

BMJ Open

BMJ Open is committed to open peer review. As part of this commitment we make the peer review history of every article we publish publicly available.

When an article is published we post the peer reviewers' comments and the authors' responses online. We also post the versions of the paper that were used during peer review. These are the versions that the peer review comments apply to.

The versions of the paper that follow are the versions that were submitted during the peer review process. They are not the versions of record or the final published versions. They should not be cited or distributed as the published version of this manuscript.

BMJ Open is an open access journal and the full, final, typeset and author-corrected version of record of the manuscript is available on our site with no access controls, subscription charges or pay-per-view fees (<http://bmjopen.bmj.com>).

If you have any questions on BMJ Open's open peer review process please email info.bmjopen@bmj.com

BMJ Open

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

Journal:	<i>BMJ Open</i>
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

SCHOLARONE™
Manuscripts



I, the Submitting Author has the right to grant and does grant on behalf of all authors of the Work (as defined in the below author licence), an exclusive licence and/or a non-exclusive licence for contributions from authors who are: i) UK Crown employees; ii) where BMJ has agreed a CC-BY licence shall apply, and/or iii) in accordance with the terms applicable for US Federal Government officers or employees acting as part of their official duties; on a worldwide, perpetual, irrevocable, royalty-free basis to BMJ Publishing Group Ltd ("BMJ") its licensees and where the relevant Journal is co-owned by BMJ to the co-owners of the Journal, to publish the Work in this journal and any other BMJ products and to exploit all rights, as set out in our [licence](#).

The Submitting Author accepts and understands that any supply made under these terms is made by BMJ to the Submitting Author unless you are acting as an employee on behalf of your employer or a postgraduate student of an affiliated institution which is paying any applicable article publishing charge ("APC") for Open Access articles. Where the Submitting Author wishes to make the Work available on an Open Access basis (and intends to pay the relevant APC), the terms of reuse of such Open Access shall be governed by a Creative Commons licence – details of these licences and which [Creative Commons](#) licence will apply to this Work are set out in our licence referred to above.

Other than as permitted in any relevant BMJ Author's Self Archiving Policies, I confirm this Work has not been accepted for publication elsewhere, is not being considered for publication elsewhere and does not duplicate material already published. I confirm all authors consent to publication of this Work and authorise the granting of this licence.

1
2
3 **Quality indicators for cardiac rehabilitation after myocardial infarction in China: a consensus**
4 **panel and a national questionnaire**
5
6

7 Xianghui Zheng^{1,2#}, Maomao Zhang^{1,2#}, Yang Zheng^{1,2}, Yongxiang Zhang^{1,2}, Junnan Wang³, Ping
8 Zhang⁴, Xuwen Yang⁵, Shan Li⁶, Rongjing Ding⁷, Gaowa Siqin⁸, Xinyu Hou^{1,2}, Liangqi Chen^{1,2},
9 Min Zhang^{1,2}, Yong Sun^{1,2}, Jian Wu^{1,2*}, Bo Yu^{1,2}
10
11

12 ¹ Department of Cardiology, the Second Affiliated Hospital of Harbin Medical University, Harbin,
13 Heilongjiang Province, China

14 ² The Key Laboratory of Myocardial Ischemia, Harbin Medical University, Ministry of Education,
15 Harbin, Heilongjiang Province, China

16 ³ Department of Cardiology, the Second Hospital of Jilin University, Changchun, Jilin Province,
17 China

18 ⁴ Department of Cardiology, Beijing Tsinghua Changgung Hospital, Beijing, China

19 ⁵ Department of Cardiology, Tianjin Chest Hospital, Tianjin Cancer Hospital, Tianjin, China

20 ⁶ Department of Cardiology, Affiliated Hospital of Qingdao University, Qingdao, China

21 ⁷ Department of Cardiology, Peking University People's Hospital, Beijing, China

22 ⁸ Department of Cardiology, Inner Mongolia People's Hospital, Inner Mongolia, China

23
24
25
26
27
28 * Corresponding author: Jian Wu, Department of Cardiology, the Second Affiliated Hospital
29 of Harbin Medical University, No. 246, Xuefu Road, Nangang District, Harbin, China.

30 E-mail address: wujian780805@163.com
31
32

33 # These authors contributed equally to this work.
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

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

1
2
3 and societal burden. A recent study shows that 41.5% of MI patients are unable to work by 12
4 months after AMI.²

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

17
18
19
20
21 CR programs remain clinically underused, and participation in CR remains dismally low world
22 over. The rate of CR participation generally ranges between 6.6% and 53.5% in the USA.¹⁴ CR was
23 used only in 13.9% of patients hospitalized for AMI and 31.0% after coronary artery bypass graft
24 surgery.¹⁴ The results of a European survey revealed an average participation rate of 44.9%, in
25 patients with coronary heart disease, with the highest participation rate of 85.4% in Lithuania, and
26 the lowest rate (0.0%) in Greece.¹⁵ Only 34% of Canadian patients with indications participated in
27 CR.¹⁶ A review of medical records of 1330 AMI patients revealed only 30.5% participation between
28 December 2017 and September 2018 at a university hospital in China that vigorously carried out
29 CR programs. However, most hospitals currently do not carry out CR programs, and other medical
30 institutions also are far below the participation rate of 30.5%. Besides, adherence to evidence-based
31 performance measures of CR is also suboptimal in China. Therefore, effective strategies to increase
32 enrollment and adherence to CR are urgently needed.

33
34
35
36
37 Quality improvement means improving health care, and systems of care delivered by individual
38 physician. Quality indicators (QIs) provide direction and specific methods for quality improvement.
39 A study on ICU patients showed that a multifaceted quality improvement intervention improved the
40 adoption of care practices.¹⁷ And there was a significant improvement in patients with acute
41 ischemic stroke by a multifaceted quality improvement intervention.¹⁸ In addition, many countries,
42 such as the USA, Japan, and Canada have developed QIs for improving CR but are lacking in the
43 Chinese context. Implementation of QIs can increase the participation and adherence over longer-
44 term in post-MI patients. For example, a two-year study showed a significant increase in the
45 percentage of enrollment in CR with a series of quality improvement interventions, including policy
46 change, a 7-minute video describing the benefits of CR, and incentives.¹⁹ A randomized controlled
47 trial revealed that early appointments within 10 days of hospital discharge improved CR attendance
48 almost by 3-folds versus standard appointments after 35 days.²⁰

49
50
51
52 Besides, there are also some gaps in the effectiveness of CR in China. Increasing participation is
53 an important goal for successful implementation of CR programs, which could decrease morbidity
54 and mortality due to MI. The aim of this study was to describe candidate QIs and test their feasibility
55 and applicability to improve the participation and the completing effect of CR in post-MI Chinese
56 patients.
57

58 59 **Methods**

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

1
2
3 indicators were selected based on the participants' ratings. Also, participants could suggest new QIs
4 outside of those mentioned in the questionnaire.
5

6 **Data collection and analysis**

7 Two authors (XZ and YZ) were responsible for data collection and cross checking. Mean score
8 of each indicator was calculated as: the sum of all participants' ratings/ the number of participants.
9 And median performance of QIs was calculated as: number of times the indicator was met/ the
10 number of participants (excluding participants who did not fill in) x100.
11
12

13 **Results**

14 **Collection of QIs**

15 A review of the literature identified 203 articles, and after perusing the titles and abstracts, 176
16 were excluded as they were not related to QIs for CR. After careful examination, 17 articles were
17 found to be eligible to be included.^{14, 19-34} A list of 26 potential indicators including 16 about
18 improving the rate of participation and adherence to CR and 10 on the effect of completing the CR
19 was created (Supplementary Table 1). A flowchart of the literature search and selection of eligible
20 articles is shown in Supplementary Figure 1.
21
22

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

24 The consensus panel including 17 cardiologists from 12 CR centers individually rated each
25 indicator on a ten-point scale questionnaire. The rating of each indicator is shown in Supplementary
26 Figure 2 and 3. After careful evaluation, only indicators with an average score >7 that could improve
27 the quality of CR in China were accepted (Figure 1). Finally, a total of 18 QIs were selected and
28 divided into two domains: (1) improving participation and adherence and (2) completion effect of
29 CR (Table 1).
30
31

32 **National questionnaire and top five indicators for imminent improvement**

33 A nationwide telephonic or WeChat survey involving 89 people from 4 municipalities and 18
34 provinces in China was carried out with a response rate of 100%. And 89 participants included 21
35 cardiologists, 15 nurses, 18 physical therapists, 11 clinical psychologists, 13 registered dietitians
36 and 11 health follow-up staff. Each participant selected three indicators considered to be critical to
37 improve post-MI CR in China (Figures 2 and 3). Results showed that the five most important
38 indicators were 'automatically referring all eligible patients at the time of discharge',
39 'recommending CR in discharge guidance' and 'prescribing exercise based on assessment of
40 physical fitness', 'full time staff for educating patients about CR', 'assessment and education of
41 patients regarding coronary disease risk factors' (Table 2) with score ratios of 47.2%, 38.2 %, 28.1%,
42 25.8% and 19.1%, respectively.
43
44

45 **Practice test**

46 A practice test was performed on 165 patients with MI enrolled in the study revealed a median
47 performance of 43.1% (9.9-86.1%). Indicators with high performance (minimum to maximum 72.1-
48 86.1%) were 'assessment and education of patients on tobacco and alcohol consumption',
49 'recommending CR in discharge guidance'. There were also several low performing indicators
50 (minimum to maximum 9.9-29.7%), including 'holding multidisciplinary conferences', 'frequency
51 of CR registration and recommendation as indicators for assessing the performance of doctor',
52 'immediate reservation of CR for referral patients', 'providing patients with written invitations and
53 program brochures' (Table 1).
54
55
56
57
58
59
60

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

1
2
3 implementation of CR.

4 In short, application of these indicators would standardize and improve the quality of CR in China.
5 During the course of the study, two more supplementary indicators-extending the hospital
6 rehabilitation time and strengthening the application of traditional Chinese sports, such as Taiji and
7 Baduanjin in CR were pointed out that warrant further discussion. This study provides significant
8 guidance for the development of cardiac rehabilitation in our country. Nevertheless, further studies
9 are needed to evaluate the validity, reliability and feasibility of these indicators.
10
11
12

13 **Study limitation**

14 There are many limitations in our study. First, we retrieved the literature through a public database,
15 hence, there was a possibility of publication bias. Second, there might be investigation bias rooted
16 in that the participants of the consensus panel were all cardiologists and the national questionnaire
17 was not distributed to all regions and cardiac rehabilitation centers in the country. In addition, to
18 assess the measurability and completeness of the proposal indicators, we included post-MI patients
19 who already had participated in I and II phase CR in the clinical practice test. Consequently, we
20 found that the performance of the proposed indicators was high.
21
22
23
24

25 **Conclusion**

26 In this study, a consensus panel identified 18 candidate indicators to improve the quality of CR
27 in patients with MI in China. A nationwide survey revealed the 5 indicators that required imminent
28 improvement to facilitate better enrollment in CR programs in the country. Moreover, a practice test
29 on MI patients confirmed the feasibility and completeness of the developed indicators. The test also
30 revealed that holding multidisciplinary conferences and better communication between referral
31 physician and patient about CR can improve the performance of the CR program in clinics.
32 Application of the proposed indicators would improve the quality of care through CR in post-MI
33 Chinese patients.
34
35
36
37

38 **Acknowledgements**

39 The authors are grateful to the members of the consensus panel and the staff who participated in
40 the national questionnaire.
41
42
43

44 **Author contribution**

45 All authors contributed to conception and design of the work. XZ and YZheng contributed to
46 analysis and interpretation. JWu, YZhang, JWang, PZ, XY, SL, RD, GS, BY and YS contributed to
47 acquisition of data. XZ and MaoZ drafted the manuscript. MinZ, XH and LC critically revised the
48 manuscript. All authors reviewed and agrees to the final version.
49
50

51 **Funding**

52 This work was supported by the National Key R&D Program of China (Grant no.
53 2016YFC1301100), the National Natural Science Foundation of China (Grants no. 81670373,
54 81670459 and 81771946), and the Key Laboratory of Myocardial Ischemia, Harbin Medical
55 University, Ministry of Education (KF201806 to X.Z., KF201716 to Y.Z., KF201822 to L.C.).
56
57
58

59 **Competing interests**

1
2
3 None declared.
4
5

6 **Patient consent for publication**

7 Not required.
8
9

10 **Ethics approval**

11 Ethical approval and patient consent were not required. Analyses were based on anonymised data.
12
13

14 **Provenance and peer review**

15 Not commissioned; externally peer reviewed.
16
17

18 **Data sharing statement**

19 No additional data are available.
20
21

- 22 1. Piepoli MF, Corra U, Dendale P, et al. Challenges in secondary prevention after acute
23 myocardial infarction: A call for action. *European heart journal Acute cardiovascular*
24 *care* 2017;6(4):299-310. doi: 10.1177/2048872616689773
25
26
27
28
29
30 2. Dreyer RP, Xu X, Zhang W, et al. Return to Work After Acute Myocardial Infarction:
31 Comparison Between Young Women and Men. *Circ Cardiovasc Qual Outcomes*
32 2016;9(2 Suppl 1):S45-52. doi: 10.1161/CIRCOUTCOMES.115.002611 [published
33
34
35
36
37
38
39
40
41 3. Ribeiro F, Oliveira NL, Silva G, et al. Exercise-based cardiac rehabilitation increases daily
42 physical activity of patients following myocardial infarction: subanalysis of two
43 randomised controlled trials. *Physiotherapy* 2017;103(1):59-65. doi:
44
45
46
47
48
49
50
51 4. Lee BJ, Go JY, Kim AR, et al. Quality of Life and Physical Ability Changes After Hospital-
52 Based Cardiac Rehabilitation in Patients With Myocardial Infarction. *Ann Rehabil Med*
53 2017;41(1):121-28. doi: 10.5535/arm.2017.41.1.121 [published Online First:
54
55
56
57
58
59
60
2017/03/16]

- 1
2
3
4 5. Hermann M, Witassek F, Erne P, et al. Impact of cardiac rehabilitation referral on one-year
5
6 outcome after discharge of patients with acute myocardial infarction. *Eur J Prev Cardiol*
7
8
9 2019;26(2):138-44. doi: 10.1177/2047487318807766 [published Online First:
10
11 2018/10/20]
12
- 13
14 6. Schwaab B, Zeymer U, Jannowitz C, et al. Improvement of low-density lipoprotein cholesterol
15
16 target achievement rates through cardiac rehabilitation for patients after ST elevation
17
18 myocardial infarction or non-ST elevation myocardial infarction in Germany: Results of
19
20 the PATIENT CARE registry. *European journal of preventive cardiology*
21
22 2019;26(3):249-58. doi: 10.1177/2047487318817082
23
24
- 25
26 7. Zhang Y, Cao H, Jiang P, et al. Cardiac rehabilitation in acute myocardial infarction patients
27
28 after percutaneous coronary intervention: A community-based study. *Medicine*
29
30 2018;97(8):e9785. doi: 10.1097/MD.0000000000009785
31
32
- 33
34 8. Tsai YJ, Li MH, Chen CH, et al. Improved oxygen uptake efficiency slope in acute myocardial
35
36 infarction patients after early phase I cardiac rehabilitation. *International journal of*
37
38 *rehabilitation research Internationale Zeitschrift fur Rehabilitationsforschung Revue*
39
40 *internationale de recherches de readaptation* 2017;40(3):215-19. doi:
41
42 10.1097/MRR.000000000000229
43
44
45
- 46
47 9. Hambrecht R, Wolf A, Gielen S, et al. Effect of exercise on coronary endothelial function in
48
49 patients with coronary artery disease. *The New England journal of medicine*
50
51 2000;342(7):454-60. doi: 10.1056/NEJM200002173420702
52
53
- 54
55 10. Vanhees L, Fagard R, Thijs L, et al. Prognostic value of training-induced change in peak
56
57 exercise capacity in patients with myocardial infarcts and patients with coronary bypass
58
59
60

- 1
2
3
4 surgery. *The American journal of cardiology* 1995;76(14):1014-9.
5
6
7 11. Martin BJ, Hauer T, Arena R, et al. Cardiac rehabilitation attendance and outcomes in
8
9 coronary artery disease patients. *Circulation* 2012;126(6):677-87. doi:
10
11 10.1161/CIRCULATIONAHA.111.066738
12
13
14 12. Hammill BG, Curtis LH, Schulman KA, et al. Relationship between cardiac rehabilitation
15
16 and long-term risks of death and myocardial infarction among elderly Medicare
17
18 beneficiaries. *Circulation* 2010;121(1):63-70. doi:
19
20 10.1161/CIRCULATIONAHA.109.876383
21
22
23
24 13. Smith SC, Jr., Benjamin EJ, Bonow RO, et al. AHA/ACCF secondary prevention and risk
25
26 reduction therapy for patients with coronary and other atherosclerotic vascular disease:
27
28 2011 update: a guideline from the American Heart Association and American College
29
30 of Cardiology Foundation endorsed by the World Heart Federation and the Preventive
31
32 Cardiovascular Nurses Association. *Journal of the American College of Cardiology*
33
34 2011;58(23):2432-46. doi: 10.1016/j.jacc.2011.10.824
35
36
37
38
39
40 14. Suaya JA, Shepard DS, Normand SL, et al. Use of cardiac rehabilitation by Medicare
41
42 beneficiaries after myocardial infarction or coronary bypass surgery. *Circulation*
43
44 2007;116(15):1653-62. doi: 10.1161/CIRCULATIONAHA.107.701466
45
46
47
48 15. Kotseva K, Wood D, De Backer G, et al. Use and effects of cardiac rehabilitation in patients
49
50 with coronary heart disease: results from the EUROASPIRE III survey. *European*
51
52 *journal of preventive cardiology* 2013;20(5):817-26. doi: 10.1177/2047487312449591
53
54
55
56 16. Grace SL, Bennett S, Ardern CI, et al. Cardiac rehabilitation series: Canada. *Progress in*
57
58 *cardiovascular diseases* 2014;56(5):530-5. doi: 10.1016/j.pcad.2013.09.010
59
60

- 1
2
3
4 17. Scales DC, Dainty K, Hales B, et al. A multifaceted intervention for quality improvement in
5
6 a network of intensive care units: a cluster randomized trial. *Jama* 2011;305(4):363-72.
7
8
9 doi: 10.1001/jama.2010.2000
10
11
12 18. Wang Y, Li Z, Zhao X, et al. Effect of a Multifaceted Quality Improvement Intervention on
13
14 Hospital Personnel Adherence to Performance Measures in Patients With Acute
15
16 Ischemic Stroke in China: A Randomized Clinical Trial. *Jama* 2018;320(3):245-54. doi:
17
18 10.1001/jama.2018.8802
19
20
21
22 19. Pack QR, Johnson LL, Barr LM, et al. Improving cardiac rehabilitation attendance and
23
24 completion through quality improvement activities and a motivational program. *Journal*
25
26 *of cardiopulmonary rehabilitation and prevention* 2013;33(3):153-9. doi:
27
28 10.1097/HCR.0b013e31828db386
29
30
31
32 20. Pack QR, Mansour M, Barboza JS, et al. An early appointment to outpatient cardiac
33
34 rehabilitation at hospital discharge improves attendance at orientation: a randomized,
35
36 single-blind, controlled trial. *Circulation* 2013;127(3):349-55. doi:
37
38 10.1161/CIRCULATIONAHA.112.121996
39
40
41
42
43 21. Ades PA, Keteyian SJ, Wright JS, et al. Increasing Cardiac Rehabilitation Participation From
44
45 20% to 70%: A Road Map From the Million Hearts Cardiac Rehabilitation Collaborative.
46
47 *Mayo Clinic proceedings* 2017;92(2):234-42. doi: 10.1016/j.mayocp.2016.10.014
48
49
50
51 22. Kehler DS, Kent D, Beaulac J, et al. Examining Patient Outcome Quality Indicators Based
52
53 on Wait Time From Referral to Entry Into Cardiac Rehabilitation: A PILOT
54
55 OBSERVATIONAL STUDY. *Journal of cardiopulmonary rehabilitation and prevention*
56
57 2017;37(4):250-56. doi: 10.1097/HCR.0000000000000232
58
59
60

- 1
2
3
4 23. Harkness K, Smith KM, Taraba L, et al. Effect of a postoperative telephone intervention on
5
6 attendance at intake for cardiac rehabilitation after coronary artery bypass graft surgery.
7
8
9 *Heart & lung : the journal of critical care* 2005;34(3):179-86.
10
11
12 24. Grace SL, Parsons TL, Duhamel TA, et al. The quality of cardiac rehabilitation in Canada:
13
14 a report of the Canadian Cardiac Rehab Registry. *The Canadian journal of cardiology*
15
16 2014;30(11):1452-5. doi: 10.1016/j.cjca.2014.06.016
17
18
19 25. Gaalema DE, Savage PD, Rengo JL, et al. Financial incentives to promote cardiac
20
21 rehabilitation participation and adherence among Medicaid patients. *Preventive*
22
23 *medicine* 2016;92:47-50. doi: 10.1016/j.yjmed.2015.11.032
24
25
26
27 26. Beatty AL, Li S, Thomas L, et al. Trends in referral to cardiac rehabilitation after myocardial
28
29 infarction: data from the National Cardiovascular Data Registry 2007 to 2012. *Journal*
30
31 *of the American College of Cardiology* 2014;63(23):2582-83. doi:
32
33 10.1016/j.jacc.2014.03.030
34
35
36
37 27. Ohtera S, Kanazawa N, Ozasa N, et al. Proposal of quality indicators for cardiac
38
39 rehabilitation after acute coronary syndrome in Japan: a modified Delphi method and
40
41 practice test. *BMJ open* 2017;7(1):e013036. doi: 10.1136/bmjopen-2016-013036
42
43
44
45 28. Balady GJ, Ades PA, Bittner VA, et al. Referral, enrollment, and delivery of cardiac
46
47 rehabilitation/secondary prevention programs at clinical centers and beyond: a
48
49 presidential advisory from the American Heart Association. *Circulation*
50
51 2011;124(25):2951-60. doi: 10.1161/CIR.0b013e31823b21e2
52
53
54
55 29. Grace SL, Russell KL, Reid RD, et al. Effect of cardiac rehabilitation referral strategies on
56
57 utilization rates: a prospective, controlled study. *Archives of internal medicine*
58
59
60

- 2011;171(3):235-41. doi: 10.1001/archinternmed.2010.501
30. Grace SL, Poirier P, Norris CM, et al. Pan-Canadian development of cardiac rehabilitation and secondary prevention quality indicators. *The Canadian journal of cardiology* 2014;30(8):945-8. doi: 10.1016/j.cjca.2014.04.003
31. Van Engen-Verheul M, Kemps H, Kraaijenhagen R, et al. Modified Rand method to derive quality indicators: a case study in cardiac rehabilitation. *Studies in health technology and informatics* 2011;169:88-92.
32. Kotter T, Blozik E, Scherer M. Methods for the guideline-based development of quality indicators--a systematic review. *Implementation science : IS* 2012;7:21. doi: 10.1186/1748-5908-7-21
33. Thomas RJ, Chiu JS, Goff DC, Jr., et al. Reliability of abstracting performance measures: results of the cardiac rehabilitation referral and reliability (CR3) project. *Journal of cardiopulmonary rehabilitation and prevention* 2014;34(3):172-9. doi: 10.1097/HCR.0000000000000048
34. Grace SL, Tan Y, Oh P, et al. Feasibility of Assessing 2 Cardiac Rehabilitation Quality Indicators. *Journal of cardiopulmonary rehabilitation and prevention* 2016;36(2):112-6. doi: 10.1097/HCR.0000000000000136
35. Grace SL, Gravely-Witte S, Brujal J, et al. Contribution of patient and physician factors to cardiac rehabilitation enrollment: a prospective multilevel study. *European journal of cardiovascular prevention and rehabilitation : official journal of the European Society of Cardiology, Working Groups on Epidemiology & Prevention and Cardiac Rehabilitation and Exercise Physiology* 2008;15(5):548-56. doi: 10.1097/HJR.0b013e328305df05

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.

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

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

Figure 1

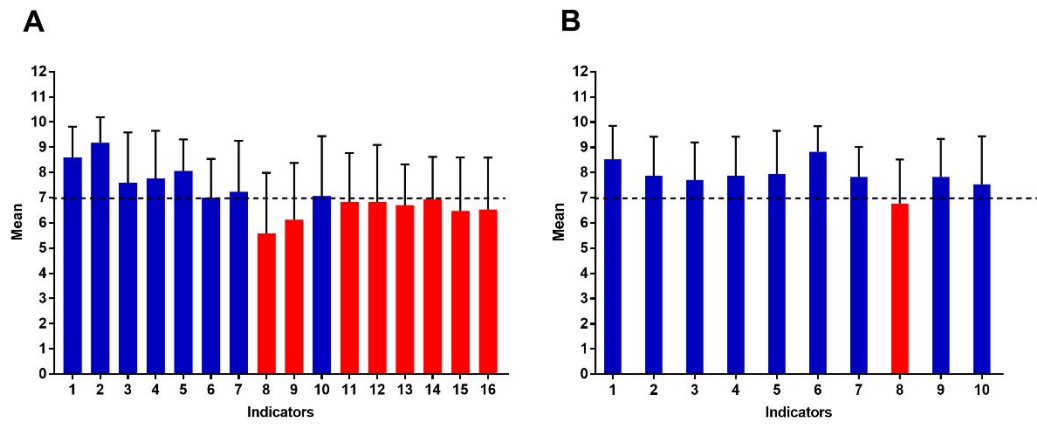


Figure 1. Mean of all indicators from the consensus panel. A. The mean of domain 1: improving participation and adherence of CR. B. The mean of domain 2: completion effect of CR.

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

Figure 2



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

Figure 3

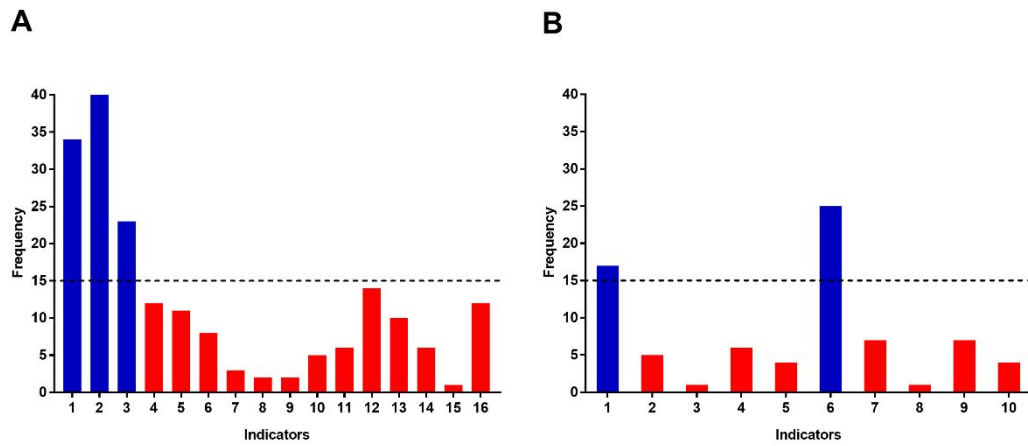
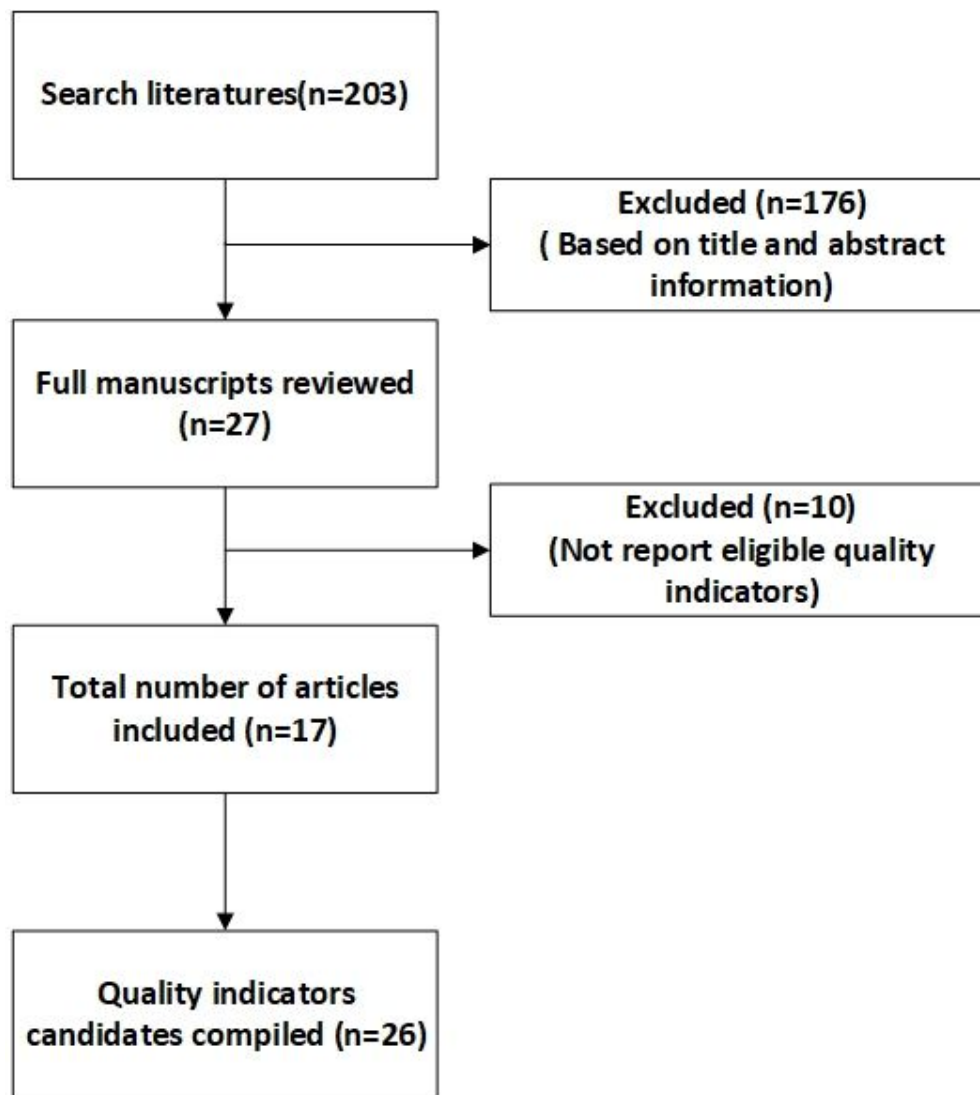


Figure 3. The national questionnaire. Indicators from the national questionnaires that needed to immediate improvement (blue).

