Nat Rev Cardiol. Author manuscript; available in PMC 2015 July 03.

Published in final edited form as:

Nat Rev Cardiol. 2014 October ; 11(10): 586–596. doi:10.1038/nrcardio.2014.98.

Global Availability of Cardiac Rehabilitation

Karam Turk-Adawi,
Cardiovascular Rehabilitation & Prevention, University Health Network, 399 Bathurst Street, Toronto, Ontario, M5T 2S8, Canada

Nizal Sarrafzadegan, and
Isfahan Cardiovascular Research Center, Cardiovascular Research Institute, Isfahan University of Medical Sciences, Seddigheh Tahereh Research and Treatment Hospital, Khorram Ave, PO Box: 81465-1148 Isfahan, Iran

Sherry L. Grace
School of Kinesiology and Health Science, York University, 4700 Keele Street, Toronto, Ontario, M3J 1P3, Canada, and Cardiovascular Rehabilitation & Prevention, University Health Network, 399 Bathurst Street, Toronto, Ontario, M5T 2S8, Canada

Abstract

The most prevalent non-communicable disease globally, namely cardiovascular disease (CVD), is also the leading cause of mortality, with over 80% of the deaths occurring in low- and middle-income countries. To lessen the impact of CVDs on individuals and societies, a comprehensive approach is needed. Cardiac rehabilitation (CR) involves delivery of structured exercise, education and risk reduction, in a cost-effective manner. Robust evidence demonstrates it reduces mortality up to 25%, improves functional capacity, as well as decreases re-hospitalization. Despite its benefits, and clinical practice guideline recommendations to refer cardiac patients, CR programs are grossly under-used. Worldwide, there is low availability of CR; only 38.8% of countries globally have CR programs. Specifically, 68.0% of high-income and 23% of LMICs (28.2% for middle- and 8.3% for low-income countries) have CR. CR density estimates ranged from 1 program per 0.1–6.4 million inhabitants. CR availability is much lower than that of other evidence-based secondary prevention therapies, such as revascularization and pharmacological therapies. Multi-level strategies to augment CR capacity and availability at national and international levels such as supportive public health policies, systematic referral strategies, and alternative models of delivery are needed.

Introduction

Cardiovascular disease (CVD) is the most prevalent non-communicable disease and the leading cause of mortality globally.[1] With increasing CVD prevalence, the burden of CVD is growing significantly, particularly in low- and middle-income countries (LMICs)[2,3] (Box 1).

Correspondence to: Nizal Sarrafzadegan.

Conflicts to disclose: none

Indeed, more than 80% of the CVD deaths occur in LMICs.[1] Over the next few decades, 23 million people per year will die due to CVD.[1,4]

Box 1

Definitions

High-, middle-, and low-income countries

Countries are classified according to 2012 Gross National Income per capita.

Low-income: $1,035 or less;

Middle-income: $1,036 – $12,615

Lower middle income: $1,036 – $4,085

Upper middle income: $4,086 – $12,615

High-income: $12,616 or more

Source: The World Bank.[3] http://data.worldbank.org/about/country-classifications

Disability Adjusted Life Years (DALYS)

The World Health Organization defines DALYs as "The sum of years of potential life lost due to premature mortality and the years of productive life lost due to disability." World Health Organization. [7]

According to the World Economic Forum,[4] in 2010, there were 62.5 million new cases of CVD, of which 24.2 million were attributed to ischemic heart disease (Table 1). By 2030, the number of new CVD cases is expected to grow to 84 million, of which 32.3 million will be ischemic heart disease cases.[4]

Patients with established CVD have a high risk of consequent major events, such as fatal and non-fatal myocardial infarction.[5] Accordingly, CVD is also the leading cause of disability globally.[6] It is responsible for 10% disability-adjusted life years (DALYs; Box 1 for definition[7]) lost worldwide, accounting for 10% of the DALYs lost in LMICs, and 18% of DALYs lost in high-income countries.[1] For example, 47 million DALYs globally were lost because of coronary heart disease (CHD), and this figure is expected to increase to 82 million DALYs in 2020.[8]

With regard to CVD prevalence worldwide, currently, there is no standardized source for this information. However, Murray and Lopez (1996)[9] estimated the prevalence of acute myocardial infarction in 1990 as 501,000 cases worldwide. Recently, the Global Burden of Disease Study 2010 estimated the global prevalence of angina due to ischemic heart disease as 111.7 million individuals or 1.62% of the total world's population.[10] To provide more insight about the number of individuals living with CVD, available data from selected high and middle-income countries are shown in Table 2. Caution however is warranted in interpreting and comparing these estimates, due to variability in prevalence operationalization.

