Li	The Second Hospital of Dalian Medical University, Dalian, Liaoning Province
Chuanfen Liu	Peking University People's Hospital, Beijing
Rongjing Ding	Peking University People's Hospital, Beijing
Jian Wu	the Second Affiliated Hospital of Harbin Medical University, Harbin, Heilongjiang Province
Yongxiang Zhang	the Second Affiliated Hospital of Harbin Medical University, Harbin, Heilongjiang Province
Qiaoyu Ren	Heilongjiang Agricultural Reclamation Sanjiang People's Hospital, Jiamusi, Heilongjiang Province
Shibo Wang	Heilongjiang Agricultural Reclamation Sanjiang People's Hospital, Jiamusi, Heilongjiang Province
Ying Xin	Harbin Second Hospital, Harbin, Heilongjiang Province
Jing Yao	Hegang People's Hospital, Hegang, Heilongjiang Province

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Quality indicators for cardiac rehabilitation after myocardial infarction in China: a consensus panel and practice test

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2020-039757.R4
Article Type:	Original research
Date Submitted by the Author:	16-Dec-2020
Complete List of Authors:	Zheng, Xianghui; Second Affiliated Hospital of Harbin Medical University Zhang, Maomao; Second Affiliated Hospital of Harbin Medical University Zheng, Yang; Second Affiliated Hospital of Harbin Medical University Zhang, Yongxiang; Second Affiliated Hospital of Harbin Medical University Wang, Junnan; Jilin University Second Hospital, Cardiology Zhang, Ping; Beijing Tsinghua Changgung Hospital Yang, Xuwen; Tianjin Chest Hospital, Tianjin Cancer Hospital Li, Shan; The Affiliated Hospital of Qingdao University Ding, Rong jing; Peking University People's Hospital, Department of cardiology Siqin, Gaowa; Inner Mongolia People's Hospital Hou, Xinyu; Second Affiliated Hospital of Harbin Medical University Chen, Liangqi; Second Affiliated Hospital of Harbin Medical University Zhang, Min; Second Affiliated Hospital of Harbin Medical University Sun, Yong; Key Laboratories of Education Ministry for Myocardial Ischemia Mechanism and Treatment, 2nd Affiliated Hospital of Harbin Medical University, Cardiology Wu, Jian; Second Affiliated Hospital of Harbin Medical University, Yu, Bo; Key Laboratories of Education Ministry for Myocardial Ischemia Mechanism and Treatment, 2nd Affiliated Hospital of Harbin Medical University, Cardiology
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Keywords:	Myocardial infarction < CARDIOLOGY, REHABILITATION MEDICINE, Coronary heart disease < CARDIOLOGY

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Quality indicators for cardiac rehabilitation after myocardial infarction in China: a consensus panel and practice test

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Abstract

Objectives: Cardiac rehabilitation (CR) improves outcomes after myocardial infarction (MI), but it is underutilized in China. The purpose of this study was to develop a set of quality indicators (QIs) to improve clinical practices and to confirm the measurability and performance of the developed QIs for CR in Chinese patients after MI.

Design and setting: The QIs were developed by Chinese expert consensus panel during in-person meetings. The 5 QIs most in need of improvement were selected using a national questionnaire. Finally, the completion rate and feasibility of the QIs was verified in a group of MI survivors at university hospitals in China.

Participants: Seventeen professionals participated in the consensus panel, 89 personnel in the field of CR participated in the national questionnaire, and 165 MI survivors participated in the practice test.

Results: A review of 17 eligible articles generated 26 potential QIs, among which 17 were selected by the consensus panel after careful evaluation. The 17 QIs were divided into two domains: (1) improving participation and adherence and (2) CR process standardization. Nationwide telephone and WeChat surveys identified the 5 QIs most in need of improvement. A multicenter practice test (n=165) revealed that the mean performance value of the proposed QIs was 43.9% (9.9-86.1%) according to post-MI patients.

Conclusions: The consensus panel identified a comprehensive set of QIs for CR in post-MI patients. A nationwide questionnaire survey was used to identify the QIs that need immediate attention to improve the quality of CR. Although practice tests confirmed the measurability of the proposed QIs in clinical practice, the implementation of the QIs needs to be improved.

Keywords

cardiac rehabilitation, quality indicators, myocardial infarction, consensus panel, national questionnaire

Strengths and limitations of this study

This is the first study proposing immediate improvement in CR QIs on the basis of the results of a nationwide survey and instituting improvement guidelines for CR in China.

The completion rate and feasibility of the developed QIs were revealed by a multicenter practice test.

The composition of the consensus panel may have resulted in bias in the selection of QIs.

The national questionnaire was not distributed to all regions and CR centers in the country.

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Introduction

Acute myocardial infarction (AMI) is highly prevalent globally and a leading cause of mortality and adult disability.[1 2] Currently, the annual mortality rate due to myocardial infarction (MI) is less than 10%, but up to 20% of patients experience relapse within the first year.[3] A cardiovascular disease report published in 2018 stated that in China, due to the aging population, the mortality rate of AMI, which is exponentially higher in rural areas, increased from 2002 to 2016.[4] Only 55.9% of Chinese patients return to work within 12 months after AMI.[5] Among the hospitalization expenses for cardiovascular and cerebrovascular diseases in 2016, AMI accounted for 19.085 billion yuan.[4] Thus, Chinese people with a history of MI represent a substantial healthcare burden.