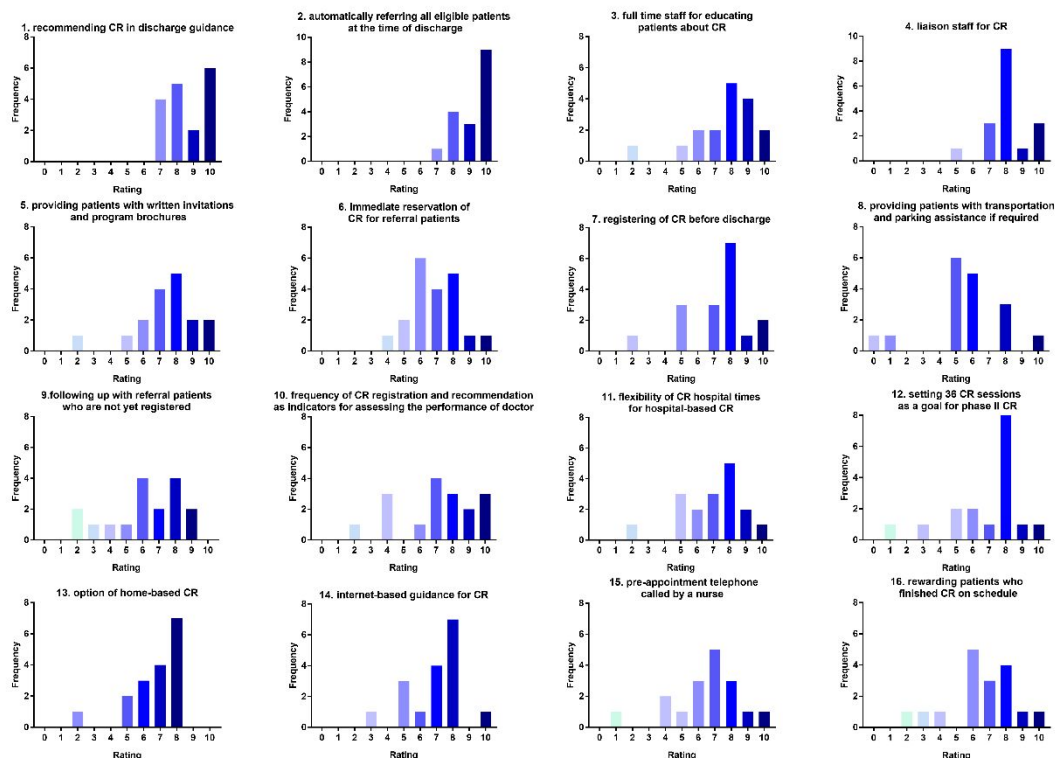
Supplementary Figure 1



Supplementary Figure 1. Flow chart of the literature search.

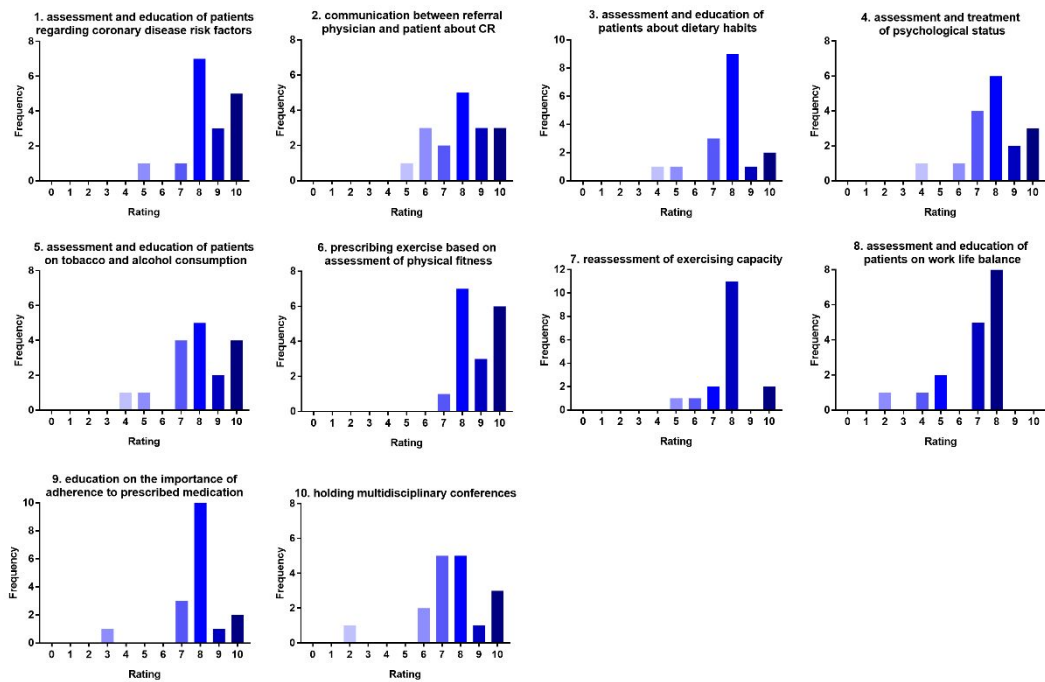
only

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.

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.

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

BMJ Open

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

Journal:	<i>BMJ Open</i>
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

SCHOLARONE™
Manuscripts



I, the Submitting Author has the right to grant and does grant on behalf of all authors of the Work (as defined in the below author licence), an exclusive licence and/or a non-exclusive licence for contributions from authors who are: i) UK Crown employees; ii) where BMJ has agreed a CC-BY licence shall apply, and/or iii) in accordance with the terms applicable for US Federal Government officers or employees acting as part of their official duties; on a worldwide, perpetual, irrevocable, royalty-free basis to BMJ Publishing Group Ltd ("BMJ") its licensees and where the relevant Journal is co-owned by BMJ to the co-owners of the Journal, to publish the Work in this journal and any other BMJ products and to exploit all rights, as set out in our [licence](#).

The Submitting Author accepts and understands that any supply made under these terms is made by BMJ to the Submitting Author unless you are acting as an employee on behalf of your employer or a postgraduate student of an affiliated institution which is paying any applicable article publishing charge ("APC") for Open Access articles. Where the Submitting Author wishes to make the Work available on an Open Access basis (and intends to pay the relevant APC), the terms of reuse of such Open Access shall be governed by a Creative Commons licence – details of these licences and which [Creative Commons](#) licence will apply to this Work are set out in our licence referred to above.

Other than as permitted in any relevant BMJ Author's Self Archiving Policies, I confirm this Work has not been accepted for publication elsewhere, is not being considered for publication elsewhere and does not duplicate material already published. I confirm all authors consent to publication of this Work and authorise the granting of this licence.

1
2
3 **Quality indicators for cardiac rehabilitation after myocardial infarction in China: a consensus**
4 **panel and practice test**
5

6 Xianghui Zheng^{1,2#}, Maomao Zhang^{1,2#}, Yang Zheng^{1,2}, Yongxiang Zhang^{1,2}, Junnan Wang³, Ping
7 Zhang⁴, Xuwen Yang⁵, Shan Li⁶, Rongjing Ding⁷, Gaowa Siqin⁸, Xinyu Hou^{1,2}, Liangqi Chen^{1,2},
8 Min Zhang^{1,2}, Yong Sun^{1,2}, Jian Wu^{1,2*}, Bo Yu^{1,2}
9
10

11
12 ¹ Department of Cardiology, the Second Affiliated Hospital of Harbin Medical University, Harbin,
13 Heilongjiang Province, China

14 ² The Key Laboratory of Myocardial Ischemia, Harbin Medical University, Ministry of Education,
15 Harbin, Heilongjiang Province, China

16 ³ Department of Cardiology, the Second Hospital of Jilin University, Changchun, Jilin Province,
17 China

18 ⁴ Department of Cardiology, Beijing Tsinghua Changgung Hospital, Beijing, China

19 ⁵ Department of Cardiology, Tianjin Chest Hospital, Tianjin Cancer Hospital, Tianjin, China

20 ⁶ Department of Cardiology, Affiliated Hospital of Qingdao University, Qingdao, China

21 ⁷ Department of Cardiology, Peking University People's Hospital, Beijing, China

22 ⁸ Department of Cardiology, Inner Mongolia People's Hospital, Inner Mongolia, China

23
24
25 * Corresponding author: Jian Wu, Department of Cardiology, the Second Affiliated Hospital
26 of Harbin Medical University, No. 246, Xuefu Road, Nangang District, Harbin, China.

27 E-mail address: wujian780805@163.com
28
29

30
31
32 # These authors contributed equally to this work.
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

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.

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

1
2
3 rehabilitation programs.²¹ In addition, many countries, such as the USA, Japan, and Canada, have
4 developed QIs for improving CR, but QIs are lacking in China. Implementation of QIs can increase
5 long-term participation and adherence by post-MI patients. For example, a two-year study reported
6 a significant increase in enrollment in CR after the implementation of a series of quality
7 improvement interventions, including policy changes, a 7-minute video describing the benefits of
8 CR, and incentives.²² The early utilization of a cardiac access clinic resulted in an unprecedented
9 (~3-fold) increase in the number of ST-elevation myocardial infarction (STEMI) patients
10 participating in CR.²³ A randomized controlled trial also revealed that early appointments within
11 10 days of hospital discharge improved CR attendance by approximately 3-fold compared with
12 standard appointments after 35 days.²⁴

13
14
15
16
17
18 CR plays an important role in reducing mortality in patients with MI, improving patient quality
19 of life and reducing China's economic burden.²⁵⁻²⁷ Cardiovascular rehabilitation process
20 standardization in China needs to be improved. Increasing participation is an important goal for the
21 successful implementation of CR programs, which could decrease morbidity and mortality due to
22 MI. The aim of this study was to describe candidate QIs and test their feasibility and applicability,
23 as well as to improve the CR participation and compliance rates in Chinese post-MI patients.
24
25
26
27
28

29 **Methods**

30 **Quality indicator development**

31
32
33 Databases including PubMed, CINAHL Ebsco, and EMBASE were searched for eligible articles
34 published through August 2018 using the keywords cardiac rehabilitation, quality indicator, and
35 myocardial infarction; MeSH terms; and Emtree headings. Two authors (XZ and MZ) conducted
36 the literature review by first reading titles and abstracts and then reading the full text of potential
37 articles. Articles from the search results were included if the following conditions were met: (1) the
38 study provided QIs for CR and (2) the study was published in English. The compiled QIs were
39 further divided into two domains: improving the CR participation and adherence rates and
40 standardizing CR processes. Any disagreement about study inclusion was resolved by a third author
41 (JWu).
42
43
44
45

46 **Consensus panel**

47
48
49 The consensus panel consisted of 17 individuals, with a maximum of 2 individuals from each CR
50 center. Members were selected upon meeting the following criteria: (1) the individual had at least 1
51 year of experience in CR; (2) the individual held a position as a leader of a regional CR program;
52 (3) the individual was committed to the advancement of CR; and (4) the individual agreed to
53 participate in an in-person meeting to discuss CR quality improvement. Two authors (XZ and
54 YZheng) assessed the qualifications of the members, and disagreements were resolved by consensus
55 or the third author (JWu). Members were responsible for scoring the collected QIs based on their
56 experience and determining the final QIs for CR in MI patients in China.
57
58
59
60

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

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

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

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

1
2
3 educating patients about CR' and 'employing CR liaison staff'. In addition, the study revealed QIs
4 that are necessary for CR process standardization in China, such as 'assessment and education of
5 patients regarding coronary disease risk factors', 'assessment and education of patients about dietary
6 habits', and 'prescribing exercise based on physical fitness'. It is worth mentioning that the
7 completion rate of 'holding multidisciplinary meetings' was very low in the practice test, but the
8 implementation of this QI can improve recovery in patients with multiple diseases. Moreover,
9 measuring the completion rate of the proposed QIs is important. First, relevant QIs should be
10 recorded in electronic medical records. A questionnaire survey about the implementation of QIs in
11 patients with MI at discharge and after CR was conducted. In addition, relevant medical staff should
12 be evaluated in practice by self-assessment and other assessment scales.
13
14
15
16
17

18 It is also important to understand the barriers to appropriate CR, including lack of health
19 awareness, inadequate policies, insufficiency of CR, lack of healthcare system support and care
20 discontinuity. Gary et al. reported that older females with a low socioeconomic status, with a low
21 education level, with poor self-efficacy, with multiple comorbidities and who were unable to
22 communicate in English were more likely to not participate in CR.³⁵ Enrollment in the CR program
23 is affected by many healthcare system-related factors, including lack of referral, limited facilitation
24 of enrollment after referral, lack of programs that serve specific geographic areas and low-income
25 communities, and gender-dominated programs.⁴⁴ In this study, we proposed QIs that would
26 overcome these barriers and aid in the successful implementation of CR.
27
28
29
30

31 During the course of the study, two additional supplementary indicators, 'extending the hospital
32 rehabilitation time' and 'strengthening the application of traditional Chinese exercise', were added.
33 Tai Chi Chuan practice was associated with a VO₂ peak increase in patients with MI.⁴⁵ Baduanjin
34 exercise therapy in post-MI patients reverses adverse left ventricular (LV) remodeling and improves
35 clinical outcomes.⁴⁶ Therefore, traditional Chinese exercises, such as Tai Chi Chuan and baduanjin,
36 may constitute effective forms of CR in patients with MI.
37
38
39

40 In summary, the application of these QIs would help standardize and improve the quality of CR
41 in China. This study provides significant guidance for the development of CR in our country.
42 Nevertheless, further studies are needed to evaluate the validity, reliability and feasibility of these
43 QIs.
44
45
46
47
48

49 **Study limitations**

50 There are many limitations in our study. First, in the quality indicator development section of the
51 methods, we retrieved the literature from public databases; hence, there is a possibility of publication
52 bias. Second, investigation bias may exist because the consensus panel participants were all
53 cardiologists and the national questionnaire was not distributed to all regions and CR centers in the
54 country. These factors may also lead to bias in the results of the practice test due to the absence of
55 data from nonteaching hospitals, the relatively small sample size and the lack of data concerning
56 baseline characteristics of the patients. Moreover, to assess the measurability and completeness of
57
58
59
60

1
2
3 the proposed QIs, only patients who participated in CR programs were selected to complete the
4 practice test. As such, data from those who did not participate in these programs were not available.
5
6
7

8 9 **Conclusion**

10
11 In this study, a consensus panel identified 17 candidate QIs to assess improvements in the quality
12 of CR in patients with MI in China. A nationwide survey revealed the 5 QIs that required imminent
13 improvement to facilitate increased enrollment in CR programs in the country. Moreover, a practice
14 test administered to MI patients confirmed the feasibility and completeness of the developed QIs.
15 The test also revealed that holding multidisciplinary meetings and improving communication
16 between referral physicians and patients about CR can improve the performance of the CR program
17 in clinics. Application of the proposed QIs would improve the quality of CR care in Chinese post-
18 MI patients.
19
20
21
22
23
24

25 **Acknowledgments**

26
27 The authors are grateful to the members of the consensus panel, the staff who participated in the
28 national questionnaire, and the patients who completed the practice test.
29

30 **Author contribution**

31
32
33 All authors contributed to conception and design of the work. XZ and YZheng contributed to
34 analysis and interpretation. JWu, YZhang, JWang, PZ, XY, SL, RD, GS, BY and YS contributed to
35 acquisition of data. XZ and MaoZ drafted the manuscript. MinZ, XH and LC critically revised the
36 manuscript. All authors reviewed and agrees to the final version.
37
38
39

40 **Funding**

41
42 This work was supported by the National Key R&D Program of China (Grant no.
43 2016YFC1301100), the National Natural Science Foundation of China (Grants no. 81670373,
44 81670459 and 81771946), and the Key Laboratory of Myocardial Ischemia, Harbin Medical
45 University, Ministry of Education (KF201806 to X.Z., KF201716 to Y.Z., KF201822 to L.C.).
46
47
48

49 **Competing interests**

50
51 None declared.
52
53

54 **Patient consent for publication**

55
56 Patients and/or the public were involved in the design, or conduct, or reporting, or dissemination
57 plans of this research. Refer to the Methods section for further details.
58
59
60

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.

References

1. Reed GW, Rossi JE, Cannon CP. Acute myocardial infarction. *Lancet* 2017;389(10065):197-

- 1
2
3
4 210. doi: 10.1016/S0140-6736(16)30677-8 [published Online First: 2016/08/10]
5
6
7 2. Piepoli MF, Corra U, Dendale P, et al. Challenges in secondary prevention after acute
8
9 myocardial infarction: A call for action. *Eur Heart J Acute Cardiovasc Care*
10
11 2017;6(4):299-310. doi: 10.1177/2048872616689773 [published Online First:
12
13 2017/06/14]
14
15
16
17 3. Chen W, Gao R, Liu L, et al. Summary of Chinese Cardiovascular Disease Report 2017.
18
19 *Chinese Circulation Journal* 2018;33(01):1-8. doi: 10.3969/j.issn.1000-
20
21 3614.2018.01.001
22
23
24
25 4. Jiang Z, Dreyer RP, Spertus JA, et al. Factors Associated With Return to Work After Acute
26
27 Myocardial Infarction in China. *JAMA Netw Open* 2018;1(7):e184831. doi:
28
29 10.1001/jamanetworkopen.2018.4831 [published Online First: 2019/01/16]
30
31
32
33 5. Salzwedel A, Jensen K, Rauch B, et al. Effectiveness of comprehensive cardiac rehabilitation
34
35 in coronary artery disease patients treated according to contemporary evidence based
36
37 medicine: Update of the Cardiac Rehabilitation Outcome Study (CROS-II). *Eur J Prev*
38
39 *Cardiol* 2020:2047487320905719. doi: 10.1177/2047487320905719 [published Online
40
41 First: 2020/02/25]
42
43
44
45 6. Hermann M, Witassek F, Erne P, et al. Impact of cardiac rehabilitation referral on one-year
46
47 outcome after discharge of patients with acute myocardial infarction. *Eur J Prev Cardiol*
48
49 2019;26(2):138-44. doi: 10.1177/2047487318807766 [published Online First:
50
51 2018/10/20]
52
53
54
55 7. Lee BJ, Go JY, Kim AR, et al. Quality of Life and Physical Ability Changes After Hospital-
56
57 Based Cardiac Rehabilitation in Patients With Myocardial Infarction. *Ann Rehabil Med*
58
59
60

- 1
2
3
4 2017;41(1):121-28. doi: 10.5535/arm.2017.41.1.121 [published Online First:
5
6 2017/03/16]
7
8
9 8. Ribeiro F, Oliveira NL, Silva G, et al. Exercise-based cardiac rehabilitation increases daily
10
11 physical activity of patients following myocardial infarction: subanalysis of two
12
13 randomised controlled trials. *Physiotherapy* 2017;103(1):59-65. doi:
14
15 10.1016/j.physio.2015.12.002 [published Online First: 2016/03/26]
16
17
18 9. Schwaab B, Zeymer U, Jannowitz C, et al. Improvement of low-density lipoprotein cholesterol
19
20 target achievement rates through cardiac rehabilitation for patients after ST elevation
21
22 myocardial infarction or non-ST elevation myocardial infarction in Germany: Results of
23
24 the PATIENT CARE registry. *Eur J Prev Cardiol* 2019;26(3):249-58. doi:
25
26 10.1177/2047487318817082 [published Online First: 2018/12/05]
27
28
29 10. Tsai YJ, Li MH, Chen CH, et al. Improved oxygen uptake efficiency slope in acute
30
31 myocardial infarction patients after early phase I cardiac rehabilitation. *Int J Rehabil*
32
33 *Res* 2017;40(3):215-19. doi: 10.1097/MRR.0000000000000229 [published Online First:
34
35 2017/04/15]
36
37
38 11. Hambrecht R, Wolf A, Gielen S, et al. Effect of exercise on coronary endothelial function in
39
40 patients with coronary artery disease. *N Engl J Med* 2000;342(7):454-60. doi:
41
42 10.1056/NEJM200002173420702 [published Online First: 2000/02/17]
43
44
45 12. Vanhees L, Fagard R, Thijs L, et al. Prognostic value of training-induced change in peak
46
47 exercise capacity in patients with myocardial infarcts and patients with coronary bypass
48
49 surgery. *Am J Cardiol* 1995;76(14):1014-9. doi: 10.1016/s0002-9149(99)80287-2
50
51 [published Online First: 1995/11/15]
52
53
54
55
56
57
58
59
60

- 1
2
3
4 13. Martin BJ, Hauer T, Arena R, et al. Cardiac rehabilitation attendance and outcomes in
5
6 coronary artery disease patients. *Circulation* 2012;126(6):677-87. doi:
7
8 10.1161/CIRCULATIONAHA.111.066738 [published Online First: 2012/07/11]
9
10
11 14. Hammill BG, Curtis LH, Schulman KA, et al. Relationship between cardiac rehabilitation
12
13 and long-term risks of death and myocardial infarction among elderly Medicare
14
15 beneficiaries. *Circulation* 2010;121(1):63-70. doi:
16
17 10.1161/CIRCULATIONAHA.109.876383 [published Online First: 2009/12/23]
18
19
20 15. Smith SC, Jr., Benjamin EJ, Bonow RO, et al. AHA/ACCF secondary prevention and risk
21
22 reduction therapy for patients with coronary and other atherosclerotic vascular disease:
23
24 2011 update: a guideline from the American Heart Association and American College
25
26 of Cardiology Foundation endorsed by the World Heart Federation and the Preventive
27
28 Cardiovascular Nurses Association. *J Am Coll Cardiol* 2011;58(23):2432-46. doi:
29
30 10.1016/j.jacc.2011.10.824 [published Online First: 2011/11/08]
31
32
33 16. Grace SL, Bennett S, Ardern CI, et al. Cardiac rehabilitation series: Canada. *Prog*
34
35 *Cardiovasc Dis* 2014;56(5):530-5. doi: 10.1016/j.pcad.2013.09.010 [published Online
36
37 First: 2014/03/13]
38
39
40 17. Kotseva K, Wood D, De Backer G, et al. Use and effects of cardiac rehabilitation in patients
41
42 with coronary heart disease: results from the EUROASPIRE III survey. *Eur J Prev*
43
44 *Cardiol* 2013;20(5):817-26. doi: 10.1177/2047487312449591 [published Online First:
45
46 2012/06/22]
47
48
49 18. Suaya JA, Shepard DS, Normand SL, et al. Use of cardiac rehabilitation by Medicare
50
51 beneficiaries after myocardial infarction or coronary bypass surgery. *Circulation*
52
53
54
55
56
57
58
59
60

- 1
2
3
4 2007;116(15):1653-62. doi: 10.1161/CIRCULATIONAHA.107.701466 [published
5
6
7 Online First: 2007/09/26]
8
- 9 19. Scales DC, Dainty K, Hales B, et al. A multifaceted intervention for quality improvement in
10
11 a network of intensive care units: a cluster randomized trial. *JAMA* 2011;305(4):363-
12
13 72. doi: 10.1001/jama.2010.2000 [published Online First: 2011/01/21]
14
15
16
- 17 20. Wang Y, Li Z, Zhao X, et al. Effect of a Multifaceted Quality Improvement Intervention on
18
19 Hospital Personnel Adherence to Performance Measures in Patients With Acute
20
21 Ischemic Stroke in China: A Randomized Clinical Trial. *JAMA* 2018;320(3):245-54. doi:
22
23 10.1001/jama.2018.8802 [published Online First: 2018/07/01]
24
25
26
- 27 21. Abreu A, Frederix I, Dendale P, et al. Standardization and quality improvement of secondary
28
29 prevention through cardiovascular rehabilitation programmes in Europe: The avenue
30
31 towards EAPC accreditation programme: A position statement of the Secondary
32
33 Prevention and Rehabilitation Section of the European Association of Preventive
34
35 Cardiology (EAPC). *Eur J Prev Cardiol* 2020:2047487320924912. doi:
36
37 10.1177/2047487320924912 [published Online First: 2020/06/02]
38
39
40
41
42
- 43 22. Pack QR, Johnson LL, Barr LM, et al. Improving cardiac rehabilitation attendance and
44
45 completion through quality improvement activities and a motivational program. *J*
46
47 *Cardiopulm Rehabil Prev* 2013;33(3):153-9. doi: 10.1097/HCR.0b013e31828db386
48
49 [published Online First: 2013/04/19]
50
51
52
- 53 23. Parker K, Stone JA, Arena R, et al. An early cardiac access clinic significantly improves
54
55 cardiac rehabilitation participation and completion rates in low-risk ST-elevation
56
57 myocardial infarction patients. *Can J Cardiol* 2011;27(5):619-27. doi:
58
59
60

- 1
2
3
4 10.1016/j.cjca.2010.12.076 [published Online First: 2011/04/12]
5
6
7 24. Pack QR, Mansour M, Barboza JS, et al. An early appointment to outpatient cardiac
8
9 rehabilitation at hospital discharge improves attendance at orientation: a randomized,
10
11 single-blind, controlled trial. *Circulation* 2013;127(3):349-55. doi:
12
13 10.1161/CIRCULATIONAHA.112.121996 [published Online First: 2012/12/20]
14
15
16
17 25. He CJ, Zhu CY, Zhu YJ, et al. Effect of exercise-based cardiac rehabilitation on clinical
18
19 outcomes in patients with myocardial infarction in the absence of obstructive coronary
20
21 artery disease (MINOCA). *Int J Cardiol* 2020 doi: 10.1016/j.ijcard.2020.05.019
22
23 [published Online First: 2020/05/18]
24
25
26
27 26. Liao HH, Wang PC, Yeh EH, et al. Impact of disease-specific care certification on clinical
28
29 outcome and healthcare performance of myocardial infarction in Taiwan. *J Chin Med*
30
31 *Assoc* 2020;83(2):156-63. doi: 10.1097/JCMA.000000000000237 [published Online
32
33 First: 2019/12/14]
34
35
36
37 27. Cai H, Zheng Y, Liu Z, et al. Effect of pre-discharge cardiopulmonary fitness on outcomes
38
39 in patients with ST-elevation myocardial infarction after percutaneous coronary
40
41 intervention. *BMC Cardiovasc Disord* 2019;19(1):210. doi: 10.1186/s12872-019-1189-
42
43 x [published Online First: 2019/09/08]
44
45
46
47
48 28. Ades PA, Keteyian SJ, Wright JS, et al. Increasing Cardiac Rehabilitation Participation From
49
50 20% to 70%: A Road Map From the Million Hearts Cardiac Rehabilitation Collaborative.
51
52 *Mayo Clin Proc* 2017;92(2):234-42. doi: 10.1016/j.mayocp.2016.10.014 [published
53
54 Online First: 2016/11/20]
55
56
57
58 29. Kehler DS, Kent D, Beaulac J, et al. Examining Patient Outcome Quality Indicators Based
59
60

- 1
2
3
4 on Wait Time From Referral to Entry Into Cardiac Rehabilitation: A PILOT
5
6 OBSERVATIONAL STUDY. *J Cardiopulm Rehabil Prev* 2017;37(4):250-56. doi:
7
8 10.1097/HCR.000000000000232 [published Online First: 2017/02/09]
9
10
11
12 30. Gaalema DE, Savage PD, Rengo JL, et al. Financial incentives to promote cardiac
13
14 rehabilitation participation and adherence among Medicaid patients. *Prev Med*
15
16 2016;92:47-50. doi: 10.1016/j.ypmed.2015.11.032 [published Online First: 2016/10/30]
17
18
19 31. Grace SL, Parsons TL, Duhamel TA, et al. The quality of cardiac rehabilitation in Canada:
20
21 a report of the Canadian Cardiac Rehab Registry. *Can J Cardiol* 2014;30(11):1452-5.
22
23 doi: 10.1016/j.cjca.2014.06.016 [published Online First: 2014/12/03]
24
25
26 32. Harkness K, Smith KM, Taraba L, et al. Effect of a postoperative telephone intervention on
27
28 attendance at intake for cardiac rehabilitation after coronary artery bypass graft surgery.
29
30 *Heart Lung* 2005;34(3):179-86. doi: 10.1016/j.hrtlng.2004.07.010 [published Online
31
32 First: 2005/07/15]
33
34
35 33. Ohtera S, Kanazawa N, Ozasa N, et al. Proposal of quality indicators for cardiac
36
37 rehabilitation after acute coronary syndrome in Japan: a modified Delphi method and
38
39 practice test. *BMJ Open* 2017;7(1):e013036. doi: 10.1136/bmjopen-2016-013036
40
41 [published Online First: 2017/01/31]
42
43
44 34. Beatty AL, Li S, Thomas L, et al. Trends in referral to cardiac rehabilitation after myocardial
45
46 infarction: data from the National Cardiovascular Data Registry 2007 to 2012. *J Am*
47
48 *Coll Cardiol* 2014;63(23):2582-83. doi: 10.1016/j.jacc.2014.03.030 [published Online
49
50 First: 2014/04/29]
51
52
53 35. Balady GJ, Ades PA, Bittner VA, et al. Referral, enrollment, and delivery of cardiac
54
55
56
57
58
59
60

- 1
2
3
4 rehabilitation/secondary prevention programs at clinical centers and beyond: a
5
6 presidential advisory from the American Heart Association. *Circulation*
7
8 2011;124(25):2951-60. doi: 10.1161/CIR.0b013e31823b21e2 [published Online First:
9
10 2011/11/16]
11
12
13
14 36. Grace SL, Poirier P, Norris CM, et al. Pan-Canadian development of cardiac rehabilitation
15
16 and secondary prevention quality indicators. *Can J Cardiol* 2014;30(8):945-8. doi:
17
18 10.1016/j.cjca.2014.04.003 [published Online First: 2014/07/30]
19
20
21
22 37. Van Engen-Verheul M, Kemps H, Kraaijenhagen R, et al. Modified Rand method to derive
23
24 quality indicators: a case study in cardiac rehabilitation. *Stud Health Technol Inform*
25
26 2011;169:88-92. [published Online First: 2011/09/07]
27
28
29
30 38. Grace SL, Russell KL, Reid RD, et al. Effect of cardiac rehabilitation referral strategies on
31
32 utilization rates: a prospective, controlled study. *Arch Intern Med* 2011;171(3):235-41.
33
34 doi: 10.1001/archinternmed.2010.501 [published Online First: 2011/02/18]
35
36
37
38 39. Grace SL, Tan Y, Oh P, et al. Feasibility of Assessing 2 Cardiac Rehabilitation Quality
39
40 Indicators. *J Cardiopulm Rehabil Prev* 2016;36(2):112-6. doi:
41
42 10.1097/HCR.000000000000136 [published Online First: 2015/08/08]
43
44
45
46 40. Thomas RJ, Chiu JS, Goff DC, Jr., et al. Reliability of abstracting performance measures:
47
48 results of the cardiac rehabilitation referral and reliability (CR3) project. *J Cardiopulm*
49
50 *Rehabil Prev* 2014;34(3):172-9. doi: 10.1097/HCR.000000000000048 [published
51
52 Online First: 2014/03/08]
53
54
55
56 41. Reid RD, Morrin LI, Beaton LJ, et al. Randomized trial of an internet-based computer-
57
58 tailored expert system for physical activity in patients with heart disease. *Eur J Prev*
59
60

- 1
2
3
4 *Cardiol* 2012;19(6):1357-64. doi: 10.1177/1741826711422988 [published Online First:
5
6 2011/09/10]
7
8
9 42. Hamm LF, Kavanagh T, Campbell RB, et al. Timeline for peak improvements during 52
10
11 weeks of outpatient cardiac rehabilitation. *J Cardiopulm Rehabil* 2004;24(6):374-80;
12
13 quiz 81-2. doi: 10.1097/00008483-200411000-00002 [published Online First:
14
15 2005/01/06]
16
17
18
19 43. Kotter T, Blozik E, Scherer M. Methods for the guideline-based development of quality
20
21 indicators--a systematic review. *Implement Sci* 2012;7:21. doi: 10.1186/1748-5908-7-
22
23 21 [published Online First: 2012/03/23]
24
25
26
27 44. Grace SL, Gravely-Witte S, Brual J, et al. Contribution of patient and physician factors to
28
29 cardiac rehabilitation enrollment: a prospective multilevel study. *Eur J Cardiovasc Prev*
30
31 *Rehabil* 2008;15(5):548-56. doi: 10.1097/HJR.0b013e328305df05 [published Online
32
33 First: 2008/10/03]
34
35
36
37 45. Nery RM, Zanini M, de Lima JB, et al. Tai Chi Chuan improves functional capacity after
38
39 myocardial infarction: A randomized clinical trial. *Am Heart J* 2015;169(6):854-60. doi:
40
41 10.1016/j.ahj.2015.01.017 [published Online First: 2015/06/02]
42
43
44
45 46. Mao S, Zhang X, Shao B, et al. Baduanjin Exercise Prevents post-Myocardial Infarction Left
46
47 Ventricular Remodeling (BE-PREMIER trial): Design and Rationale of a Pragmatic
48
49 Randomized Controlled Trial. *Cardiovasc Drugs Ther* 2016;30(3):315-22. doi:
50
51 10.1007/s10557-016-6660-7 [published Online First: 2016/04/24]
52
53
54
55
56
57
58
59
60

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.

