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## CONSENSUS STATEMENT

## Cardiac rehabilitation delivery model for low-resource settings

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**ABSTRACT**

**Objective** Cardiovascular disease is a global epidemic, which is largely preventable. Cardiac rehabilitation (CR) is demonstrated to be cost-effective and efficacious in high-income countries. CR could represent an important approach to mitigate the epidemic of cardiovascular disease in lower-resource settings. The purpose of this consensus statement was to review low-cost approaches to delivering the core components of CR, to propose a testable model of CR which could feasibly be delivered in middle-income countries.

**Methods** A literature review regarding delivery of each core CR component, namely: (1) lifestyle risk factor management (ie, physical activity, diet, tobacco and mental health), (2) medical risk factor management (eg, lipid control, blood pressure control), (3) education for self-management and (4) return to work, in low-resource settings was undertaken. Recommendations were developed based on identified articles, using a modified GRADE approach where evidence in a low-resource setting was available, or consensus where evidence was not.

**Results** Available data on cost of CR delivery in low-resource settings suggests it is not feasible to deliver CR in low-resource settings as is delivered in high-resource ones. Strategies which can be implemented to deliver all of the core CR components in low-resource settings were summarised in practice recommendations, and approaches to patient assessment proffered. It is suggested that CR be adapted by delivery by non-physician healthcare workers, in non-clinical settings.

**Conclusions** Advocacy to achieve political commitment for broad delivery of adapted CR services in low-resource settings is needed.

**INTRODUCTION**

The epidemic of coronary heart disease (CHD) in low/middle-income countries (LMICs) is staggering.<sup>1</sup> Resultant premature mortality has significant negative economic impact. To lessen the impact of CHD on individuals and societies, a comprehensive approach is needed. Cardiac rehabilitation (CR) provides such an approach, through delivery of risk reduction therapies and promotion of heart-healthy behaviours such as physical activity, nutrition and tobacco cessation. CR, delivered to patients with stable angina through to myocardial infarction, and its' sequelae, as well as those who have undergone an interventional procedure to ameliorate these

conditions, reduces cardiovascular mortality by 26% and rehospitalisation by 18%.<sup>2</sup>

There has been considerable implementation of expensive acute coronary care units and revascularisation centres in many MICs, yet research suggests that proven, low-cost secondary prevention strategies such as CR are not implemented.<sup>3</sup> To our knowledge, CR is only available in approximately one-quarter of MICs and one-tenth of Low-income countries (LICs).<sup>4</sup> The reasons are complex, and include healthcare budgetary issues (particularly for LICs), inadequate legislation, lack of trained healthcare providers, the dearth of randomised controlled trials on effects of CR in LMICs such as are available in high-income countries (HICs)<sup>2</sup> and most centrally lack of clinical practice guidelines on how CR can be implemented in low-resource settings.<sup>5 6</sup>

In 1993, the World Health Organization (WHO) published a seminal report entitled 'Rehabilitation after Cardiovascular Diseases, With Special Emphasis on Developing Countries', which outlined recommendations on how CR could be delivered in low-resource settings.<sup>6</sup> Despite considerable advances in our knowledge about CR and in information and communication technologies in the last two decades, this WHO report has not been updated. More recently, all of the components of an integrated CR service can be found within the targets set by WHO in their 25×25 initiative. In the WHO Global Action Plan for the Prevention and Control of Non-Communicable Diseases (2013–2020), it is recommended that all patients 'should have access... to nationally determined sets of the needed ... rehabilitative health services' (p. 13), with CR specifically listed in the menu of policy options (p. 69).<sup>1</sup>

Accordingly, an expert panel was convened to develop a testable CR model for low-resource settings (primarily MICs and under-resourced areas in HICs), which is forwarded herein. The development process applied is described in online supplementary file 1, and was informed by previous methods.<sup>7</sup> The search strategy for the literature review to inform recommendation development is shown in online supplementary file 1. Consideration of costs and affordability preface the model recommendations.