Cardiac rehabilitation (CR), a comprehensive secondary prevention framework, aims to improve the overall quality of life as well as morbidity and mortality in patients with heart disease.[6 7] CR has a pivotal role along with timely reperfusion strategies and optimized lifestyle and pharmacological therapies in the contemporary approach to post-MI patients.[8] Previous data, including randomized trials and systematic reviews, have established the positive impact of CR and its significant role in reducing morbidity and mortality in post-MI patients.[9-11] Other known benefits of CR include improvements in exercise capacity and quality of life and positive effects on coronary endothelial function, blood pressure, insulin resistance, and inflammatory markers.[12-16] There is a strong association between the number of CR sessions and long-term post-MI outcomes, with different studies reporting the importance of compliance with these programs with regard to cardiac events.[17 18] Given these data, CR is considered a class I recommendation for post-MI patients by the American Heart Association, the American College of Cardiology and the European Society of Cardiology.[19 20]

CR programs are clinically underutilized, and participation in CR is dismally low worldwide.[21-23] Notably, contemporary data from the EUROASPIRE V registry underscores the notion that many coronary patients have unhealthy lifestyles, namely in regards to smoking, diet and sedentary behavior.[24] CR is available in only 111/203 (54.7%) countries globally.[25] A report described the rate of CR participation as ranging between 6.6% and 53.5% in the USA.[23] CR was utilized by only 13.9% of patients hospitalized for AMI and 31.0% of patients after coronary artery bypass graft surgery.[23] A European survey reported that less than half of the patients were advised to attend CR programs.[22] Only 34% of Canadian patients with the appropriate indications participated in CR.[21] At present, to the best of our knowledge, there are no data on the CR participation rate in China. In addition, adherence to evidence-based CR performance measures is suboptimal in China.[26] Therefore, effective strategies to increase enrollment and adherence to CR are urgently needed.

Quality improvement is characterized by improvements in health care and systems of care delivered by individual physicians.[27 28] Quality indicators (QIs) provide direction and specific methods for quality improvement.[29 30] A study involving intensive care unit patients showed that a multifaceted quality improvement intervention improved the adoption of care practices.[31] A multifaceted quality improvement intervention resulted in significant improvements in hospital

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personnel adherence to evidence-based performance measures evaluating the care of patients with acute ischemic stroke.[32] The European Association of Preventive Cardiology (EAPC) has defined minimal and optimal cardiovascular rehabilitation standards to increase the quality of cardiovascular rehabilitation programs.[33] In addition, many countries, such as the USA, Japan, and Canada, have developed QIs for improving CR, but QIs are lacking in China. Implementation of QIs can increase long-term participation and adherence by post-MI patients. For example, a two-year study reported a significant increase in enrollment in CR after the implementation of a series of quality improvement interventions, including policy changes, a 7-minute video describing the benefits of CR, and incentives.[34] The early utilization of a cardiac access clinic resulted in an unprecedented (~3-fold) increase in the number of ST-elevation myocardial infarction (STEMI) patients participating in CR.[35] A randomized controlled trial also revealed that early appointments within 10 days of hospital discharge improved CR attendance compared with standard appointments after 35 days.[36]

CR can play important roles in reducing mortality in patients with MI, improving patient quality of life and reducing China's healthcare burden.[37-39] CR process standardization in China needs to be improved.[40] Increasing participation is an important goal for the successful implementation of CR programs, which could decrease morbidity and mortality due to MI. This study aimed to describe candidate QIs and test their feasibility and applicability to provide a basis for future strategies to improve the CR participation and compliance rates in Chinese post-MI patients.

Methods

Quality indicator development

Databases including PubMed, CINAHL Ebsco, and EMBASE were searched for eligible articles published through August 2018 using the keywords cardiac rehabilitation, quality indicator, and myocardial infarction; MeSH terms; and Emtree headings. Two authors (XZ and MZ) conducted the literature review by first reading titles and abstracts and then reading the full text of potential articles. Articles from the search results were included if the following conditions were met: (1) the study provided QIs for CR and (2) the study was published in English. The compiled QIs were further divided into two domains: improving CR participation and adherence rates and standardizing CR processes. Any disagreement about study inclusion was resolved by a third author (JWu).

Consensus panel

The consensus panel consisted of 17 individuals, with a maximum of 2 individuals from each CR center. Members were selected upon meeting the following criteria: (1) the individual had at least 1 year of experience in CR; (2) the individual held a position as a leader of a regional CR program; (3) the individual was committed to the advancement of CR; and (4) the individual agreed to participate in an in-person meeting to discuss CR quality improvement. Two authors (XZ and YZheng) assessed the qualifications of the members, and disagreements were resolved by consensus or a third author (JWu). Members were responsible for scoring the collected QIs based on their

experience and determining the final QIs for CR in post-MI patients.

Scoring method and selection criteria

The candidate QIs generated from the literature were scored on a ten-point scale. Scoring criteria were based on four aspects: whether they were evidence-based, the feasibility of implementation, their validity, and reliability. The QIs were judged according to the clinical experience of the consensus panel. The four criteria were used to generate one score. QIs that received scores ≥7 and were considered to be significant in the improvement of CR were included in the study. QIs with <7 but >5 points were not considered in this study, and QIs with <5 points were excluded. A QI was considered acceptable for improving the quality of CR in post-MI Chinese patients based on its average score.