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

For peer review only

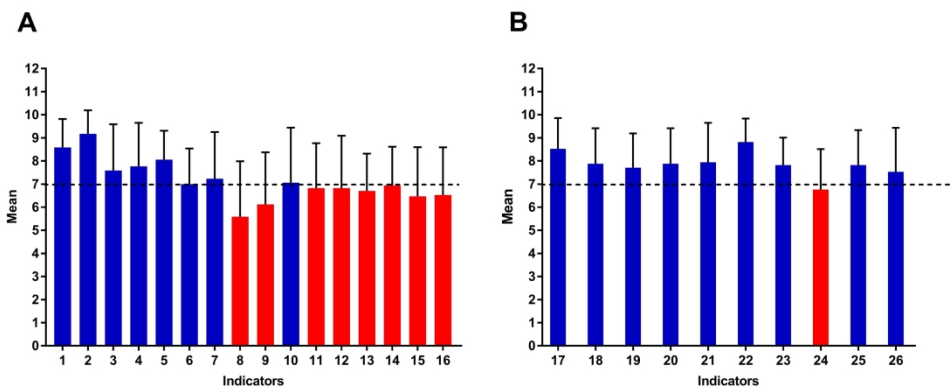
Table 1 The proposal quality indicators and percentage scores for cardiac rehabilitation of patients with myocardial infarction

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	19.0
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.

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



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)

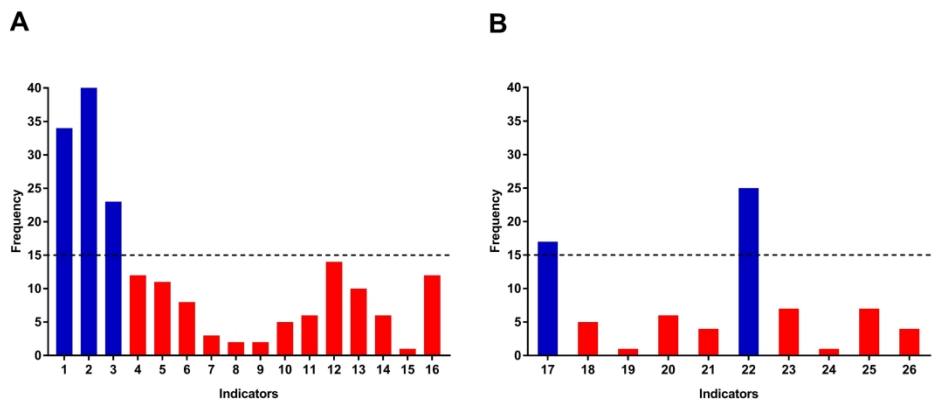
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60



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

254x190mm (300 x 300 DPI)

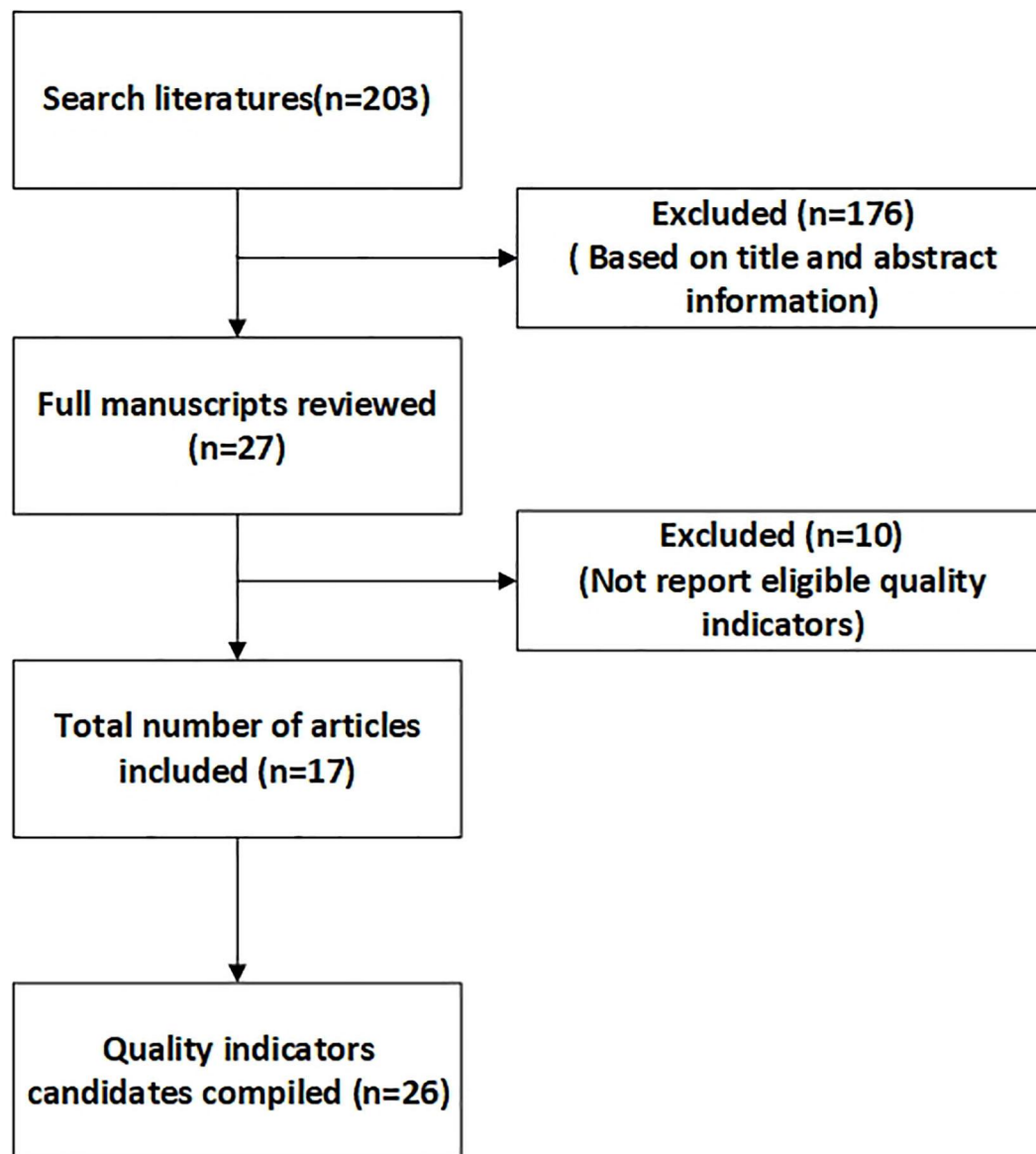


Quality indicators from the national questionnaires that were identified as needing immediate improvement (blue).

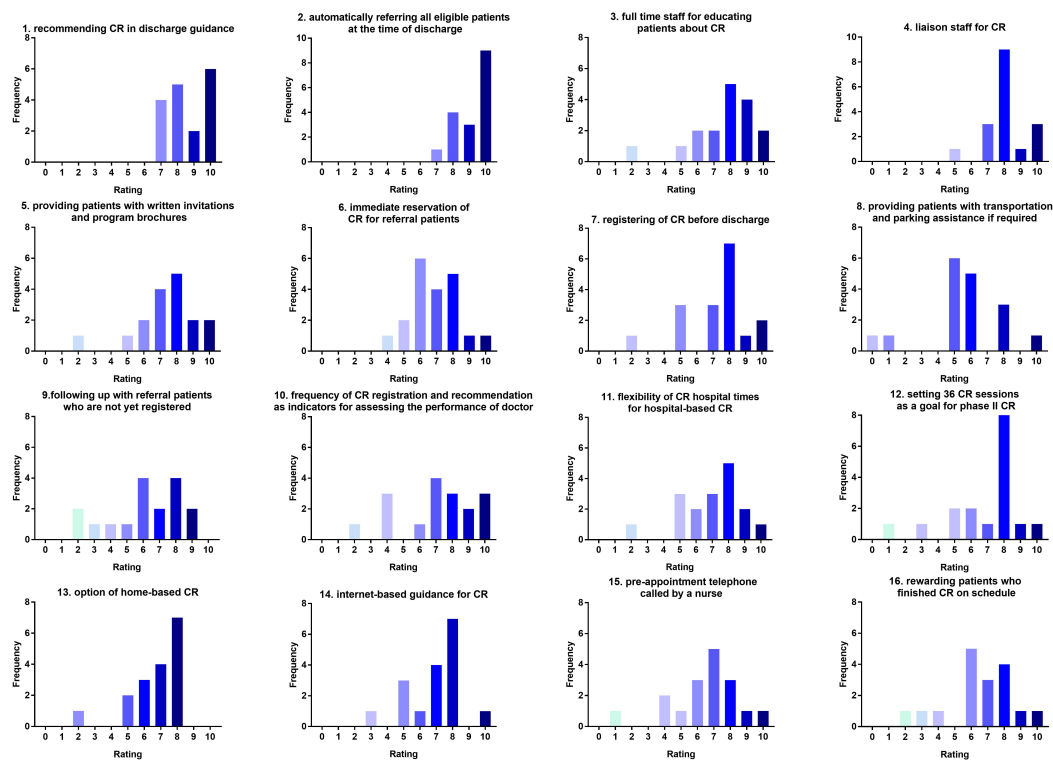
262x114mm (300 x 300 DPI)

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

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

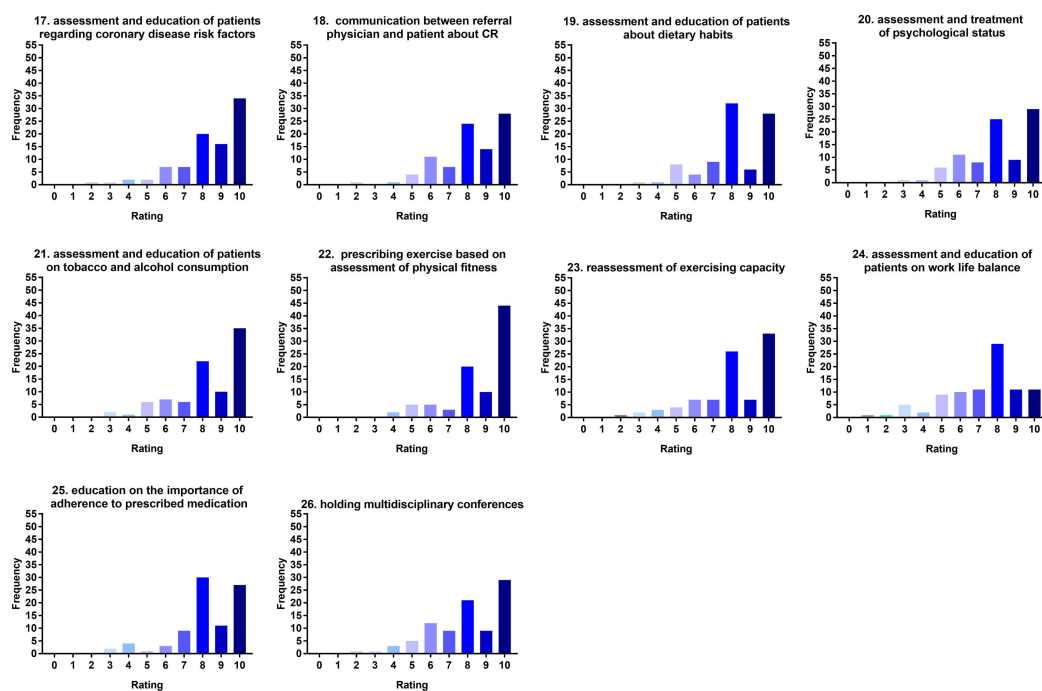


Supplementary Figure 2. Rating distribution of domain 1 candidate quality indicators. The X-axis indicates individual indicator evaluation by the panel. The Y-axis indicates the number of panel members who scored the indicator.



view only

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.



Review only

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

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

BMJ Open

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

Journal:	<i>BMJ Open</i>
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

SCHOLARONE™
Manuscripts



I, the Submitting Author has the right to grant and does grant on behalf of all authors of the Work (as defined in the below author licence), an exclusive licence and/or a non-exclusive licence for contributions from authors who are: i) UK Crown employees; ii) where BMJ has agreed a CC-BY licence shall apply, and/or iii) in accordance with the terms applicable for US Federal Government officers or employees acting as part of their official duties; on a worldwide, perpetual, irrevocable, royalty-free basis to BMJ Publishing Group Ltd ("BMJ") its licensees and where the relevant Journal is co-owned by BMJ to the co-owners of the Journal, to publish the Work in this journal and any other BMJ products and to exploit all rights, as set out in our [licence](#).

The Submitting Author accepts and understands that any supply made under these terms is made by BMJ to the Submitting Author unless you are acting as an employee on behalf of your employer or a postgraduate student of an affiliated institution which is paying any applicable article publishing charge ("APC") for Open Access articles. Where the Submitting Author wishes to make the Work available on an Open Access basis (and intends to pay the relevant APC), the terms of reuse of such Open Access shall be governed by a Creative Commons licence – details of these licences and which [Creative Commons](#) licence will apply to this Work are set out in our licence referred to above.

Other than as permitted in any relevant BMJ Author's Self Archiving Policies, I confirm this Work has not been accepted for publication elsewhere, is not being considered for publication elsewhere and does not duplicate material already published. I confirm all authors consent to publication of this Work and authorise the granting of this licence.

1
2
3 **Quality indicators for cardiac rehabilitation after myocardial infarction in China: a consensus**
4 **panel and practice test**
5

6 Xianghui Zheng^{1,2#}, Maomao Zhang^{1,2#}, Yang Zheng^{1,2}, Yongxiang Zhang^{1,2}, Junnan Wang³, Ping
7 Zhang⁴, Xuwen Yang⁵, Shan Li⁶, Rongjing Ding⁷, Gaowa Siqin⁸, Xinyu Hou^{1,2}, Liangqi Chen^{1,2},
8 Min Zhang^{1,2}, Yong Sun^{1,2}, Jian Wu^{1,2*}, Bo Yu^{1,2}
9
10

11
12 ¹ Department of Cardiology, the Second Affiliated Hospital of Harbin Medical University, Harbin,
13 Heilongjiang Province, China

14 ² The Key Laboratory of Myocardial Ischemia, Harbin Medical University, Ministry of Education,
15 Harbin, Heilongjiang Province, China

16 ³ Department of Cardiology, the Second Hospital of Jilin University, Changchun, Jilin Province,
17 China

18 ⁴ Department of Cardiology, Beijing Tsinghua Changgung Hospital, Beijing, China

19 ⁵ Department of Cardiology, Tianjin Chest Hospital, Tianjin Cancer Hospital, Tianjin, China

20 ⁶ Department of Cardiology, Affiliated Hospital of Qingdao University, Qingdao, China

21 ⁷ Department of Cardiology, Peking University People's Hospital, Beijing, China

22 ⁸ Department of Cardiology, Inner Mongolia People's Hospital, Inner Mongolia, China

23
24
25
26
27
28 * Corresponding author: Jian Wu, Department of Cardiology, the Second Affiliated Hospital
29 of Harbin Medical University, No. 246, Xuefu Road, Nangang District, Harbin, China.

30 E-mail address: wujian780805@163.com
31

32
33 # These authors contributed equally to this work.
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

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.

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

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

1
2
3 acute ischemic stroke.³² The European Association of Preventive Cardiology (EAPC) has defined
4 minimal and optimal cardiovascular rehabilitation standards to increase the quality of cardiovascular
5 rehabilitation programs.³³ In addition, many countries, such as the USA, Japan, and Canada, have
6 developed QIs for improving CR, but QIs are lacking in China. Implementation of QIs can increase
7 long-term participation and adherence by post-MI patients. For example, a two-year study reported
8 a significant increase in enrollment in CR after the implementation of a series of quality
9 improvement interventions, including policy changes, a 7-minute video describing the benefits of
10 CR, and incentives.³⁴ The early utilization of a cardiac access clinic resulted in an unprecedented
11 (~3-fold) increase in the number of ST-elevation myocardial infarction (STEMI) patients
12 participating in CR.³⁵ A randomized controlled trial also revealed that early appointments within 10
13 days of hospital discharge improved CR attendance by approximately 3-fold compared with
14 standard appointments after 35 days.³⁶

15
16
17
18
19
20
21 CR can have an important role in reducing mortality in patients with MI, improving patient
22 quality of life and reducing China's healthcare burden.³⁷⁻³⁹ CR process standardization in China
23 needs to be improved.⁴⁰ Increasing participation is an important goal for the successful
24 implementation of CR programs, which could decrease morbidity and mortality due to MI. The aim
25 of this study was to describe candidate QIs and test their feasibility and applicability, so as to provide
26 potential future strategies to improve the CR participation and compliance rates in Chinese post-MI
27 patients.
28
29
30
31

32 33 **Methods**

34 35 **Quality indicator development**

36
37 Databases including PubMed, CINAHL Ebsco, and EMBASE were searched for eligible articles
38 published through August 2018 using the keywords cardiac rehabilitation, quality indicator, and
39 myocardial infarction; MeSH terms; and Emtree headings. Two authors (XZ and MZ) conducted
40 the literature review by first reading titles and abstracts and then reading the full text of potential
41 articles. Articles from the search results were included if the following conditions were met: (1) the
42 study provided QIs for CR and (2) the study was published in English. The compiled QIs were
43 further divided into two domains: improving CR participation and adherence rates and standardizing
44 CR processes. Any disagreement about study inclusion was resolved by a third author (JWu).
45
46
47
48

49 50 **Consensus panel**

51
52 The consensus panel consisted of 17 individuals, with a maximum of 2 individuals from each CR
53 center. Members were selected upon meeting the following criteria: (1) the individual had at least 1
54 year of experience in CR; (2) the individual held a position as a leader of a regional CR program;
55 (3) the individual was committed to the advancement of CR; and (4) the individual agreed to
56 participate in an in-person meeting to discuss CR quality improvement. Two authors (XZ and
57 YZheng) assessed the qualifications of the members, and disagreements were resolved by consensus
58 or a third author (JWu). Members were responsible for scoring the collected QIs based on their
59
60

1
2
3 experience and determining the final QIs for CR in post-MI patients.
4

5 **Scoring method and selection criteria**

6
7 The candidate QIs generated from the literature were scored on a ten-point scale. Scoring criteria
8 were based on four aspects: whether they were evidence-based, the feasibility of implementation,
9 their validity, and their reliability. The QIs were judged according to the clinical experience of the
10 consensus panel. The four criteria were used to generate one score. QIs that received scores ≥ 7 and
11 considered to be significant in the improvement of CR were included in the study. QIs with < 7
12 but > 5 points were not considered in this study, and QIs with < 5 points were excluded. A QI was
13 considered acceptable for improving the quality of CR in post-MI Chinese patients based on its
14 average score.
15
16
17
18

19 **National questionnaire**

20
21 A questionnaire-based survey was conducted nationwide by either telephone or WeChat (a
22 communication tool in China). Participants included cardiologists, nurses, physical therapists,
23 clinical psychologists, registered dietitians and follow-up staff caring for CR patients (health
24 managers who follow up patients via telephone etc.) who met the following criteria: (1) working in
25 an established CR center; and (2) at least 1 year of experience in CR. JWu and YZhang conducted
26 a questionnaire-based survey on the participants. The participants were asked to select 3 out of 26
27 candidate QIs that they felt required urgent improvement to allow the selection of the top 5 QIs that
28 required immediate improvement in China. The top 5 most important QIs were determined based
29 on the frequency selected by the participants. Additionally, participants could suggest new QIs
30 outside of those mentioned in the questionnaire.
31
32
33
34
35

36 **Practice test**

37
38 A practice test was performed as to review the adaptability of each QI before implementation due
39 to differences in healthcare systems and social circumstances, such as the size of the CR center and
40 patient education, to assess the completion rate of the proposed QIs selected by the consensus panel.
41 The patient inclusion criteria were as follows: (1) a history of AMI; (2) completion of phase I and
42 II CR at one of the 5 teaching hospitals (Beijing Tsinghua Changgung Hospital, the Second
43 Hospital of Jilin University, Tianjin Chest Hospital and Affiliated Hospital of Qingdao University
44 and the Second Affiliated Hospital of Harbin Medical University) between September 3, 2018 and
45 October 31, 2019; and (3) consent to participate in the study. Patients filled out an 18-question
46 questionnaire about proposed QIs that was developed specifically for this study, and evaluated
47 whether the CR center implemented the proposed QIs. The patients did not answer if they were
48 unsure or did not understand the question. In addition, the consensus panel unanimously agreed that
49 a score greater than 70% was considering good performance, whereas a score less than 30% was
50 considered poor performance. The questionnaire was approved by the ethics committees of the 5
51 teaching hospitals.
52
53
54
55
56
57

58 **Patient and Public Involvement**

1
2
3 Patient and public involvement Patients and the public were not involved in the design of the
4 study.
5

6 7 **Data collection and analysis**

8
9 Two authors (XZ and YZ) were responsible for data collection and cross checking. The mean
10 score of each QI was calculated as the sum of all participants' ratings/number of participants. The
11 percentage scores of QIs was calculated as follows: number of times the QI was achieved/number
12 of participants (excluding participants who did not answer) × 100. The mean performance is the
13 average of the percentages of all quality indicators.
14
15
16

17 **Results**

18 19 **Collection of QIs**

20
21 A review of the literature identified 203 articles, and after screening the titles and abstracts, 176
22 were excluded, as they were not related to QIs for CR. After full-text screening, 17 articles were
23 eligible and subsequently included.^{34 36 41-55} A list of 26 potential QIs, including 16 regarding
24 improvement of the CR participation and adherence rates and 10 regarding the effects of completing
25 CR, was generated (Supplementary Table 1). A flowchart of the literature search and selection of
26 eligible articles is shown in Supplementary Figure 1.
27
28
29

30 31 **The consensus panel and proposal of QIs of CR in post-MI patients**

32
33 The consensus panel included 17 experts in the field of CR from 12 CR centers (Supplementary
34 Table 2). Seventeen experts who met the inclusion criteria were cardiologists and individually rated
35 each QI on a ten-point scale. The rating of each QI is shown in Supplementary Figures 2 and 3.
36 After careful evaluation, only QIs with an average score ≥ 7 that could potentially improve the
37 quality of CR in China were accepted (Figure 1). Finally, a total of 17 QIs were selected and divided
38 into two domains: (1) improving participation and adherence and (2) standardizing CR processes
39 (Table 1). There were two more supplementary indicators: extending the hospital rehabilitation time
40 and strengthening the application of traditional Chinese sports.
41
42
43
44

45 46 **National questionnaire and top five QIs for imminent improvement**

47
48 Eighty-nine professionals met the national survey participation criteria; among them, 60 people
49 participated in a telephone survey, and 29 people participated in a WeChat survey. The survey
50 response rate was 100%. The 89 participants from 4 municipalities and 18 provinces in China
51 included 21 cardiologists, 15 nurses, 18 physical therapists, 11 clinical psychologists, 13 registered
52 dietitians and 11 health follow-up staff. Each participant selected three QIs considered critical to
53 improve post-MI CR in China (Figures 2 and 3). The results showed that the five most important
54 QIs were 'automatically referring all eligible patients at the time of discharge', 'recommending CR
55 in discharge guidance', 'prescribing exercise based on an assessment of physical fitness',
56 'employing full-time staff for educating patients about CR', and 'assessment and education of
57 patients regarding coronary disease risk factors' (Table 2), with score ratios of 47.2%, 38.2%, 28.1%,
58
59
60

1
2
3 25.8% and 19.1%, respectively.
4

5 **Practice test**

6
7 The practice test was completed by 165 patients who met the inclusion criteria, and no patients
8 refused to participate in the study (30 patients from Beijing Tsinghua Changgung Hospital, 30
9 patients from the Second Hospital of Jilin University, 34 patients from Tianjin Chest Hospital, 30
10 patients from Affiliated Hospital of Qingdao University and 41 patients from the Second Affiliated
11 Hospital of Harbin Medical University). The results revealed a mean performance value of 43.1%
12 (9.9-86.1%). The QIs that achieved good performance (minimum to maximum 72.1-86.1%) were
13 'assessment and education of patients on tobacco and alcohol consumption' and 'recommending
14 CR in discharge guidance'. There were also several low-performing QIs (minimum to maximum
15 9.9-29.7%), including 'holding multidisciplinary meetings, 'frequency of CR registration and
16 recommendation as QIs for assessing doctor performance', 'immediate enrollment in CR for referral
17 patients', and 'providing patients with written invitations and program brochures' (Table 1).
18
19
20
21
22
23
24
25

26 **Discussion**

27
28 In this study, 26 QIs generated from 17 articles were assessed as candidate QIs for CR. Out of
29 the 26 QIs, 17 were selected by a Chinese multidisciplinary consensus panel and divided into two
30 domains based on participation and adherence and outcomes. The findings of the nationwide
31 questionnaire could guide clinical quality improvement. The practice test showed the feasibility and
32 applicability of all 17 QIs in the Chinese context.
33
34

35
36 To our knowledge, this is the first study proposing an immediate improvement in CR QIs on the
37 basis of the results of a nationwide survey and the implementation of improvement guidelines for
38 CR in China. However, although still in its infancy, CR in China has developed rapidly. According
39 to data published by the Chinese Society of Rehabilitation Medicine (CARM), the number of CR
40 centers has increased from 6 in 2012 to more than 500 currently.⁵⁶ Hence, the improved
41 implementation of CR programs is imperative, given the current situation. We consider that QI
42 development is a time-efficient and resource-saving approach.⁵⁷ In many countries, CR is strongly
43 associated with quality of life improvement. For example, the USA has effectively implemented QI
44 monitoring to increase the CR participation rate.⁴¹ Similarly, Canada has developed QIs to promote
45 the broad development of CR programs,⁴⁴ and Japan has also proposed QIs to assess improvements
46 in the quality of CR after acute coronary syndrome (ACS).⁴⁶ Moreover, the EAPC described QIs to
47 assess improvements in CR process standardization in Europe.³³ In this study, we propose QIs to
48 promote the improvement of CR in China considering the recommendations reported in these
49 previous studies.
50
51
52
53
54

55
56 CR is still in the early phase of development in China.⁴⁰ Given the uneven distribution of CR
57 programs, the consensus panel selected QIs to promote improvements in participation and adherence
58 that were simple, practical and in line with the current status of CR in the country. For example, the
59 present report suggests that 'recommending CR in discharge guidance' was key in emphasizing the
60

1
2
3 importance and necessity of CR, and ‘automatically referring all eligible patients at the time of
4 discharge’ was one of the best way to increase participation in CR. Other suitable QIs were
5 ‘employing full-time staff for educating patients about CR’ and ‘employing CR liaison staff’. In
6 addition, the study revealed QIs that are necessary for CR process standardization in China, such as
7 ‘assessment and education of patients regarding coronary disease risk factors’, ‘assessment and
8 education of patients about dietary habits’, and ‘prescribing exercise based on physical fitness’. It
9 is worth mentioning that the completion rate of ‘holding multidisciplinary meetings’ was very low
10 in the practice test, but the implementation of this QI can improve recovery in patients with multiple
11 diseases.^{29 58 59} Moreover, measuring the completion rate of the proposed QIs is important.⁶⁰⁻⁶²
12 Moreover, measuring the completion rate of the proposed QIs is important. There are some methods
13 for measuring. First of all, QIs should be recorded in the medical record. In this way, the completion
14 of the QIs can be checked in the medical record. Second, from the perspective of patients,
15 a questionnaire about the implementation of QIs was conducted when the patients
16 were discharged. In addition, relevant medical staff should be evaluated by self-assessment and
17 other assessment scales.
18
19
20
21
22
23
24

25 It is also important to understand the barriers to appropriate CR, including lack of health
26 awareness, inadequate policies, insufficiency of CR, lack of healthcare system support and
27 inadequate professional guidelines and information systems.⁶³⁻⁶⁵ Gary et al. reported that older
28 females with a low socioeconomic status, with a low education level, with poor self-efficacy, with
29 multiple comorbidities and who were unable to communicate in English were more likely to not
30 participate in CR.⁴⁸ Enrollment in the CR program is affected by many healthcare system-related
31 factors, including lack of referral, limited facilitation of enrollment after referral, lack of programs
32 that serve specific geographic areas and low-income communities, and gender-dominated
33 programs.⁶⁶ In this study, we proposed QIs that could aid in overcoming some of these barriers and
34 also in the successful implementation of CR.
35
36
37
38
39

40 During the course of the study, two additional supplementary indicators, ‘extending the hospital
41 rehabilitation time’ and ‘strengthening the application of traditional Chinese exercise’, were added.
42 Tai Chi Chuan practice was associated with a VO₂ peak increase in patients with MI.⁶⁷ Baduanjin
43 exercise therapy in post-MI patients reverses adverse left ventricular (LV) remodeling,
44 inflammation curbing, extracellular matrix organization adjustment and improves clinical
45 outcomes.^{68 69} Baduanjin sequential therapy also appears to improve the quality of life in patients
46 with AMI after percutaneous coronary intervention, with additional benefits of lowered abdominal
47 circumference and body mass index and improved level of cardiac function.⁷⁰ Therefore, traditional
48 Chinese exercises, such as Tai Chi Chuan and baduanjin, may constitute effective forms of CR in
49 patients with MI.
50
51
52
53

54 In summary, the application of these QIs could help standardize and improve the quality of CR
55 in China. This study provides guidance for the development of CR in our country. Nevertheless,
56 further studies are needed to evaluate the validity, reliability and feasibility of these QIs, and whether
57 improvements in these parameters can be associated with clinical benefits in this patient population.
58
59
60

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.