**CR cost and affordability**

For CR to be implemented in low-resource settings, financial resources must be considered. With data largely from HICs, CR has been demonstrated to

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be both effective and cost-effective.<sup>8 9</sup> But what about other resource settings? In 2013, health expenditures accounted for 11.9% of gross domestic product in HICs but only 5.8% in MICs and 6.4% in LICs; in the same year, per capita health expenditures in low-income countries were US\$37 (hence these countries are not a focus for the recommendations herein) and US\$256 in MICs.

A recent publication has examined the costs and cost-effectiveness of CR in MICs suggesting that, as of 2015, there have been three publications with CR cost data, all from seven Latin American MICs, with another two publications from Latin American upper-MICs on the cost-effectiveness of CR.<sup>10</sup> With CR programmes based on the typical supervised CR model in the USA (three times per week with telemetry; please note CR models delivered in other HICs, however, cost less), the mean 3-month CR programme cost data for the seven Latin American MICs was approximately US\$360 to the public healthcare system. The cost-effectiveness of CR was estimated to be US\$18 050 per life-year gained and US\$22 560 per quality-adjusted life-year in Brazil and US\$3156 per life-year gained and US\$998 per quality-adjusted life-year in Colombia. According to the WHO,<sup>11</sup> CR in Brazil can be considered cost-effective at between one and three times the gross domestic product (US\$11 200 in 2013) and highly cost-effective in Colombia at less than gross domestic product (US\$7830 in 2013).

While CR may be considered cost-effective in the two Latin American upper-MICs, the mean cost for a 3-month USA-model CR programme to the public healthcare system in the seven MICs of approximately US\$360 is 61% of the 2013 mean healthcare expenditure of US\$590 in the same seven countries.<sup>10 12</sup> For this reason, it is imperative that a lower-cost approach to CR be developed, implemented and tested, as is outlined below.

### LOW-RESOURCE CR MODEL

The core components of CR have been established by the major CR associations from HICs, namely the American,<sup>13</sup> Australian,<sup>14</sup> British,<sup>15</sup> Canadian<sup>16</sup> and European associations.<sup>17</sup> These core components have also been agreed-upon in the International Council of Cardiovascular Prevention and Rehabilitation (ICCP) charter, which has also been endorsed by CR associations in LMICs.<sup>18</sup> Herein each of the following common core components has been adapted for the MIC setting: (1) assessment, (2) lifestyle risk factor management (ie, physical activity, diet, tobacco and mental health), (3) medical risk factor management (eg, lipid control, blood pressure (BP) control), (4) education for self-management and (5) return to work.

It must be conceded that delivery of CR in high-resource settings does not always include all of the recommended components, and access remains low. Moreover, despite evidence of the efficacy of CR delivered in non-hospital settings, it is most-often delivered in these expensive settings.<sup>19</sup> Herein we provide realistic guidance on minimum standards for CR delivery in low-resource settings. These recommendations are forwarded in the spirit that CR champions start small with resources, financial and otherwise, at hand. We should strive to establish programmes where possible, and then build in additional CR components as possible. These programmes must be sensitive to the health literacy, gender, religious and cultural context in which they are embedded.

The CR programme should commence with a comprehensive assessment. It is recommended that the style of the assessment be consistent with motivational interviewing.<sup>20</sup> Specifically, the assessment should be patient-centred and goal-oriented. Each of

the following elements should be considered in the intake assessment: physical activity, diet, tobacco consumption, overweight/obesity, CHD knowledge, depression, return to work, lipids, BP, medications and diabetes. At the completion of the comprehensive formal assessment, documentation should be made of the findings. The client and the CR provider should discuss a plan of treatment accordingly.

Recommendations for delivering each of the core components are shown in [table 1](#). While each core component is addressed separately, it is conceived that the lifestyle and behaviour elements weave consistently across all the recommendations, and should be applied in a patient-centred manner. Secondary prevention including BP and cholesterol management, and prescription of cardioprotective medication where available, also forms an integral part of the model. Given the centrality of exercise to CR, more detail regarding delivering this component in low-resource settings is outlined below.