As a global response to the emerging non-communicable disease burden including CVD, the World Health Organization (WHO) has set a global target for reduction of "premature deaths from non-communicable diseases by 25% by 2025".[17] All 194 WHO Member States endorsed this target during the 65th World Health Assembly in 2012.[17] In its' Global Action Plan for the Prevention and Control of Non-communicable Diseases 2013–2020,[18] the WHO underlines the need for rehabilitation, including cardiac rehabilitation (CR). CR is forwarded as a central strategy to address CVD risk factors, such as obesity and physical inactivity, and to restore loss of function. It is also forwarded to reduce the consequences of CVD, slow or stop health deterioration, fasten hospital dismissal, and improve quality of life.[18] To lessen the impact of CVDs on individuals and societies, a comprehensive approach such as that is offered in CR is needed.

Cardiac Rehabilitation

CR is a multidisciplinary approach designed to stabilize, slow, or even promote regression of CVD.[19] The World Health Organization (WHO) defines CR as the "sum of activities required to influence favourably the underlying cause of the disease, as well as to provide the best possible physical, mental and social conditions, so that the patients may, by their own efforts, preserve or resume when lost, as normal a place as possible in the community".[20] As a means of secondary and even tertiary prevention, for the purposes of this review, we refer to CR delivered in the outpatient setting.

National and international associations, such as the American Association of Cardiovascular and Pulmonary Rehabilitation[21] as well as the European Association of Cardiovascular Prevention and Rehabilitation,[22] have established the core components of CR. These include baseline assessment of patients, physical activity training and counselling, nutritional counselling, management of risk factors (i.e., dyslipidemia, hypertension, obesity, diabetes mellitus, and smoking), as well as psychosocial interventions and counselling.[21]

The components delivered work to reduce cardiovascular risk, promote and maintain healthy behaviors and active lifestyles, improve quality of life, and reduce disability.[21] Robust evidence demonstrates that CR participation reduces mortality by up to 25% over the subsequent several years when compared to usual care.[23–28] The only risks to CR use are associated with exercise, and are low.

Population indicated for CR

According to clinical practice guidelines from reputed cardiovascular societies around the world, CR is recommended for patients with a primary diagnosis of one or a combination of the following: myocardial infarction, angina, heart failure; as well as following interventions, namely coronary artery bypass graft surgery, percutaneous coronary intervention, and heart or heart/lung transplant.[29,30–32] Though we are unable to report prevalence of these CVD indications worldwide, several millions of patients, such as the 111.7 million with angina worldwide,[10] are candidates for CR. These alarming figures demonstrate the scope of the need for CR services.

Given the current and expected future increase in CVD trends, CR capacity will need to be high to meet such demand. Consistent with the current international focus on CVD prevention and control, this review aims to describe the availability of CR in both high-income countries and LMICs, and to juxtapose this in the context of the accessibility of CR in these countries.

Availability of CR by country income classification

An extensive search (Box 2) of peer-reviewed and grey literature was undertaken to identify the presence of CR in all countries as recognized by the World Bank, and by their income classification (Box 1). Results are shown in Figure 1.

Box 2

Review criteria

In October 2013, Medline, Excerpta Medica Database (EMBASE), and Google Scholar were searched for relevant articles. The authors started the search with cardiac rehabilitation surveys, meta-analyses, and reviews to report availability of CR and literature in high-, middle-, and low-income countries. The authors' also used their personal collections of journal articles and references from key articles to write the review. Grey literature was used by searching CR by country, and searching services provided by hospitals within countries using the Google search engine to find CR Web sites.