National questionnaire

A questionnaire-based survey was conducted nationwide by either telephone or WeChat (a communication tool in China). Participants included cardiologists, nurses, physical therapists, clinical psychologists, registered dietitians and follow-up staff caring for CR patients (health managers who follow up patients via telephone, etc.) who met the following criteria: (1) working in an established CR center; and (2) at least 1 year of experience in CR. J Wu and Y Zhang conducted a questionnaire-based survey with the participants. The participants were asked to select 3 out of 26 candidate QIs that they felt required urgent improvement to allow the selection of the top 5 QIs that required immediate improvement in China. The top 5 most important QIs were determined based on the frequency selected by the participants. Additionally, participants could suggest new QIs outside of those mentioned in the questionnaire.

Practice test

A practice test was performed to review the adaptability of each QI before implementation due to differences in healthcare systems and social circumstances, such as the size of the CR center and patient education, to assess the completion rate of the proposed QIs selected by the consensus panel. The patient inclusion criteria were as follows: (1) a history of AMI; (2) completion of phase Ⅰ and Ⅱ CR at one of the 5 teaching hospitals (Beijing Tsinghua Changgung Hospital, the Second Hospital of Jilin University, Tianjin Chest Hospital and Affiliated Hospital of Qingdao University and the Second Affiliated Hospital of Harbin Medical University) between September 3, 2018 and October 31, 2019; and (3) consent to participate in the study. Patients filled out a 17-question questionnaire (Supplementary Table 1) about the proposed QIs that was developed specifically for this study and evaluated whether the CR center implemented the proposed QIs. The patients did not answer if they were unsure or did not understand the question. In addition, the consensus panel unanimously agreed that a score greater than 70% was considered good performance, whereas a score less than 30% was considered a poor performance. The questionnaire was approved by the ethics committees of the 5 teaching hospitals.

Patient and public involvement

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Patients and the public were not involved in the design of the study.

Data collection and analysis

Two authors (XZ and YZ) were responsible for data collection and cross-checking. The mean score of each QI was calculated as the sum of all participants' ratings/number of participants. The percentage score for each QIs was calculated as follows: the number of times the QI was achieved/the number of participants (excluding participants who did not answer)×100. The mean performance was the average of the percentages of all quality indicators.

Results

Collection of QIs

A review of the literature identified 203 articles, and after screening the titles and abstracts, 176 were excluded, as they were not related to QIs for CR. After the full-text screening, 17 articles were eligible and subsequently included.[34 36 41-55] A list of 26 potential QIs, including 16 regarding the improvement of the CR participation and adherence rates and 10 regarding the standardization of the CR processes, was generated (Supplementary Table 2). A flowchart of the literature search and selection of eligible articles is shown in Supplementary Figure 1.

The consensus panel and proposal of QIs of CR in post-MI patients

The consensus panel included 17 experts in the field of CR from 12 CR centers (Supplementary Table 3). Seventeen experts who met the inclusion criteria were cardiologists and individually rated each QI on a ten-point scale. The rating of each QI is shown in Supplementary Figures 2 and 3. After careful evaluation, only QIs with an average score ≥7 that could potentially improve the quality of CR in China were accepted (Figure 1). Finally, a total of 17 QIs were selected and divided into two domains: (1) improving participation and adherence and (2) standardizing CR processes (Table 1). There were two more supplementary indicators: extending the hospital rehabilitation time and strengthening the application of traditional Chinese sports.

National questionnaire and top five QIs for imminent improvement

Eighty-nine professionals met the national survey participation criteria; among them, 60 people participated in a telephone survey, and 29 people participated in a WeChat survey. The survey response rate was 100%. The 89 participants from 4 municipalities and 18 provinces in China included 21 cardiologists, 15 nurses, 18 physical therapists, 11 clinical psychologists, 13 registered dietitians and 11 health follow-up staff. Each participant selected three QIs considered critical to improving post-MI CR in China (Figures 2 and 3). The results showed that the five most important QIs were ‘automatically referring all eligible patients at the time of discharge’, ‘recommending CR in discharge guidance’, ‘prescribing exercise based on an assessment of physical fitness’, ‘employing full-time staff for educating patients about CR’, and ‘assessment and education of

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patients regarding coronary disease risk factors' (Table 2), with score ratios of 47.2%, 38.2%, 28.1%, 25.8% and 19.1%, respectively.

Practice test

The practice test was completed by 165 patients who met the inclusion criteria, and no patients refused to participate in the study (30 patients from Beijing Tsinghua Changgung Hospital, 30 patients from the Second Hospital of Jilin University, 34 patients from Tianjin Chest Hospital, 30 patients from Affiliated Hospital of Qingdao University and 41 patients from the Second Affiliated Hospital of Harbin Medical University). The results revealed a mean performance value of 43.9% (9.9-86.1%). The QIs that achieved good performance (minimum to maximum 72.1-86.1%) were 'assessment and education of patients on tobacco and alcohol consumption' and 'recommending CR in discharge guidance'. There were also several low-performing QIs (minimum to maximum 9.9-29.7%), including 'holding multidisciplinary meetings, 'frequency of CR registration and recommendation as QIs for assessing doctor performance', 'immediate enrollment in CR for referral patients', and 'providing patients with written invitations and program brochures' (Table 1).

Discussion

In this study, 26 QIs generated from 17 articles were assessed as candidate QIs for CR. Out of the 26 QIs, 17 were selected by a Chinese expert consensus panel and divided into two domains based on participation and adherence and CR process standardization. The findings of the nationwide questionnaire could guide clinical quality improvement. The practice test showed the feasibility and applicability of all 17 QIs in the Chinese context.