### Physical activity

The benefits of regular exercise in patients with CHD have been well established in both well-resourced and low-resource settings.<sup>2 21</sup> There is a strong positive effect of physical exercise training on the pathogenesis of CHD, symptoms specific to the pathology, physical fitness and strength and quality of life. Accordingly, programmes of exercise should, wherever feasible, be offered to all subjects recovering from major CHD events.<sup>22</sup>

#### Stratification of patient risk for an adverse event during exercise

There are few contraindications to participation in some form of regular physical exercise. It is important to appreciate that patients at both ends of the functional spectrum will present for CR. Some will be able to perform exercise without adverse consequences (low-risk patients) and others will have very limited exercise capacity, active ischaemia, acute heart failure, significant arrhythmia or ventricular dysfunction (high-risk). Thus, the process of risk stratification is important.<sup>13</sup> The application of a process of risk stratification can guide the exercise intensity and duration, and the appropriate facility type and nature of health professional to supervise the exercise. The intensity of activity at which a cardiac event is likely to occur should be appropriately explained to the patient.

There is evidence that low-risk individuals can safely exercise without medical supervision and safely and promptly return to preillness activities including work. Medical supervision is suggested for high-risk patients (eg, those with exercise-induced myocardial ischaemia with possible ST segment depression and/or angina pectoris and those with left ventricular ejection fraction <30% or ventricular arrhythmia).<sup>13</sup> Wherever possible, high-risk cardiac patients should be supervised during moderate exercise by a healthcare provider skilled in management of emergency cardiac events and principles of exercise prescription and patient monitoring in disease states. However, this is not possible in all settings.

#### Exercise equipment

The practicalities and realities of providing comprehensive CR including exercise in low-resource settings can be challenging, and require clever usage of existing resources, which can be modified. Equipment for exercise provision and monitoring may be minimal in low-resource settings providing further challenge. Exercise equipment can be costly and also requires maintenance. Furthermore, training of necessary personnel is required to prescribe exercise to patients with the use of advanced equipment. Therefore, in low-resource settings, non-equipment based

**Table 1** Intervention recommendations for delivery of the core components of CR in low-resource settings, with level of evidence