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.

References

1. Reed GW, Rossi JE, Cannon CP. Acute myocardial infarction. *Lancet* 2017;389(10065):197-210. doi: 10.1016/S0140-6736(16)30677-8 [published Online First: 2016/08/10]

- 1
2
3
4 2. Dagenais GR, Leong DP, Rangarajan S, et al. Variations in common diseases, hospital
5
6 admissions, and deaths in middle-aged adults in 21 countries from five continents
7
8 (PURE): a prospective cohort study. *Lancet* 2020;395(10226):785-94. doi:
9
10 10.1016/S0140-6736(19)32007-0 [published Online First: 2019/09/08]
11
12
13
- 14 3. Piepoli MF, Corra U, Dendale P, et al. Challenges in secondary prevention after acute
15
16 myocardial infarction: A call for action. *Eur Heart J Acute Cardiovasc Care*
17
18 2017;6(4):299-310. doi: 10.1177/2048872616689773 [published Online First:
19
20 2017/06/14]
21
22
23
- 24 4. Ma LY, Chen WW, Gao RL, et al. China cardiovascular diseases report 2018: an updated
25
26 summary. *J Geriatr Cardiol* 2020;17(1):1-8. doi: 10.11909/j.issn.1671-
27
28 5411.2020.01.001 [published Online First: 2020/03/07]
29
30
31
- 32 5. Jiang Z, Dreyer RP, Spertus JA, et al. Factors Associated With Return to Work After Acute
33
34 Myocardial Infarction in China. *JAMA Netw Open* 2018;1(7):e184831. doi:
35
36 10.1001/jamanetworkopen.2018.4831 [published Online First: 2019/01/16]
37
38
39
- 40 6. Ambrosetti M, Abreu A, Corra U, et al. Secondary prevention through comprehensive
41
42 cardiovascular rehabilitation: From knowledge to implementation. 2020 update. A
43
44 position paper from the Secondary Prevention and Rehabilitation Section of the
45
46 European Association of Preventive Cardiology. *Eur J Prev Cardiol*
47
48 2020:2047487320913379. doi: 10.1177/2047487320913379 [published Online First:
49
50 2020/04/01]
51
52
53
54
- 55 7. Anderson L, Oldridge N, Thompson DR, et al. Exercise-Based Cardiac Rehabilitation for
56
57 Coronary Heart Disease: Cochrane Systematic Review and Meta-Analysis. *J Am Coll*
58
59
60

- 1
2
3
4 *Cardiol* 2016;67(1):1-12. doi: 10.1016/j.jacc.2015.10.044 [published Online First:
5
6 2016/01/15]
7
8
9 8. Salzwedel A, Jensen K, Rauch B, et al. Effectiveness of comprehensive cardiac rehabilitation
10
11 in coronary artery disease patients treated according to contemporary evidence based
12
13 medicine: Update of the Cardiac Rehabilitation Outcome Study (CROS-II). *Eur J Prev*
14
15 *Cardiol*2020:2047487320905719. doi: 10.1177/2047487320905719 [published Online
16
17 First: 2020/02/25]
18
19
20
21
22 9. Hermann M, Witassek F, Erne P, et al. Impact of cardiac rehabilitation referral on one-year
23
24 outcome after discharge of patients with acute myocardial infarction. *Eur J Prev Cardiol*
25
26 2019;26(2):138-44. doi: 10.1177/2047487318807766 [published Online First:
27
28 2018/10/20]
29
30
31
32
33 10. Lee BJ, Go JY, Kim AR, et al. Quality of Life and Physical Ability Changes After Hospital-
34
35 Based Cardiac Rehabilitation in Patients With Myocardial Infarction. *Ann Rehabil Med*
36
37 2017;41(1):121-28. doi: 10.5535/arm.2017.41.1.121 [published Online First:
38
39 2017/03/16]
40
41
42
43 11. Ribeiro F, Oliveira NL, Silva G, et al. Exercise-based cardiac rehabilitation increases daily
44
45 physical activity of patients following myocardial infarction: subanalysis of two
46
47 randomised controlled trials. *Physiotherapy* 2017;103(1):59-65. doi:
48
49 10.1016/j.physio.2015.12.002 [published Online First: 2016/03/26]
50
51
52
53 12. Schwaab B, Zeymer U, Jannowitz C, et al. Improvement of low-density lipoprotein
54
55 cholesterol target achievement rates through cardiac rehabilitation for patients after ST
56
57 elevation myocardial infarction or non-ST elevation myocardial infarction in Germany:
58
59
60

- 1
2
3
4 Results of the PATIENT CARE registry. *Eur J Prev Cardiol* 2019;26(3):249-58. doi:
5
6 10.1177/2047487318817082 [published Online First: 2018/12/05]
7
8
9 13. Tsai YJ, Li MH, Chen CH, et al. Improved oxygen uptake efficiency slope in acute
10
11 myocardial infarction patients after early phase I cardiac rehabilitation. *Int J Rehabil*
12
13 *Res* 2017;40(3):215-19. doi: 10.1097/MRR.000000000000229 [published Online First:
14
15 2017/04/15]
16
17
18 14. Hambrecht R, Wolf A, Gielen S, et al. Effect of exercise on coronary endothelial function in
19
20 patients with coronary artery disease. *N Engl J Med* 2000;342(7):454-60. doi:
21
22 10.1056/NEJM200002173420702 [published Online First: 2000/02/17]
23
24
25 15. Vanhees L, Fagard R, Thijs L, et al. Prognostic value of training-induced change in peak
26
27 exercise capacity in patients with myocardial infarcts and patients with coronary bypass
28
29 surgery. *Am J Cardiol* 1995;76(14):1014-9. doi: 10.1016/s0002-9149(99)80287-2
30
31 [published Online First: 1995/11/15]
32
33
34 16. Gevaert AB, Adams V, Bahls M, et al. Towards a personalised approach in exercise-based
35
36 cardiovascular rehabilitation: How can translational research help? A 'call to action'
37
38 from the Section on Secondary Prevention and Cardiac Rehabilitation of the European
39
40 Association of Preventive Cardiology. *Eur J Prev Cardiol* 2020;27(13):1369-85. doi:
41
42 10.1177/2047487319877716 [published Online First: 2019/10/05]
43
44
45 17. Martin BJ, Hauer T, Arena R, et al. Cardiac rehabilitation attendance and outcomes in
46
47 coronary artery disease patients. *Circulation* 2012;126(6):677-87. doi:
48
49 10.1161/CIRCULATIONAHA.111.066738 [published Online First: 2012/07/11]
50
51
52 18. Hammill BG, Curtis LH, Schulman KA, et al. Relationship between cardiac rehabilitation
53
54
55
56
57
58
59
60

- 1
2
3
4 and long-term risks of death and myocardial infarction among elderly Medicare
5
6 beneficiaries. *Circulation* 2010;121(1):63-70. doi:
7
8
9 10.1161/CIRCULATIONAHA.109.876383 [published Online First: 2009/12/23]
10
11
12 19. Smith SC, Jr., Benjamin EJ, Bonow RO, et al. AHA/ACCF secondary prevention and risk
13
14 reduction therapy for patients with coronary and other atherosclerotic vascular disease:
15
16 2011 update: a guideline from the American Heart Association and American College
17
18 of Cardiology Foundation endorsed by the World Heart Federation and the Preventive
19
20 Cardiovascular Nurses Association. *J Am Coll Cardiol* 2011;58(23):2432-46. doi:
21
22 10.1016/j.jacc.2011.10.824 [published Online First: 2011/11/08]
23
24
25
26
27 20. Piepoli MF, Hoes AW, Agewall S, et al. 2016 European Guidelines on cardiovascular
28
29 disease prevention in clinical practice: The Sixth Joint Task Force of the European
30
31 Society of Cardiology and Other Societies on Cardiovascular Disease Prevention in
32
33 Clinical Practice (constituted by representatives of 10 societies and by invited
34
35 experts)Developed with the special contribution of the European Association for
36
37 Cardiovascular Prevention & Rehabilitation (EACPR). *Eur Heart J* 2016;37(29):2315-
38
39 81. doi: 10.1093/eurheartj/ehw106 [published Online First: 2016/05/26]
40
41
42
43
44
45 21. Grace SL, Bennett S, Ardern CI, et al. Cardiac rehabilitation series: Canada. *Prog*
46
47 *Cardiovasc Dis* 2014;56(5):530-5. doi: 10.1016/j.pcad.2013.09.010 [published Online
48
49 First: 2014/03/13]
50
51
52
53 22. Kotseva K, Wood D, De Backer G, et al. Use and effects of cardiac rehabilitation in patients
54
55 with coronary heart disease: results from the EUROASPIRE III survey. *Eur J Prev*
56
57 *Cardiol* 2013;20(5):817-26. doi: 10.1177/2047487312449591 [published Online First:
58
59
60

- 1
2
3
4 2012/06/22]
- 5
6
7 23. Suaya JA, Shepard DS, Normand SL, et al. Use of cardiac rehabilitation by Medicare
8
9 beneficiaries after myocardial infarction or coronary bypass surgery. *Circulation*
10
11 2007;116(15):1653-62. doi: 10.1161/CIRCULATIONAHA.107.701466 [published
12
13 Online First: 2007/09/26]
- 14
15
16
17 24. Kotseva K, De Backer G, De Bacquer D, et al. Lifestyle and impact on cardiovascular risk
18
19 factor control in coronary patients across 27 countries: Results from the European
20
21 Society of Cardiology ESC-EORP EUROASPIRE V registry. *Eur J Prev Cardiol*
22
23 2019;26(8):824-35. doi: 10.1177/2047487318825350 [published Online First:
24
25 2019/02/12]
- 26
27
28
29
30 25. Turk-Adawi K, Supervia M, Lopez-Jimenez F, et al. Cardiac Rehabilitation Availability and
31
32 Density around the Globe. *EClinicalMedicine* 2019;13:31-45. doi:
33
34 10.1016/j.eclinm.2019.06.007 [published Online First: 2019/09/14]
- 35
36
37
38 26. Committee of Cardiac R, Prevention of Chinese Association of Rehabilitation M, Committee
39
40 of Cardiovascular Disease of China Association of G, et al. [China expert consensus
41
42 on psychological prescription for patients with cardiovascular disease2020]. *Zhonghua*
43
44 *Nei Ke Za Zhi* 2020;59(10):764-71. doi: 10.3760/cma.j.cn112138-20200203-00050
45
46 [published Online First: 2020/09/29]
- 47
48
49
50
51 27. Nixon AC, Brown J, Brotherton A, et al. Implementation of a frailty screening programme
52
53 and Geriatric Assessment Service in a nephrology centre: a quality improvement
54
55 project. *J Nephrol* 2020 doi: 10.1007/s40620-020-00878-y [published Online First:
56
57 2020/10/12]
- 58
59
60

- 1
2
3
4 28. Marino VR, Hyer K, Hamilton L, et al. Evaluation of a quality improvement initiative to
5
6 increase rates of advance directive conversation documentation in primary care.
7
8
9 *Geriatr Nurs* 2020 doi: 10.1016/j.gerinurse.2020.09.004 [published Online First:
10
11 2020/10/12]
12
13
14 29. Vos EL, Koppert LB, Jager A, et al. From Multiple Quality Indicators of Breast Cancer Care
15
16 Toward Hospital Variation of a Summary Measure. *Value Health* 2020;23(9):1200-09.
17
18 doi: 10.1016/j.jval.2020.05.011 [published Online First: 2020/09/18]
19
20
21
22 30. Vos EL, Lingsma HF, Jager A, et al. Effect of Case-Mix and Random Variation on Breast
23
24 Cancer Care Quality Indicators and Their Rankability. *Value Health* 2020;23(9):1191-
25
26 99. doi: 10.1016/j.jval.2019.12.014 [published Online First: 2020/09/18]
27
28
29
30 31. Scales DC, Dainty K, Hales B, et al. A multifaceted intervention for quality improvement in
31
32 a network of intensive care units: a cluster randomized trial. *JAMA* 2011;305(4):363-
33
34 72. doi: 10.1001/jama.2010.2000 [published Online First: 2011/01/21]
35
36
37
38 32. Wang Y, Li Z, Zhao X, et al. Effect of a Multifaceted Quality Improvement Intervention on
39
40 Hospital Personnel Adherence to Performance Measures in Patients With Acute
41
42 Ischemic Stroke in China: A Randomized Clinical Trial. *JAMA* 2018;320(3):245-54. doi:
43
44 10.1001/jama.2018.8802 [published Online First: 2018/07/01]
45
46
47
48 33. Abreu A, Frederix I, Dendale P, et al. Standardization and quality improvement of secondary
49
50 prevention through cardiovascular rehabilitation programmes in Europe: The avenue
51
52 towards EAPC accreditation programme: A position statement of the Secondary
53
54 Prevention and Rehabilitation Section of the European Association of Preventive
55
56 Cardiology (EAPC). *Eur J Prev Cardiol* 2020:2047487320924912. doi:
57
58
59
60

- 1
2
3
4 10.1177/2047487320924912 [published Online First: 2020/06/02]
5
6
7 34. Pack QR, Johnson LL, Barr LM, et al. Improving cardiac rehabilitation attendance and
8
9 completion through quality improvement activities and a motivational program. *J*
10
11 *Cardiopulm Rehabil Prev* 2013;33(3):153-9. doi: 10.1097/HCR.0b013e31828db386
12
13 [published Online First: 2013/04/19]
14
15
16
17 35. Parker K, Stone JA, Arena R, et al. An early cardiac access clinic significantly improves
18
19 cardiac rehabilitation participation and completion rates in low-risk ST-elevation
20
21 myocardial infarction patients. *Can J Cardiol* 2011;27(5):619-27. doi:
22
23 10.1016/j.cjca.2010.12.076 [published Online First: 2011/04/12]
24
25
26
27 36. Pack QR, Mansour M, Barboza JS, et al. An early appointment to outpatient cardiac
28
29 rehabilitation at hospital discharge improves attendance at orientation: a randomized,
30
31 single-blind, controlled trial. *Circulation* 2013;127(3):349-55. doi:
32
33 10.1161/CIRCULATIONAHA.112.121996 [published Online First: 2012/12/20]
34
35
36
37 37. He CJ, Zhu CY, Zhu YJ, et al. Effect of exercise-based cardiac rehabilitation on clinical
38
39 outcomes in patients with myocardial infarction in the absence of obstructive coronary
40
41 artery disease (MINOCA). *Int J Cardiol* 2020 doi: 10.1016/j.ijcard.2020.05.019
42
43
44 [published Online First: 2020/05/18]
45
46
47
48 38. Liao HH, Wang PC, Yeh EH, et al. Impact of disease-specific care certification on clinical
49
50 outcome and healthcare performance of myocardial infarction in Taiwan. *J Chin Med*
51
52 *Assoc* 2020;83(2):156-63. doi: 10.1097/JCMA.000000000000237 [published Online
53
54 First: 2019/12/14]
55
56
57
58 39. Cai H, Zheng Y, Liu Z, et al. Effect of pre-discharge cardiopulmonary fitness on outcomes
59
60

- 1
2
3
4 in patients with ST-elevation myocardial infarction after percutaneous coronary
5
6 intervention. *BMC Cardiovasc Disord* 2019;19(1):210. doi: 10.1186/s12872-019-1189-
7
8 x [published Online First: 2019/09/08]
9
10
11 40. Bei Y, Shi C, Zhang Z, et al. Advance for Cardiovascular Health in China. *J Cardiovasc*
12
13 *Transl Res* 2019;12(3):165-70. doi: 10.1007/s12265-018-9852-7 [published Online
14
15 First: 2018/12/12]
16
17
18 41. Ades PA, Keteyian SJ, Wright JS, et al. Increasing Cardiac Rehabilitation Participation From
19
20 20% to 70%: A Road Map From the Million Hearts Cardiac Rehabilitation Collaborative.
21
22 *Mayo Clin Proc* 2017;92(2):234-42. doi: 10.1016/j.mayocp.2016.10.014 [published
23
24 Online First: 2016/11/20]
25
26
27
28 42. Kehler DS, Kent D, Beaulac J, et al. Examining Patient Outcome Quality Indicators Based
29
30 on Wait Time From Referral to Entry Into Cardiac Rehabilitation: A PILOT
31
32 OBSERVATIONAL STUDY. *J Cardiopulm Rehabil Prev* 2017;37(4):250-56. doi:
33
34 10.1097/HCR.0000000000000232 [published Online First: 2017/02/09]
35
36
37
38 43. Gaalema DE, Savage PD, Rengo JL, et al. Financial incentives to promote cardiac
39
40 rehabilitation participation and adherence among Medicaid patients. *Prev Med*
41
42 2016;92:47-50. doi: 10.1016/j.ypmed.2015.11.032 [published Online First: 2016/10/30]
43
44
45
46
47 44. Grace SL, Parsons TL, Duhamel TA, et al. The quality of cardiac rehabilitation in Canada:
48
49 a report of the Canadian Cardiac Rehab Registry. *Can J Cardiol* 2014;30(11):1452-5.
50
51 doi: 10.1016/j.cjca.2014.06.016 [published Online First: 2014/12/03]
52
53
54
55 45. Harkness K, Smith KM, Taraba L, et al. Effect of a postoperative telephone intervention on
56
57 attendance at intake for cardiac rehabilitation after coronary artery bypass graft surgery.
58
59
60

- 1
2
3
4 *Heart Lung* 2005;34(3):179-86. doi: 10.1016/j.hrtlng.2004.07.010 [published Online
5
6
7 First: 2005/07/15]
8
9
10 46. Ohtera S, Kanazawa N, Ozasa N, et al. Proposal of quality indicators for cardiac
11
12 rehabilitation after acute coronary syndrome in Japan: a modified Delphi method and
13
14 practice test. *BMJ Open* 2017;7(1):e013036. doi: 10.1136/bmjopen-2016-013036
15
16 [published Online First: 2017/01/31]
17
18
19 47. Beatty AL, Li S, Thomas L, et al. Trends in referral to cardiac rehabilitation after myocardial
20
21 infarction: data from the National Cardiovascular Data Registry 2007 to 2012. *J Am*
22
23 *Coll Cardiol* 2014;63(23):2582-83. doi: 10.1016/j.jacc.2014.03.030 [published Online
24
25 First: 2014/04/29]
26
27
28
29 48. Balady GJ, Ades PA, Bittner VA, et al. Referral, enrollment, and delivery of cardiac
30
31 rehabilitation/secondary prevention programs at clinical centers and beyond: a
32
33 presidential advisory from the American Heart Association. *Circulation*
34
35 2011;124(25):2951-60. doi: 10.1161/CIR.0b013e31823b21e2 [published Online First:
36
37 2011/11/16]
38
39
40
41
42 49. Grace SL, Poirier P, Norris CM, et al. Pan-Canadian development of cardiac rehabilitation
43
44 and secondary prevention quality indicators. *Can J Cardiol* 2014;30(8):945-8. doi:
45
46 10.1016/j.cjca.2014.04.003 [published Online First: 2014/07/30]
47
48
49
50 50. Van Engen-Verheul M, Kemps H, Kraaijenhagen R, et al. Modified Rand method to derive
51
52 quality indicators: a case study in cardiac rehabilitation. *Stud Health Technol Inform*
53
54 2011;169:88-92. [published Online First: 2011/09/07]
55
56
57
58 51. Grace SL, Russell KL, Reid RD, et al. Effect of cardiac rehabilitation referral strategies on
59
60

- 1
2
3
4 utilization rates: a prospective, controlled study. *Arch Intern Med* 2011;171(3):235-41.
5
6 doi: 10.1001/archinternmed.2010.501 [published Online First: 2011/02/18]
7
8
- 9 52. Grace SL, Tan Y, Oh P, et al. Feasibility of Assessing 2 Cardiac Rehabilitation Quality
10 Indicators. *J Cardiopulm Rehabil Prev* 2016;36(2):112-6. doi:
11 10.1097/HCR.000000000000136 [published Online First: 2015/08/08]
12
13
14
15
16
- 17 53. Thomas RJ, Chiu JS, Goff DC, Jr., et al. Reliability of abstracting performance measures:
18 results of the cardiac rehabilitation referral and reliability (CR3) project. *J Cardiopulm*
19 *Rehabil Prev* 2014;34(3):172-9. doi: 10.1097/HCR.000000000000048 [published
20 Online First: 2014/03/08]
21
22
23
24
25
26
- 27 54. Reid RD, Morrin LI, Beaton LJ, et al. Randomized trial of an internet-based computer-
28 tailored expert system for physical activity in patients with heart disease. *Eur J Prev*
29 *Cardiol* 2012;19(6):1357-64. doi: 10.1177/1741826711422988 [published Online First:
30 2011/09/10]
31
32
33
34
35
36
- 37 55. Hamm LF, Kavanagh T, Campbell RB, et al. Timeline for peak improvements during 52
38 weeks of outpatient cardiac rehabilitation. *J Cardiopulm Rehabil* 2004;24(6):374-80;
39 quiz 81-2. doi: 10.1097/00008483-200411000-00002 [published Online First:
40 2005/01/06]
41
42
43
44
45
46
- 47 56. Hu D. [Bright beginning of Chinese cardiac rehabilitation post a rough road]. *Zhonghua Xin*
48 *Xue Guan Bing Za Zhi* 2015;43(2):118. [published Online First: 2015/04/25]
49
50
51
52
- 53 57. Kotter T, Blozik E, Scherer M. Methods for the guideline-based development of quality
54 indicators--a systematic review. *Implement Sci* 2012;7:21. doi: 10.1186/1748-5908-7-
55 21 [published Online First: 2012/03/23]
56
57
58
59
60

- 1
2
3
4 58. Chen J, Tong Y, Cheng Y, et al. Establishment and Empirical Evaluation of a Quality
5
6 Indicator System for Postoperative Pain Management. *Pain Med* 2020 doi:
7
8 10.1093/pm/pnaa221 [published Online First: 2020/10/12]
9
10
11 59. van der Velden AW, van Triest MI, Schoffelen AF, et al. Structural Antibiotic Surveillance
12
13 and Stewardship via Indication-Linked Quality Indicators: Pilot in Dutch Primary Care.
14
15 *Antibiotics (Basel)* 2020;9(10) doi: 10.3390/antibiotics9100670 [published Online First:
16
17 2020/10/08]
18
19
20
21 60. Montesano M, Reed JL, Tulloch HE, et al. Cardiac rehabilitation is associated with greater
22
23 improvements in psychological health following coronary artery bypass graft surgery
24
25 when compared to percutaneous coronary intervention. *Appl Physiol Nutr Metab* 2020
26
27 doi: 10.1139/apnm-2020-0213 [published Online First: 2020/06/17]
28
29
30
31 61. Chockalingam P, Rajaram A, Maiya A, et al. A multicentre retrospective study on quality
32
33 and outcomes of cardiac rehabilitation programs in India. *Indian Heart J* 2020;72(1):55-
34
35 57. doi: 10.1016/j.ihj.2020.03.002 [published Online First: 2020/05/20]
36
37
38
39 62. Thomas E, O'Neil A. Considerations for Developing Quality Indicators for Cardiac
40
41 Rehabilitation in Australia. *Heart Lung Circ* 2020;29(1):e12-e13. doi:
42
43 10.1016/j.hlc.2018.11.009 [published Online First: 2019/12/21]
44
45
46
47 63. Podlogar MAC, Dolansky MA. Cardiac Rehabilitation as Part of Management in Postacute
48
49 Care: Opportunities for Improving Care. *Clin Geriatr Med* 2019;35(4):561-69. doi:
50
51 10.1016/j.cger.2019.07.010 [published Online First: 2019/09/24]
52
53
54
55 64. Pesah E, Supervia M, Turk-Adawi K, et al. A Review of Cardiac Rehabilitation Delivery
56
57 Around the World. *Prog Cardiovasc Dis* 2017;60(2):267-80. doi:
58
59
60

- 1
2
3
4 10.1016/j.pcad.2017.08.007 [published Online First: 2017/08/29]
5
6
7 65. Bjarnason-Wehrens B, McGee H, Zwisler AD, et al. Cardiac rehabilitation in Europe: results
8
9 from the European Cardiac Rehabilitation Inventory Survey. *Eur J Cardiovasc Prev*
10
11 *Rehabil* 2010;17(4):410-8. doi: 10.1097/HJR.0b013e328334f42d [published Online
12
13 First: 2010/03/20]
14
15
16
17 66. Grace SL, Gravely-Witte S, Brujal J, et al. Contribution of patient and physician factors to
18
19 cardiac rehabilitation enrollment: a prospective multilevel study. *Eur J Cardiovasc Prev*
20
21 *Rehabil* 2008;15(5):548-56. doi: 10.1097/HJR.0b013e328305df05 [published Online
22
23 First: 2008/10/03]
24
25
26
27 67. Nery RM, Zanini M, de Lima JB, et al. Tai Chi Chuan improves functional capacity after
28
29 myocardial infarction: A randomized clinical trial. *Am Heart J* 2015;169(6):854-60. doi:
30
31 10.1016/j.ahj.2015.01.017 [published Online First: 2015/06/02]
32
33
34
35 68. Mao S, Zhang X, Shao B, et al. Baduanjin Exercise Prevents post-Myocardial Infarction Left
36
37 Ventricular Remodeling (BE-PREMIER trial): Design and Rationale of a Pragmatic
38
39 Randomized Controlled Trial. *Cardiovasc Drugs Ther* 2016;30(3):315-22. doi:
40
41 10.1007/s10557-016-6660-7 [published Online First: 2016/04/24]
42
43
44
45 69. Mao S, Zhang X, Chen M, et al. Beneficial Effects of Baduanjin Exercise on Left Ventricular
46
47 Remodelling in Patients after Acute Myocardial Infarction: an Exploratory Clinical Trial
48
49 and Proteomic Analysis. *Cardiovasc Drugs Ther* 2020 doi: 10.1007/s10557-020-
50
51 07047-0 [published Online First: 2020/08/08]
52
53
54
55
56 70. Chen MG, Liang X, Kong L, et al. Effect of Baduanjin Sequential Therapy on the Quality of
57
58 Life and Cardiac Function in Patients with AMI After PCI: A Randomized Controlled
59
60

1
2
3
4 Trial. *Evid Based Complement Alternat Med* 2020;2020:8171549. doi:

5
6 10.1155/2020/8171549 [published Online First: 2020/07/28]
7
8
9
10
11
12

13 **Figure Legends**

14
15 Figure 1. Mean of all the indicators identified by the consensus panel. A. The mean of domain 1:
16 improving CR participation and adherence. B. The mean of domain 2: CR process standardization.

17
18 Figure 2. Regional distributions of the national questionnaire. Blue represents the areas surveyed,
19 while white represents areas not surveyed.
20

21
22 Figure 3. Quality indicators from the national questionnaires that were identified as needing
23 immediate improvement (blue).
24

25
26 Supplementary Figure 1. Flow chart of the literature search process.

27
28 Supplementary Figure 2. Rating distribution of domain 1 candidate quality indicators. The X-axis
29 indicates individual indicator evaluation by the panel. The Y-axis indicates the number of panel
30 members who scored the indicator.
31

32
33 Supplementary Figure 3. Rating distribution of domain 2 candidate indicators. The X-axis indicates
34 individual indicator evaluation by the panel. The Y-axis indicates the number of panel members
35 who scored the quality indicator.
36
37
38
39

40 **Table Legends**

41
42 Table 1. The proposed quality indicators and their percentage scores for CR in patients with MI.

43
44 Table 2. Top 5 quality indicators that were identified as needing improvement.

45
46 Supplementary Table 1. Candidate QIs to improve CR in patients with MI.

47
48 Supplemental Table 2. Information about professionals of the consensus pane.
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

For peer review only

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

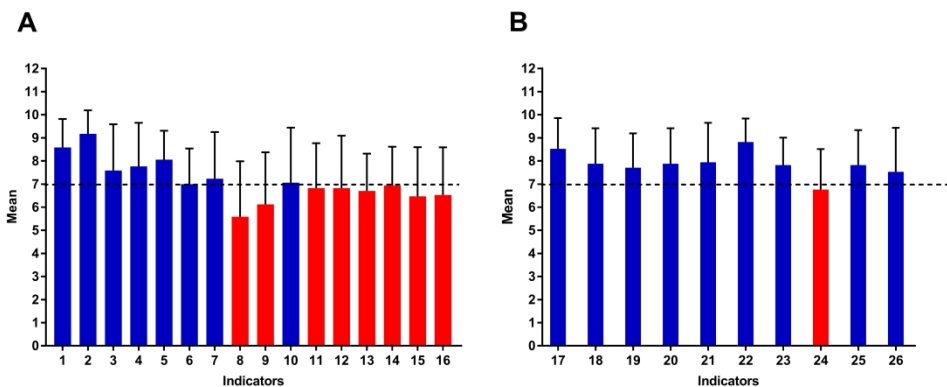
Quality Indicators	Numerator/ denominator	Performance %
Domain 1: Improving CR participation and adherence		
QI-1: recommending CR in discharge guidance	142/165	86.1
QI-2: automatically referring all eligible patients at the time of discharge	56/163	34.4
QI-3: employing full-time staff for educating 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	19.0
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.