This is, to the best of our knowledge, the first study proposing an immediate improvement in CR QIs on the basis of the results of a nationwide survey and the implementation of improvement guidelines for CR in China. However, although still in its infancy, CR in China has developed rapidly. According to data published by the Chinese Society of Rehabilitation Medicine (CARM), the number of CR centers has increased from 6 in 2012 to more than 500 currently.[56] Hence, the improved implementation of CR programs is imperative, given the current situation. We consider that QI development is a time-efficient and resource-saving approach.[57] In many countries, CR is strongly associated with quality of life improvement. For example, the USA has effectively implemented QI monitoring to increase the CR participation rate.[41] Similarly, Canada has developed QIs to promote the broad development of CR programs,[44] and Japan has also proposed QIs to assess improvements in the quality of CR after acute coronary syndrome (ACS).[46] Moreover, the EAPC described QIs to assess improvements in the CR process standardization in Europe.[33] In this study, we propose QIs to promote the improvement of CR in China considering the recommendations reported in these previous studies.

CR is still in the early phase of development in China.[40] Given the uneven distribution of CR programs, the consensus panel selected QIs to promote improvements in participation and adherence that were simple, practical and in line with the current status of CR in the country. For example, the

present report suggests that 'recommending CR in discharge guidance' was key in emphasizing the importance and necessity of CR, and 'automatically referring all eligible patients 'at the time of discharge' was one of the best ways to increase participation in CR. Other suitable QIs were 'employing full-time staff for educating patients about CR' and 'employing CR liaison staff'. In addition, the study revealed QIs that are necessary for CR process standardization in China, such as 'assessment and education of patients regarding coronary disease risk factors', 'assessment and education of patients about dietary habits', and 'prescribing exercise based on physical fitness'. It is worth mentioning that the completion rate of 'holding multidisciplinary meetings' was very low in the practice test, but the implementation of this QI can improve recovery in patients with multiple diseases.[29 58 59] Moreover, measuring the completion rate of the proposed QIs is important.[60-62] There are some measurement methods. First, QIs should be recorded in the medical record. In this way, the completion of the QIs can be checked. Second, from the perspective of patients, a questionnaire about the implementation of QIs was conducted at discharge. Relevant medical staff should be evaluated by self-assessment and other assessment scales. In addition, clinical audits, a method of establishing whether healthcare is being provided in line with the relevant standards and identifying areas for improvements, should be performed.[63] CR programs could be improved by continuous assessment.[64]

It is also important to understand the barriers to appropriate CR, including lack of health awareness, inadequate policies, insufficiency of CR, lack of healthcare system support and inadequate professional guidelines and information systems.[65-67] Gary et al. reported that older females with low socioeconomic status, with a low education level, with poor self-efficacy, with multiple comorbidities and without the ability to communicate in English were more likely to not participate in CR.[48] Enrollment in the CR program is affected by many healthcare system-related factors, including lack of referral, limited facilitation of enrollment after referral, lack of programs that serve specific geographic areas and low-income communities, and gender-dominated programs.[68] In this study, we proposed QIs that could aid in overcoming some of these barriers and also in the successful implementation of CR.

During the course of the study, two additional supplementary indicators, 'extending the hospital rehabilitation time' and 'strengthening the application of traditional Chinese exercise', were added. Tai Chi Chuan practice was associated with a VO_2 peak increase in patients with MI.[69] Baduanjin exercise therapy in post-MI patients reduced adverse left ventricular (LV) remodeling and was associated with beneficial effects in terms of inflammation and extracellular matrix organization.[70 71] Baduanjin sequential therapy also appeared to improve the quality of life in patients with AMI after percutaneous coronary intervention, with additional benefits of reducing the abdominal circumference and body mass index and improving the level of cardiac function.[72] Therefore, traditional Chinese exercises, such as Tai Chi Chuan and Baduanjin, may constitute effective forms of CR in patients with MI.

In summary, the application of these QIs could help standardize and improve the quality of CR in China. This study provides guidance for the development of CR in our country. Nevertheless, further studies are needed to evaluate the validity, reliability and feasibility of these QIs and to

determine whether improvements in these parameters are associated with clinical benefits in this patient population.

Study limitations

There are many limitations of our study. First, in the QI development section of the methods, we retrieved the literature from public databases; hence, there is a possibility of publication bias. Second, investigation bias may exist because the consensus panel participants were all cardiologists and the national questionnaire was not distributed to all regions and CR centers in the country. The baseline characteristics were not collected for the professionals in the national questionnaire, and no specific calculation was performed to determine the sample size needed for the national questionnaire. These factors may also lead to bias in the results of the practice test due to the absence of data from nonteaching hospitals, the relatively small sample size and the lack of data concerning baseline characteristics of the patients (i.e. sex, age, marital status, cardiovascular risk factors, prior history of myocardial infarction, ST-segment or non-ST-segment elevation MI, LV ejection fraction, percutaneous coronary intervention, coronary artery bypass grafting, medication, etc.). Moreover, to assess the measurability and completeness of the proposed QIs, only patients who participated in CR programs were selected to complete the practice test. As such, data from those who did not participate in these programs were not available.