CR availability in high-income countries

National and regional surveys, such as the CARINEX Survey,[33] and the European CR Inventory Survey[34] have described CR availability in many high-income countries. Of the 75 globally, results showed CR services are available in 51 (68.0%). These are Australia,[35] Austria,[33] Bahrain,[36] Barbados,[37] Belgium,[34] Bermuda,[38] Brunei Darussalam,[39] Canada, [40] Channel Islands,[41] Chile,[42] Croatia,[34] Cyprus,[34] Czech Republic,[43] Denmark,[44] Estonia,[43] Finland,[34] France,[45] Germany,[46] Greece,[47] Hong Kong,[48] Iceland,[34] Ireland,[33] Isle of Man, [49] Israel,[50] Italy,[51] Japan,[52] Korea/Republic,[53] Kuwait,[54] Latvia,[55] Lithuania,[34] Luxembourg,[34] Netherlands,[34] New Zealand,[56] Norway,[57] Poland,[34] Portugal,[34] Puerto Rico,[58] Qatar,[59] Russian Federation,[34] Singapore,[60] Slovak Republic,[34] Slovenia,[61] Spain,[33] Sweden,[34] Switzerland,[62] Trinidad and Tobago,[63] United Arab Emirates,[64] United Kingdom,[65] United States,[66] Uruguay,[42] and the Virgin Islands (U.S.). [67]

CR availability in middle-income countries

The most comprehensive data on the availability of CR in middle-income countries were published in two regional surveys: the Latin America and the Caribbean survey with 14 participating countries,[68] and the South American survey with 9 participating countries.[42] Moreover, a recent review[69] explored CR services in LMICs and reported they were available in 22.1%. Of the 103 middle-income countries globally, this search revealed CR services exist in 29 (28.2%) countries (Figure 1). These were: Algeria,[70] Argentina,[42]

Belarus,[69] Bosnia And Herzegovina,[69] Brazil,[68] Bulgaria,[69] China,[71] Colombia,[68] Costa Rica,[69] Cuba,[69] Ecuador,[42] Egypt,[72] India,[73] Indonesia,[74] Iran,[75] Malaysia,[69] Mexico,[68] Pakistan,[76] Panama,[69] Paraguay,[42] Peru,[68] Philippines,[43] Romania,[77] South Africa,[78] Sri Lanka,[69] Thailand,[69] Tunisia,[79] Turkey,[80] and Venzuela.[42]

CR availability in low-income countries

Of the 36 low-income countries globally, CR services were available in only 3 (8.3%). These were: Afghanistan,[81] Bangladesh,[82] and Kenya.[83]

Thus, overall, CR is available in 83 out of the 214 (38.8%) countries worldwide. CR services are available in only 23% of the LMICs, where 80% of CVD deaths occur[84] underlining the insufficient supply of CR in countries with the greatest cardiovascular burden. There is an inverse relationship between the availability of CR and the number of patients indicated for CR therapy.

Density of CR

CR density, expressed as number of CR programs per inhabitant (population density), was used as a crude estimate of the number of indicated patients who may have a spot in a CR program by country. While it would be more informative to report the number of *indicated* patients per CR program (i.e., CR capacity),[42,51] unfortunately as outlined above, country-level CVD prevalence data is not available for many countries. Moreover, this approach is limited by the variation in number of patients treated annually across CR programs (e.g., range of 75–232 patients/program in a US study).[85] Finally, there is no accepted density threshold which could indicate sufficient CR capacity. There is a published position statement recommending a benchmark of 70% CR enrolment[40]; however, the translation of this recommendation into a density value has yet to be undertaken. Still, in line with previous research,[42] the density of CR is presented and for the first time, compared across regions of the world (Table 3).

High-income countries

Based on national and regional surveys in high-income countries, CR density ranges from one program per 100 thousand to 300 thousand inhabitants,[42,51,86] except in the case of Chile which has recently been classified as high-income.[3] In the United States specifically, which has the highest CR density worldwide, there was one CR program per 102 thousand inhabitants in 2003, with a range of one program per 23 to 261 thousand inhabitants by state.[86]

CR density in LMICs

In middle-income countries, CR density is smaller than that of high-income countries.[42] It ranged from 0.9–6.4 (Table 3). CR density in the United States was almost 23-fold greater than that reported in South America, where CR density was estimated at one program per 2.3 million inhabitants.[42] Further, while CR density was 1 program per less than half a million inhabitants in high-income countries,[42,51,86] CR density was almost 1 program per 1 to 6 million inhabitants in middle-income countries.

