Review Article

Title: Cardiac Rehabilitation Quality Improvement: A Narrative Review

Authors: Mahshid Moghei, MSc[1], Paul Oh, MD[2], Caroline Chessex, MD[2] & Sherry L. Grace, PhD, FCCS[1, 2]

[1]School of Kinesiology and Health Science, York University, Toronto, Canada.
[2]Cardiovascular Prevention and Rehabilitation Program, University Health Network, University of Toronto, ON.

Corresponding Author: Prof. Sherry L Grace PhD; Bethune 368, York University, 4700 Keele Street, Toronto, ON, M3J 1P3, Canada; Phone: (416) 736-2100 ext. 22364; sgrace@yorku.ca

The authors report no relationships that could be construed as a conflict of interest.

Funding: None
Word count: 4076

Acknowledgements
We thank Rajiv Nariani for his help with the literature search

Cardiac Rehabilitation Quality Improvement: A Narrative Review

Structured Abstract
PURPOSE: Despite evidence of the effectiveness of cardiac rehabilitation (CR), there is wide variability in the nature of programs, which may impact their quality. The objectives of this review were to: (1) evaluate the ways in which we measure CR quality internationally, (2) summarize what we know about CR quality and quality improvement, and finally (3) recommend potential ways to improve it.
METHODS: For this narrative review, first, the literature was searched for CR quality indicators (QIs) available internationally, and experts consulted. For the second objective, literature on CR quality was reviewed, and data on available QIs were obtained from the Canadian Cardiac Rehab Registry (CCRR). For the last objectives, literature on healthcare quality improvement strategies that might apply in CR settings was reviewed.
RESULTS: CR QIs have been developed by American, Canadian, European, Australian, and Japanese CR associations. CR quality has only been audited across the United Kingdom, Netherlands and Canada. Twenty-seven QIs are assessed in the CCRR. CR quality was high for the following indicators: promoting physical activity post-program, assessing blood pressure, and communicating with primary care. Areas of low quality included: provision of stress management, smoking cessation, incorporating the recommended elements in discharge summaries, and assessment of blood glucose. Recommended approaches to improve quality include: patient and provider education, reminder systems, organizational change, and advocacy for improved CR reimbursement. Audit and feedback alone is not successful.
CONCLUSIONS: Although not a lot is known about CR quality, gaps were identified. The quality improvement initiatives recommended herein require testing, to ascertain whether quality can be improved.

Condensed Abstract:
There is wide variability in cardiac rehabilitation (CR) programs, which may impact quality. Through this narrative review, quality indicators from Canadian, American, European, Australian, and Japanese CR associations are summarized. The sparse data available on CR quality suggests there are gaps in care. Improvement initiatives must be implemented and tested.

Key words: Quality improvement, Quality indicators, Cardiac rehabilitation, Healthcare

Cardiovascular disease (CVD) is among the leading burdens of disease and disability globally.[1] As a result, secondary prevention is crucial. Cardiac rehabilitation (CR) is the recommended program model designed to reduce risk.[2,3]

CR services are provided through a multi-component, inter-disciplinary approach.[4,5] The core components of CR are as follows: risk factor assessment, patient education, lifestyle risk factor management (physical activity and weight management, diet and smoking cessation), psychosocial health, and medical risk factor management.[4–8]

There are many benefits to CR participation, with the most significant being a 26% reduction in cardiovascular mortality and 18% reduction in re-hospitalization shown in the most recent Cochrane review.[9] Considering it is such a complex intervention however, it is understandable there may be considerable variability in the nature of services delivered and by which type of healthcare providers, resulting in inconsistent care quality.[10] This inconsistency could negatively impact patient outcomes.

Care Quality

According to the Institute of Medicine, quality of care is "the degree to which health services for individuals and populations increase the likelihood of desired health outcomes and are consistent with current professional knowledge".[11] Care quality is a multidimensional construct that incorporates the concepts of safety, equity, evidence-based medicine, timeliness of care, efficiency and patient-centeredness.

In order to quantify the quality of CR care, evidence-based recommendations need to be translated into well-defined, evidence-based and measurable elements of practice performance, known as quality indicators (QIs).[12] Donabedian's framework highlights the importance of considering structure, process and outcome indicators.[13] 'Structures' of health care are

characterized as the physical and organizational components of care settings (e.g., facilities, equipment, personal). 'Processes' rely on structures to provide means and resources to perform patient care activities. 'Outcomes' are improvements in patient health (e.g., promoting recovery, functional restoration, survival and patient satisfaction).

With knowledge regarding where quality of CR services is low, we can work towards improving the quality of services for patients. Quality improvement is defined as "the effort to improve the degree to which health services increase the likelihood of desired health outcomes".[11] Thus, the purpose of this paper was to review: (1) the ways in which we measure CR quality around the globe, (2) what we know about the quality of CR, and (3) and what CR quality improvement approaches have been tried. Finally, (4) potential ways to improve CR quality specifically where it is lowest are forwarded, followed by (b) broad recommendations for quality improvement as pertinent to the CR context.

Methods

For this narrative review, first, key informants from the International Council of Cardiovascular Prevention and Rehabilitation were approached to identify CR QIs in their countries. Second, the literature was searched for CR QIs, studies on CR quality and quality improvement. Third, data from the Canadian Cardiac Rehabilitation Registry (CCRR) were mined for quality indicators (objective 2). Finally, research on healthcare quality improvement strategies and how they might apply in CR settings was sought (objective 4).

Literature was identified by searching the PubMed, Scopus and Cochrane Library databases from inception. A Librarian assisted with the search. Examples of search terms included: "quality of care", "quality improvement", "quality indicators", "performance measures", "health outcomes", "cardiac care", "cardiac rehabilitation", and "improve practice".

To ensure relevant studies were not missed, the "related articles" feature in PubMed was used to identify further similar articles.

For the first 3 objectives, studies had to pertain to outpatient, Phase II CR, delivered to adults. Studies of any design were included. Articles that were not in English or were not peer-reviewed were excluded.