Conclusion

In this study, a consensus panel identified 17 candidate QIs to assess improvements in the quality of CR in post-MI patients in China. A nationwide survey revealed the 5 QIs that required imminent improvement to facilitate increased enrollment in CR programs in the country. Moreover, a practice test administered to MI survivors confirmed the feasibility and completeness of the developed QIs. The application of the proposed QIs could improve the quality of CR care in Chinese post-MI patients.

Acknowledgments

The authors are grateful to the members of the consensus panel, the staff who participated in the national questionnaire, and the patients who completed the practice test. Our deepest gratitude goes to the reviewers and the editor for their careful work and thoughtful suggestions that have helped substantially improve the quality of this paper.

Author contribution

All authors contributed to the conception and design of the work. XZ and YZheng contributed to the analysis and interpretation. JWu, YZhang, JWang, PZ, XY, SL, RD, GS, BY and YS contributed to the acquisition of the data. XZ and MaoZ drafted the manuscript. MinZ, XH and LC critically

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revised the manuscript. All authors reviewed and agreed to the final version.

Funding

This work was supported by the National Key R&D Program of China (Grant no. 2016YFC1301100), the National Natural Science Foundation of China (Grants no. 81670373, 81670459 and 81771946), and the Key Laboratory of Myocardial Ischemia, Harbin Medical University, Ministry of Education (KF201806 to X.Z., KF201716 to Y.Z., KF201822 to L.C.).

Competing interests

None declared.

Patient consent for publication

Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research. Refer to the Methods section for further details.

Ethics approval

The study was approved by the ethics committee of Beijing Tsinghua Changgung Hospital, the Second Hospital of Jilin University, Tianjin Chest Hospital and Affiliated Hospital of Qingdao University and the Second Affiliated Hospital of Harbin Medical University. This study is part of a study registered in ClinicalTrials.gov NCT03528382.

Provenance and peer review

Not commissioned; externally peer reviewed.

Data sharing statement

No additional data are available.

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Figure Legends

Figure 1. Mean of all the indicators identified by the consensus panel. A. The mean of domain 1: improving CR participation and adherence. B. The mean of domain 2: CR process standardization.

Figure 2. Regional distributions of the national questionnaire. Blue represents the areas surveyed, while white represents areas not surveyed.

Figure 3. Quality indicators from the national questionnaires that were identified as needing immediate improvement (blue).

Supplementary Figure 1. Flow chart of the literature search process.

Supplementary Figure 2. Rating distribution of domain 1 candidate quality indicators. The X-axis indicates individual indicator evaluation by the panel. The Y-axis indicates the number of panel members who scored the indicator.

Supplementary Figure 3. Rating distribution of domain 2 candidate indicators. The X-axis indicates

individual indicator evaluation by the panel. The Y-axis indicates the number of panel members who scored the quality indicator.

Table Legends

Table 1. The proposed quality indicators and their percentage scores for CR in patients with MI.

Table 2. Top 5 quality indicators that were identified as needing improvement.

Supplementary Table 1. The questionnaire used in the practice test.

Supplementary Table 2. Candidate QIs to improve CR in patients with MI.

Supplementary Table 3. Information about professionals in the consensus panel.

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Table 1 The proposed quality indicators and percentage scores for cardiac rehabilitation of patients with myocardial infarction

Quality Indicators	Numerator/ denominator	Performance %
Domain 1: Improving CR participation and adherence		
QI-1: recommending CR in discharge guidance	142/165	86.1
QI-2: automatically referring all eligible patients at the time of discharge	56/163	34.4
QI-3: employing full-time staff for educating patients about CR	72/162	44.4
QI-4: providing patients with written invitations and program brochures	49/165	29.7
QI-5: employing liaison staff for CR	51/161	31.7
QI-6: immediate enrollment in CR for referral patients	31/164	18.9
QI-7: enrollment in CR before discharge	67/162	41.4
QI-10: frequency of CR enrollment and recommendation as indicators for assessing doctor performance	28/153	18.3
Domain 2: CR process standardization		
QI-17: assessment and education of patients regarding coronary disease risk factors	79/165	47.9
QI-18: communication between referral physician and patient about CR	95/157	60.5
QI-19: assessment and education of patients about dietary habits	81/165	49.1
QI-20: assessment and treatment of psychological issues	85/165	51.5
QI-21: assessment of and education of patients about tobacco and alcohol consumption	119/165	72.1
QI-22: prescribing exercise based on an assessment of physical fitness	86/165	52.1
QI-23: reassessment of exercise capacity	71/165	43.0
QI-25: education about the importance of adherence to prescribed medication	91/165	55.2
QI-26: holding multidisciplinary meetings	16/162	9.9

These are the QIs with a rating ≥7, with the same numbers as those in Supplementary Table 2.

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Indicators	Numerator/ denominator	Importance (%)
Top 1: automatically referring all eligible patients at the time of discharge	42/89	47.2
Top 2: recommending CR in discharge guidance	34/89	38.2
Top 3: prescribing exercise based on an assessment of physical fitness	25/89	28.1
Top 4: employing full-time staff for educating patients about CR	23/89	25.8
Top 5: assessment and education of patients regarding coronary disease risk factors	17/89	19.1