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

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46



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)

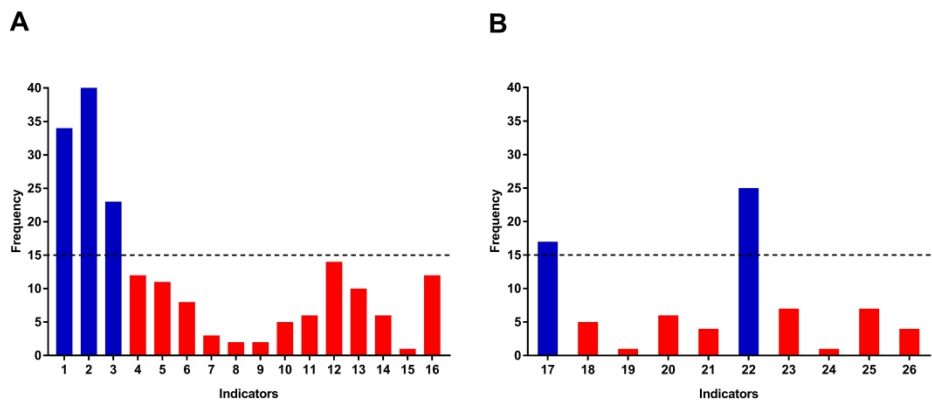
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60



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

254x190mm (300 x 300 DPI)

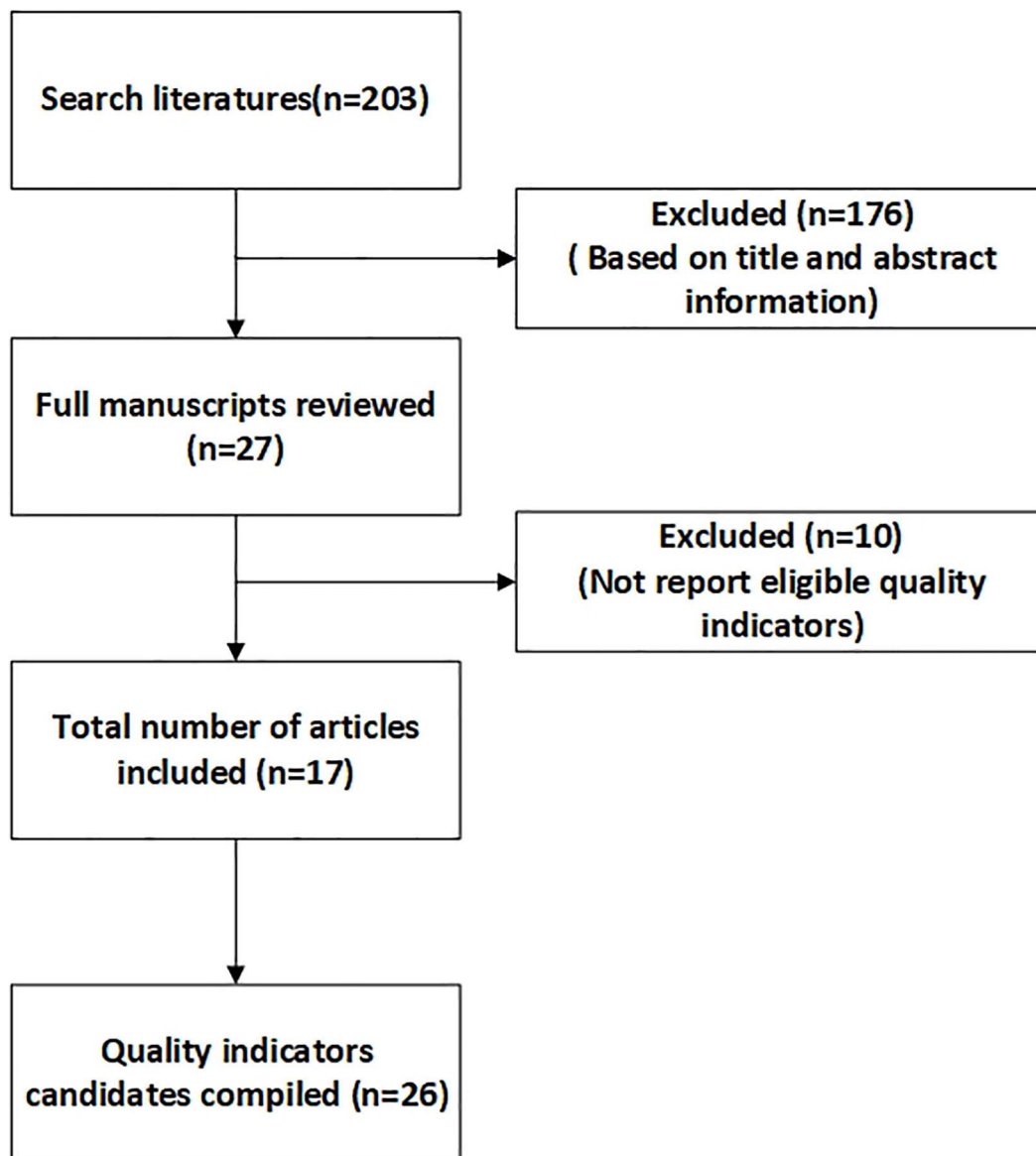


Quality indicators from the national questionnaires that were identified as needing immediate improvement (blue).

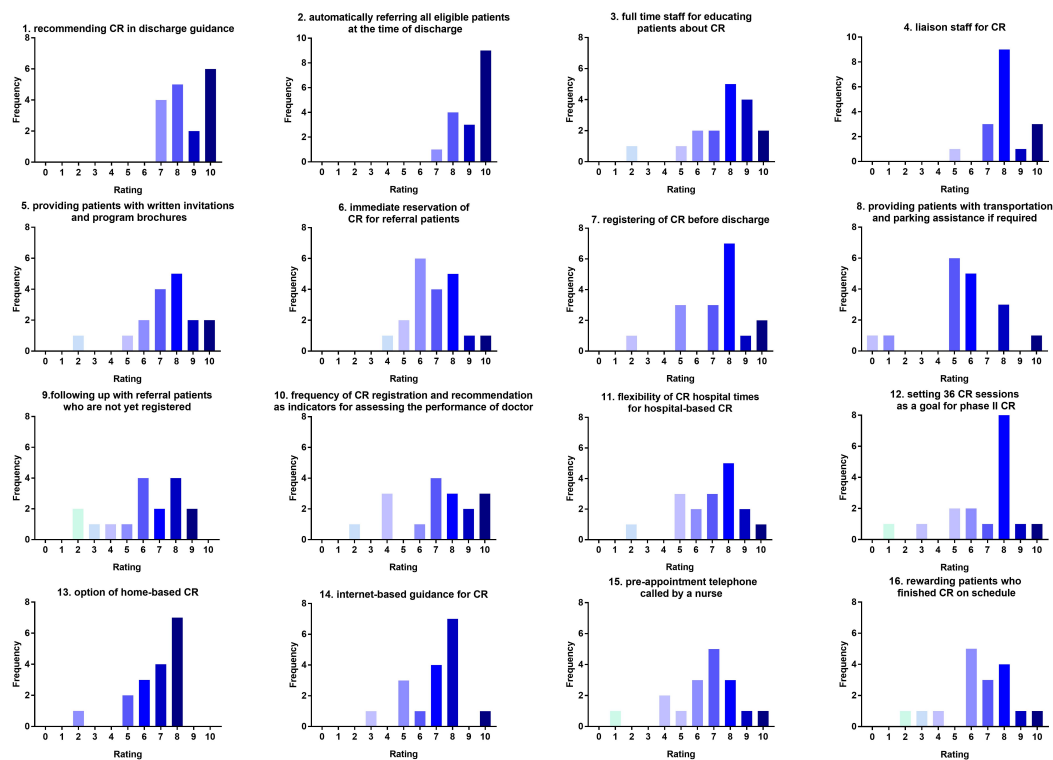
262x114mm (600 x 600 DPI)

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

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

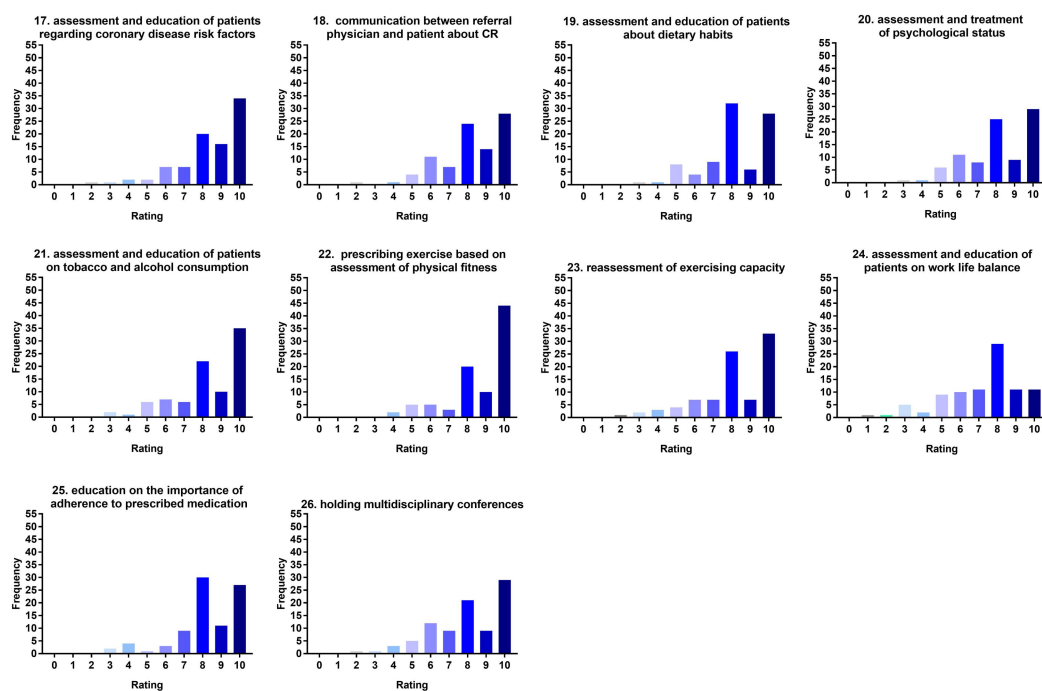


Supplementary Figure 2. Rating distribution of domain 1 candidate quality indicators. The X-axis indicates individual indicator evaluation by the panel. The Y-axis indicates the number of panel members who scored the indicator.



view only

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.



Review only

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

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

BMJ Open

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

Journal:	<i>BMJ Open</i>
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
Primary Subject Heading:	Cardiovascular medicine
Secondary Subject Heading:	Cardiovascular medicine
Keywords:	Myocardial infarction < CARDIOLOGY, REHABILITATION MEDICINE, Coronary heart disease < CARDIOLOGY

SCHOLARONE™
Manuscripts



I, the Submitting Author has the right to grant and does grant on behalf of all authors of the Work (as defined in the below author licence), an exclusive licence and/or a non-exclusive licence for contributions from authors who are: i) UK Crown employees; ii) where BMJ has agreed a CC-BY licence shall apply, and/or iii) in accordance with the terms applicable for US Federal Government officers or employees acting as part of their official duties; on a worldwide, perpetual, irrevocable, royalty-free basis to BMJ Publishing Group Ltd ("BMJ") its licensees and where the relevant Journal is co-owned by BMJ to the co-owners of the Journal, to publish the Work in this journal and any other BMJ products and to exploit all rights, as set out in our [licence](#).

The Submitting Author accepts and understands that any supply made under these terms is made by BMJ to the Submitting Author unless you are acting as an employee on behalf of your employer or a postgraduate student of an affiliated institution which is paying any applicable article publishing charge ("APC") for Open Access articles. Where the Submitting Author wishes to make the Work available on an Open Access basis (and intends to pay the relevant APC), the terms of reuse of such Open Access shall be governed by a Creative Commons licence – details of these licences and which [Creative Commons](#) licence will apply to this Work are set out in our licence referred to above.

Other than as permitted in any relevant BMJ Author's Self Archiving Policies, I confirm this Work has not been accepted for publication elsewhere, is not being considered for publication elsewhere and does not duplicate material already published. I confirm all authors consent to publication of this Work and authorise the granting of this licence.

1
2
3 **Quality indicators for cardiac rehabilitation after myocardial infarction in China: a consensus**
4 **panel and practice test**
5

6 Xianghui Zheng^{1,2#}, Maomao Zhang^{1,2#}, Yang Zheng^{1,2}, Yongxiang Zhang^{1,2}, Junnan Wang³, Ping
7 Zhang⁴, Xuwen Yang⁵, Shan Li⁶, Rongjing Ding⁷, Gaowa Siqin⁸, Xinyu Hou^{1,2}, Liangqi Chen^{1,2},
8 Min Zhang^{1,2}, Yong Sun^{1,2}, Jian Wu^{1,2*}, Bo Yu^{1,2}
9
10

11
12 ¹ Department of Cardiology, the Second Affiliated Hospital of Harbin Medical University, Harbin,
13 Heilongjiang Province, China

14 ² The Key Laboratory of Myocardial Ischemia, Harbin Medical University, Ministry of Education,
15 Harbin, Heilongjiang Province, China

16 ³ Department of Cardiology, the Second Hospital of Jilin University, Changchun, Jilin Province,
17 China

18 ⁴ Department of Cardiology, Beijing Tsinghua Changgung Hospital, Beijing, China

19 ⁵ Department of Cardiology, Tianjin Chest Hospital, Tianjin Cancer Hospital, Tianjin, China

20 ⁶ Department of Cardiology, Affiliated Hospital of Qingdao University, Qingdao, China

21 ⁷ Department of Cardiology, Peking University People's Hospital, Beijing, China

22 ⁸ Department of Cardiology, Inner Mongolia People's Hospital, Inner Mongolia, China

23
24
25 * Corresponding author: Jian Wu, Department of Cardiology, the Second Affiliated Hospital
26 of Harbin Medical University, No. 246, Xuefu Road, Nangang District, Harbin, China.

27 E-mail address: wujian780805@163.com
28
29

30
31
32 # These authors contributed equally to this work.
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

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.

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

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

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

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

1
2
3 experience and determining the final QIs for CR in post-MI patients.
4

5 **Scoring method and selection criteria**

6
7 The candidate QIs generated from the literature were scored on a ten-point scale. Scoring criteria
8 were based on four aspects: whether they were evidence-based, the feasibility of implementation,
9 their validity, and their reliability. The QIs were judged according to the clinical experience of the
10 consensus panel. The four criteria were used to generate one score. QIs that received scores ≥ 7 and
11 considered to be significant in the improvement of CR were included in the study. QIs with < 7
12 but > 5 points were not considered in this study, and QIs with < 5 points were excluded. A QI was
13 considered acceptable for improving the quality of CR in post-MI Chinese patients based on its
14 average score.
15
16
17
18

19 **National questionnaire**

20
21 A questionnaire-based survey was conducted nationwide by either telephone or WeChat (a
22 communication tool in China). Participants included cardiologists, nurses, physical therapists,
23 clinical psychologists, registered dietitians and follow-up staff caring for CR patients (health
24 managers who follow up patients via telephone etc.) who met the following criteria: (1) working in
25 an established CR center; and (2) at least 1 year of experience in CR. J Wu and Y Zhang conducted
26 a questionnaire-based survey with the participants. The participants were asked to select 3 out of 26
27 candidate QIs that they felt required urgent improvement to allow the selection of the top 5 QIs that
28 required immediate improvement in China. The top 5 most important QIs were determined based
29 on the frequency selected by the participants. Additionally, participants could suggest new QIs
30 outside of those mentioned in the questionnaire.
31
32
33
34
35

36 **Practice test**

37
38 An practice test was performed as to review the adaptability of each QI before implementation
39 due to differences in healthcare systems and social circumstances, such as the size of the CR center
40 and patient education, to assess the completion rate of the proposed QIs selected by the consensus
41 panel. The patient inclusion criteria were as follows: (1) a history of AMI; (2) completion of phase
42 I and II CR at one of the 5 teaching hospitals (Beijing Tsinghua Changgung Hospital, the Second
43 Hospital of Jilin University, Tianjin Chest Hospital and Affiliated Hospital of Qingdao University
44 and the Second Affiliated Hospital of Harbin Medical University) between September 3, 2018 and
45 October 31, 2019; and (3) consent to participate in the study. Patients filled out an 17-question
46 questionnaire (Supplementary Table 1) about proposed QIs that was developed specifically for this
47 study and evaluated whether the CR center implemented the proposed QIs. The patients did not
48 answer if they were unsure or did not understand the question. In addition, the consensus panel
49 unanimously agreed that a score greater than 70% was considering good performance, whereas a
50 score less than 30% was considered poor performance. The questionnaire was approved by the
51 ethics committees of the 5 teaching hospitals.
52
53
54
55
56
57

58 **Patient and public involvement**

1
2
3 Patients and the public were not involved in the design of the study.
4

5 **Data collection and analysis**

6
7 Two authors (XZ and YZ) were responsible for data collection and cross checking. The mean
8 score of each QI was calculated as the sum of all participants' ratings/number of participants. The
9 percentage score for each QIs was calculated as follows: the number of times the QI was
10 achieved/the number of participants (excluding participants who did not answer)×100. The mean
11 performance was the average of the percentages of all quality indicators.
12
13
14
15

16 **Results**

17 **Collection of QIs**

18
19 A review of the literature identified 203 articles, and after screening the titles and abstracts, 176
20 were excluded, as they were not related to QIs for CR. After full-text screening, 17 articles were
21 eligible and subsequently included.^{34 36 41-55} A list of 26 potential QIs, including 16 regarding
22 improvement of the CR participation and adherence rates and 10 regarding the standardization of
23 the CR processes, was generated (Supplementary Table 2). A flowchart of the literature search and
24 selection of eligible articles is shown in Supplementary Figure 1.
25
26
27
28
29
30
31

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

33
34 The consensus panel included 17 experts in the field of CR from 12 CR centers (Supplementary
35 Table 3). Seventeen experts who met the inclusion criteria were cardiologists and individually rated
36 each QI on a ten-point scale. The rating of each QI is shown in Supplementary Figures 2 and 3.
37 After careful evaluation, only QIs with an average score ≥ 7 that could potentially improve the
38 quality of CR in China were accepted (Figure 1). Finally, a total of 17 QIs were selected and divided
39 into two domains: (1) improving participation and adherence and (2) standardizing CR processes
40 (Table 1). There were two more supplementary indicators: extending the hospital rehabilitation time
41 and strengthening the application of traditional Chinese sports.
42
43
44
45

46 **National questionnaire and top five QIs for imminent improvement**

47
48 Eighty-nine professionals met the national survey participation criteria; among them, 60 people
49 participated in a telephone survey, and 29 people participated in a WeChat survey. The survey
50 response rate was 100%. The 89 participants from 4 municipalities and 18 provinces in China
51 included 21 cardiologists, 15 nurses, 18 physical therapists, 11 clinical psychologists, 13 registered
52 dietitians and 11 health follow-up staff. Each participant selected three QIs considered critical to
53 improve post-MI CR in China (Figures 2 and 3). The results showed that the five most important
54 QIs were 'automatically referring all eligible patients at the time of discharge', 'recommending CR
55 in discharge guidance', 'prescribing exercise based on an assessment of physical fitness',
56 'employing full-time staff for educating patients about CR', and 'assessment and education of
57
58
59
60

1
2
3 patients regarding coronary disease risk factors' (Table 2), with score ratios of 47.2%, 38.2%, 28.1%,
4 25.8% and 19.1%, respectively.
5
6

7 **Practice test**

8
9 The practice test was completed by 165 patients who met the inclusion criteria, and no patients
10 refused to participate in the study (30 patients from Beijing Tsinghua Changgung Hospital, 30
11 patients from the Second Hospital of Jilin University, 34 patients from Tianjin Chest Hospital, 30
12 patients from Affiliated Hospital of Qingdao University and 41 patients from the Second Affiliated
13 Hospital of Harbin Medical University). The results revealed a mean performance value of 43.9%
14 (9.9-86.1%). The QIs that achieved good performance (minimum to maximum 72.1-86.1%) were
15 'assessment and education of patients on tobacco and alcohol consumption' and 'recommending
16 CR in discharge guidance'. There were also several low-performing QIs (minimum to maximum
17 9.9-29.7%), including 'holding multidisciplinary meetings, 'frequency of CR registration and
18 recommendation as QIs for assessing doctor performance', 'immediate enrollment in CR for referral
19 patients', and 'providing patients with written invitations and program brochures' (Table 1).
20
21
22
23
24
25
26

27 **Discussion**

28
29 In this study, 26 QIs generated from 17 articles were assessed as candidate QIs for CR. Out of
30 the 26 QIs, 17 were selected by a Chinese expert consensus panel and divided into two domains
31 based on participation and adherence and CR process standardization. The findings of the
32 nationwide questionnaire could guide clinical quality improvement. The practice test showed the
33 feasibility and applicability of all 17 QIs in the Chinese context.
34
35

36
37 To our knowledge, this is the first study proposing an immediate improvement in CR QIs on the
38 basis of the results of a nationwide survey and the implementation of improvement guidelines for
39 CR in China. However, although still in its infancy, CR in China has developed rapidly. According
40 to data published by the Chinese Society of Rehabilitation Medicine (CARM), the number of CR
41 centers has increased from 6 in 2012 to more than 500 currently.⁵⁶ Hence, the improved
42 implementation of CR programs is imperative, given the current situation. We consider that QI
43 development is a time-efficient and resource-saving approach.⁵⁷ In many countries, CR is strongly
44 associated with quality of life improvement. For example, the USA has effectively implemented QI
45 monitoring to increase the CR participation rate.⁴¹ Similarly, Canada has developed QIs to promote
46 the broad development of CR programs,⁴⁴ and Japan has also proposed QIs to assess improvements
47 in the quality of CR after acute coronary syndrome (ACS).⁴⁶ Moreover, the EAPC described QIs to
48 assess improvements in CR process standardization in Europe.³³ In this study, we propose QIs to
49 promote the improvement of CR in China considering the recommendations reported in these
50 previous studies.
51
52
53
54
55

56
57 CR is still in the early phase of development in China.⁴⁰ Given the uneven distribution of CR
58 programs, the consensus panel selected QIs to promote improvements in participation and adherence
59 that were simple, practical and in line with the current status of CR in the country. For example, the
60

1
2
3
4 present report suggests that ‘recommending CR in discharge guidance’ was key in emphasizing the
5 importance and necessity of CR, and ‘automatically referring all eligible patients ‘at the time of
6 discharge’ was one of the best ways to increase participation in CR. Other suitable QIs were
7 ‘employing full-time staff for educating patients about CR’ and ‘employing CR liaison staff’. In
8 addition, the study revealed QIs that are necessary for CR process standardization in China, such as
9 ‘assessment and education of patients regarding coronary disease risk factors’, ‘assessment and
10 education of patients about dietary habits’, and ‘prescribing exercise based on physical fitness’. It
11 is worth mentioning that the completion rate of ‘holding multidisciplinary meetings’ was very low
12 in the practice test, but the implementation of this QI can improve recovery in patients with multiple
13 diseases.^{29 58 59} Moreover, measuring the completion rate of the proposed QIs is important.⁶⁰⁻⁶² There
14 are some measurement methods. First, QIs should be recorded in the medical record. In this way,
15 the completion of the QIs can be checked. Second, from the perspective of patients, a questionnaire
16 about the implementation of QIs was conducted at discharge. Relevant medical staff should be
17 evaluated by self-assessment and other assessment scales. In addition, clinical audits, a method of
18 establishing whether healthcare is being provided in line with the relevant standards and identifying
19 areas for improvements, should be performed.⁶³ CR programs could be improved by continuous
20 assessment.⁶⁴

21
22
23
24
25
26
27
28 It is also important to understand the barriers to appropriate CR, including lack of health
29 awareness, inadequate policies, insufficiency of CR, lack of healthcare system support and
30 inadequate professional guidelines and information systems.⁶⁵⁻⁶⁷ Gary et al. reported that older
31 females with a low socioeconomic status, with a low education level, with poor self-efficacy, with
32 multiple comorbidities and without the ability to communicate in English were more likely to not
33 participate in CR.⁴⁸ Enrollment in the CR program is affected by many healthcare system-related
34 factors, including lack of referral, limited facilitation of enrollment after referral, lack of programs
35 that serve specific geographic areas and low-income communities, and gender-dominated
36 programs.⁶⁸ In this study, we proposed QIs that could aid in overcoming some of these barriers and
37 also in the successful implementation of CR.

38
39
40
41
42
43 During the course of the study, two additional supplementary indicators, ‘extending the hospital
44 rehabilitation time’ and ‘strengthening the application of traditional Chinese exercise’, were added.
45 Tai Chi Chuan practice was associated with a VO₂ peak increase in patients with MI.⁶⁹ Baduanjin
46 exercise therapy in post-MI patients reduced adverse left ventricular (LV) remodeling and was
47 associated with beneficial effects in terms of inflammation and extracellular matrix organization.⁷⁰
48 ⁷¹ Baduanjin sequential therapy also appeared to improve the quality of life in patients with AMI
49 after percutaneous coronary intervention, with additional benefits of reducing the abdominal
50 circumference and body mass index and improving the level of cardiac function.⁷² Therefore,
51 traditional Chinese exercises, such as Tai Chi Chuan and baduanjin, may constitute effective forms
52 of CR in patients with MI.

53
54
55
56
57 In summary, the application of these QIs could help standardize and improve the quality of CR
58 in China. This study provides guidance for the development of CR in our country. Nevertheless,
59 further studies are needed to evaluate the validity, reliability and feasibility of these QIs and to
60

1
2
3 determine whether improvements in these parameters are associated with clinical benefits in this
4 patient population.
5
6
7

8 9 **Study limitations**

10
11 There are many limitations of our study. First, in the QI development section of the methods, we
12 retrieved the literature from public databases; hence, there is a possibility of publication bias. Second,
13 investigation bias may exist because the consensus panel participants were all cardiologists and the
14 national questionnaire was not distributed to all regions and CR centers in the country. The baseline
15 characteristics were not collected for the professionals in the national questionnaire, and no specific
16 calculation was performed to determine the sample size needed for the national questionnaire. These
17 factors may also lead to bias in the results of the practice test due to the absence of data from
18 nonteaching hospitals, the relatively small sample size and the lack of data concerning baseline
19 characteristics of the patients (i.e. sex, age, marital status, cardiovascular risk factors, prior history
20 of myocardial infarction, ST-segment or non-ST-segment elevation myocardial infarction, left
21 ventricular ejection fraction, percutaneous coronary intervention, coronary artery bypass grafting,
22 medication, etc.). Moreover, to assess the measurability and completeness of the proposed QIs, only
23 patients who participated in CR programs were selected to complete the practice test. As such, data
24 from those who did not participate in these programs were not available.
25
26
27
28
29
30
31
32

33 **Conclusion**

34
35 In this study, a consensus panel identified 17 candidate QIs to assess improvements in the quality
36 of CR in post-MI patients in China. A nationwide survey revealed the 5 QIs that required imminent
37 improvement to facilitate increased enrollment in CR programs in the country. Moreover, a practice
38 test administered to MI survivors confirmed the feasibility and completeness of the developed QIs.
39 Application of the proposed QIs could improve the quality of CR care in Chinese post-MI patients.
40
41
42
43
44

45 **Acknowledgments**

46
47 The authors are grateful to the members of the consensus panel, the staff who participated in the
48 national questionnaire, and the patients who completed the practice test. Our deepest gratitude goes
49 to the reviewers and the editor for their careful work and thoughtful suggestions that have helped
50 substantially improve the quality of this paper.
51
52
53

54 **Author contribution**

55
56 All authors contributed to the conception and design of the work. XZ and YZheng contributed to
57 the analysis and interpretation. JWu, YZhang, JWang, PZ, XY, SL, RD, GS, BY and YS contributed
58 to the acquisition of the data. XZ and MaoZ drafted the manuscript. MinZ, XH and LC critically
59 revised the manuscript. All authors reviewed and agreed to the final version.
60

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.