Core component	Recommendation	Level of evidence*
1. Exercise	1a. Programmes of exercise should, wherever feasible, be offered to all subjects recovering from major CHD events. <sup>w1-w11</sup>	LMICs—low quality of evidence
	1b. The frequency goal should be to conduct exercise training on at least 3 days but preferably on most days of the week.	Consensus based
	1c. If an exercise ECG has been conducted prior to exercise, the heart rate during exercise should be kept below the symptomatic threshold. If no exercise ECG has been possible then the presence of chest pain induced by exercise and relieved by rest or nitroglycerin warrants evaluation prior to initiating exercise at intensities at or above this intensity. Without an exercise ECG, the recommended exercise training intensity should be in the light and moderate ranges.	Consensus based
	1d. The duration of aerobic exercise training would depend on the patient's initial functional capacity and progression in the programme and might start with a 10 min bout of aerobic exercise and gradually progress to 60 min per session at a rate of about 10%–20% in duration per week. Warm-up and cool-down activities would precede and follow the aerobic exercise bout.	Consensus based
	1e. Patients at lower risk or who have completed a period of supervised rehabilitation can be promoted to exercise safely in a home-based or community setting. Supervised exercise setting is for high-risk patients. <sup>w12 w13</sup>	LMICs—low quality of evidence
	1f. Walking is the preferred mode of exercise, as it is no-cost. However, non-weight-bearing exercise is recommended for patients with musculoskeletal pain or limitations. This should be augmented with resistance training where possible.	Consensus based
2. Diet	2a. Fruits and vegetables Consumed in abundance as affordable, particularly locally grown fruits and vegetables. At least 400 g/day (ie, five portions), but ideally double this. There should be a greater intake of vegetables than fruit. <sup>w14 w15</sup> Having a variety of different coloured fruit and/or vegetables daily will aid a diverse micronutrient intake. A maximum of one glass (150 mL) of fruit juice each day.	HIC—high quality of evidence Consensus based
	2b. Whole grains and fibre Should be incorporated into the diet in the least refined and highest fibre form. <sup>w16</sup> Refined starches and sugars along with sugar-sweetened beverages should be limited. <sup>w17</sup>	HICs—moderate quality of evidence HICs—moderate quality of evidence <sup>w17</sup>
	2c. Dietary fat The primary source of fat should be an unsaturated fat (olive oil, sunflower oil, canola/rapeseed oil) replacing saturated fat (lard, butter) where possible. <sup>w18 w19</sup> Trans fatty acids (partially hydrogenated fat) should be avoided.	HICs—high quality of evidence
	2d. Salt Less than 5 g salt/2000 mg sodium per day. <sup>w20</sup> Reduction of processed, smoked, cured, bread and cereal products will aid achievement.	HICs—high quality of evidence
	2e. Protein Use fish, poultry, nuts and legumes as an alternative to fatty red or processed meats. For those living in coastal areas, eating fish caught locally may be more affordable.	Consensus based
	2f. Dairy products These are non-essential although can be useful sources of protein or calcium for some; there is no benefit from a high intake.	Consensus based
	2g. Vitamin and mineral supplements Not required if a balanced diet is consumed, unless indicated by other conditions.	Consensus based
	2h. Patients with raised LDL cholesterol The incorporation of stanol and sterol ester products can be encouraged in the correct dose. <sup>w21</sup>	HICs—moderate quality of evidence
3. Tobacco	<i>Psychological interventions</i> 3a. For all patients: brief advice from trained health professional or physician Brief opportunistic advice consists of up to 30 min of discussion with patients aimed at prompting a quit attempt and in some cases enhancing chances of the success of that quit attempt. It can be provided by a physician, nurse or trained health personnel at the CR facility. It may include advice to stop, providing information about the health consequences of smoking, how the different components of cigarette smoke cause harm, the benefits of quitting, advice on methods of quitting and in some cases offer of further support. <sup>w22</sup>	LMICs—high quality of evidence
	<i>Pharmacological interventions where available: non-physician based</i> 3b. NRT NRT products are recommended for all smokers and smokeless tobacco users with stable cardiovascular disease and those who have suffered an acute event on hospital discharge. <sup>w23 w24</sup> Those with unstable disease should be assessed by a cardiologist prior to NRT use.	HICs—high quality of evidence
	<i>Pharmacological interventions options for physicians: based on availability, affordability and individual patient profile</i> 3c. Where a physician and the medications are available and affordable, patients should be offered bupropion, cytisine or varenicline. <sup>w25-w28</sup>	HICs—moderate quality of evidence
4. Body weight/ composition	4a. All patients with established CHD should have serial (eg, every 6 months) monitoring of BMI and waist circumference.	Consensus based
	4b. In individuals who are overweight (BMI>25) or obese (BMI>30), a combination of weight loss, dietary changes and physical activity is recommended. <sup>w7 w29</sup>	LMICs—moderate quality of evidence
5. Education	5a. Patient education should be personalised, led by trained staff, with regular contact between staff and patients. It should be delivered in individual and/or group settings and if possible, include family members and caregivers. Patient's specific health goals should be discussed.	Consensus based