Table 2 Top 5 quality indicators that need improvement

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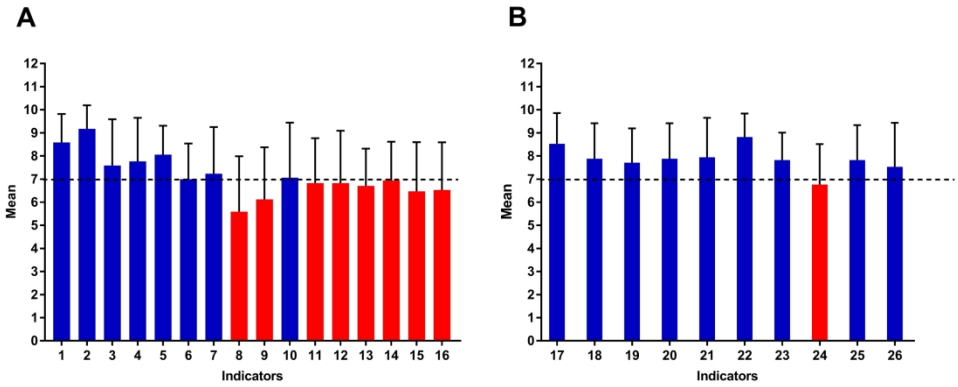

Figure 1

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Figure 2

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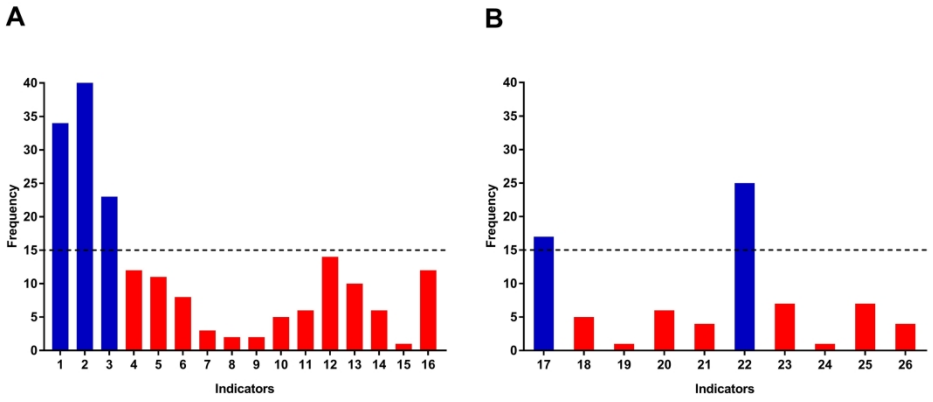