References

1. Reed GW, Rossi JE, Cannon CP. Acute myocardial infarction. *Lancet* 2017;389(10065):197-210. doi: 10.1016/S0140-6736(16)30677-8 [published Online First: 2016/08/10]
2. Dagenais GR, Leong DP, Rangarajan S, et al. Variations in common diseases, hospital admissions, and deaths in middle-aged adults in 21 countries from five continents

- (PURE): a prospective cohort study. *Lancet* 2020;395(10226):785-94. doi: 10.1016/S0140-6736(19)32007-0 [published Online First: 2019/09/08]
3. Piepoli MF, Corra U, Dendale P, et al. Challenges in secondary prevention after acute myocardial infarction: A call for action. *Eur Heart J Acute Cardiovasc Care* 2017;6(4):299-310. doi: 10.1177/2048872616689773 [published Online First: 2017/06/14]
4. Ma LY, Chen WW, Gao RL, et al. China cardiovascular diseases report 2018: an updated summary. *J Geriatr Cardiol* 2020;17(1):1-8. doi: 10.11909/j.issn.1671-5411.2020.01.001 [published Online First: 2020/03/07]
5. Jiang Z, Dreyer RP, Spertus JA, et al. Factors Associated With Return to Work After Acute Myocardial Infarction in China. *JAMA Netw Open* 2018;1(7):e184831. doi: 10.1001/jamanetworkopen.2018.4831 [published Online First: 2019/01/16]
6. Ambrosetti M, Abreu A, Corra U, et al. Secondary prevention through comprehensive cardiovascular rehabilitation: From knowledge to implementation. 2020 update. A position paper from the Secondary Prevention and Rehabilitation Section of the European Association of Preventive Cardiology. *Eur J Prev Cardiol* 2020;2047487320913379. doi: 10.1177/2047487320913379 [published Online First: 2020/04/01]
7. Anderson L, Oldridge N, Thompson DR, et al. Exercise-Based Cardiac Rehabilitation for Coronary Heart Disease: Cochrane Systematic Review and Meta-Analysis. *J Am Coll Cardiol* 2016;67(1):1-12. doi: 10.1016/j.jacc.2015.10.044 [published Online First: 2016/01/15]

- 1
2
3
4 8. Salzwedel A, Jensen K, Rauch B, et al. Effectiveness of comprehensive cardiac rehabilitation
5
6 in coronary artery disease patients treated according to contemporary evidence based
7
8
9 medicine: Update of the Cardiac Rehabilitation Outcome Study (CROS-II). *Eur J Prev*
10
11 *Cardiol* 2020;2047487320905719. doi: 10.1177/2047487320905719 [published Online
12
13 First: 2020/02/25]
14
15
16
17 9. Hermann M, Witassek F, Erne P, et al. Impact of cardiac rehabilitation referral on one-year
18
19 outcome after discharge of patients with acute myocardial infarction. *Eur J Prev Cardiol*
20
21 2019;26(2):138-44. doi: 10.1177/2047487318807766 [published Online First:
22
23 2018/10/20]
24
25
26
27 10. Lee BJ, Go JY, Kim AR, et al. Quality of Life and Physical Ability Changes After Hospital-
28
29 Based Cardiac Rehabilitation in Patients With Myocardial Infarction. *Ann Rehabil Med*
30
31 2017;41(1):121-28. doi: 10.5535/arm.2017.41.1.121 [published Online First:
32
33 2017/03/16]
34
35
36
37 11. Ribeiro F, Oliveira NL, Silva G, et al. Exercise-based cardiac rehabilitation increases daily
38
39 physical activity of patients following myocardial infarction: subanalysis of two
40
41 randomised controlled trials. *Physiotherapy* 2017;103(1):59-65. doi:
42
43 10.1016/j.physio.2015.12.002 [published Online First: 2016/03/26]
44
45
46
47
48 12. Schwaab B, Zeymer U, Jannowitz C, et al. Improvement of low-density lipoprotein
49
50 cholesterol target achievement rates through cardiac rehabilitation for patients after ST
51
52 elevation myocardial infarction or non-ST elevation myocardial infarction in Germany:
53
54 Results of the PATIENT CARE registry. *Eur J Prev Cardiol* 2019;26(3):249-58. doi:
55
56 10.1177/2047487318817082 [published Online First: 2018/12/05]
57
58
59
60

- 1
2
3
4 13. Tsai YJ, Li MH, Chen CH, et al. Improved oxygen uptake efficiency slope in acute
5
6 myocardial infarction patients after early phase I cardiac rehabilitation. *Int J Rehabil*
7
8
9 *Res* 2017;40(3):215-19. doi: 10.1097/MRR.000000000000229 [published Online First:
10
11 2017/04/15]
12
13
14 14. Hambrecht R, Wolf A, Gielen S, et al. Effect of exercise on coronary endothelial function in
15
16 patients with coronary artery disease. *N Engl J Med* 2000;342(7):454-60. doi:
17
18 10.1056/NEJM200002173420702 [published Online First: 2000/02/17]
19
20
21
22 15. Vanhees L, Fagard R, Thijs L, et al. Prognostic value of training-induced change in peak
23
24 exercise capacity in patients with myocardial infarcts and patients with coronary bypass
25
26 surgery. *Am J Cardiol* 1995;76(14):1014-9. doi: 10.1016/s0002-9149(99)80287-2
27
28 [published Online First: 1995/11/15]
29
30
31
32 16. Gevaert AB, Adams V, Bahls M, et al. Towards a personalised approach in exercise-based
33
34 cardiovascular rehabilitation: How can translational research help? A 'call to action'
35
36 from the Section on Secondary Prevention and Cardiac Rehabilitation of the European
37
38 Association of Preventive Cardiology. *Eur J Prev Cardiol* 2020;27(13):1369-85. doi:
39
40 10.1177/2047487319877716 [published Online First: 2019/10/05]
41
42
43
44
45 17. Martin BJ, Hauer T, Arena R, et al. Cardiac rehabilitation attendance and outcomes in
46
47 coronary artery disease patients. *Circulation* 2012;126(6):677-87. doi:
48
49 10.1161/CIRCULATIONAHA.111.066738 [published Online First: 2012/07/11]
50
51
52
53 18. Hammill BG, Curtis LH, Schulman KA, et al. Relationship between cardiac rehabilitation
54
55 and long-term risks of death and myocardial infarction among elderly Medicare
56
57 beneficiaries. *Circulation* 2010;121(1):63-70. doi:
58
59
60

- 1
2
3
4 10.1161/CIRCULATIONAHA.109.876383 [published Online First: 2009/12/23]
5
6
7 19. Smith SC, Jr., Benjamin EJ, Bonow RO, et al. AHA/ACCF secondary prevention and risk
8
9 reduction therapy for patients with coronary and other atherosclerotic vascular disease:
10
11 2011 update: a guideline from the American Heart Association and American College
12
13 of Cardiology Foundation endorsed by the World Heart Federation and the Preventive
14
15 Cardiovascular Nurses Association. *J Am Coll Cardiol* 2011;58(23):2432-46. doi:
16
17 10.1016/j.jacc.2011.10.824 [published Online First: 2011/11/08]
18
19
20
21
22 20. Piepoli MF, Hoes AW, Agewall S, et al. 2016 European Guidelines on cardiovascular
23
24 disease prevention in clinical practice: The Sixth Joint Task Force of the European
25
26 Society of Cardiology and Other Societies on Cardiovascular Disease Prevention in
27
28 Clinical Practice (constituted by representatives of 10 societies and by invited
29
30 experts)Developed with the special contribution of the European Association for
31
32 Cardiovascular Prevention & Rehabilitation (EACPR). *Eur Heart J* 2016;37(29):2315-
33
34 81. doi: 10.1093/eurheartj/ehw106 [published Online First: 2016/05/26]
35
36
37
38
39
40 21. Grace SL, Bennett S, Ardern CI, et al. Cardiac rehabilitation series: Canada. *Prog*
41
42 *Cardiovasc Dis* 2014;56(5):530-5. doi: 10.1016/j.pcad.2013.09.010 [published Online
43
44 First: 2014/03/13]
45
46
47
48 22. Kotseva K, Wood D, De Backer G, et al. Use and effects of cardiac rehabilitation in patients
49
50 with coronary heart disease: results from the EUROASPIRE III survey. *Eur J Prev*
51
52 *Cardiol* 2013;20(5):817-26. doi: 10.1177/2047487312449591 [published Online First:
53
54 2012/06/22]
55
56
57
58 23. Suaya JA, Shepard DS, Normand SL, et al. Use of cardiac rehabilitation by Medicare
59
60

- 1
2
3
4 beneficiaries after myocardial infarction or coronary bypass surgery. *Circulation*
5
6 2007;116(15):1653-62. doi: 10.1161/CIRCULATIONAHA.107.701466 [published
7
8 Online First: 2007/09/26]
9
10
11 24. Kotseva K, De Backer G, De Bacquer D, et al. Lifestyle and impact on cardiovascular risk
12
13 factor control in coronary patients across 27 countries: Results from the European
14
15 Society of Cardiology ESC-EORP EUROASPIRE V registry. *Eur J Prev Cardiol*
16
17 2019;26(8):824-35. doi: 10.1177/2047487318825350 [published Online First:
18
19 2019/02/12]
20
21
22
23
24 25. Turk-Adawi K, Supervia M, Lopez-Jimenez F, et al. Cardiac Rehabilitation Availability and
25
26 Density around the Globe. *EClinicalMedicine* 2019;13:31-45. doi:
27
28 10.1016/j.eclinm.2019.06.007 [published Online First: 2019/09/14]
29
30
31
32 26. Committee of Cardiac R, Prevention of Chinese Association of Rehabilitation M, Committee
33
34 of Cardiovascular Disease of China Association of G, et al. [China expert consensus
35
36 on psychological prescription for patients with cardiovascular disease2020]. *Zhonghua*
37
38 *Nei Ke Za Zhi* 2020;59(10):764-71. doi: 10.3760/cma.j.cn112138-20200203-00050
39
40
41 [published Online First: 2020/09/29]
42
43
44
45 27. Nixon AC, Brown J, Brotherton A, et al. Implementation of a frailty screening programme
46
47 and Geriatric Assessment Service in a nephrology centre: a quality improvement
48
49 project. *J Nephrol* 2020 doi: 10.1007/s40620-020-00878-y [published Online First:
50
51 2020/10/12]
52
53
54
55 28. Marino VR, Hyer K, Hamilton L, et al. Evaluation of a quality improvement initiative to
56
57 increase rates of advance directive conversation documentation in primary care.
58
59
60

- 1
2
3
4 *Geriatr Nurs* 2020 doi: 10.1016/j.gerinurse.2020.09.004 [published Online First:
5
6 2020/10/12]
7
8
9 29. Vos EL, Koppert LB, Jager A, et al. From Multiple Quality Indicators of Breast Cancer Care
10
11 Toward Hospital Variation of a Summary Measure. *Value Health* 2020;23(9):1200-09.
12
13 doi: 10.1016/j.jval.2020.05.011 [published Online First: 2020/09/18]
14
15
16 30. Vos EL, Lingsma HF, Jager A, et al. Effect of Case-Mix and Random Variation on Breast
17
18 Cancer Care Quality Indicators and Their Rankability. *Value Health* 2020;23(9):1191-
19
20 99. doi: 10.1016/j.jval.2019.12.014 [published Online First: 2020/09/18]
21
22
23 31. Scales DC, Dainty K, Hales B, et al. A multifaceted intervention for quality improvement in
24
25 a network of intensive care units: a cluster randomized trial. *JAMA* 2011;305(4):363-
26
27 72. doi: 10.1001/jama.2010.2000 [published Online First: 2011/01/21]
28
29
30 32. Wang Y, Li Z, Zhao X, et al. Effect of a Multifaceted Quality Improvement Intervention on
31
32 Hospital Personnel Adherence to Performance Measures in Patients With Acute
33
34 Ischemic Stroke in China: A Randomized Clinical Trial. *JAMA* 2018;320(3):245-54. doi:
35
36 10.1001/jama.2018.8802 [published Online First: 2018/07/01]
37
38
39 33. Abreu A, Frederix I, Dendale P, et al. Standardization and quality improvement of secondary
40
41 prevention through cardiovascular rehabilitation programmes in Europe: The avenue
42
43 towards EAPC accreditation programme: A position statement of the Secondary
44
45 Prevention and Rehabilitation Section of the European Association of Preventive
46
47 Cardiology (EAPC). *Eur J Prev Cardiol* 2020:2047487320924912. doi:
48
49 10.1177/2047487320924912 [published Online First: 2020/06/02]
50
51
52 34. Pack QR, Johnson LL, Barr LM, et al. Improving cardiac rehabilitation attendance and
53
54
55
56
57
58
59
60

- 1
2
3
4 completion through quality improvement activities and a motivational program. *J*
5
6 *Cardiopulm Rehabil Prev* 2013;33(3):153-9. doi: 10.1097/HCR.0b013e31828db386
7
8
9 [published Online First: 2013/04/19]
10
11
12 35. Parker K, Stone JA, Arena R, et al. An early cardiac access clinic significantly improves
13
14 cardiac rehabilitation participation and completion rates in low-risk ST-elevation
15
16 myocardial infarction patients. *Can J Cardiol* 2011;27(5):619-27. doi:
17
18 10.1016/j.cjca.2010.12.076 [published Online First: 2011/04/12]
19
20
21
22 36. Pack QR, Mansour M, Barboza JS, et al. An early appointment to outpatient cardiac
23
24 rehabilitation at hospital discharge improves attendance at orientation: a randomized,
25
26 single-blind, controlled trial. *Circulation* 2013;127(3):349-55. doi:
27
28 10.1161/CIRCULATIONAHA.112.121996 [published Online First: 2012/12/20]
29
30
31
32 37. He CJ, Zhu CY, Zhu YJ, et al. Effect of exercise-based cardiac rehabilitation on clinical
33
34 outcomes in patients with myocardial infarction in the absence of obstructive coronary
35
36 artery disease (MINOCA). *Int J Cardiol* 2020 doi: 10.1016/j.ijcard.2020.05.019
37
38
39 [published Online First: 2020/05/18]
40
41
42
43 38. Liao HH, Wang PC, Yeh EH, et al. Impact of disease-specific care certification on clinical
44
45 outcome and healthcare performance of myocardial infarction in Taiwan. *J Chin Med*
46
47 *Assoc* 2020;83(2):156-63. doi: 10.1097/JCMA.000000000000237 [published Online
48
49 First: 2019/12/14]
50
51
52
53 39. Cai H, Zheng Y, Liu Z, et al. Effect of pre-discharge cardiopulmonary fitness on outcomes
54
55 in patients with ST-elevation myocardial infarction after percutaneous coronary
56
57 intervention. *BMC Cardiovasc Disord* 2019;19(1):210. doi: 10.1186/s12872-019-1189-
58
59
60

- 1
2
3
4 x [published Online First: 2019/09/08]
5
6
7 40. Bei Y, Shi C, Zhang Z, et al. Advance for Cardiovascular Health in China. *J Cardiovasc*
8
9 *Transl Res* 2019;12(3):165-70. doi: 10.1007/s12265-018-9852-7 [published Online
10
11 First: 2018/12/12]
12
13
14 41. Ades PA, Keteyian SJ, Wright JS, et al. Increasing Cardiac Rehabilitation Participation From
15
16 20% to 70%: A Road Map From the Million Hearts Cardiac Rehabilitation Collaborative.
17
18 *Mayo Clin Proc* 2017;92(2):234-42. doi: 10.1016/j.mayocp.2016.10.014 [published
19
20 Online First: 2016/11/20]
21
22
23
24 42. Kehler DS, Kent D, Beaulac J, et al. Examining Patient Outcome Quality Indicators Based
25
26 on Wait Time From Referral to Entry Into Cardiac Rehabilitation: A PILOT
27
28 OBSERVATIONAL STUDY. *J Cardiopulm Rehabil Prev* 2017;37(4):250-56. doi:
29
30 10.1097/HCR.0000000000000232 [published Online First: 2017/02/09]
31
32
33
34 43. Gaalema DE, Savage PD, Rengo JL, et al. Financial incentives to promote cardiac
35
36 rehabilitation participation and adherence among Medicaid patients. *Prev Med*
37
38 2016;92:47-50. doi: 10.1016/j.ypmed.2015.11.032 [published Online First: 2016/10/30]
39
40
41
42 44. Grace SL, Parsons TL, Duhamel TA, et al. The quality of cardiac rehabilitation in Canada:
43
44 a report of the Canadian Cardiac Rehab Registry. *Can J Cardiol* 2014;30(11):1452-5.
45
46 doi: 10.1016/j.cjca.2014.06.016 [published Online First: 2014/12/03]
47
48
49
50 45. Harkness K, Smith KM, Taraba L, et al. Effect of a postoperative telephone intervention on
51
52 attendance at intake for cardiac rehabilitation after coronary artery bypass graft surgery.
53
54 *Heart Lung* 2005;34(3):179-86. doi: 10.1016/j.hrtlng.2004.07.010 [published Online
55
56 First: 2005/07/15]
57
58
59
60

- 1
2
3
4 46. Ohtera S, Kanazawa N, Ozasa N, et al. Proposal of quality indicators for cardiac
5
6 rehabilitation after acute coronary syndrome in Japan: a modified Delphi method and
7
8 practice test. *BMJ Open* 2017;7(1):e013036. doi: 10.1136/bmjopen-2016-013036
9
10 [published Online First: 2017/01/31]
11
12
13
14 47. Beatty AL, Li S, Thomas L, et al. Trends in referral to cardiac rehabilitation after myocardial
15
16 infarction: data from the National Cardiovascular Data Registry 2007 to 2012. *J Am*
17
18 *Coll Cardiol* 2014;63(23):2582-83. doi: 10.1016/j.jacc.2014.03.030 [published Online
19
20 First: 2014/04/29]
21
22
23
24 48. Balady GJ, Ades PA, Bittner VA, et al. Referral, enrollment, and delivery of cardiac
25
26 rehabilitation/secondary prevention programs at clinical centers and beyond: a
27
28 presidential advisory from the American Heart Association. *Circulation*
29
30 2011;124(25):2951-60. doi: 10.1161/CIR.0b013e31823b21e2 [published Online First:
31
32 2011/11/16]
33
34
35
36
37 49. Grace SL, Poirier P, Norris CM, et al. Pan-Canadian development of cardiac rehabilitation
38
39 and secondary prevention quality indicators. *Can J Cardiol* 2014;30(8):945-8. doi:
40
41 10.1016/j.cjca.2014.04.003 [published Online First: 2014/07/30]
42
43
44
45 50. Van Engen-Verheul M, Kemps H, Kraaijenhagen R, et al. Modified Rand method to derive
46
47 quality indicators: a case study in cardiac rehabilitation. *Stud Health Technol Inform*
48
49 2011;169:88-92. [published Online First: 2011/09/07]
50
51
52
53 51. Grace SL, Russell KL, Reid RD, et al. Effect of cardiac rehabilitation referral strategies on
54
55 utilization rates: a prospective, controlled study. *Arch Intern Med* 2011;171(3):235-41.
56
57 doi: 10.1001/archinternmed.2010.501 [published Online First: 2011/02/18]
58
59
60

- 1
2
3
4 52. Grace SL, Tan Y, Oh P, et al. Feasibility of Assessing 2 Cardiac Rehabilitation Quality
5
6 Indicators. *J Cardiopulm Rehabil Prev* 2016;36(2):112-6. doi:
7
8
9 10.1097/HCR.000000000000136 [published Online First: 2015/08/08]
10
11
12 53. Thomas RJ, Chiu JS, Goff DC, Jr., et al. Reliability of abstracting performance measures:
13
14 results of the cardiac rehabilitation referral and reliability (CR3) project. *J Cardiopulm*
15
16 *Rehabil Prev* 2014;34(3):172-9. doi: 10.1097/HCR.000000000000048 [published
17
18 Online First: 2014/03/08]
19
20
21
22 54. Reid RD, Morrin LI, Beaton LJ, et al. Randomized trial of an internet-based computer-
23
24 tailored expert system for physical activity in patients with heart disease. *Eur J Prev*
25
26 *Cardiol* 2012;19(6):1357-64. doi: 10.1177/1741826711422988 [published Online First:
27
28 2011/09/10]
29
30
31
32 55. Hamm LF, Kavanagh T, Campbell RB, et al. Timeline for peak improvements during 52
33
34 weeks of outpatient cardiac rehabilitation. *J Cardiopulm Rehabil* 2004;24(6):374-80;
35
36 quiz 81-2. doi: 10.1097/00008483-200411000-00002 [published Online First:
37
38 2005/01/06]
39
40
41
42
43 56. Hu D. [Bright beginning of Chinese cardiac rehabilitation post a rough road]. *Zhonghua Xin*
44
45 *Xue Guan Bing Za Zhi* 2015;43(2):118. [published Online First: 2015/04/25]
46
47
48 57. Kotter T, Blozik E, Scherer M. Methods for the guideline-based development of quality
49
50 indicators--a systematic review. *Implement Sci* 2012;7:21. doi: 10.1186/1748-5908-7-
51
52 21 [published Online First: 2012/03/23]
53
54
55
56 58. Chen J, Tong Y, Cheng Y, et al. Establishment and Empirical Evaluation of a Quality
57
58 Indicator System for Postoperative Pain Management. *Pain Med* 2020 doi:
59
60

- 1
2
3
4 10.1093/pm/pnaa221 [published Online First: 2020/10/12]
5
6
7 59. van der Velden AW, van Triest MI, Schoffelen AF, et al. Structural Antibiotic Surveillance
8
9 and Stewardship via Indication-Linked Quality Indicators: Pilot in Dutch Primary Care.
10
11 *Antibiotics (Basel)* 2020;9(10) doi: 10.3390/antibiotics9100670 [published Online First:
12
13 2020/10/08]
14
15
16
17 60. Montesano M, Reed JL, Tulloch HE, et al. Cardiac rehabilitation is associated with greater
18
19 improvements in psychological health following coronary artery bypass graft surgery
20
21 when compared to percutaneous coronary intervention. *Appl Physiol Nutr Metab* 2020
22
23 doi: 10.1139/apnm-2020-0213 [published Online First: 2020/06/17]
24
25
26
27 61. Chockalingam P, Rajaram A, Maiya A, et al. A multicentre retrospective study on quality
28
29 and outcomes of cardiac rehabilitation programs in India. *Indian Heart J* 2020;72(1):55-
30
31 57. doi: 10.1016/j.ihj.2020.03.002 [published Online First: 2020/05/20]
32
33
34
35 62. Thomas E, O'Neil A. Considerations for Developing Quality Indicators for Cardiac
36
37 Rehabilitation in Australia. *Heart Lung Circ* 2020;29(1):e12-e13. doi:
38
39 10.1016/j.hlc.2018.11.009 [published Online First: 2019/12/21]
40
41
42
43 63. Backhouse A, Ogunlayi F. Quality improvement into practice. *BMJ* 2020;368:m865. doi:
44
45 10.1136/bmj.m865 [published Online First: 2020/04/03]
46
47
48 64. Rosengren A, Wallentin L. Cardiovascular Medicine in Sweden: Improvement by
49
50 Continuous Measuring. *Circulation* 2020;141(14):1124-26. doi:
51
52 10.1161/CIRCULATIONAHA.119.041280 [published Online First: 2020/04/07]
53
54
55
56 65. Podlogar MAC, Dolansky MA. Cardiac Rehabilitation as Part of Management in Postacute
57
58 Care: Opportunities for Improving Care. *Clin Geriatr Med* 2019;35(4):561-69. doi:
59
60

- 1
2
3
4 10.1016/j.cger.2019.07.010 [published Online First: 2019/09/24]
5
6
7 66. Pesah E, Supervia M, Turk-Adawi K, et al. A Review of Cardiac Rehabilitation Delivery
8
9 Around the World. *Prog Cardiovasc Dis* 2017;60(2):267-80. doi:
10 10.1016/j.pcad.2017.08.007 [published Online First: 2017/08/29]
11
12
13
14 67. Bjarnason-Wehrens B, McGee H, Zwisler AD, et al. Cardiac rehabilitation in Europe: results
15
16 from the European Cardiac Rehabilitation Inventory Survey. *Eur J Cardiovasc Prev*
17
18 *Rehabil* 2010;17(4):410-8. doi: 10.1097/HJR.0b013e3283334f42d [published Online
19
20 First: 2010/03/20]
21
22
23
24
25 68. Grace SL, Gravely-Witte S, Brual J, et al. Contribution of patient and physician factors to
26
27 cardiac rehabilitation enrollment: a prospective multilevel study. *Eur J Cardiovasc Prev*
28
29 *Rehabil* 2008;15(5):548-56. doi: 10.1097/HJR.0b013e328305df05 [published Online
30
31 First: 2008/10/03]
32
33
34
35 69. Nery RM, Zanini M, de Lima JB, et al. Tai Chi Chuan improves functional capacity after
36
37 myocardial infarction: A randomized clinical trial. *Am Heart J* 2015;169(6):854-60. doi:
38
39 10.1016/j.ahj.2015.01.017 [published Online First: 2015/06/02]
40
41
42
43 70. Mao S, Zhang X, Shao B, et al. Baduanjin Exercise Prevents post-Myocardial Infarction Left
44
45 Ventricular Remodeling (BE-PREMIER trial): Design and Rationale of a Pragmatic
46
47 Randomized Controlled Trial. *Cardiovasc Drugs Ther* 2016;30(3):315-22. doi:
48
49 10.1007/s10557-016-6660-7 [published Online First: 2016/04/24]
50
51
52
53 71. Mao S, Zhang X, Chen M, et al. Beneficial Effects of Baduanjin Exercise on Left Ventricular
54
55 Remodelling in Patients after Acute Myocardial Infarction: an Exploratory Clinical Trial
56
57 and Proteomic Analysis. *Cardiovasc Drugs Ther* 2020 doi: 10.1007/s10557-020-
58
59
60

1
2
3
4 07047-0 [published Online First: 2020/08/08]
5

6 72. Chen MG, Liang X, Kong L, et al. Effect of Baduanjin Sequential Therapy on the Quality of
7
8 Life and Cardiac Function in Patients with AMI After PCI: A Randomized Controlled
9
10 Trial. *Evid Based Complement Alternat Med* 2020;2020:8171549. doi:
11
12 10.1155/2020/8171549 [published Online First: 2020/07/28]
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

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.

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.

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46

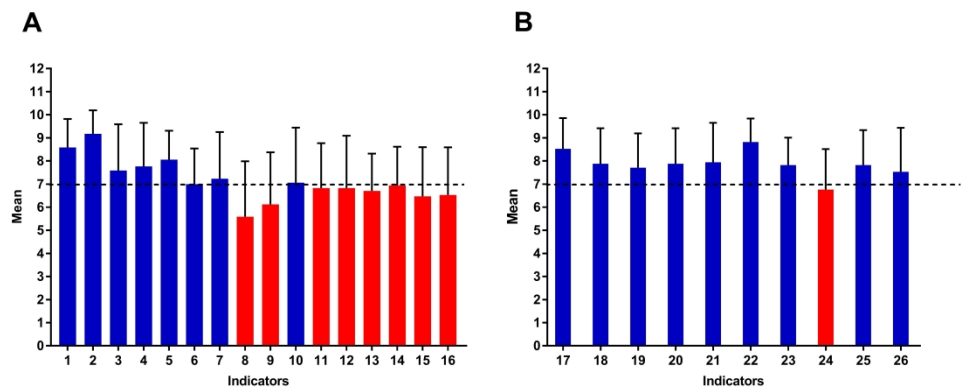
Indicators	Numerator/ denominator	Importance (%)
Top 1: automatically referring all eligible patients at the time of discharge	42/89	47.2
Top 2: recommending CR in discharge guidance	34/89	38.2
Top 3: prescribing exercise based on an assessment of physical fitness	25/89	28.1
Top 4: employing full-time 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

For peer review only

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60



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)

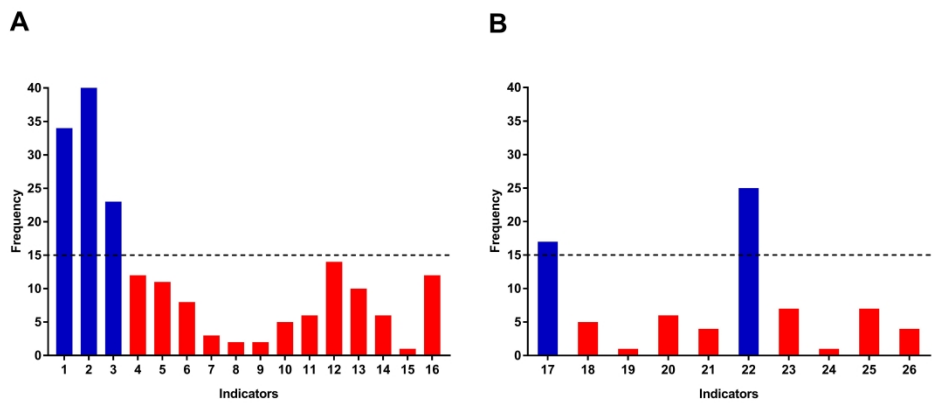
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60



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

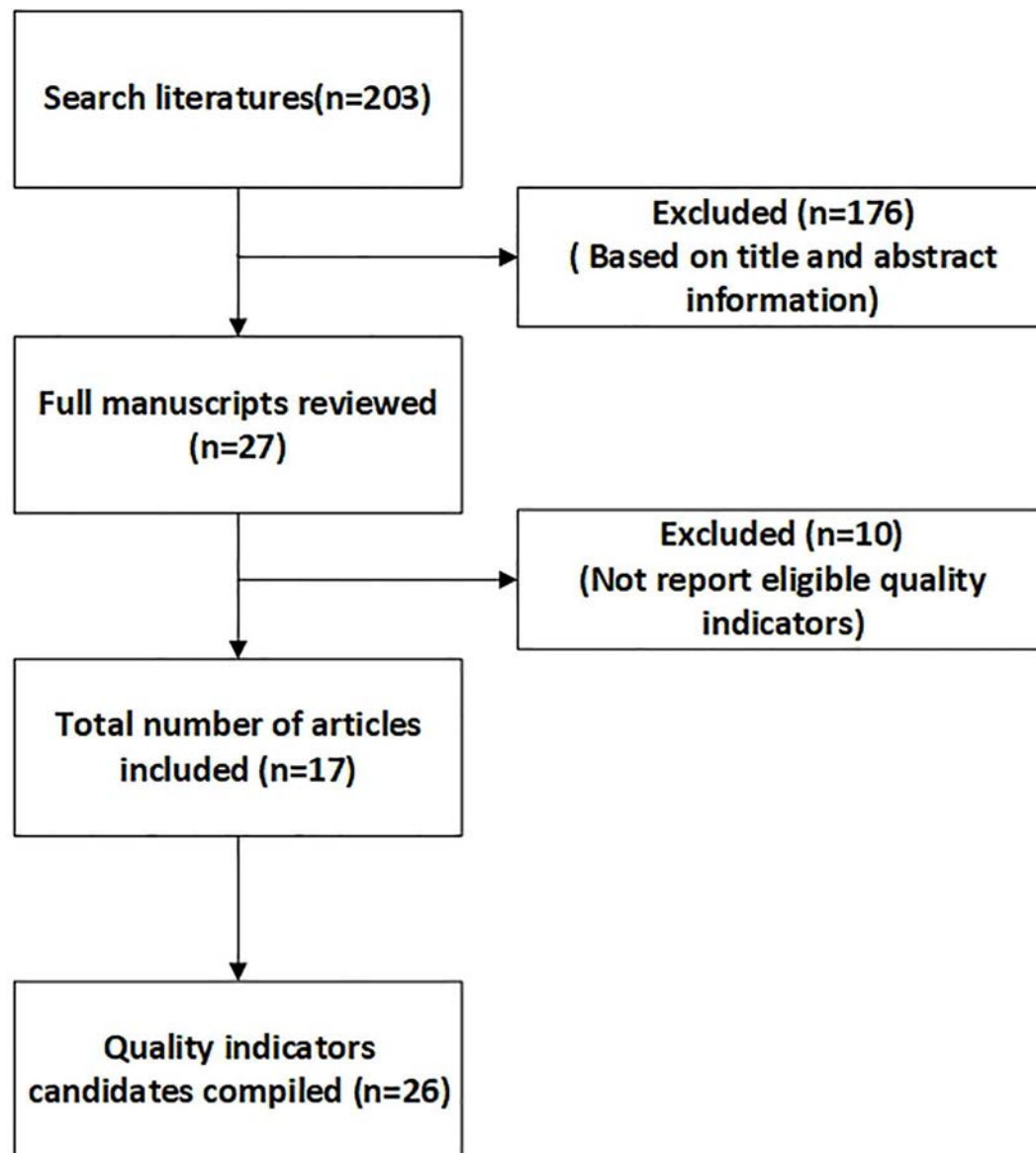
254x190mm (300 x 300 DPI)

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

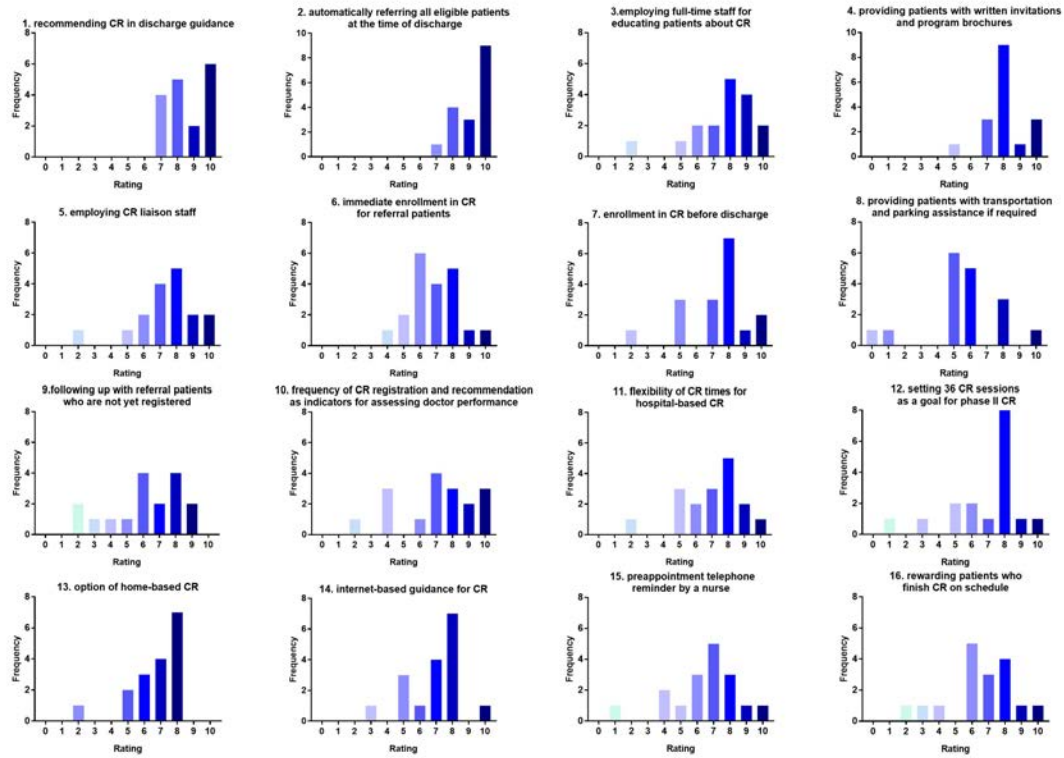


Quality indicators from the national questionnaires that were identified as needing immediate improvement (blue).