Results

Cardiac Rehabilitation Quality Indicators

In the field of CR, QIs have been developed by several professional associations, namely the American Association of Cardiovascular and Pulmonary Rehabilitation (AACPR)[14,15] with the American Heart Association / American College of Cardiology Foundation ACCF/AHA,[16] European Association of Preventive Cardiology (EAPC),[17] Australian Cardiovascular Health and Rehabilitation Association (ACRA)[18] and Canadian Cardiovascular Society (CCS) with the Canadian Association of Cardiovascular Prevention and Rehabilitation (CACPR).[19] Furthermore, a Dutch group has developed QIs,[20] as well as Japan (through their government Ministry of Health).[21] The British Association of Cardiovascular Prevention and Rehabilitation (BACPR) has 6 "minimum standards",[22] which are similarly used to ensure program quality (e.g., wait time, initial assessment, program duration, discharge assessment). The QIs developed, such as CR referral as outlined above, are fairly consistent across these national organizations (see http://globalcardiacrehab.com/public-resources/quality-indicators/ and Table 1). These QIs are outlined below, in chronological order of development (except the Canadian indicators which were developed third are presented last in greatest detail).

The AACVPR (along with ACCF/AHA) developed a subtype of QIs called performance measures (i.e., QIs that are more formally vetted such that they could be suitable for public reporting).[12] There were 15.[14] The first performance measures related to referral to CR, from in-patient and out-patient settings. There were also measures specific to the delivery of CR such as assessment of risk for adverse cardiovascular events, and individualized assessment of blood pressure and lipid control. The performance measures included both structure and process indicators, however measures focusing on outcomes were lacking. Their performance measures were updated in 2010.[14,15] They worked to demonstrate the reliability of the referral measures,[23] so that the National Quality Forum would endorse them and they could potentially be reported publicly and pay-for-performance instituted.

They were recently reviewed and revised by AHA/ACCF, in collaboration with AACVPR, resulting in 5 performance measures (measuring referral and enrollment, including for patients with heart failure) and 3 quality measures (measuring wait time, adherence, and communication about patient outcomes).[16] In addition, AAVPR developed and tested 3 outcomes measures (improvement in functional capacity, improvement in depressive symptoms, and optimal blood pressure control) and one process measure (tobacco cessation intervention).[24]

A group under the leadership of Dr. Niels Peek in Europe applied a RAND methodology to develop a set of 18 structure (5), process (8) and outcome (5) QIs.[20] They have gone on to use these indicators to inform quality improvement, through development of an online system to report on quality in real-time.[25] The EAPC has developed a QI for the referral of patients to an in-patient or out-patient CR program.[17] In the supplemental appendix they also present some structure QIs, and loosely proffer a "checklist" of process indicators.

ACRA has developed "key performance indicators" related to their five core components, namely access to services, assessment and monitoring, recovery and long-term management, lifestyle modifications and most centrally evaluation and quality improvement.[18] They have suggested 71 QIs, each reported as a percentage.

QIs have most recently been developed in Japan.[21] They undertook a review of the literature and guideline clearinghouses, and identified 16 indicator sets and 23 guidelines, presenting 27 unique indicators. These were then assessed using a modified Delphi process. The final set of 13 QIs are primarily process-related. They field-tested the QIs in a small pilot to confirm the measurability of the proposed indicators in real-world clinical practice.

In Canada, there is a set of 30 CR QIs.[19] They were developed in accordance with the CCS Best Practice methodology.[26] In phase 1, experts in the field from across Canada and representatives of stakeholder organizations were invited to serve on the working group to plan and organize the QI development initiative. The CR QI working group created sub-theme or domain groups (outlined below), to ensure expert representation across all CR core components. In phase 2, a long list of QIs was developed and a literature review undertaken to establish the evidence base for the candidate QIs. The working group considered candidate QIs from the American and Dutch measures available at that time. The subtheme groups then drafted the QIs, specifying numerators and denominators, and providing the evidence basis to support the QI. The drafted QIs underwent formal expert panel review and rating, followed by public consultation. In phase 3, the QIs were submitted to the CCS QI Steering Committee and CACPR for approval, and knowledge translation was undertaken. This included field-testing of 2 QIs.[27]

The final set of QIs are categorized into five domains: (1) Referral, access and wait times (4 QIs), (2) Secondary prevention: assessment, risk stratification, and control (10 QIs), (3)

Behavioural change, program adherence, psychosocial issues, education, and return-to-work (11), (4) CR model and structure (2), and (5) Discharge transition, linkage and communication (3).[19] Overall, there are 2 structure, 25 process and 3 outcome QIs. Given this may be unwieldy to programs, a "top 5" was denoted.[19]

CR Quality

Unfortunately there are only a couple of publications reporting on CR quality to our knowledge.[28] These are all from Canada (see below), except for one recent study from the United Kingdom.[22] Using data from the 170 programs in BACPR's National Audit of Cardiac Rehabilitation from 2013 to 2014, each program was scored one point for meeting each of the 6 minimum standards. CR quality varied significantly, with 30% of programs considered "high" quality (i.e., met ≥5 standards).

There have been a handful of other studies reporting on whether programs offer all core components among other guideline criteria related to quality,[29,30] but not assessing QIs specifically. The AACVPR registry has now been in existence for several years,[31] so it is hoped it can be exploited to assess CR quality in future.[32] Finally, a group in Australia is developing a CR registry, with the minimum data set based on Canadian QIs.[33]

The greatest source of multisite CR data in Canada is the CCRR, which is governed through CACPR. Capturing data at program intake and discharge, approximately 200 data elements are collected on each patient.[34]

The first version of the CCRR data dictionary enabled assessment of 14/30 CR QIs in 3 domain areas. As per Donabedian's Framework, 10 were considered "process" QIs, and the rest "outcome" QIs. At the time of assessment, there were 5447 patient records in the CCRR.[35]

Results showed that wait times exceeded the 30-day QI target, at a median of 84 days from referral to enrollment. Assessment of blood pressure (90%) and adiposity (85%) were high, however of lipids (41%), blood glucose (23%), and depression overall (13%) were low. A majority of the participants (68%) achieved the half metabolic equivalent of task (MET) increase in exercise capacity from CR program entry to exit. Of smokers, only 61% were offered smoking cessation therapy. Thirty percent of participants were offered stress management. The CR program completion QI was met in 90% of patients. If we consider 90% as a benchmark of "quality", clearly again there is considerable variability across indicators (we have also shown significant variability between programs).[28]

The CCRR since formed a Task Force to update data elements and definitions, to (among other reasons) enable greater assessments of the QIs. Through the CCRR Data Dictionary 2.0, 27 /30 QIs can now be assessed (Table 2); the 2 structure QIs still cannot be assessed (no program-level data), nor can the inpatient referral QI as only data from CR intake are collected. Therefore, we are now poised to, for the first time, more fully characterize the quality of CR in Canada.