Figure 3

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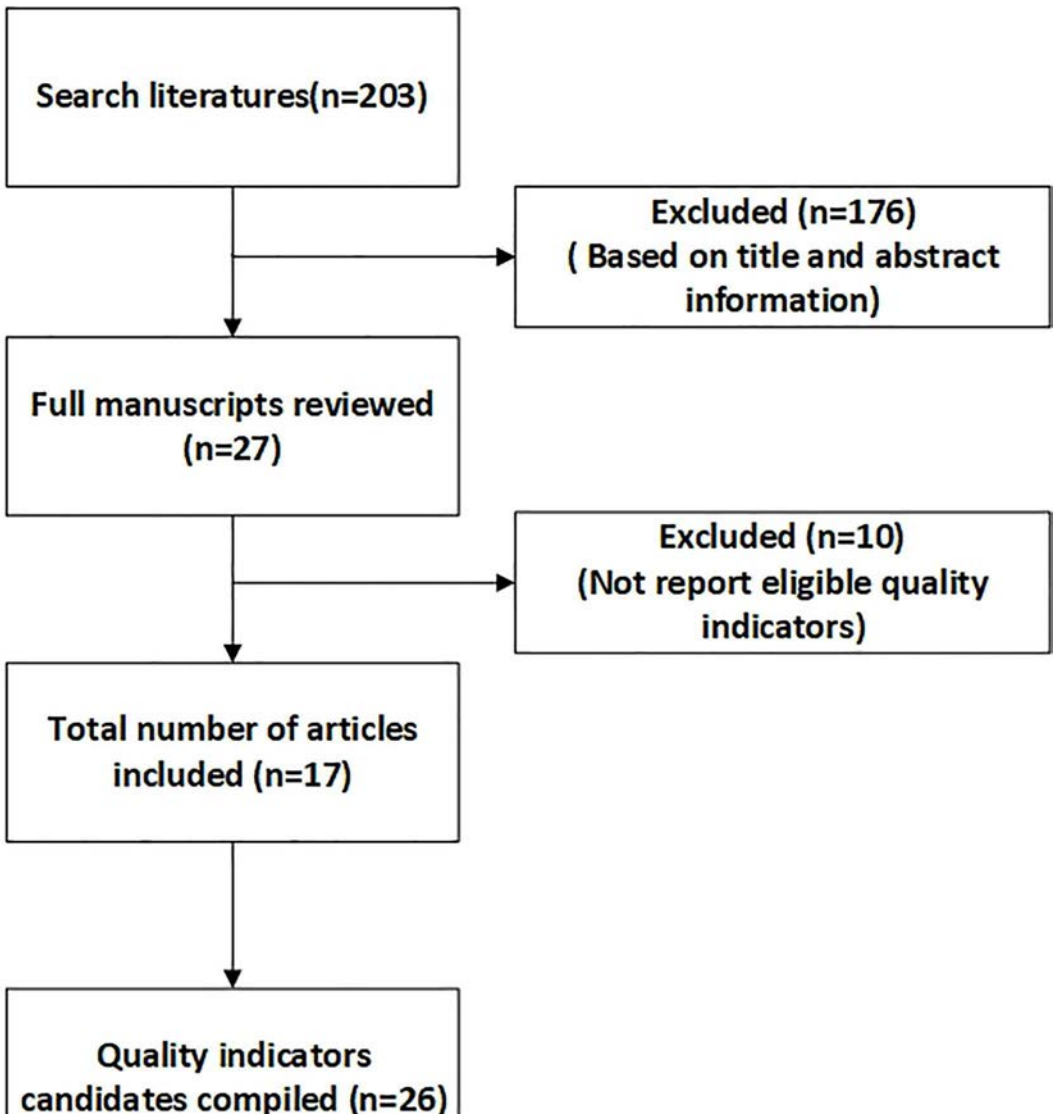
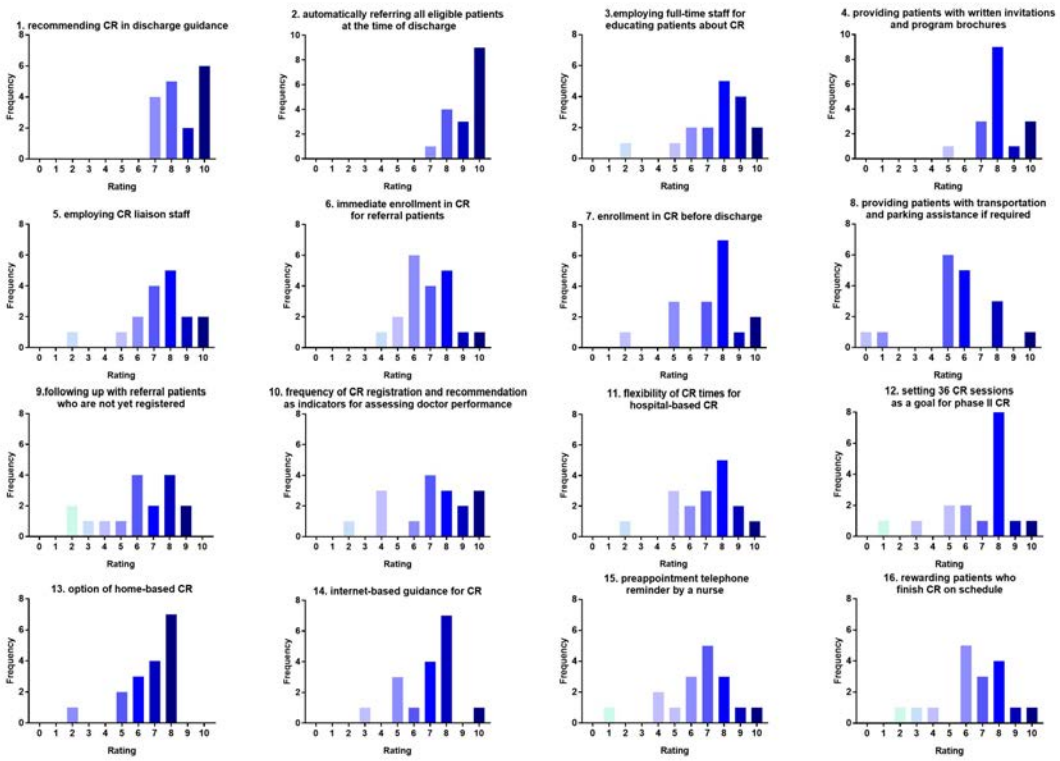
Supplementary Figure 1



Supplementary Figure 2



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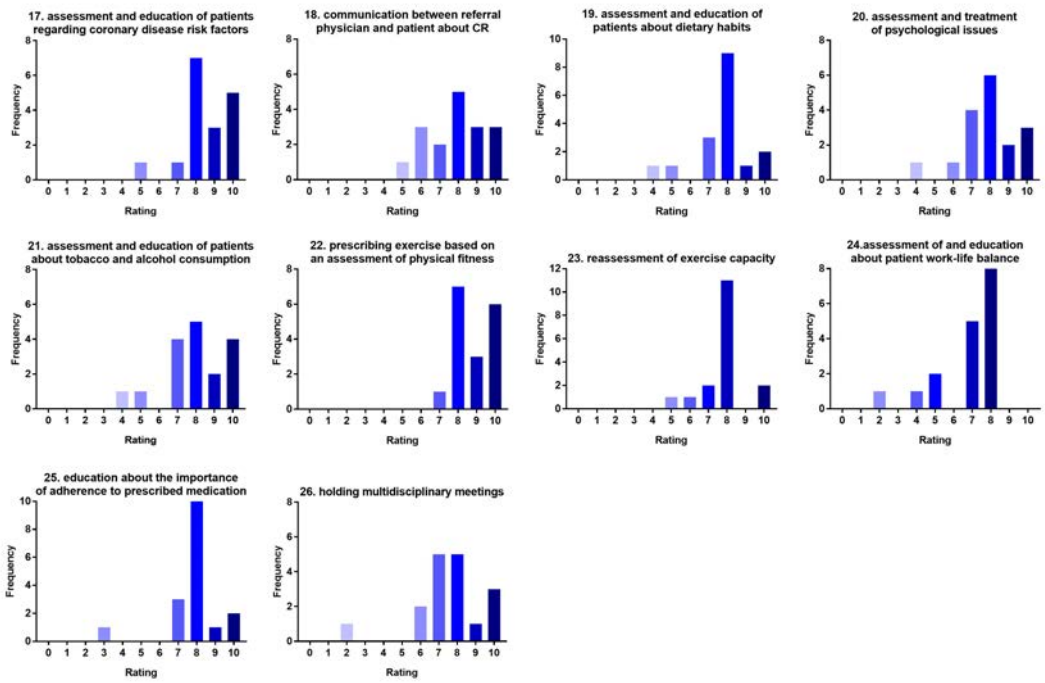
Supplementary Figure 3



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Supplementary Table 1. The questionnaire used in the practice test.