262x114mm (600 x 600 DPI)

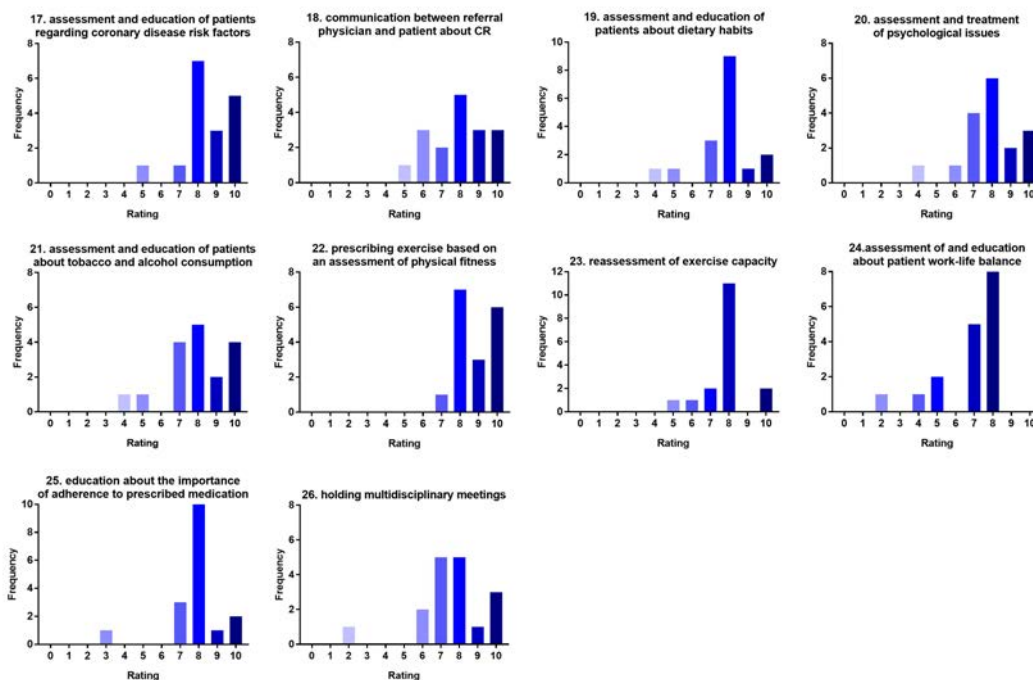
Supplementary Figure 1

Supplementary Figure 2



Review only

Supplementary Figure 3



review only

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.		

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

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

BMJ Open

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

Journal:	<i>BMJ Open</i>
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
Primary Subject Heading:	Cardiovascular medicine
Secondary Subject Heading:	Cardiovascular medicine
Keywords:	Myocardial infarction < CARDIOLOGY, REHABILITATION MEDICINE, Coronary heart disease < CARDIOLOGY

SCHOLARONE™
Manuscripts



I, the Submitting Author has the right to grant and does grant on behalf of all authors of the Work (as defined in the below author licence), an exclusive licence and/or a non-exclusive licence for contributions from authors who are: i) UK Crown employees; ii) where BMJ has agreed a CC-BY licence shall apply, and/or iii) in accordance with the terms applicable for US Federal Government officers or employees acting as part of their official duties; on a worldwide, perpetual, irrevocable, royalty-free basis to BMJ Publishing Group Ltd ("BMJ") its licensees and where the relevant Journal is co-owned by BMJ to the co-owners of the Journal, to publish the Work in this journal and any other BMJ products and to exploit all rights, as set out in our [licence](#).

The Submitting Author accepts and understands that any supply made under these terms is made by BMJ to the Submitting Author unless you are acting as an employee on behalf of your employer or a postgraduate student of an affiliated institution which is paying any applicable article publishing charge ("APC") for Open Access articles. Where the Submitting Author wishes to make the Work available on an Open Access basis (and intends to pay the relevant APC), the terms of reuse of such Open Access shall be governed by a Creative Commons licence – details of these licences and which [Creative Commons](#) licence will apply to this Work are set out in our licence referred to above.

Other than as permitted in any relevant BMJ Author's Self Archiving Policies, I confirm this Work has not been accepted for publication elsewhere, is not being considered for publication elsewhere and does not duplicate material already published. I confirm all authors consent to publication of this Work and authorise the granting of this licence.

1
2
3 **Quality indicators for cardiac rehabilitation after myocardial infarction in China: a consensus**
4 **panel and practice test**
5

6 Xianghui Zheng^{1,2#}, Maomao Zhang^{1,2#}, Yang Zheng^{1,2}, Yongxiang Zhang^{1,2}, Junnan Wang³, Ping
7 Zhang⁴, Xuwen Yang⁵, Shan Li⁶, Rongjing Ding⁷, Gaowa Siqin⁸, Xinyu Hou^{1,2}, Liangqi Chen^{1,2},
8 Min Zhang^{1,2}, Yong Sun^{1,2}, Jian Wu^{1,2*}, Bo Yu^{1,2}
9
10

11
12 ¹ Department of Cardiology, the Second Affiliated Hospital of Harbin Medical University, Harbin,
13 Heilongjiang Province, China

14 ² The Key Laboratory of Myocardial Ischemia, Harbin Medical University, Ministry of Education,
15 Harbin, Heilongjiang Province, China

16 ³ Department of Cardiology, the Second Hospital of Jilin University, Changchun, Jilin Province,
17 China

18 ⁴ Department of Cardiology, Beijing Tsinghua Changgung Hospital, Beijing, China

19 ⁵ Department of Cardiology, Tianjin Chest Hospital, Tianjin Cancer Hospital, Tianjin, China

20 ⁶ Department of Cardiology, Affiliated Hospital of Qingdao University, Qingdao, China

21 ⁷ Department of Cardiology, Peking University People's Hospital, Beijing, China

22 ⁸ Department of Cardiology, Inner Mongolia People's Hospital, Inner Mongolia, China

23
24
25 * Corresponding author: Jian Wu, Department of Cardiology, the Second Affiliated Hospital
26 of Harbin Medical University, No. 246, Xuefu Road, Nangang District, Harbin, China.

27 E-mail address: wujian780805@163.com
28
29

30
31
32
33 # These authors contributed equally to this work.
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

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.

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 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.^{18 19}

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

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

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

1
2
3 experience and determining the final QIs for CR in post-MI patients.
4

5 **Scoring method and selection criteria**

6
7 The candidate QIs generated from the literature were scored on a ten-point scale. Scoring criteria
8 were based on four aspects: whether they were evidence-based, the feasibility of implementation,
9 their validity, and reliability. The QIs were judged according to the clinical experience of the
10 consensus panel. The four criteria were used to generate one score. QIs that received scores ≥ 7 and
11 were considered to be significant in the improvement of CR were included in the study. QIs with
12 < 7 but > 5 points were not considered in this study, and QIs with < 5 points were excluded. A QI was
13 considered acceptable for improving the quality of CR in post-MI Chinese patients based on its
14 average score.
15
16
17
18

19 **National questionnaire**

20
21 A questionnaire-based survey was conducted nationwide by either telephone or WeChat (a
22 communication tool in China). Participants included cardiologists, nurses, physical therapists,
23 clinical psychologists, registered dietitians and follow-up staff caring for CR patients (health
24 managers who follow up patients via telephone, etc.) who met the following criteria: (1) working in
25 an established CR center; and (2) at least 1 year of experience in CR. J Wu and Y Zhang conducted
26 a questionnaire-based survey with the participants. The participants were asked to select 3 out of 26
27 candidate QIs that they felt required urgent improvement to allow the selection of the top 5 QIs that
28 required immediate improvement in China. The top 5 most important QIs were determined based
29 on the frequency selected by the participants. Additionally, participants could suggest new QIs
30 outside of those mentioned in the questionnaire.
31
32
33
34
35

36 **Practice test**

37
38 A practice test was performed to review the adaptability of each QI before implementation due
39 to differences in healthcare systems and social circumstances, such as the size of the CR center and
40 patient education, to assess the completion rate of the proposed QIs selected by the consensus panel.
41 The patient inclusion criteria were as follows: (1) a history of AMI; (2) completion of phase I and
42 II CR at one of the 5 teaching hospitals (Beijing Tsinghua Changgung Hospital, the Second
43 Hospital of Jilin University, Tianjin Chest Hospital and Affiliated Hospital of Qingdao University
44 and the Second Affiliated Hospital of Harbin Medical University) between September 3, 2018 and
45 October 31, 2019; and (3) consent to participate in the study. Patients filled out a 17-question
46 questionnaire (Supplementary Table 1) about the proposed QIs that was developed specifically for
47 this study and evaluated whether the CR center implemented the proposed QIs. The patients did not
48 answer if they were unsure or did not understand the question. In addition, the consensus panel
49 unanimously agreed that a score greater than 70% was considered good performance, whereas a
50 score less than 30% was considered a poor performance. The questionnaire was approved by the
51 ethics committees of the 5 teaching hospitals.
52
53
54
55
56
57

58 **Patient and public involvement**

1
2
3 Patients and the public were not involved in the design of the study.
4

5 **Data collection and analysis**

6
7 Two authors (XZ and YZ) were responsible for data collection and cross-checking. The mean
8 score of each QI was calculated as the sum of all participants' ratings/number of participants. The
9 percentage score for each QIs was calculated as follows: the number of times the QI was
10 achieved/the number of participants (excluding participants who did not answer)×100. The mean
11 performance was the average of the percentages of all quality indicators.
12
13
14
15
16
17

18 **Results**

19 **Collection of QIs**

20
21 A review of the literature identified 203 articles, and after screening the titles and abstracts, 176
22 were excluded, as they were not related to QIs for CR. After the full-text screening, 17 articles were
23 eligible and subsequently included.^{34 36 41-55} A list of 26 potential QIs, including 16 regarding the
24 improvement of the CR participation and adherence rates and 10 regarding the standardization of
25 the CR processes, was generated (Supplementary Table 2). A flowchart of the literature search and
26 selection of eligible articles is shown in Supplementary Figure 1.
27
28
29
30
31

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

33
34 The consensus panel included 17 experts in the field of CR from 12 CR centers (Supplementary
35 Table 3). Seventeen experts who met the inclusion criteria were cardiologists and individually rated
36 each QI on a ten-point scale. The rating of each QI is shown in Supplementary Figures 2 and 3.
37 After careful evaluation, only QIs with an average score ≥ 7 that could potentially improve the
38 quality of CR in China were accepted (Figure 1). Finally, a total of 17 QIs were selected and divided
39 into two domains: (1) improving participation and adherence and (2) standardizing CR processes
40 (Table 1). There were two more supplementary indicators: extending the hospital rehabilitation time
41 and strengthening the application of traditional Chinese sports.
42
43
44
45

46 **National questionnaire and top five QIs for imminent improvement**

47
48 Eighty-nine professionals met the national survey participation criteria; among them, 60 people
49 participated in a telephone survey, and 29 people participated in a WeChat survey. The survey
50 response rate was 100%. The 89 participants from 4 municipalities and 18 provinces in China
51 included 21 cardiologists, 15 nurses, 18 physical therapists, 11 clinical psychologists, 13 registered
52 dietitians and 11 health follow-up staff. Each participant selected three QIs considered critical to
53 improving post-MI CR in China (Figures 2 and 3). The results showed that the five most important
54 QIs were 'automatically referring all eligible patients at the time of discharge', 'recommending CR
55 in discharge guidance', 'prescribing exercise based on an assessment of physical fitness',
56 'employing full-time staff for educating patients about CR', and 'assessment and education of
57
58
59
60

1
2
3 patients regarding coronary disease risk factors' (Table 2), with score ratios of 47.2%, 38.2%, 28.1%,
4 25.8% and 19.1%, respectively.
5
6

7 **Practice test**

8
9 The practice test was completed by 165 patients who met the inclusion criteria, and no patients
10 refused to participate in the study (30 patients from Beijing Tsinghua Changgung Hospital, 30
11 patients from the Second Hospital of Jilin University, 34 patients from Tianjin Chest Hospital, 30
12 patients from Affiliated Hospital of Qingdao University and 41 patients from the Second Affiliated
13 Hospital of Harbin Medical University). The results revealed a mean performance value of 43.9%
14 (9.9-86.1%). The QIs that achieved good performance (minimum to maximum 72.1-86.1%) were
15 'assessment and education of patients on tobacco and alcohol consumption' and 'recommending
16 CR in discharge guidance'. There were also several low-performing QIs (minimum to maximum
17 9.9-29.7%), including 'holding multidisciplinary meetings, 'frequency of CR registration and
18 recommendation as QIs for assessing doctor performance', 'immediate enrollment in CR for referral
19 patients', and 'providing patients with written invitations and program brochures' (Table 1).
20
21
22
23
24
25
26

27 **Discussion**

28
29 In this study, 26 QIs generated from 17 articles were assessed as candidate QIs for CR. Out of
30 the 26 QIs, 17 were selected by a Chinese expert consensus panel and divided into two domains
31 based on participation and adherence and CR process standardization. The findings of the
32 nationwide questionnaire could guide clinical quality improvement. The practice test showed the
33 feasibility and applicability of all 17 QIs in the Chinese context.
34
35

36
37 This is, to the best of our knowledge, the first study proposing an immediate improvement in CR
38 QIs on the basis of the results of a nationwide survey and the implementation of improvement
39 guidelines for CR in China. However, although still in its infancy, CR in China has developed
40 rapidly. According to data published by the Chinese Society of Rehabilitation Medicine (CARM),
41 the number of CR centers has increased from 6 in 2012 to more than 500 currently.⁵⁶ Hence, the
42 improved implementation of CR programs is imperative, given the current situation. We consider
43 that QI development is a time-efficient and resource-saving approach.⁵⁷ In many countries, CR is
44 strongly associated with quality of life improvement. For example, the USA has effectively
45 implemented QI monitoring to increase the CR participation rate.⁴¹ Similarly, Canada has developed
46 QIs to promote the broad development of CR programs,⁴⁴ and Japan has also proposed QIs to assess
47 improvements in the quality of CR after acute coronary syndrome (ACS).⁴⁶ Moreover, the EAPC
48 described QIs to assess improvements in the CR process standardization in Europe.³³ In this study,
49 we propose QIs to promote the improvement of CR in China considering the recommendations
50 reported in these previous studies.
51
52
53
54
55

56
57 CR is still in the early phase of development in China.⁴⁰ Given the uneven distribution of CR
58 programs, the consensus panel selected QIs to promote improvements in participation and adherence
59 that were simple, practical and in line with the current status of CR in the country. For example, the
60

1
2
3
4 present report suggests that ‘recommending CR in discharge guidance’ was key in emphasizing the
5 importance and necessity of CR, and ‘automatically referring all eligible patients ‘at the time of
6 discharge’ was one of the best ways to increase participation in CR. Other suitable QIs were
7 ‘employing full-time staff for educating patients about CR’ and ‘employing CR liaison staff’. In
8 addition, the study revealed QIs that are necessary for CR process standardization in China, such as
9 ‘assessment and education of patients regarding coronary disease risk factors’, ‘assessment and
10 education of patients about dietary habits’, and ‘prescribing exercise based on physical fitness’. It
11 is worth mentioning that the completion rate of ‘holding multidisciplinary meetings’ was very low
12 in the practice test, but the implementation of this QI can improve recovery in patients with multiple
13 diseases.^{29 58 59} Moreover, measuring the completion rate of the proposed QIs is important.⁶⁰⁻⁶² There
14 are some measurement methods. First, QIs should be recorded in the medical record. In this way,
15 the completion of the QIs can be checked. Second, from the perspective of patients, a questionnaire
16 about the implementation of QIs was conducted at discharge. Relevant medical staff should be
17 evaluated by self-assessment and other assessment scales. In addition, clinical audits, a method of
18 establishing whether healthcare is being provided in line with the relevant standards and identifying
19 areas for improvements, should be performed.⁶³ CR programs could be improved by continuous
20 assessment.⁶⁴

21
22
23
24
25
26
27
28 It is also important to understand the barriers to appropriate CR, including lack of health
29 awareness, inadequate policies, insufficiency of CR, lack of healthcare system support and
30 inadequate professional guidelines and information systems.⁶⁵⁻⁶⁷ Gary et al. reported that older
31 females with low socioeconomic status, with a low education level, with poor self-efficacy, with
32 multiple comorbidities and without the ability to communicate in English were more likely to not
33 participate in CR.⁴⁸ Enrollment in the CR program is affected by many healthcare system-related
34 factors, including lack of referral, limited facilitation of enrollment after referral, lack of programs
35 that serve specific geographic areas and low-income communities, and gender-dominated
36 programs.⁶⁸ In this study, we proposed QIs that could aid in overcoming some of these barriers and
37 also in the successful implementation of CR.

38
39
40
41
42 During the course of the study, two additional supplementary indicators, ‘extending the hospital
43 rehabilitation time’ and ‘strengthening the application of traditional Chinese exercise’, were added.
44 Tai Chi Chuan practice was associated with a VO₂ peak increase in patients with MI.⁶⁹ Baduanjin
45 exercise therapy in post-MI patients reduced adverse left ventricular (LV) remodeling and was
46 associated with beneficial effects in terms of inflammation and extracellular matrix organization.⁷⁰
47
48
49
50
51
52
53
54
55
56
57
58
59
60
71
72
73
74
75
76
77
78
79
80
81
82
83
84
85
86
87
88
89
90
91
92
93
94
95
96
97
98
99
100
101
102
103
104
105
106
107
108
109
110
111
112
113
114
115
116
117
118
119
120
121
122
123
124
125
126
127
128
129
130
131
132
133
134
135
136
137
138
139
140
141
142
143
144
145
146
147
148
149
150
151
152
153
154
155
156
157
158
159
160
161
162
163
164
165
166
167
168
169
170
171
172
173
174
175
176
177
178
179
180
181
182
183
184
185
186
187
188
189
190
191
192
193
194
195
196
197
198
199
200
201
202
203
204
205
206
207
208
209
210
211
212
213
214
215
216
217
218
219
220
221
222
223
224
225
226
227
228
229
230
231
232
233
234
235
236
237
238
239
240
241
242
243
244
245
246
247
248
249
250
251
252
253
254
255
256
257
258
259
260
261
262
263
264
265
266
267
268
269
270
271
272
273
274
275
276
277
278
279
280
281
282
283
284
285
286
287
288
289
290
291
292
293
294
295
296
297
298
299
300
301
302
303
304
305
306
307
308
309
310
311
312
313
314
315
316
317
318
319
320
321
322
323
324
325
326
327
328
329
330
331
332
333
334
335
336
337
338
339
340
341
342
343
344
345
346
347
348
349
350
351
352
353
354
355
356
357
358
359
360
361
362
363
364
365
366
367
368
369
370
371
372
373
374
375
376
377
378
379
380
381
382
383
384
385
386
387
388
389
390
391
392
393
394
395
396
397
398
399
400
401
402
403
404
405
406
407
408
409
410
411
412
413
414
415
416
417
418
419
420
421
422
423
424
425
426
427
428
429
430
431
432
433
434
435
436
437
438
439
440
441
442
443
444
445
446
447
448
449
450
451
452
453
454
455
456
457
458
459
460
461
462
463
464
465
466
467
468
469
470
471
472
473
474
475
476
477
478
479
480
481
482
483
484
485
486
487
488
489
490
491
492
493
494
495
496
497
498
499
500
501
502
503
504
505
506
507
508
509
510
511
512
513
514
515
516
517
518
519
520
521
522
523
524
525
526
527
528
529
530
531
532
533
534
535
536
537
538
539
540
541
542
543
544
545
546
547
548
549
550
551
552
553
554
555
556
557
558
559
560
561
562
563
564
565
566
567
568
569
570
571
572
573
574
575
576
577
578
579
580
581
582
583
584
585
586
587
588
589
590
591
592
593
594
595
596
597
598
599
600
601
602
603
604
605
606
607
608
609
610
611
612
613
614
615
616
617
618
619
620
621
622
623
624
625
626
627
628
629
630
631
632
633
634
635
636
637
638
639
640
641
642
643
644
645
646
647
648
649
650
651
652
653
654
655
656
657
658
659
660
661
662
663
664
665
666
667
668
669
670
671
672
673
674
675
676
677
678
679
680
681
682
683
684
685
686
687
688
689
690
691
692
693
694
695
696
697
698
699
700
701
702
703
704
705
706
707
708
709
710
711
712
713
714
715
716
717
718
719
720
721
722
723
724
725
726
727
728
729
730
731
732
733
734
735
736
737
738
739
740
741
742
743
744
745
746
747
748
749
750
751
752
753
754
755
756
757
758
759
760
761
762
763
764
765
766
767
768
769
770
771
772
773
774
775
776
777
778
779
780
781
782
783
784
785
786
787
788
789
790
791
792
793
794
795
796
797
798
799
800
801
802
803
804
805
806
807
808
809
810
811
812
813
814
815
816
817
818
819
820
821
822
823
824
825
826
827
828
829
830
831
832
833
834
835
836
837
838
839
840
841
842
843
844
845
846
847
848
849
850
851
852
853
854
855
856
857
858
859
860
861
862
863
864
865
866
867
868
869
870
871
872
873
874
875
876
877
878
879
880
881
882
883
884
885
886
887
888
889
890
891
892
893
894
895
896
897
898
899
900
901
902
903
904
905
906
907
908
909
910
911
912
913
914
915
916
917
918
919
920
921
922
923
924
925
926
927
928
929
930
931
932
933
934
935
936
937
938
939
940
941
942
943
944
945
946
947
948
949
950
951
952
953
954
955
956
957
958
959
960
961
962
963
964
965
966
967
968
969
970
971
972
973
974
975
976
977
978
979
980
981
982
983
984
985
986
987
988
989
990
991
992
993
994
995
996
997
998
999
1000

57 In summary, the application of these QIs could help standardize and improve the quality of CR
58 in China. This study provides guidance for the development of CR in our country. Nevertheless,
59 further studies are needed to evaluate the validity, reliability and feasibility of these QIs and to
60

1
2
3 determine whether improvements in these parameters are associated with clinical benefits in this
4 patient population.
5
6
7

8 9 **Study limitations**

10
11 There are many limitations of our study. First, in the QI development section of the methods, we
12 retrieved the literature from public databases; hence, there is a possibility of publication bias. Second,
13 investigation bias may exist because the consensus panel participants were all cardiologists and the
14 national questionnaire was not distributed to all regions and CR centers in the country. The baseline
15 characteristics were not collected for the professionals in the national questionnaire, and no specific
16 calculation was performed to determine the sample size needed for the national questionnaire. These
17 factors may also lead to bias in the results of the practice test due to the absence of data from
18 nonteaching hospitals, the relatively small sample size and the lack of data concerning baseline
19 characteristics of the patients (i.e. sex, age, marital status, cardiovascular risk factors, prior history
20 of myocardial infarction, ST-segment or non-ST-segment elevation MI, LV ejection fraction,
21 percutaneous coronary intervention, coronary artery bypass grafting, medication, etc.). Moreover,
22 to assess the measurability and completeness of the proposed QIs, only patients who participated in
23 CR programs were selected to complete the practice test. As such, data from those who did not
24 participate in these programs were not available.
25
26
27
28
29
30
31
32

33 **Conclusion**

34
35 In this study, a consensus panel identified 17 candidate QIs to assess improvements in the quality
36 of CR in post-MI patients in China. A nationwide survey revealed the 5 QIs that required imminent
37 improvement to facilitate increased enrollment in CR programs in the country. Moreover, a practice
38 test administered to MI survivors confirmed the feasibility and completeness of the developed QIs.
39 The application of the proposed QIs could improve the quality of CR care in Chinese post-MI
40 patients.
41
42
43
44
45
46

47 **Acknowledgments**

48
49 The authors are grateful to the members of the consensus panel, the staff who participated in the
50 national questionnaire, and the patients who completed the practice test. Our deepest gratitude goes
51 to the reviewers and the editor for their careful work and thoughtful suggestions that have helped
52 substantially improve the quality of this paper.
53
54

55 **Author contribution**

56
57 All authors contributed to the conception and design of the work. XZ and YZheng contributed to
58 the analysis and interpretation. JWu, YZhang, JWang, PZ, XY, SL, RD, GS, BY and YS contributed
59 to the acquisition of the data. XZ and MaoZ drafted the manuscript. MinZ, XH and LC critically
60

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.