CR program contributing data to the CCRR receive a quarterly report on the quality of their program across these 30 QIs, and this is compared to similar programs, and national benchmarks. Thus, an update on the quality of CR in Canada was obtained through the CCRR following the first quarter of 2016 (~8,000 patients from 17 of ~170 programs nationally; in 3 provinces). However, caution is warranted in interpreting some of the indicator values. For instance, QI-4 *risk assessment for adverse CVD events* and QI-20 *meeting the physical activity guideline target* had very low values, likely because variables to assess these QIs have just recently been added to the CCRR with Data Dictionary 2.0. Furthermore, the QIs for secondary prevention medications were likely artificially low as the CCRR needs to be improved with regard to the ability to enter

recent medications and to document contraindications. In addition, QI-22 *assessment for depression* may have been low due to the recent controversy in the literature about assessing depression in CVD patients.[36] Finally, QI-3 *enrolment* and QI-37 *completion* were likely artificially inflated, as data stewards may only take the time to enter data for patients who are fully engaged in the program (not dropouts; see Cochrane review for evidence-based interventions to increase these QIs).[37] For this reason, exact indicator values are not reported herein. However, we have confidence that the trends observed for the other QIs accurately reflect the nature of CR quality in Canada.

Overall, the quality of CR was particularly high in relation to QI-21 *promotion of post-CR physical activity*, QI-13 *assessment of blood pressure control*, and QI-34 *communication with primary health care*. Low quality was observed for several QIs. In particular, Q-16 *assessment of blood glucose control*, QI-30 *stress management*, QI-27 *smoking cessation*, QI-2a *wait time from hospital discharge*, QI-23 *referral of patients screening positive for possible depression*, and QI-35 *recommended elements in discharge summary* were poor.

CR Quality Improvement

QI studies in the field of CR provide evidence that improving care would significantly improve outcomes. For instance, the utilization rate of CR in post-myocardial infarction patients was only 15% in Ontario. Wijeysundera et. al. demonstrated that improving CR enrolment from 15% to the 90% quality benchmark would prevent or postpone 135 deaths per year and would yield a 1.3% reduction in CVD mortality.[38] Indeed, the contribution of CR to reducing post-MI mortality appears to be higher compared to other CVD QIs such as prescription of pharmacological therapies.[39]

A survey of CR programs in the United States showed that CR programs are using the performance measures to evaluate the quality of their programs, and where low, as the basis for quality improvement initiatives.[40] For example, three-quarters of programs reported measuring program enrolment and completion rates in the past 5 years, with two-thirds implementing an associated quality improvement initiative to address enrolment and completion rates in the same time period.

There is now some preliminary data in the literature reporting on the impact of quality improvement in the CR setting. Pack et al. evaluated a series of quality improvement initiatives on CR attendance and completion.[41] Three approaches, namely program policy changes, a patient video and motivational incentives were applied over a two-year period. Results showed significant increases in attendance and completion of their CR program from pre-initiative levels. These findings demonstrate that quality improvement initiatives can be effective in the CR setting.

The work by Peek and colleagues shows how an online system/dashboard to monitor CR program quality can be used to identify areas that require improvement, to inform improvement efforts.[25] Audit and feedback refers to the provision of summative data on clinical performance over a specified period of time to health professionals to incite improvements in performance.[42] In a Cochrane review on this approach, healthcare professionals' compliance with desired practice was found to be significantly increased with audit and feedback, although the effect was small.[42] The groups' recent cluster-randomized trial in 18 centres failed to show that online audit and feedback with educational outreach can reliably improve CR care quality.[43] Professionals disagreeing with benchmarks, deeming improvement infeasible, having their own views of what

constitutes quality of care, as well as personal preferences and beliefs about quality and improvement targets were barriers to CR quality improvement.[44–46]

Recommendations for CR Quality Improvement

Given the quality of CR as outlined above, potential evidence-based interventions that could improve quality in areas where it is lowest are now considered. We focus on provision of stress management training to all CR participants, smoking cessation, informational elements in the CR discharge summary, and assessment of blood glucose. Approaches to quality improvement more broadly will then be summarized, as pertinent to the CR context (Figure 1).

Conceptual overviews in the quality improvement field, and the closely related area of knowledge translation (KT), categorize models or approaches to improvement. These primarily include: educational, linkage and exchange, audit and feedback, informatics, organizational and patient-mediated interventions.[47] Other quality improvement strategies include facilitated relay of clinical data to providers, patient and provider education, promotion of self-management, as well as financial incentives, regulation and policy.[48] It is recommended to implement a multi-pronged approach addressing patient, provider and health system factors, to achieve sustained improvement. Finally, we must also consider CR context and quality improvement barriers identified in the work by Peek and colleagues.[43–46]

Stress Management (QI-30)

Stress management is a core component of CR.[4–8,17,18] This is important because mental, not just physical, stress has been shown to induce myocardial ischemia.[49,50] It is suspected that less than half of patients in the CCRR received stress management because CR programs may not have the resources to deliver this component. Indeed, CR is highly under-resourced relative to other cardiac interventions.

To improve quality in this area, it is suggested that CR programs collaborate with a mental healthcare professional at their institution to identify web-based resources relevant to their population, that can be provided to patients at no cost. Indeed, previous research has shown that counselling delivered via information and communications technologies improve well-being to a similar degree as face-to-face counseling with a mental health professional.[51,52] This would be considered an organizational change and provider education approach to quality improvement.[47,48]

Smoking Cessation (QI-27)

Smoking is the primary preventable risk factor in the development of CVD, and smoking cessation is the behaviour change that accounts for the greatest reductions in mortality in CVD patients.[53,54] Despite this, an alarming 70% of smokers fail to quit after hospital discharge for myocardial infarction.[55] Evidence suggests that only 30–40% of CVD patients stop smoking after a coronary event.[56,57] In the CCRR, we observed 25% of patients quit.