CR density in low-income countries has not been reported. Our extensive search identified only one program per country in the 3 low-income countries where CR was found to exist, namely Afghanistan,[81,87] Bangladesh,[82,87] and Kenya.[83,87]

Availability of CR to Patients

Physician Referral

Patient referral to a CR program by a physician is a prerequisite step for participation in most countries. In high-income countries, physician referral to CR has been highlighted as a key barrier in several studies.[88,40,42,89–92] Findings of these studies reported 33%–71% of eligible patients were not referred, and hence were unable to access to CR (Table 4), despite the scientific statements and evidence-based guidelines on referral to CR. [93] Recently, data from the EUROASPIRE III Survey, conducted in 22 European countries (19 of which were high-income countries), showed that 44.8% of the 8,845 patients eligible for CR were advised by physicians or other healthcare professionals to attend a CR program.[55] Whether this advice was a formal referral to CR or a verbal recommendation was not stated in the study; hence, this referral rate could be over-reported.

In LMICs, very few studies have investigated physician referral to CR, and where reported CR referral rates are even lower than those reported in high-income countries. In a study undertaken in Brazil[94] for example, low CR referral was reported as a barrier to enrolment. Similarly, in a survey in Iran, low physician CR referral was also reported as a barrier to participation; Iranian cardiologists perceived < 15% of patients are referred.[95] In European middle-income countries, the EUROASPIRE III survey demonstrated low CR “advice” rates, from 7.3% in Turkey to 26.4% in Romania.[55] (Table 4)

Disparities in patient access to CR

Inappropriate variability in CR use has been documented in high-income countries.[19,90,91] Certain vulnerable groups are less likely to be referred, and hence participate in CR.[19,90,91] This includes women, the elderly, ethnocultural minorities, patients of low socioeconomic status, and with comorbidities.[90,91,99] Paradoxically, these patients often have greater need for CR due to greater disease management complexity or evidence of poorer outcomes. In middle-income countries, women are similarly less represented than men (<30%) in CR.[73,75,100,101] Indeed in one CR study in Brazil, there were no women represented.[102] Given there is no evidence that these vulnerable groups derive less clinical benefit from CR, these disparities suggest that some vulnerable groups have even less access to CR than does the average patient.

CR Availability in Comparison to other Evidence-based Interventions

While the WHO states “cardiac rehabilitation should be an integral component of the long-term, comprehensive care of cardiac patients”,[103] governments allocate more resources to acute treatment of CVD than to less expensive, long-term disease management, such as CR[68,52] (Table 5). In a national CR survey, only 6.5% of 1,059 hospitals in Japan were “approved” to offering CR services.[52] This is compared to 61.8% and 58.8% of these

hospitals implementing coronary angiography and percutaneous coronary intervention, respectively, following myocardial infarction.[52]

While acute revascularization strategies such as coronary artery bypass graft surgery and percutaneous coronary interventions confer benefit for patients, CR is also considered as a Class I, Level A indication in clinical practice guidelines (i.e. useful and effective).[104,32] For example, research demonstrates coronary artery bypass graft surgery conferred significant reductions in mortality of 39% (odds ratio [OR], 0.61; 95% CI, 0.48–0.77) at 5 years of follow-up,[105] percutaneous coronary interventions conferred significant reductions of 20% (OR, 0.80; 0.64 to 0.99),[106] and CR conferred significant reductions of 26% (OR, 0.74; 0.58–0.95).[107] Moreover, a study from the United States showed that after revascularization, provision of CR would prevent or postpone the greatest number of deaths following myocardial infarction; while CR was the intervention which would prevent or postpone the greatest number of deaths in patients with unstable angina and heart failure.[108]

Middle-income countries are now starting to provide these expensive cardiac procedures. While this is appropriate given the epidemic of CVD in these contexts, resources are highly limited.[68] While the cost of CR provision in LMICs is not known, consistent with high-income countries (Table 5), it is expected to cost much less than acute revascularization. Thus, CR should be developed prior to building of operating theatres and cardiac catheterization facilities, or at a minimum in concert with it. However, a survey of centres offering cardiac catheterization in 13 Latin American countries revealed only 56% had CR programs.[68]