References

1. Reed GW, Rossi JE, Cannon CP. Acute myocardial infarction. *Lancet* 2017;389(10065):197-210. doi: 10.1016/S0140-6736(16)30677-8 [published Online First: 2016/08/10]
2. Dagenais GR, Leong DP, Rangarajan S, et al. Variations in common diseases, hospital admissions, and deaths in middle-aged adults in 21 countries from five continents (PURE): a prospective cohort study. *Lancet* 2020;395(10226):785-94. doi: 10.1016/S0140-6736(19)32007-0 [published Online First: 2019/09/08]
3. Piepoli MF, Corra U, Dendale P, et al. Challenges in secondary prevention after acute myocardial infarction: A call for action. *Eur Heart J Acute Cardiovasc Care* 2017;6(4):299-310. doi:

- 1
2
3 10.1177/2048872616689773 [published Online First: 2017/06/14]
4
5 4. Ma LY, Chen WW, Gao RL, et al. China cardiovascular diseases report 2018: an updated
6 summary. *J Geriatr Cardiol* 2020;17(1):1-8. doi: 10.11909/j.issn.1671-5411.2020.01.001
7 [published Online First: 2020/03/07]
8
9 5. Jiang Z, Dreyer RP, Spertus JA, et al. Factors Associated With Return to Work After Acute
10 Myocardial Infarction in China. *JAMA Netw Open* 2018;1(7):e184831. doi:
11 10.1001/jamanetworkopen.2018.4831 [published Online First: 2019/01/16]
12
13 6. Ambrosetti M, Abreu A, Corra U, et al. Secondary prevention through comprehensive
14 cardiovascular rehabilitation: From knowledge to implementation. 2020 update. A position
15 paper from the Secondary Prevention and Rehabilitation Section of the European
16 Association of Preventive Cardiology. *Eur J Prev Cardiol* 2020:2047487320913379. doi:
17 10.1177/2047487320913379 [published Online First: 2020/04/01]
18
19 7. Anderson L, Oldridge N, Thompson DR, et al. Exercise-Based Cardiac Rehabilitation for
20 Coronary Heart Disease: Cochrane Systematic Review and Meta-Analysis. *J Am Coll*
21 *Cardiol* 2016;67(1):1-12. doi: 10.1016/j.jacc.2015.10.044 [published Online First:
22 2016/01/15]
23
24 8. Salzwedel A, Jensen K, Rauch B, et al. Effectiveness of comprehensive cardiac rehabilitation in
25 coronary artery disease patients treated according to contemporary evidence based
26 medicine: Update of the Cardiac Rehabilitation Outcome Study (CROS-II). *Eur J Prev*
27 *Cardiol* 2020:2047487320905719. doi: 10.1177/2047487320905719 [published Online
28 First: 2020/02/25]
29
30 9. Hermann M, Witassek F, Erne P, et al. Impact of cardiac rehabilitation referral on one-year
31 outcome after discharge of patients with acute myocardial infarction. *Eur J Prev Cardiol*
32 2019;26(2):138-44. doi: 10.1177/2047487318807766 [published Online First: 2018/10/20]
33
34 10. Lee BJ, Go JY, Kim AR, et al. Quality of Life and Physical Ability Changes After Hospital-
35 Based Cardiac Rehabilitation in Patients With Myocardial Infarction. *Ann Rehabil Med*
36 2017;41(1):121-28. doi: 10.5535/arm.2017.41.1.121 [published Online First: 2017/03/16]
37
38 11. Ribeiro F, Oliveira NL, Silva G, et al. Exercise-based cardiac rehabilitation increases daily
39 physical activity of patients following myocardial infarction: subanalysis of two
40 randomised controlled trials. *Physiotherapy* 2017;103(1):59-65. doi:
41 10.1016/j.physio.2015.12.002 [published Online First: 2016/03/26]
42
43 12. Schwaab B, Zeymer U, Jannowitz C, et al. Improvement of low-density lipoprotein cholesterol
44 target achievement rates through cardiac rehabilitation for patients after ST elevation
45 myocardial infarction or non-ST elevation myocardial infarction in Germany: Results of
46 the PATIENT CARE registry. *Eur J Prev Cardiol* 2019;26(3):249-58. doi:
47 10.1177/2047487318817082 [published Online First: 2018/12/05]
48
49 13. Tsai YJ, Li MH, Chen CH, et al. Improved oxygen uptake efficiency slope in acute myocardial
50 infarction patients after early phase I cardiac rehabilitation. *Int J Rehabil Res*
51 2017;40(3):215-19. doi: 10.1097/MRR.0000000000000229 [published Online First:
52 2017/04/15]
53
54 14. Hambrecht R, Wolf A, Gielen S, et al. Effect of exercise on coronary endothelial function in
55 patients with coronary artery disease. *N Engl J Med* 2000;342(7):454-60. doi:
56 10.1056/NEJM200002173420702 [published Online First: 2000/02/17]
57
58 15. Vanhees L, Fagard R, Thijs L, et al. Prognostic value of training-induced change in peak exercise
59
60

- capacity in patients with myocardial infarcts and patients with coronary bypass surgery. *Am J Cardiol* 1995;76(14):1014-9. doi: 10.1016/s0002-9149(99)80287-2 [published Online First: 1995/11/15]
16. Gevaert AB, Adams V, Bahls M, et al. Towards a personalised approach in exercise-based cardiovascular rehabilitation: How can translational research help? A 'call to action' from the Section on Secondary Prevention and Cardiac Rehabilitation of the European Association of Preventive Cardiology. *Eur J Prev Cardiol* 2020;27(13):1369-85. doi: 10.1177/2047487319877716 [published Online First: 2019/10/05]
17. Martin BJ, Hauer T, Arena R, et al. Cardiac rehabilitation attendance and outcomes in coronary artery disease patients. *Circulation* 2012;126(6):677-87. doi: 10.1161/CIRCULATIONAHA.111.066738 [published Online First: 2012/07/11]
18. Hammill BG, Curtis LH, Schulman KA, et al. Relationship between cardiac rehabilitation and long-term risks of death and myocardial infarction among elderly Medicare beneficiaries. *Circulation* 2010;121(1):63-70. doi: 10.1161/CIRCULATIONAHA.109.876383 [published Online First: 2009/12/23]
19. Smith SC, Jr., Benjamin EJ, Bonow RO, et al. AHA/ACCF secondary prevention and risk reduction therapy for patients with coronary and other atherosclerotic vascular disease: 2011 update: a guideline from the American Heart Association and American College of Cardiology Foundation endorsed by the World Heart Federation and the Preventive Cardiovascular Nurses Association. *J Am Coll Cardiol* 2011;58(23):2432-46. doi: 10.1016/j.jacc.2011.10.824 [published Online First: 2011/11/08]
20. Piepoli MF, Hoes AW, Agewall S, et al. 2016 European Guidelines on cardiovascular disease prevention in clinical practice: The Sixth Joint Task Force of the European Society of Cardiology and Other Societies on Cardiovascular Disease Prevention in Clinical Practice (constituted by representatives of 10 societies and by invited experts) Developed with the special contribution of the European Association for Cardiovascular Prevention & Rehabilitation (EACPR). *Eur Heart J* 2016;37(29):2315-81. doi: 10.1093/eurheartj/ehw106 [published Online First: 2016/05/26]
21. Grace SL, Bennett S, Ardern CI, et al. Cardiac rehabilitation series: Canada. *Prog Cardiovasc Dis* 2014;56(5):530-5. doi: 10.1016/j.pcad.2013.09.010 [published Online First: 2014/03/13]
22. Kotseva K, Wood D, De Backer G, et al. Use and effects of cardiac rehabilitation in patients with coronary heart disease: results from the EUROASPIRE III survey. *Eur J Prev Cardiol* 2013;20(5):817-26. doi: 10.1177/2047487312449591 [published Online First: 2012/06/22]
23. Suaya JA, Shepard DS, Normand SL, et al. Use of cardiac rehabilitation by Medicare beneficiaries after myocardial infarction or coronary bypass surgery. *Circulation* 2007;116(15):1653-62. doi: 10.1161/CIRCULATIONAHA.107.701466 [published Online First: 2007/09/26]
24. Kotseva K, De Backer G, De Bacquer D, et al. Lifestyle and impact on cardiovascular risk factor control in coronary patients across 27 countries: Results from the European Society of Cardiology ESC-EORP EUROASPIRE V registry. *Eur J Prev Cardiol* 2019;26(8):824-35. doi: 10.1177/2047487318825350 [published Online First: 2019/02/12]
25. Turk-Adawi K, Supervia M, Lopez-Jimenez F, et al. Cardiac Rehabilitation Availability and Density around the Globe. *EClinicalMedicine* 2019;13:31-45. doi:

- 1
2
3 10.1016/j.eclinm.2019.06.007 [published Online First: 2019/09/14]
4
5 26. Committee of Cardiac R, Prevention of Chinese Association of Rehabilitation M, Committee of
6 Cardiovascular Disease of China Association of G, et al. [China expert consensus on
7 psychological prescription for patients with cardiovascular disease2020]. *Zhonghua Nei Ke*
8 *Za Zhi* 2020;59(10):764-71. doi: 10.3760/cma.j.cn112138-20200203-00050 [published
9 Online First: 2020/09/29]
10
11 27. Nixon AC, Brown J, Brotherton A, et al. Implementation of a frailty screening programme and
12 Geriatric Assessment Service in a nephrology centre: a quality improvement project. *J*
13 *Nephrol* 2020 doi: 10.1007/s40620-020-00878-y [published Online First: 2020/10/12]
14
15 28. Marino VR, Hyer K, Hamilton L, et al. Evaluation of a quality improvement initiative to increase
16 rates of advance directive conversation documentation in primary care. *Geriatr Nurs* 2020
17 doi: 10.1016/j.gerinurse.2020.09.004 [published Online First: 2020/10/12]
18
19 29. Vos EL, Koppert LB, Jager A, et al. From Multiple Quality Indicators of Breast Cancer Care
20 Toward Hospital Variation of a Summary Measure. *Value Health* 2020;23(9):1200-09. doi:
21 10.1016/j.jval.2020.05.011 [published Online First: 2020/09/18]
22
23 30. Vos EL, Lingsma HF, Jager A, et al. Effect of Case-Mix and Random Variation on Breast Cancer
24 Care Quality Indicators and Their Rankability. *Value Health* 2020;23(9):1191-99. doi:
25 10.1016/j.jval.2019.12.014 [published Online First: 2020/09/18]
26
27 31. Scales DC, Dainty K, Hales B, et al. A multifaceted intervention for quality improvement in a
28 network of intensive care units: a cluster randomized trial. *JAMA* 2011;305(4):363-72. doi:
29 10.1001/jama.2010.2000 [published Online First: 2011/01/21]
30
31 32. Wang Y, Li Z, Zhao X, et al. Effect of a Multifaceted Quality Improvement Intervention on
32 Hospital Personnel Adherence to Performance Measures in Patients With Acute Ischemic
33 Stroke in China: A Randomized Clinical Trial. *JAMA* 2018;320(3):245-54. doi:
34 10.1001/jama.2018.8802 [published Online First: 2018/07/01]
35
36 33. Abreu A, Frederix I, Dendale P, et al. Standardization and quality improvement of secondary
37 prevention through cardiovascular rehabilitation programmes in Europe: The avenue
38 towards EAPC accreditation programme: A position statement of the Secondary Prevention
39 and Rehabilitation Section of the European Association of Preventive Cardiology (EAPC).
40 *Eur J Prev Cardiol* 2020:2047487320924912. doi: 10.1177/2047487320924912 [published
41 Online First: 2020/06/02]
42
43 34. Pack QR, Johnson LL, Barr LM, et al. Improving cardiac rehabilitation attendance and
44 completion through quality improvement activities and a motivational program. *J*
45 *Cardiopulm Rehabil Prev* 2013;33(3):153-9. doi: 10.1097/HCR.0b013e31828db386
46 [published Online First: 2013/04/19]
47
48 35. Parker K, Stone JA, Arena R, et al. An early cardiac access clinic significantly improves cardiac
49 rehabilitation participation and completion rates in low-risk ST-elevation myocardial
50 infarction patients. *Can J Cardiol* 2011;27(5):619-27. doi: 10.1016/j.cjca.2010.12.076
51 [published Online First: 2011/04/12]
52
53 36. Pack QR, Mansour M, Barboza JS, et al. An early appointment to outpatient cardiac
54 rehabilitation at hospital discharge improves attendance at orientation: a randomized,
55 single-blind, controlled trial. *Circulation* 2013;127(3):349-55. doi:
56 10.1161/CIRCULATIONAHA.112.121996 [published Online First: 2012/12/20]
57
58 37. He CJ, Zhu CY, Zhu YJ, et al. Effect of exercise-based cardiac rehabilitation on clinical
59
60

- 1
2
3 outcomes in patients with myocardial infarction in the absence of obstructive coronary
4 artery disease (MINOCA). *Int J Cardiol* 2020 doi: 10.1016/j.ijcard.2020.05.019 [published
5 Online First: 2020/05/18]
6
7 38. Liao HH, Wang PC, Yeh EH, et al. Impact of disease-specific care certification on clinical
8 outcome and healthcare performance of myocardial infarction in Taiwan. *J Chin Med Assoc*
9 2020;83(2):156-63. doi: 10.1097/JCMA.000000000000237 [published Online First:
10 2019/12/14]
11
12 39. Cai H, Zheng Y, Liu Z, et al. Effect of pre-discharge cardiopulmonary fitness on outcomes in
13 patients with ST-elevation myocardial infarction after percutaneous coronary intervention.
14 *BMC Cardiovasc Disord* 2019;19(1):210. doi: 10.1186/s12872-019-1189-x [published
15 Online First: 2019/09/08]
16
17 40. Bei Y, Shi C, Zhang Z, et al. Advance for Cardiovascular Health in China. *J Cardiovasc Transl*
18 *Res* 2019;12(3):165-70. doi: 10.1007/s12265-018-9852-7 [published Online First:
19 2018/12/12]
20
21 41. Ades PA, Keteyian SJ, Wright JS, et al. Increasing Cardiac Rehabilitation Participation From
22 20% to 70%: A Road Map From the Million Hearts Cardiac Rehabilitation Collaborative.
23 *Mayo Clin Proc* 2017;92(2):234-42. doi: 10.1016/j.mayocp.2016.10.014 [published Online
24 First: 2016/11/20]
25
26 42. Kehler DS, Kent D, Beaulac J, et al. Examining Patient Outcome Quality Indicators Based on
27 Wait Time From Referral to Entry Into Cardiac Rehabilitation: A PILOT
28 OBSERVATIONAL STUDY. *J Cardiopulm Rehabil Prev* 2017;37(4):250-56. doi:
29 10.1097/HCR.000000000000232 [published Online First: 2017/02/09]
30
31 43. Gaalema DE, Savage PD, Rengo JL, et al. Financial incentives to promote cardiac rehabilitation
32 participation and adherence among Medicaid patients. *Prev Med* 2016;92:47-50. doi:
33 10.1016/j.ypmed.2015.11.032 [published Online First: 2016/10/30]
34
35 44. Grace SL, Parsons TL, Duhamel TA, et al. The quality of cardiac rehabilitation in Canada: a
36 report of the Canadian Cardiac Rehab Registry. *Can J Cardiol* 2014;30(11):1452-5. doi:
37 10.1016/j.cjca.2014.06.016 [published Online First: 2014/12/03]
38
39 45. Harkness K, Smith KM, Taraba L, et al. Effect of a postoperative telephone intervention on
40 attendance at intake for cardiac rehabilitation after coronary artery bypass graft surgery.
41 *Heart Lung* 2005;34(3):179-86. doi: 10.1016/j.hrtlng.2004.07.010 [published Online First:
42 2005/07/15]
43
44 46. Ohtera S, Kanazawa N, Ozasa N, et al. Proposal of quality indicators for cardiac rehabilitation
45 after acute coronary syndrome in Japan: a modified Delphi method and practice test. *BMJ*
46 *Open* 2017;7(1):e013036. doi: 10.1136/bmjopen-2016-013036 [published Online First:
47 2017/01/31]
48
49 47. Beatty AL, Li S, Thomas L, et al. Trends in referral to cardiac rehabilitation after myocardial
50 infarction: data from the National Cardiovascular Data Registry 2007 to 2012. *J Am Coll*
51 *Cardiol* 2014;63(23):2582-83. doi: 10.1016/j.jacc.2014.03.030 [published Online First:
52 2014/04/29]
53
54 48. Balady GJ, Ades PA, Bittner VA, et al. Referral, enrollment, and delivery of cardiac
55 rehabilitation/secondary prevention programs at clinical centers and beyond: a presidential
56 advisory from the American Heart Association. *Circulation* 2011;124(25):2951-60. doi:
57 10.1161/CIR.0b013e31823b21e2 [published Online First: 2011/11/16]
58
59
60

- 1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
49. Grace SL, Poirier P, Norris CM, et al. Pan-Canadian development of cardiac rehabilitation and secondary prevention quality indicators. *Can J Cardiol* 2014;30(8):945-8. doi: 10.1016/j.cjca.2014.04.003 [published Online First: 2014/07/30]
 50. Van Engen-Verheul M, Kemps H, Kraaijenhagen R, et al. Modified Rand method to derive quality indicators: a case study in cardiac rehabilitation. *Stud Health Technol Inform* 2011;169:88-92. [published Online First: 2011/09/07]
 51. Grace SL, Russell KL, Reid RD, et al. Effect of cardiac rehabilitation referral strategies on utilization rates: a prospective, controlled study. *Arch Intern Med* 2011;171(3):235-41. doi: 10.1001/archinternmed.2010.501 [published Online First: 2011/02/18]
 52. Grace SL, Tan Y, Oh P, et al. Feasibility of Assessing 2 Cardiac Rehabilitation Quality Indicators. *J Cardiopulm Rehabil Prev* 2016;36(2):112-6. doi: 10.1097/HCR.000000000000136 [published Online First: 2015/08/08]
 53. Thomas RJ, Chiu JS, Goff DC, Jr., et al. Reliability of abstracting performance measures: results of the cardiac rehabilitation referral and reliability (CR3) project. *J Cardiopulm Rehabil Prev* 2014;34(3):172-9. doi: 10.1097/HCR.000000000000048 [published Online First: 2014/03/08]
 54. Reid RD, Morrin LI, Beaton LJ, et al. Randomized trial of an internet-based computer-tailored expert system for physical activity in patients with heart disease. *Eur J Prev Cardiol* 2012;19(6):1357-64. doi: 10.1177/1741826711422988 [published Online First: 2011/09/10]
 55. Hamm LF, Kavanagh T, Campbell RB, et al. Timeline for peak improvements during 52 weeks of outpatient cardiac rehabilitation. *J Cardiopulm Rehabil* 2004;24(6):374-80; quiz 81-2. doi: 10.1097/00008483-200411000-00002 [published Online First: 2005/01/06]
 56. Hu D. [Bright beginning of Chinese cardiac rehabilitation post a rough road]. *Zhonghua Xin Xue Guan Bing Za Zhi* 2015;43(2):118. [published Online First: 2015/04/25]
 57. Kotter T, Blozik E, Scherer M. Methods for the guideline-based development of quality indicators--a systematic review. *Implement Sci* 2012;7:21. doi: 10.1186/1748-5908-7-21 [published Online First: 2012/03/23]
 58. Chen J, Tong Y, Cheng Y, et al. Establishment and Empirical Evaluation of a Quality Indicator System for Postoperative Pain Management. *Pain Med* 2020 doi: 10.1093/pm/pnaa221 [published Online First: 2020/10/12]
 59. van der Velden AW, van Triest MI, Schoffelen AF, et al. Structural Antibiotic Surveillance and Stewardship via Indication-Linked Quality Indicators: Pilot in Dutch Primary Care. *Antibiotics (Basel)* 2020;9(10) doi: 10.3390/antibiotics9100670 [published Online First: 2020/10/08]
 60. Montesano M, Reed JL, Tulloch HE, et al. Cardiac rehabilitation is associated with greater improvements in psychological health following coronary artery bypass graft surgery when compared to percutaneous coronary intervention. *Appl Physiol Nutr Metab* 2020 doi: 10.1139/apnm-2020-0213 [published Online First: 2020/06/17]
 61. Chockalingam P, Rajaram A, Maiya A, et al. A multicentre retrospective study on quality and outcomes of cardiac rehabilitation programs in India. *Indian Heart J* 2020;72(1):55-57. doi: 10.1016/j.ihj.2020.03.002 [published Online First: 2020/05/20]
 62. Thomas E, O'Neil A. Considerations for Developing Quality Indicators for Cardiac Rehabilitation in Australia. *Heart Lung Circ* 2020;29(1):e12-e13. doi: 10.1016/j.hlc.2018.11.009 [published Online First: 2019/12/21]

- 1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
63. Backhouse A, Ogunlayi F. Quality improvement into practice. *BMJ* 2020;368:m865. doi: 10.1136/bmj.m865 [published Online First: 2020/04/03]
64. Rosengren A, Wallentin L. Cardiovascular Medicine in Sweden: Improvement by Continuous Measuring. *Circulation* 2020;141(14):1124-26. doi: 10.1161/CIRCULATIONAHA.119.041280 [published Online First: 2020/04/07]
65. Podlogar MAC, Dolansky MA. Cardiac Rehabilitation as Part of Management in Postacute Care: Opportunities for Improving Care. *Clin Geriatr Med* 2019;35(4):561-69. doi: 10.1016/j.cger.2019.07.010 [published Online First: 2019/09/24]
66. Pesah E, Supervia M, Turk-Adawi K, et al. A Review of Cardiac Rehabilitation Delivery Around the World. *Prog Cardiovasc Dis* 2017;60(2):267-80. doi: 10.1016/j.pcad.2017.08.007 [published Online First: 2017/08/29]
67. Bjarnason-Wehrens B, McGee H, Zwisler AD, et al. Cardiac rehabilitation in Europe: results from the European Cardiac Rehabilitation Inventory Survey. *Eur J Cardiovasc Prev Rehabil* 2010;17(4):410-8. doi: 10.1097/HJR.0b013e328334f42d [published Online First: 2010/03/20]
68. Grace SL, Gravely-Witte S, Brujal J, et al. Contribution of patient and physician factors to cardiac rehabilitation enrollment: a prospective multilevel study. *Eur J Cardiovasc Prev Rehabil* 2008;15(5):548-56. doi: 10.1097/HJR.0b013e328305df05 [published Online First: 2008/10/03]
69. Nery RM, Zanini M, de Lima JB, et al. Tai Chi Chuan improves functional capacity after myocardial infarction: A randomized clinical trial. *Am Heart J* 2015;169(6):854-60. doi: 10.1016/j.ahj.2015.01.017 [published Online First: 2015/06/02]
70. Mao S, Zhang X, Shao B, et al. Baduanjin Exercise Prevents post-Myocardial Infarction Left Ventricular Remodeling (BE-PREMIER trial): Design and Rationale of a Pragmatic Randomized Controlled Trial. *Cardiovasc Drugs Ther* 2016;30(3):315-22. doi: 10.1007/s10557-016-6660-7 [published Online First: 2016/04/24]
71. Mao S, Zhang X, Chen M, et al. Beneficial Effects of Baduanjin Exercise on Left Ventricular Remodelling in Patients after Acute Myocardial Infarction: an Exploratory Clinical Trial and Proteomic Analysis. *Cardiovasc Drugs Ther* 2020 doi: 10.1007/s10557-020-07047-0 [published Online First: 2020/08/08]
72. Chen MG, Liang X, Kong L, et al. Effect of Baduanjin Sequential Therapy on the Quality of Life and Cardiac Function in Patients with AMI After PCI: A Randomized Controlled Trial. *Evid Based Complement Alternat Med* 2020;2020:8171549. doi: 10.1155/2020/8171549 [published Online First: 2020/07/28]

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.

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.

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

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46

For peer review only

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

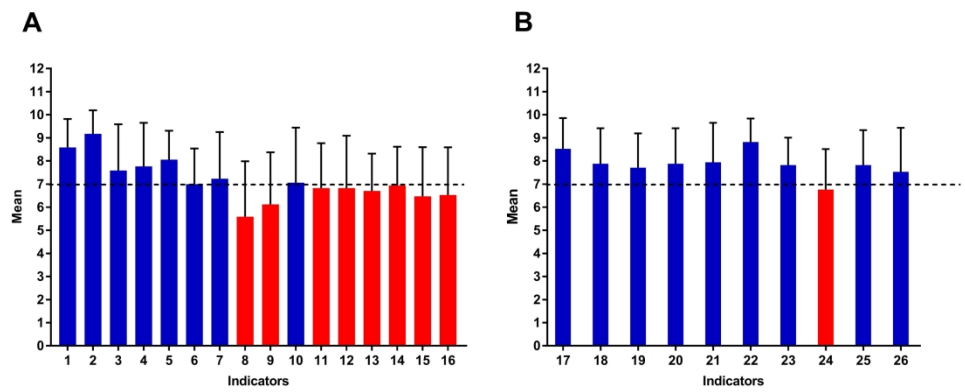


Figure 1

259x109mm (300 x 300 DPI)

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60



Figure 2

254x190mm (300 x 300 DPI)

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

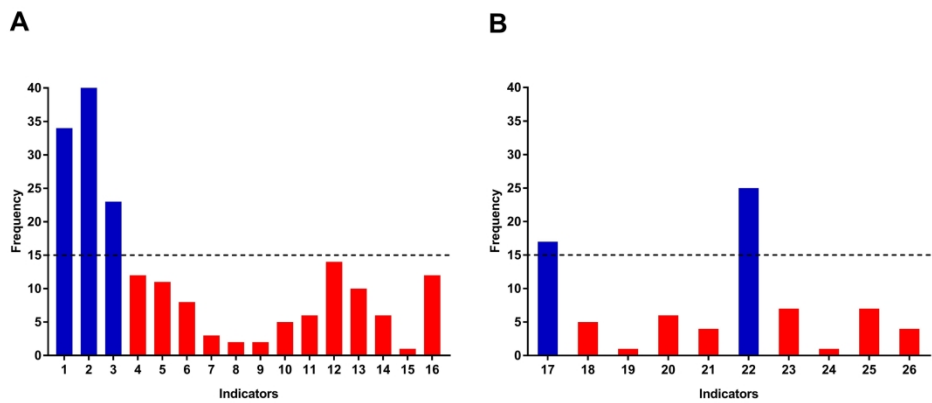
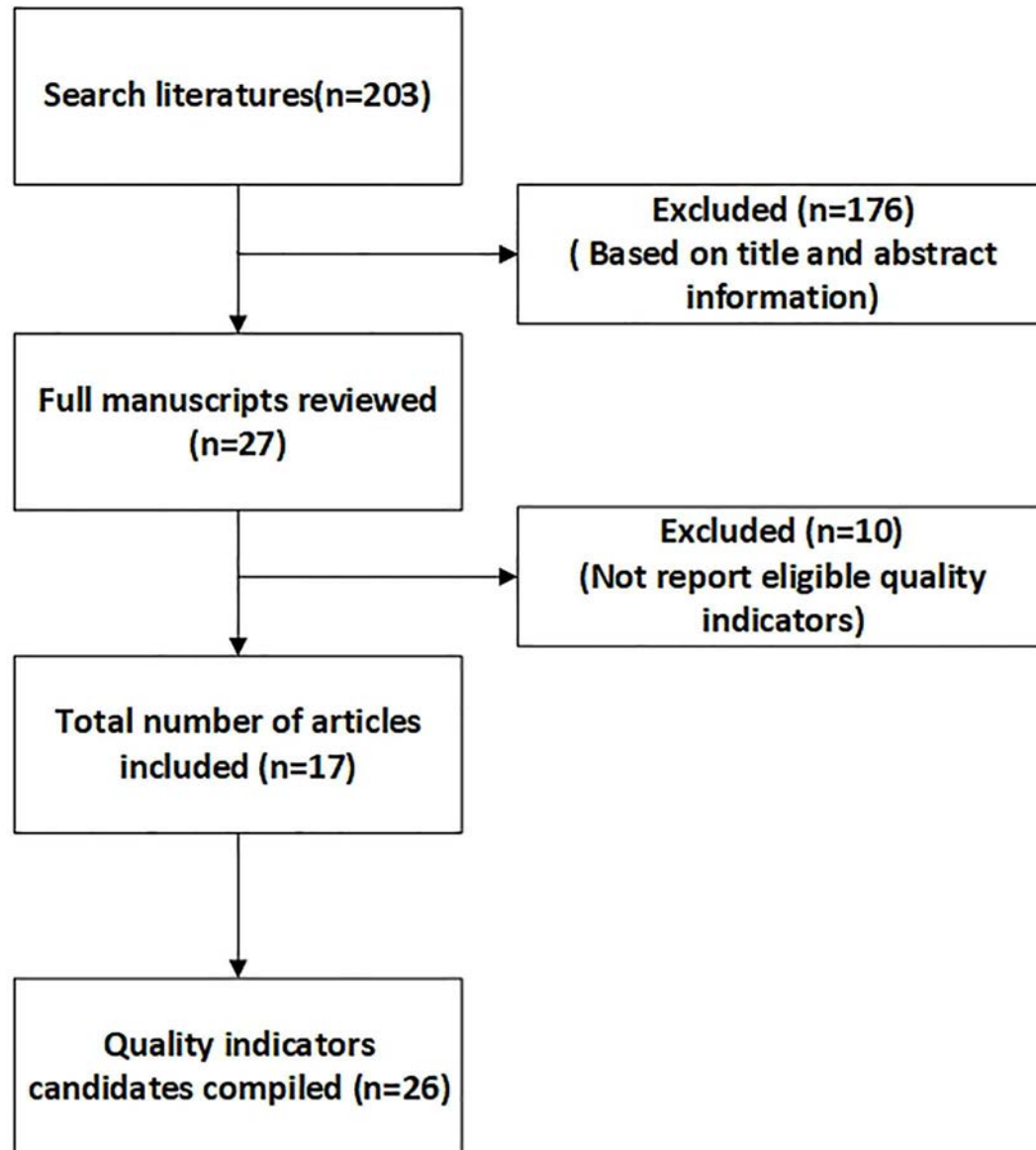
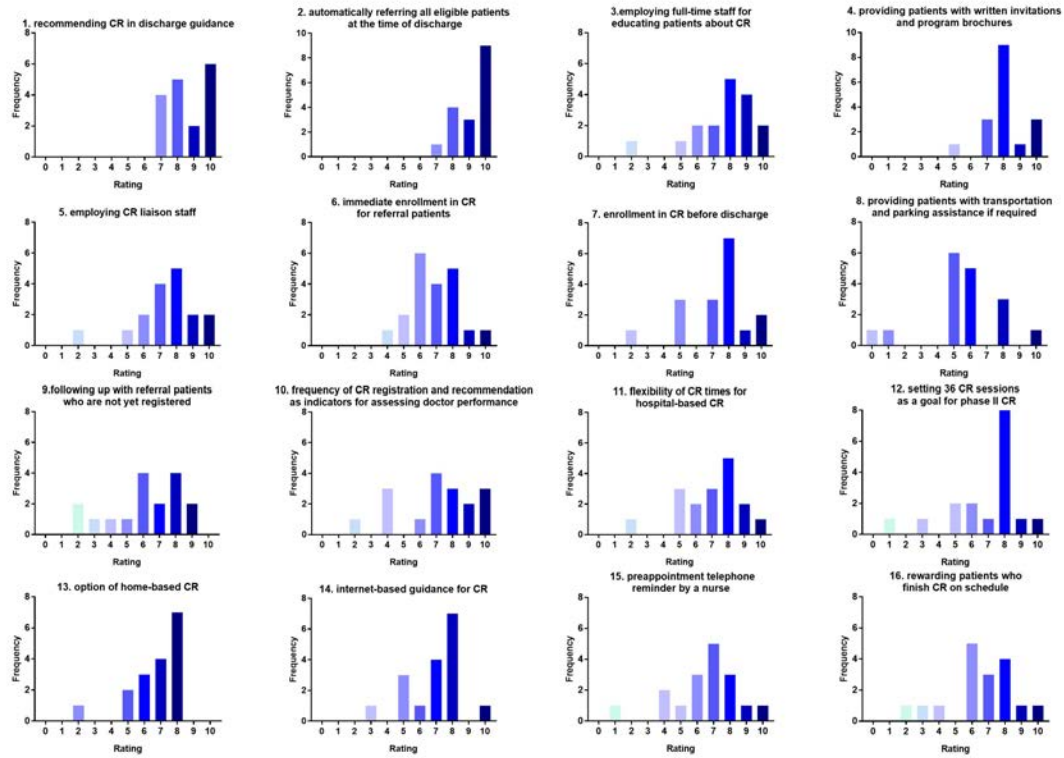


Figure 3

262x114mm (300 x 300 DPI)

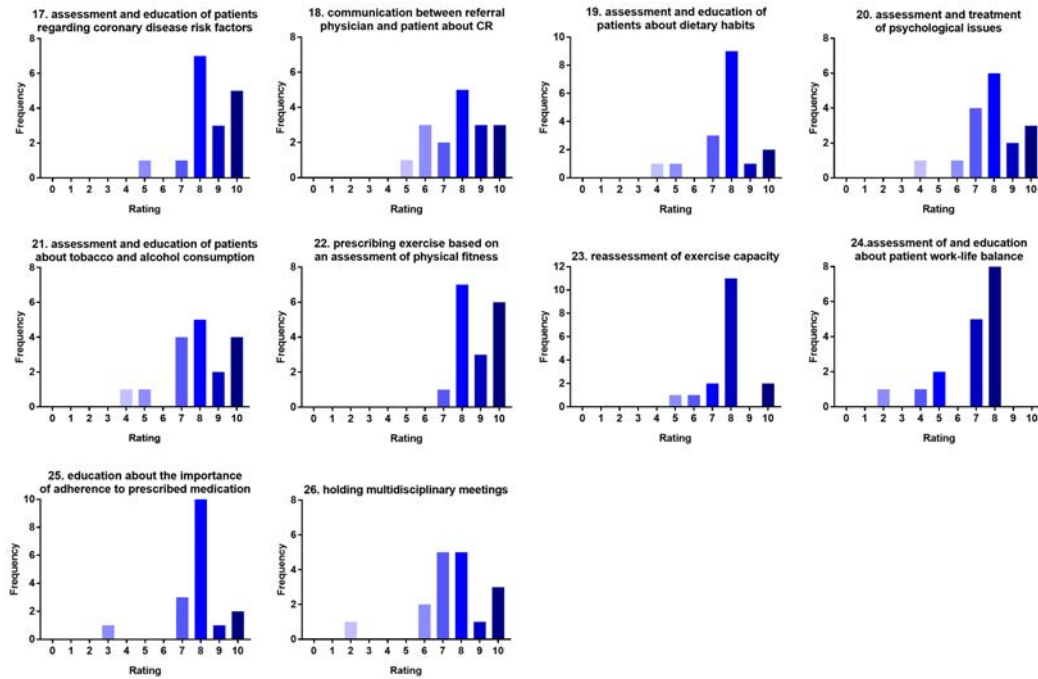
Supplementary Figure 1

Supplementary Figure 2



Review only

Supplementary Figure 3



review only

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.		

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

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