To improve this QI, programs need to ensure they have the resources available to support smokers in quitting, and to apply evidence-based approaches. Several strategies for smoking cessation have proven to be effective, namely pharmacotherapies,[58] nicotine replacement therapy[59] and behavioural support interventions such as individual counselling.[60] Nicotine replacement therapy has been shown to increase the rate of quitting by 50-70% regardless of setting.[59] Pharmacological interventions such as bupropion, also significantly increases long-term cessation by 60%.[58] A Cochrane review suggests that a combined intervention consisting of behavioural support and medications, could potentially increase smoking cessation by 70-100% compared to usual care.[61]

In order to improve quality in this area, education is needed for CR program staff on how to counsel patients on smoking cessation, considering even brief advice from a health professional can trigger a cessation attempt and lead to quitting.[62] This would require provider education. Furthermore, incentives could be provided where possible, to encourage patients to quit. The use of incentives has previously been shown to be effective in promoting health behaviour.[63] Organizational change may also be required to ensure the CR team has the appropriate skill-mix, and staff have the time for cessation counselling.

Recommended Elements in Discharge Summaries (QI-35)

To ensure long-term risk factor management and secondary prevention, it is imperative that primary care providers receive complete information on care provided during CR. Patient discharge summaries should include the following 4 recommended elements: (1) a description of the patient's lifestyle risk factors (physical activity, diet and smoking), (2) medical risk factors (blood pressure, lipids and glucose as relevant), (3) cardiac medications, and (4) long-term management goals. These elements were selected based on previous research where primary care providers were interviewed regarding the information they need to support secondary prevention in CR graduates.[64]

A quality improvement strategy to overcome the lack of inclusion of these elements in the discharge summaries is organizational change. Programs should institute changes to the discharge summary template, so that it includes all 4 elements. In addition, electronic CR records may be used to generate standard discharge summaries, which report on the 4 elements identified above.

Assessment of Blood Glucose in Patients with Diabetes (QI-16)

Diabetes mellitus is associated with poorer outcomes in patients with CVD, yet is highly common in this population.[65] Knowledge of fasting blood glucose and /or hemoglobin A_{1c} values informs CR providers how well patients are controlling their diabetes, as well as how their exercise sessions may be impacted (e.g., hypoglycemia).

Given diabetes is associated with CVD onset, many patients with diabetes likely have another healthcare provider who is managing their diabetes and hence assessing blood glucose. Low quality for this indicator suggests that CR programs may be relying on these other healthcare providers outside the CR program to manage diabetes. CR program staff may be reluctant to order another blood glucose assessment over concerns of the wasted resources expended with duplicate testing. Therefore, it is suggested that CR programs request the Hb_{A1C} results from these other providers. Then this information can be used by CR staff to ensure patients are receiving appropriate advice regarding exercise and self-management of their blood glucose levels. This could be achieved by facilitated relay of clinical data to providers.

Recommendations for CR Program Improvement of Any Quality Indicator

As outlined above, the CCRR provides quarterly reports to participating CR programs across Canada that displays their performance on 27 QIs (Table 2). This could be considered an audit and feedback strategy.[42] It is hoped that by providing quarterly reports to participating programs, they will initiate quality improvement efforts such as those that have been suggested herein. This could be tried by other CR registries.[32] However, the CR community should not rely solely on such a strategy, as the work by Peek and colleagues summarized above demonstrates that there are barriers to achieving quality improvement following receipt of feedback.[43–46] The AACVPR and BACPR also have program certification programs, and whether these result in quality improvement also warrants investigation.[66]

Some QIs, particularly structure QIs, would be best addressed with change at the level of the health system itself. With regard to healthcare providers, reminder systems could be particularly impactful, such as computer-based reminders and decision support.[48] Indeed, results of the QI survey of CR programs outlined in the introduction shows such approaches were often implemented to augment referral.[40] Within CR programs, reminders could be used to trigger program staff to monitor response to a newly-initiated treatment for example (i.e., patient reports initiating Bupropion so provider could check in with the patient 2 weeks later to discuss how they are tolerating it and how the patient is faring with cessation attempts). Furthermore, facilitated relay of clinical data to providers should be applied to facilitate transmission of clinical data amongst CR team members given programs are inter-professional, and also between CR staff and patient's primary and specialty care providers to ensure long-term management of all CVD risk factors. Programs should make full use of electronic patient records to enable timely relay of clinical data to providers.[48]

Finally, advocacy initiatives are warranted for improved funding policy for CR programs. CR services are variably funded across the country and around the globe.[67] Advocacy is needed to ensure programs are properly resourced to deliver all core components of CR (such as stress management and smoking cessation). The International Council of Cardiovascular Prevention and Rehabilitation has recently developed some recommendations and tools for CR reimbursement advocacy (http://globalcardiacrehab.com/advocacy/).

Limitations

This was a narrative review. Given a search strategy was not fully specified (i.e., PICOs) and registered, and a systematic search of the literature was not performed, it is possible that articles were missed. Moreover, the approach to making recommendations for CR quality

improvement was based more on author / expert consensus than evidence, given the state of science in this area.

Conclusions

The major CR societies internationally have developed CR QIs, through rigorous processes. There is quite a large variation in the number, but not nature, of indicators. There remains however little evidence regarding the link between the indicators and patient outcomes.

Although CR is shown to be very effective, where characterized, there are some gaps between recommended CR care and CR care delivered. To address the areas of low quality in CR, quality improvement initiatives are required. Some key approaches to improve quality should include patient and provider education, reminder systems, organizational change and advocating for improved CR reimbursement. These recommendations require testing to assess whether they can improve quality.

Finally, CR programs should be encouraged to join registries in their jurisdictions, and trained to provide complete, high-quality data. This will enable us to report in a more generalizable way on the quality of CR, to be confident in quality reports, and to work with interested programs to implement these quality improvement recommendations and test their impact. It is hoped that through CR quality improvement, we can ensure patients achieve the best health outcomes, and we can have high-performing chronic CVD care systems globally.