CR utilization is also less than other guideline-recommended secondary prevention therapies, namely medications.[111] For example, in a study on implementation of the American Heart Association's Get with the Guidelines program,[112] in multiple hospitals they were able to achieve rates of 94% aspirin use, 92.5% beta-blockade, and 84.8% angiotensin-converting enzyme inhibitor use. This is in stark contrast to the rates of CR use reported herein. With regard to outpatient care, data from the American College of Cardiology's Practice Innovation and Clinical Excellence (PINNACLE) program similarly reveal greater, although more moderate, provision of evidence-based therapies than CR.[113] In a sample of 8,132 coronary artery disease patients, CR referral was only 18.1%, eclipsed only by diabetes screening at 13.3%. Other practice recommendations such as blood pressure measurement (94.0%), smoking assessment (83.8%), and annual lipid assessment (74.3%) were much higher.[113]

A similar situation of greater provision of non-CR secondary prevention recommendations is observed in LMICs. For instance, the proportion of CHD patients receiving aspirin was 81.2%; beta-blockers was 48.1%; angiotensin-converting enzyme inhibitors was 39.8%; and for statins was 29.8% in 10 countries.[114]

Reasons for Under-utilization of CR

Much research has been done in high-income countries to identify reasons for under-utilization of CR despite its benefits. For example, in a systematic review, Murray et al.[115]

found 253 factors associated with uptake of cardiovascular lifestyle behavior change programs including CR. These barriers have been described at three inter-related levels: patient, provider, and system levels.

The most commonly-reported patient-related CR barriers included older age, low socioeconomic status, role obligations and subsequent time conflicts (i.e., work), patient disinterest, and comorbidities.[19, 76, 88,90,91,97,115–117] Despite the scarcity of studies on CR barriers from middle-income countries, the barriers reported were consistent with those in high-income countries. [76,94,95,102] With regard to low-income countries, no studies on CR barriers were identified.

Physicians, in both high and middle-income settings, are demonstrated to play an important role in CR utilization.[19,95,117,118] Inadequate physician knowledge about CR benefits, lack of incentives to refer and low physician endorsement of CR to their patients have been often described.[95,117] Low physician referral may be compounded by their subjective assessment of a patient's (in)ability to participate, and lack of implementation of systematic CR referral strategies at patient discharge.[40,119, 118] Moreover, compensation for physicians to provide CR is considered much less than that for interventional cardiologists, which likely plays a role in physician choice of specialty and area of practice. This would lead to the system-level barrier of lack of health human resource capacity to deliver CR.

At the health-system level there are also many barriers to CR provision. Limited availability of CR programs, financial constraints, distance, transportation problems, and lack of insurance coverage are some of the most frequently-reported system-level barriers in high- and middle-income countries.[19,95,102,115,117]

CR barriers have only been investigated in the middle-income countries of Brazil, Iran, and Pakistan.[76, 94,95, 102] Physicians perceived low patient referral in Iran due to limited general knowledge about CR program and its benefits, limited knowledge about methods of reimbursement, and lack of insurance coverage.[95] In Brazil, distance, cost, lack of patient knowledge about CR benefits, and work and family responsibilities were barriers to CR participation.[94,102] Similarly, employment conflicts and distance were the main barriers to CR participation in Pakistan.[76] Barriers to CR provision in low-income settings have not been investigated, however barriers to healthcare provision more broadly have been well-described.

Strategies to Increase CR Provision

There are loud calls to increase CR provision in high-income countries,[120] and clearly these calls need to be broadcast in LMICs. Implementation of evidence-based care is highly dependent upon the behaviors of policy-makers, healthcare professionals and patients.[121,122] The Theoretical Domains Framework[122] integrates theories of behavior change to address complex implementation problems such as with CR. It may be useful in developing complex interventions to overcome the gap in CR implementation, through its consideration of theory, as well as evidence and practical barriers, as reviewed herein.