Optimization of the quality of CR questionnaire for patients with AMI in China		
Quality Indicators	**YES**	**NO**
Domain 1: Improving CR participation and adherence		
QI-1: recommending CR in discharge guidance		
QI-2: automatically referring all eligible patients at the time of discharge		
QI-3: employing full-time staff for educating patients about CR		
QI-4: providing patients with written invitations and program brochures		
QI-5: employing liaison staff for CR		
QI-6: immediate enrollment in CR for referral patients		
QI-7: enrollment in CR before discharge		
QI-10: frequency of CR enrollment and recommendation as indicators for assessing doctor performance		
Domain 2: CR process standardization		
QI-17: assessment and education of patients regarding coronary disease risk factors		
QI-18: communication between referral physician and patient about CR		
QI-19: assessment and education of patients about dietary habits		
QI-20: assessment and treatment of psychological issues		
QI-21: assessment of and education of patients about tobacco and alcohol consumption		
QI-22: prescribing exercise based on an assessment of physical fitness		
QI-23: reassessment of exercise capacity		
QI-25: education about the importance of adherence to prescribed medication		
QI-26: holding multidisciplinary meetings		
Please complete this questionnaire truthfully with regard to reporting whether the above QIs were implemented in the process of CR. If they were implemented, please fill in yes; otherwise, fill in no. Thank you very much for your participation and support. CR=cardiac rehabilitation, AMI=acute myocardial infarction, QIs=quality indicators.		

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Supplementary Table 2 Candidate quality indicators for CR in patients with MI

Quality Indicators	Reference
Domain 1: Improving CR participation and adherence	
QI-1: recommending CR in discharge guidance	28, 38
QI-2: automatically referring all eligible patients at the time of discharge	28, 34, 35, 36, 38, 39, 40
QI-3: employing full-time staff for educating patients about CR	28, 38
QI-4: providing patients with written invitations and program brochures	35
QI-5: employing CR liaison staff	35
QI-6: immediate enrollment in CR for referral patients	24, 29, 31, 36, 37
QI-7: enrollment in CR before discharge	35
QI-8: providing patients with transportation and parking assistance if required	35
QI-9: following up with referral patients who are not yet registered	35
QI-10: frequency of CR registration and recommendation as indicators for assessing doctor performance	22
QI-11: flexibility of CR times for hospital-based CR	28, 35
QI-12: setting 36 CR sessions as a goal for phase II CR	22, 42
QI-13: option of home-based CR	28
QI-14: internet-based guidance for CR	41
QI-15: preappointment telephone reminder by a nurse	32
QI-16: rewarding patients who finish CR on schedule	22, 30
Domain 2: Process standardization of CR	
QI-17: assessment and education of patients regarding coronary disease risk factors	31 , 33, 36
QI-18: communication between referral physician and patient about CR	33
QI-19: assessment and education of patients about dietary habits	33
QI-20: assessment and treatment of psychological issues	31, 33
QI-21: assessment and education of patients about tobacco and alcohol consumption	31, 33
QI-22: prescribing exercise based on an assessment of physical fitness	31, 33, 36
QI-23: reassessment of exercise capacity	33
QI-24: assessment of and education about patient work-life balance	33
QI-25: education about the importance of adherence to prescribed medication	33
QI-26: holding multidisciplinary meetings	33

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Supplementary Table 3 Information about professionals of the consensus panel.

Experts of the consensus panel	Cardiac rehabilitation centres
Xuwen Yang	Tianjin Chest Hospital, Tianjin Cancer Hospital, Tianjin
Yuanhui Liu	Guangdong Provincial People's Hospital, Guangzhou, Guangdong Province
Gaowa Siqin	Inner Mongolia People's Hospital, Inner Mongolia
Shumei Zhang	Inner Mongolia People's Hospital, Inner Mongolia
Junnan Wang	the Second Hospital of Jilin University, Changchun, Jilin Province
Yinjun Li	the Fourth Hospital of Shenyang, Shenyang, Liaoning Province
Jian Zhang	General Hospital of Northern Theater Command, Shenyang, Liaoning Province
Cheng Liu	General Hospital of Northern Theater Command, Shenyang, Liaoning Province
Guihua Li	The Second Hospital of Dalian Medical University, Dalian, Liaoning Province
Chuanfen Liu	Peking University People's Hospital, Beijing
Rongjing Ding	Peking University People's Hospital, Beijing
Jian Wu	the Second Affiliated Hospital of Harbin Medical University, Harbin, Heilongjiang Province
Yongxiang Zhang	the Second Affiliated Hospital of Harbin Medical University, Harbin, Heilongjiang Province
Qiaoyu Ren	Heilongjiang Agricultural Reclamation Sanjiang People's Hospital, Jiamusi, Heilongjiang Province
Shibo Wang	Heilongjiang Agricultural Reclamation Sanjiang People's Hospital, Jiamusi, Heilongjiang Province
Ying Xin	Harbin Second Hospital, Harbin, Heilongjiang Province
Jing Yao	Hegang People's Hospital, Hegang, Heilongjiang Province

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