References

1. Vos T, Flaxman AD, Naghavi M. Years lived with disability (YLDs) for 1160 sequelae of 289 diseases and injuries 1990–2010: a systematic analysis for the Global Burden of Disease Study 2010. *Lancet*. 2012;380(9859):2163-2196. doi:10.1016/S0140-6736(12)61729-2.
2. Smith SC, 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. *Circulation*. 2011;124(22):2458-2473. doi:10.1161/CIR.0b013e318235eb4d.
3. Fihn SD, Gardin JM, Abrams J, et al. 2012 ACCF/AHA/ACP/AATS/PCNA/SCAI/STS Guideline for the Diagnosis and Management of Patients With Stable Ischemic Heart Disease: Executive Summary. *J Am Coll Cardiol*. 2012;60(24):2564-2603. doi:10.1016/j.jacc.2012.07.012.
4. Stone J, Arthur H. *Canadian Guidelines for Cardiac Rehabiliation and Cardiovascular Disease Prevention: Translating Knoweldge into Action*. 3rd ed. Winnipeg, Manitoba, Canada: Canadian Association of Cardiac Rehabilitation (CACR); 2009.
5. Balady GJ, Williams MA, Ades PA, et al. Core Components of Cardiac Rehabilitation/ Secondary Prevention Programs: 2007 Update. *J Cardiopulm Rehabil Prev*. 2007;27(3):121-129. doi:10.1097/01.HCR.0000270696.01635.aa.
6. Buckley J, Doherty P, Furze G, et al. *Standards and Core Components for Cardiovascular Disease Prevention and Rehabilitation*. London UK; 2017.
7. Grace SL, Turk-Adawi KI, Contractor A, et al. Cardiac Rehabilitation Delivery Model for Low-Resource Settings: An International Council of Cardiovascular Prevention and Rehabilitation Consensus Statement. *Prog Cardiovasc Dis*. 2016;59(3):1-20. doi:http://dx.doi.org/10.1016/j.pcad.2016.08.004.
8. Grace SL, Turk-Adawi KI, Contractor A, et al. Cardiac rehabilitation delivery model for low-resource settings. *Heart*. 2016;102(18):1449-1455. doi:10.1136/heartjnl-2015-309209.
9. Anderson L, Oldridge N, Thompson DR, et al. Exercise-Based Cardiac Rehabilitation for Coronary Heart Disease. *J Am Coll Cardiol*. 2016;67(1):1-12. doi:10.1016/j.jacc.2015.10.044.
10. Price KJ, Gordon BA, Bird SR, Benson AC. A review of guidelines for cardiac rehabilitation exercise programmes: Is there an international consensus? *Eur J Prev Cardiol*. 2016. doi:10.1177/2047487316657669.
11. Institute of Medicine. *Crossing the Quality Chasm: A New Health System for the 21st Century*. Washington, D.C.: National Academy Press; 2001.
12. Bonow RO, Masoudi FA, Rumsfeld JS, et al. ACC/AHA Classification of Care Metrics: Performance Measures and Quality Metrics. *J Am Coll Cardiol*. 2008;52(24):2113-2117. doi:10.1016/j.jacc.2008.10.014.
13. Donabedian A. The Criteria and Standards of Quality. *J Ambul Care Manage*. 1983;6(2):80.
14. Thomas RJ, King M, Lui K, et al. AACVPR/ACC/AHA 2007 performance measures on cardiac rehabilitation for referral to and delivery of cardiac rehabilitation/secondary prevention services. *J Cardiopulm Rehabil Prev*. 2007;27(5):260-290.

doi:https://dx.doi.org/10.1097/01.HCR.0000291295.24776.7b.
15. Thomas RJ, King M, Lui K, Oldridge N, Piña IL, Spertus J. AACVPR/ACCF/AHA 2010 Update: Performance measures on cardiac rehabilitation for referral to cardiac rehabilitation/secondary prevention services: A report of the American Association of Cardiovascular and Pulmonary Rehabilitation and the American College. *J Cardiopulm Rehabil Prev*. 2010;56(5):279-288. doi:10.1016/j.jacc.2010.06.006.
16. Thomas RJ, Balady G, Banka G, et al. 2018 ACC/AHA Clinical Performance and Quality Measures for Cardiac Rehabilitation. A Report of the American College of Cardiology/American Heart Association Task Force on Performance Measures. *Circ Cardiovasc Qual Outcomes*. 2018;11(4).
17. 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 representati. *Eur Heart J*. 2016;37(29):2315-2381. doi:10.1093/eurheartj/ehw106.
18. Woodruffe S, Neubeck L, Clark RA, et al. Australian Cardiovascular Health and Rehabilitation Association (ACRA) Core Components of Cardiovascular Disease Secondary Prevention and Cardiac Rehabilitation 2014. *Hear Lung Circ*. 2015;24(5):430-441. doi:10.1016/j.hlc.2014.12.008.
19. Grace SL, Poirier P, Norris CM, Oakes GH, Somanader DS, Suskin N. Pan-Canadian development of cardiac rehabilitation and secondary prevention quality indicators. *Can J Cardiol*. 2014;30(8):945-948. doi:10.1016/j.cjca.2014.04.003.
20. Van Engen-Verheul M, Kemps H, Kraaijenhagen R, De Keizer N, Peek N, Van Engen-Verheul, Mariette; Kemps, Hareld; Kraaijenhagen, Roderik; De Keizer, Nicolette; Peek N. Modified Rand method to derive quality indicators: a case study in cardiac rehabilitation. *Stud Health Technol Inform*. 2011;169:88-92. doi:10.3233/978-1-60750-806-9-88.
21. Ohtera S, Kanazawa N, Ozasa N, Ueshima K, Nakayama T. Proposal of quality indicators for cardiac rehabilitation after acute coronary syndrome in Japan: a modified Delphi method and practice test. *BMJ Open*. 2017;7(1):e013036. doi:10.1136/bmjopen-2016-013036.
22. Doherty P, Salman A, Furze G, Dalal HM, Harrison A. Does cardiac rehabilitation meet minimum standards: an observational study using UK national audit? *Open Hear*. 2017;4(1).
23. Thomas RJ, Chiu JS, Goff DC, et al. Reliability of abstracting performance measures: results of the cardiac rehabilitation referral and reliability (CR3) project. *J Cardiopulm Rehabil Prev*. 2014;34(3):172-179. doi:10.1097/HCR.0000000000000048.
24. Pack QR, Bauldoff G, Lichtman SW, et al. Prioritization, Development, and Validation of American Association of Cardiovascular and Pulmonary Rehabilitation Performance Measures. *J Cardiopulm Rehabiliation Prev*. 2018;38(4):208-214.
25. van Engen-Verheul MMM, van der Veer SN, de Keizer NF, Tjon Sjoe Sjoe W, van der Zwan EPA, Peek N. A web-based system to facilitate local, systematic quality improvement by multidisciplinary care teams: development and first experiences of CARDSS Online. *Stud Health Technol Inform*. 2013;192:248-252. doi:10.3233/978-1-61499-289-9-248.
26. Tu J V, Abrahamyan L, Donovan LR, Boom N. Best practices for developing cardiovascular quality indicators. *Can J Cardiol*. 2013;29(11):1516-1519.