Strategies to improve rehabilitation service delivery worldwide have been described by the WHO.[123] They include reforming policies, expanding research, developing funding mechanisms to address barriers, increasing health human resources, expanding and decentralizing service delivery, and increasing the use and affordability of technology. Below, strategies to increase CR supply and demand, with particular relevance to LMICs, are forwarded.

Health policies to increase CR capacity

To address the inadequate availability of CR globally, coordinated effort at national and international levels are required.[124] With regard to reforming CR policies specifically, surveys of program directors in high- and middle-income countries alike confirmed the need for national policies to support CR provision and comprehensive reimbursement.[125,68] While sufficient evidence exists to support the provision of CR in high-income contexts, there have been few randomized controlled trials of CR undertaken in LMICs[71,126,127] (however it is expected that greater gains would be observed given the low rates of risk factor screening and control).[128] With expanded, context-specific research evidence, Ministries of Health could then implement public health policies that acknowledge, promote, and prioritize resources to support CR.[68]

With respect to low resources for CR delivery in LMICs, we have highlighted the discrepancy between the dissemination of expensive coronary interventions for treatment of CHD versus the poor implementation of CR (despite being less expensive, requiring less infrastructure and its' efficacy).[68] This underscores the need for re-allocation of resources and development of novel funding models to support cost-effective[129] strategies such as CR. For instance, in the recent edition of the British Association for Cardiovascular Prevention and Rehabilitation Standards, they suggest that CR should be part of the "integrated cardiology service".[130] As cardiology services are being developed in LMICs, CR should be a required service provided post-event or procedure. This could reduce the need for repeat revascularization and other downstream medical care utilization.

While alternative models of CR delivery will be considered below, expanding health human resources and service delivery as recommended by WHO would likely also have substantive impact in increasing CR supply. CR rotations should be incorporated into training and education of healthcare providers, from community health workers to physicians. "Task-shifting" of provision of some of the core elements of CR, such as self-management education for instance, could be allocated to nurses rather than physicians, for example. Other approaches such as increasing the hours of operation of existing programs, and development of satellite sites of well-established programs could also greatly "scale up" CR capacity.

Health system approaches to increase CR demand

Arguably, if we increase patient demand for CR, then there will be pressure to increase provision (i.e., bottom-up approach). In a Cochrane review by Davies et al, 3 RCTs of interventions to increase patient uptake were identified. [131] These studies were conducted in high-income countries, and all were successful. One of these was low-cost,[132] however the

other 2 were complex and human resource-intensive.[133,134] The former intervention comprised provision of a motivational letter to patients. A recent study[135] also revealed that the use of theory-based invitation letters improved attendance at CR. Such a low-cost, simple method should be adapted and tested in middle-income contexts.

Systematic CR referral is a policy that has been demonstrated to increase CR use.[136] Several associations have endorsed CR referral,[40] including as an indicator of care quality, namely the American Association of Cardiovascular and Pulmonary Rehabilitation,[137] the European Association for Cardiovascular Prevention and Rehabilitation,[29] and the Canadian Association of Cardiac Rehabilitation (http://ddqi.ccs.ca/). Further, the latter association is close to achieving “pay for performance” for CR referral.[138] This funding reform could represent a “disruptive innovation” in increasing CR participation rates.

Alternative models of CR delivery to increase reach

Due to the challenges confronting the delivery of traditional hospital-based CR including cost and accessibility, alternative models have been developed. Some of these models are seen in both high- and middle-income countries, such as home-[127,139] and community-based programs.[100,139,140] These programs are found to be as effective as hospital-based CR in reduction of CVD risk factors and mortality in recent systematic reviews.[41,142] Moreover, home-based programs are shown to be as beneficial as supervised programs in middle-income countries, and may be lower cost.[73] Unfortunately, due to lack of comprehensive reimbursement approaches for these models (with the United Kingdom being a notable exception) their implementation has not been wide.

Another alternative model for CR implementation is provision within the primary healthcare setting,[143,144] which is much more broadly available globally than specialty care. Integration of chronic care into primary healthcare in low-resource settings has been successful, such as for diabetes and hypertension.[145] Though such findings are promising, primary care providers are often over-stretched with limited capacity to engage in preventive care. Use of “physician extenders” trained in the core elements of CR may support CR provision in this context.