doi:10.1016/j.cjca.2013.05.012.
27. Grace, S.L., Tan, Y., Oh, P., Aggarwal, S., Unsworth, K., & Suskin N. Feasibility of assessing two cardiac rehabilitation quality indicators. *J Cardiopulm Rehabil Prev*. 2016;36(2):112-116.
28. Somanader D, Chessex C, Ginsburg L, Grace SL. The Quality and Variability of Cardiac Rehabilitation Delivery: Applying the Canadian Quality Indicators. *J Cardiopulm Rehabil Prev*. 2017;37(6):412-420.
29. Pesah E, Supervia M, Turk-Adawi K, Grace SL. A review of cardiac rehabilitation delivery around the world. *Prog Cardiovasc Dis*. 2017;60(2):267-280. doi:10.1016/j.pcad.2017.08.007.
30. Zullo MD, Jackson LW, Whalen CC, Dolansky MA. Evaluation of the recommended core components of cardiac rehabilitation practice: an opportunity for quality improvement. *J Cardiopulm Rehabil Prev*. 2012;32(1):32-40. doi:10.1097/HCR.0b013e31823be0e2.
31. American Association for Cardiovascular and Pulmonary Rehabilitation (AACVPR). AACVPR Outpatient Cardiac Rehabilitation Data Registry. https://www.aacvpr.org/Registry/Cardiac-Rehab-Registry. Accessed June 7, 2018.
32. Poffley A, Thomas E, Grace SL, et al. A systematic review of cardiac rehabilitation registries. *Eur J Prev Cardiol*. 2017;24(15):1596-1609. doi:10.1177/2047487317724576.
33. Thomas E, Grace S., Boyle D, et al. Feasibility of utilising a data capture tool to develop a cardiac rehabilitation registry. *Circ Cardiovasc Qual Outcomes*. (Manuscript in preparation).
34. Grace SL, Parsons TL, Heise K, Bacon SL. The Canadian Cardiac Rehabilitation Registry: Inaugural Report on the Status of Cardiac Rehabilitation in Canada. *Rehabil Res Pract*. 2015;2015:1-6. doi:10.1155/2015/278979.
35. Grace SL, Parsons TL, Duhamel TA, Somanader D, Suskin N. The Quality of Cardiac Rehabilitation in Canada: A Report of the Canadian Cardiac Rehab Registry. *Can J Cardiol*. 2014;30(11):1452-1455. doi:10.1016/j.cjca.2014.06.016.
36. Thombs BD, de Jonge P, Coyne JC, et al. Depression Screening and Patient Outcomes in Cardiovascular Care: A Systematic Review. *JAMA*. 2008;300(18):2161-2171. doi:10.1001/jama.2008.667.
37. Karmali KN, Davies P, Taylor F, Beswick A, Martin N, Ebrahim S. Promoting patient uptake and adherence in cardiac rehabilitation. *Cochrane database Syst Rev*. 2014;6:CD007131. doi:10.1002/14651858.CD007131.pub3.
38. Wijeysundera HC, Mitsakakis N, Witteman W, et al. Achieving Quality Indicator Benchmarks and Potential Impact on Coronary Heart Disease Mortality. *Can J Cardiol*. 2011;27(6):756-762. doi:10.1016/j.cjca.2011.06.005.
39. Kottke TE, Faith DA, Jordan CO, Pronk NP, Thomas RJ, Capewell S. The comparative effectiveness of heart disease prevention and treatment strategies. *Am J Prev Med*. 2009;36(1):82-88. doi:10.1016/j.amepre.2008.09.010.
40. Pack QR, Squires RW, Lopez-Jimenez F, et al. Participation Rates, Process Monitoring, and Quality Improvement Among Cardiac Rehabilitation Programs in the United States: A National Survey. *J Cardiopulm Rehabil Prev*. 2015;35(3):173-180. doi:10.1097/HCR.0000000000000108.
41. Pack QR, Johnson LL, Barr LM, et al. Improving cardiac rehabilitation attendance and completion through quality improvement activities and a motivational program. *J Cardiopulm Rehabil Prev*. 2013;33(3):153-159. doi:10.1097/HCR.0b013e31828db386.

42. Ivers N, Jamtvedt G, Flottorp S, et al. Audit and feedback: effects on professional practice and healthcare outcomes. *Cochrane database Syst Rev*. 2012;6(7):CD000259. doi:10.1002/14651858.CD000259.pub3.
43. Gude WT, van Engen-Verheul MM, van der Veer SN, et al. Effect of a web-based audit and feedback intervention with outreach visits on the clinical performance of multidisciplinary teams: a cluster-randomized trial in cardiac rehabilitation. *Implement Sci*. 2016;11(1):1-16. doi:10.1186/s13012-016-0516-1.
44. Gude WT, van Engen-Verheul MM, van der Veer SN, de Keizer NF, Peek N. How does audit and feedback influence intentions of health professionals to improve practice? A laboratory experiment and field study in cardiac rehab. *BMJ Qual Saf*. 2016:1-9.
45. Gude WT, Van Der Veer SN, Van Engen-Verheul MM, De Keizer NF, Peek N. Inside the Black Box of Audit and Feedback: A Laboratory Study to Explore Determinants of Improvement Target Selection by Healthcare Professionals in Cardiac Rehabilitation. In: *Studies in Health Technology and Informatics*. Vol 216. ; 2015:424-428. doi:10.3233/978-1-61499-564-7-424.
46. van Engen-Verheul MM, Peek N, Haafkens JA, et al. What is needed to implement a web-based audit and feedback intervention with outreach visits to improve care quality: A concept mapping study among cardiac rehabilitation teams. *Int J Med Inform*. 2017;97:76-85. doi:10.1016/j.ijmedinf.2016.10.003.
47. Straus S, Tetroe J, Graham ID. *Knowledge Translation in Health Care: Moving from Evidence to Practice*. Vol 1. (Straus S, Tetroe J, Graham ID, eds.). Oxford, Chichester, Hoboken: Blackwell Publishing Ltd; 2009.
48. Agency for Healthcare Research and Quality A. Patient safety and quality: an evidence-based handbook for nurses. *Agency Healthc Res Qual AHRQ*. 2008;(08):1-1403. doi:AHRQ Publication No. 08-0043.
49. Rozanski A, Blumenthal JA, Kaplan J. Impact of psychological factors on the pathogenesis of cardiovascular disease and implications for therapy. *Circulation*. 1999;99(16):2192-2217.
50. Jiang W, Babyak M, Krantz DS, et al. Mental stress--induced myocardial ischemia and cardiac events. *JAMA*. 1996;275(21):1651-1656.
51. Varnfield M, Karunanithi M, Lee C-K, et al. Smartphone-based home care model improved use of cardiac rehabilitation in postmyocardial infarction patients: results from a randomised controlled trial. *Heart*. 2014;100(22):1770-1779. doi:10.1136/heartjnl-2014-305783.
52. Newman MG, Szkodny LE, Llera SJ, Przeworski A. A review of technology-assisted self-help and minimal contact therapies for anxiety and depression: is human contact necessary for therapeutic efficacy? *Clin Psychol Rev*. 2011;31(1):89-103. doi:10.1016/j.cpr.2010.09.008.
53. Barth J, Bengel J. Smoking cessation in patients with coronary heart disease: risk reduction and an evaluation of the efficacy of interventions. In: *Evidence-Based Psychocardiology*. Vol Chapter 3. Washington DC: American Psychiatric Association; 2007:83-105.
54. Critchley J, Capewell S. Smoking cessation for the secondary prevention of coronary heart disease. *Cochrane database Syst Rev*. 2004;1(1):CD003041. doi:10.1002/14651858.CD003041.pub2.
55. Ladapo JA, Jaffer FA, Weinstein MC, Froelicher ES. Projected cost-effectiveness of

smoking cessation interventions in patients hospitalized with myocardial infarction. *Arch Intern Med*. 2011;171(1):39-45. doi:10.1001/archinternmed.2010.479.
56. Quist-Paulsen P, Gallefoss F. Randomised controlled trial of smoking cessation intervention after admission for coronary heart disease. *BMJ*. 2003;327(7426):1254-1257.
57. Burling TA, Singleton EG, Bigelow GE, Baile WF, Gottlieb SH. Smoking following myocardial infarction: a critical review of the literature. *Health Psychol*. 1984;3(1):83-96.
58. Hughes J, Stead L, Cahill K, Lancaster T. Antidepressants for smoking cessation (Review). *Cochrane Libr*. 2014;(1):1-145. doi:10.1002/14651858.CD000031.pub3.Copyright.
59. Silagy C, Lancaster T, Stead L, Mant D, Fowler G. Nicotine replacement therapy for smoking cessation. *Cochrane database Syst Rev*. 2002;(4):CD000146. doi:10.1002/14651858.CD000146.
60. Lancaster T, Stead LF. Individual behavioural counselling for smoking cessation. *Cochrane Database Syst Rev*. 2005;(2):CD001292. doi:10.1002/14651858.CD001292.pub2.
61. Stead LF, Lancaster T. Combined pharmacotherapy and behavioural interventions for smoking cessation. *J Evid Based Med*. 2012;5(4):242-242. doi:10.1002/14651858.CD008286.pub2.
62. Roberts NJ, Kerr SM, Smith SMS. Behavioral Interventions Associated with Smoking Cessation in the Treatment of Tobacco Use. *Heal Serv Insights*. 2013;6:79. doi:10.4137/HSI.S11092.
63. Mitchell MS, Goodman JM, Alter DA, et al. Financial incentives for exercise adherence in adults: Systematic review and meta-analysis. *Am J Prev Med*. 2013;45(5):658-667. doi:10.1016/j.amepre.2013.06.017.
64. Polyzotis PA, Suskin N, Unsworth K, et al. Primary care provider receipt of cardiac rehabilitation discharge summaries: are they getting what they want to promote long-term risk reduction? *Circ Cardiovasc Qual Outcomes*. 2013;6(1):83-89. doi:10.1161/CIRCOUTCOMES.112.967539.
65. Wood DA, Cuff D, Frohlich J, Ignaszewski A. Prevention, diagnosis, and treatment of cardiovascular disease in patients with diabetes. *BC Med J*. 2005;47(8):424-428.
66. Furze G, Doherty P, Grant-Pearce C. Development of a UK National Certification Programme for Cardiac Rehabilitation (NCP_CR). *Br J Cardiol*. 2016;23(July):102-105. doi:10.5837/bjc.2016.024.
67. Babu AS, Lopez-Jimenez F, Thomas RJ, et al. Advocacy for outpatient cardiac rehabilitation globally. *BMC Health Serv Res*. 2016;16(1):471. doi:https://dx.doi.org/10.1186/s12913-016-1658-1.