Finally, internet-based, telehealth, and mobile device delivery modalities represent a burgeoning and active area of CR research. These program models have advantages in terms of cost, time (i.e., no conflict with work schedules, no transportation required, less interference with family obligations), privacy (i.e., no group embarrassment), and in overcoming logistical barriers such as infrastructure and health human resource constraints. Based on our literature review, internet- or web-based models[141,146] have only been tested in high-income countries to date. Because of the variations in the internet-based interventions, it was not possible to compare effectiveness of internet-based with hospital-based CR program[146]; still, the internet-based interventions had positive effects on health behavior compliance, physical activity, as well as psychosocial and clinical outcomes (i.e., blood pressure, cholesterol, hospital visits.[146] Mobile CR models are emerging in high-income countries with promising results.[141,147] While there are yet no data from LMICs, one study is under way in Jordan.[147,148] Given the penetrance of mobile technology in many LMICs, these models have significant potential to increase delivery of CR.

Conclusions

While the global trends of CVD burden and death are increasing, the global availability of CR is very low. Only 38.8% of countries have CR programs, with densities in middle-income contexts as low as one program per 6 million inhabitants. The problem is worse in LMICs where only 23% of countries have CR, yet they have the greatest burden of CVD. While the multi-factorial reasons for this paradox are known, so are strategies to increase provision. Moreover, novel delivery modalities hold incredible promise of reach, given the penetrance of mobile phones in LMICs in particular. We have effectively increased CR use in the United States and much of Western Europe, countries which have a plethora health care system delivery models. It is time to focus our efforts on tailoring these approaches to LMICs. The burden of evidence for CR is equivalent to other therapies, and thus as cardiology services are developed in LMICs, CR should be at the forefront of care.

Acknowledgments

The authors gratefully acknowledge the assistance of the University Health Network information specialist Ms. Maureen Pakosh in conducting the electronic database searches. Dr. Sarrafzadegan also acknowledges the University of British Columbia School of Population and Public Health where she was undertaking sabbatical while writing this manuscript.

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Key points

- CR services are poorly implemented worldwide, with 38.8% of countries having CR services globally
- CR services are available in only 23% of LMICs, countries which have the greatest cardiovascular disease burden and highest rates of mortality.
- The density of CR is greatest in the United States where there is one program per 102,000 inhabitants; this contrasts starkly with middle-income countries with a density of one program per 1–6 million inhabitants
- Less than 50% of eligible patients are referred to CR programs
- CR services are less often implemented than are other evidence-based secondary prevention therapies, though its' cost is much less
- More research is required to evaluate effectiveness of affordable and feasible CR models in both high and LMICs, while taking advantage of new technologies

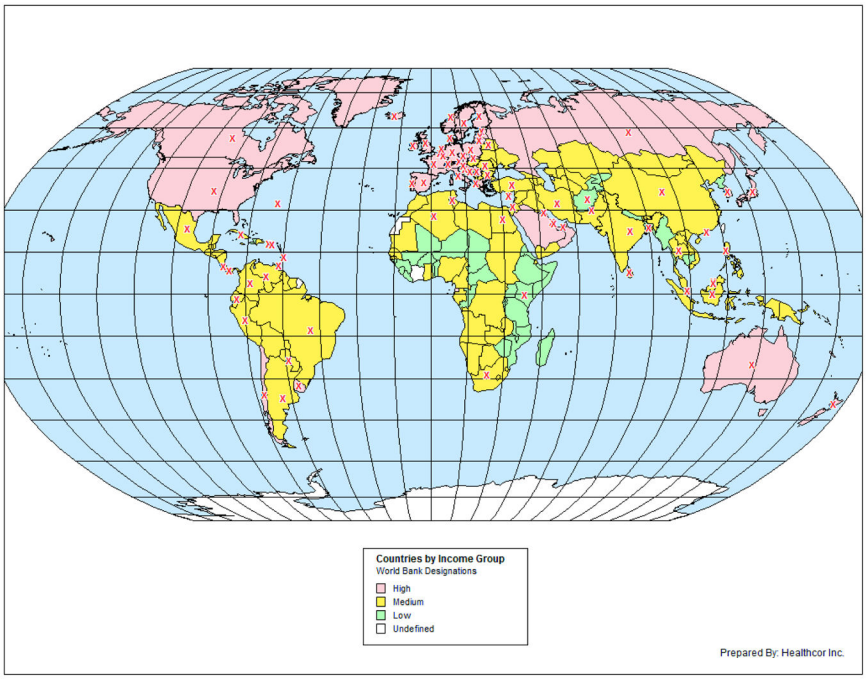

Figure 1.