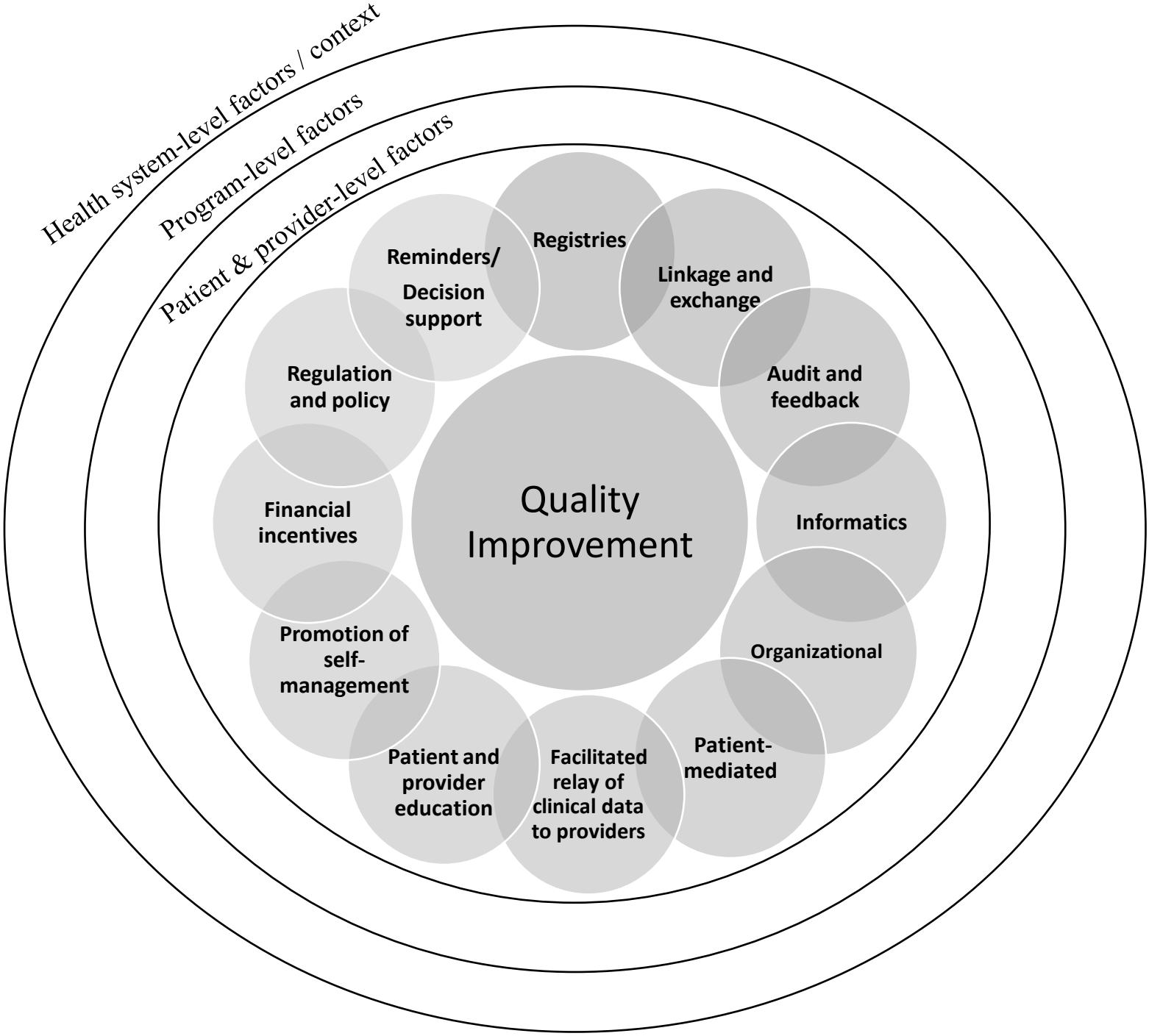
Health system-level factors / context
Program-level factors
Patient & provider-level factors
Quality Improvement
Registries
Linkage and exchange
Audit and feedback
Informatics
Organizational
Patient-mediated
Facilitated relay of clinical data to providers
Patient and provider education
Promotion of self-management
Financial incentives
Regulation and policy
Reminders/ Decision support

Table 1. Cardiac Rehabilitation Quality Indicators Around the World, by Type

Association (number of indicators)	AHA / ACCF / AACVPR (10)	ACRA (71)	BACPR (6)	CCS / CACPR (30)	EAPC* (1)	(13)	Total (/6)
Country / Region	United States	Australia	England	Canada	Europe	Japan	
Structure							
Comprehensive program (all core components)			x				1
Medical director supervision				x	x		2
Emergency response strategy				x	x		2
Program duration			x				1
Multidisciplinary team with qualifications		x	x		x	x	4
CR offered to all indicated patients		x	x			x	3
Program model type documented (including reason & patient choice)		x					1
Audit / evaluation of program		x	x				2
Process							
Referral	x	x	x	x	x	x	6
Wait times	x		x	x			3
Enrollment	x	x		x			3
Under-served populations		x					1
Initial assessment		x	x			x	3
Sociodemographic characteristics		x					1
Risk for adverse CVD		x		x	x		3

events							
Clinical history		x					1
Functional capacity		x				x	2
Diet		x			x		2
Depression		x		x	x	x	4
Anxiety		x		x	x		3
Medical risk factors§		x		x	x	x	4
Patient education				x	x		2
Self-management		x		x			2
Symptoms /cardiac emergencies		x			x		2
Exercise		x				x	2
Diet/ weight management		x			x		2
Medication		x			x	x	3
Smoking cessation		x			x	x	3
Medical risk factors§		x			x	x	3
Spouse / family inclusion		x					1
Assessment of physical activity		x		x			2
Exercise prescription		inferred			x	x	3
Structured exercise training		x				x	2
Assessment of quality of life‡		x					1
Assessment of return to work‡						x	1
Assessment of adherence to secondary prevention medications‡		x		x			2
Tobacco cessation support / counselling‡	x	x		x	x		4
Stress management / psychosocial counselling‡				x	x		2

Re-assessment at CR end		x	x			x	3
Recommended elements in discharge summary	x	x		x			3
Communication with primary healthcare practitioner	x	x		x		x	4
Summative communication with patient		x		x			2
Promotion of post-CR physical activity		x		x	x		3
Post-program re-assessment (e.g., 12-month follow-up)		x			x		2
Outcome							
On evidence-based medications				x			1
Medication adherence		x					1
Interim events		x					1
Increase in exercise capacity	x			x			2
Meeting physical activity guideline target		x		x			2
Adherence to CR program	x			x		x	3
Smoking cessation		x		x			2
Change in diet		x					1
Body mass index / anthropometrics		x					1
Medical risk factor management§	x (blood pressure)	x				x	3
Psychological status	x (depression)	x			x		3
Knowledge		x					1
Return to work		x			x		2
Return to driving		x			x		2
Return to sexual activity		x			x		2
Quality of life		x			x		2

CR program completion		x		x		x	3
Under-served populations		x					1
Morbidity and mortality		x					1

ACE, Angiotensin-Converting Enzyme; AACVPR, American Association of Cardiovascular and Pulmonary Rehabilitation; ACCF, American College of Cardiology Foundation; ACRA, Australian Cardiovascular Health and Rehabilitation Association; AHA, American Heart Association; ARB, Angiotensin II Receptor Blocker; ASA, Acetylsalicylic Acid; BACPR, British Association of Cardiovascular Prevention and Rehabilitation; CABG, Coronary Artery Bypass Graft; CACPR, Canadian Association of Cardiovascular Prevention and Rehabilitation; CCS, Canadian Cardiovascular Society; CR, Cardiac Rehabilitation; EAPC, European Association of Preventive Cardiology; $HbA1_C$, Glycated hemoglobin; QI, quality indicator.

*Netherlands-specific QIs not shown. Includes elements from supplemental appendix.

ǂSome indicators are considered as process measures, but as outcome measures by other CR associations (e.g., was smoking cessation counselling provided vs did patients cease smoking). Moreover, for some risk factors the indicators refer to education, whereas for others it is counselling. Attempted to capture both in table, but harmonization would be helpful.

§Blood pressure, lipids, blood glucose

Note: for parsimony, in some instances sub-elements of indicators are not shown. Also, some indicators were comprised of multiple measures, and so were demarcated in more than one row (e.g., for Japan the indicator of “assessment and education regarding eating habits”).