Availability of cardiac rehabilitation in high-, middle-, and low-income countries

Note. Countries coloured white do not exist in the current World Bank's income-group list, as of January 2014.

Table 1

Cardiovascular disease incidence and cost (in 1000s) worldwide

Year	Total cost (billions of US$)	CHF incidence	IHD incidence	Stroke incidence
2010	863	10,072	24,167	28,299
2015	906	10,821	25,933	30,370
2020	957	11,830	28,284	33,122
2025	1,002	12,754	30,369	35,571
2030	1,044	13,637	32,339	37,886
Total, all years, 2010–2030	**20,032**			

Source: (Bloom et al., 2011) [4]

Abbreviations: IHD, ischemic heart disease; CHF, congestive heart failure; US, United States

Table 2

Prevalence of cardiovascular disease for selected countries

Country (year)	Prevalence (million)	Disease
Australia (2009)[11]	3.7	CVD
Brazil (2008)[12]	6.7	heart disease
Canada (2007)[13]	1.3	heart disease
China (2010)[14]	235	CVD
India (NA)[15]	45	CHD
United States (2010)[16]	15.4	CHD

Abbreviations: CHD, coronary heart disease; CVD, cardiovascular disease; NA, not available.

Table 3

Density of cardiac rehabilitation programs by country and income classification

Country	CR Density (million inhabitants/program)
High-income	
Chile *[42]	1.7
Italy[51]	0.3
United States[86]	0.1
Uruguay *[42]	0.3
Middle-income	
Brazil[42]	4.9
Colombia[42]	0.9
Ecuador[42]	2.9
Paraguay[42]	6.4
Peru[42]	3.1
Venezuela[42]	3.3
Low-income **	
Afghanistan[81]	29.1
Bangladesh[82]	164.4
Kenya[83]	40.9

* Recently classified as high-income countries.[3]

** Extrapolated estimate.

Table 4

Proportion of patients referred to CR by country

Country	No. Patients	% Referred	Diagnosis
High-income			
Australia[96]	15, 186	29%	Cardiac event
Australia, Canada, USA [97]	30,333	34%	Coronary artery disease
Canada[91]	3,739	52%	CABG, PCI
UK[98] (England, Wales, Northern Ireland)	146,000	45–67%	MI, unstable angina or following revascularization
USA[89]	72,817	56%	MI, PCI, CABG
USA[90]	145,661	60%	PCI
LMICs			
Hungary[55]	452	57% *	CABG, PCI, MI, acute myocardial ischemia without infarction
Iran[95]	NA	15% **	NS
Romania[55]	516	26.4% *	CABG, PCI, MI, acute myocardial ischemia without infarction
Turkey[55]	329	7.3% *	CABG, PCI, MI, acute myocardial ischemia without infarction

* Patients were advised by physicians or health professionals to attend CR.

** Based on 122 physicians' perception. Abbreviations: CABG, coronary artery bypass graft surgery; MI, myocardial infarction; percutaneous coronary intervention; NS, not specified; NA, not applicable; UK, United Kingdom; USA, United States of America.

Table 5

Cost of treatment for cardiovascular diseases in 2 high-income countries

Intervention	Cost
UK[109]	
Cardiac rehabilitation	£427
CABG for chronic angina (elective)	£4,956
Angioplasty for chronic angina (elective)	£2,369
USA	
Cardiac rehabilitation[110]	$US1,728
CABG[16]	$US133, 247
PCI[16]	$US67, 086
Cardiac catheterization[16]	$US39,264

Abbreviations: CABG, coronary artery bypass graft surgery; MI, myocardial infarction; PCI, percutaneous coronary intervention; UK, United Kingdom; USA, United States of America.