Continued

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Table 1 Continued

Core component	Recommendation	Level of evidence*
	5b. The aim of education should be to influence health beliefs, to elicit positive emotions, to increase optimism about the possibility of change and to heighten the salience of personal experience or other evidence supporting self-efficacy.	Consensus based
	5c. In addition to education on physical activity, risk factor control, smoking cessation and drug treatment (where feasible), dietary education should be given in terms of food not nutrients, at an appropriate level, in order to facilitate informed healthy choices. Advice should be adapted to meet the specific needs of the patient in the context of his/her family, taking into account factors such as age, culture and lifestyle. For maximum benefit, any targets should be realistic for the longer-term to ensure life-long maintenance.	Consensus based
6. Mental health	6a. Where CR programmes have access to healthcare professionals capable of: (1) undertaking diagnostic interviews for depression and (2) providing collaborative, stepped depression treatment for those with a positive diagnosis, patients should be screened for depression.	Consensus based
	6b. Patients who receive a positive depression diagnosis should be encouraged to adhere to CR to achieve the mental health benefits. <sup>w30-w32</sup>	LMICs—moderate quality of evidence
	6c. Depression treatment, with antidepressants and/or pharmacotherapy should be based on patient preference and availability. Response to therapy should be monitored, and stepped where inadequate symptom reduction is achieved. <sup>w33</sup>	HICs—moderate quality of evidence Consensus based
	Treatment should be communicated with the CR team.	
	6d. CR programmes should offer stress management, where a trained healthcare provider is available. <sup>w34</sup>	HICs—moderate quality of evidence
7. Return to work	7a. All CR patients should undergo assessment of occupational type, employment status and desired occupational status.	Consensus based
	7b. Patients with physically demanding occupations or jobs involving public safety should undergo risk evaluation prior to return to work. Where available, treadmill testing is recommended as the modality of choice for exercise assessment, to ascertain ischaemic threshold, and electrical instability. The 6 min walk test is a viable alternative where resources do not permit treadmill testing.	Consensus based
	7c. Low-risk individuals are those with no angina symptoms and with good functional status (able to perform >7 METS of work). These patients can return to work within 2 weeks of their event, preferably with some initial CR programming and a plan for ongoing contact and support. <sup>w35</sup>	HICs—moderate quality of evidence
8. Lipids	8a. All patients with established CHD should have baseline and subsequent (eg, every 3–6 months) on treatment lipid profile assessments where available.	Consensus based
	8b. A combination of lifestyle modifications (including dietary changes and physical activity) and pharmacotherapy (where available and affordable) is recommended for all patients. <sup>w29 w36</sup>	LMICs—moderate quality of evidence
	8c. Statin therapy, unless contraindicated (in patients with known allergic reactions to statins, active liver disease, as well as in pregnant and lactating women), is warranted for all patients with established CHD, regardless of capacity to test for baseline lipid levels. Absence of blood draw should not be a barrier to prescription of statins. Type and dose of statin is dependent on region/country-specific cost-effectiveness analysis, availability and affordability. Ideally, this should be titrated to achieve a target LDL-C of <70 mg/dL, <sup>w37</sup> or to achieve ≥50% reduction in baseline LDL-C. <sup>w38</sup>	HICs—high quality of evidence
9. Hypertension control	9a. All people who have CHD and heart failure are recommended to have BP assessed at initial CR sessions. Where feasible, multiple BP readings including out of office BP readings (readings in community settings, pharmacies, home) should be used to supplement readings performed in CR sessions. People with high readings assessed in a quiet, comfortable environment (ie, ≥140/90 mm Hg) at two or more visits can be diagnosed with hypertension, while hypertensive urgencies and emergencies are diagnosed immediately. People on treatment for hypertension with BP readings <140/90 mm Hg are also considered to have hypertension. <sup>w39</sup>	HICs—moderate quality of evidence
	9b. Lifestyle behaviour advice for people with hypertension as outlined previously in this document is a core aspect of hypertension management. <sup>w29 w36</sup>	LMICs—moderate quality of evidence
	9c. Where available, antihypertensive medications, outlined in the cardioprotective point below should be used in specific clinical circumstances (eg, ACE inhibitors in heart failure).	See point 10
	9d. Achieving the target BP (<140/90 mm Hg) should be the primary clinical focus. <sup>w40-w43</sup> Diuretic is often the most affordable and accessible antihypertensive medication. BP control generally requires more than one drug and when three or more drugs are required, barring contraindication, one should be a diuretic. <sup>w40-w42 w44-w46</sup>	HICs—moderate quality of evidence
	9e. In people with heart failure, an aldosterone antagonist is indicated where available and affordable. <sup>w40-w42 w44 w46</sup>	HICs—moderate quality of evidence
	9f. In people with heart failure, a non-dihydropyridine calcium channel blockers should not be used. <sup>w40-w42 w44 w46</sup>	HICs—moderate quality of evidence
	9g. In people with CHD, hypotension and reducing diastolic pressure below 60 mm Hg should be avoided. Therefore, short-acting potent oral agents like nifedipine capsules should not be used. <sup>w40 w43 w46-w48</sup>	HICs—moderate quality of evidence
10. Cardioprotective therapies	Access to cardioprotective therapies can be limited in LMICs. The recommendations below are only pertinent to regions where these medications are available, affordable and accessible. Unless there is a specific contraindication, history of allergy or definite history of intolerance, the following cardioprotective medications should be prescribed universally in specific scenarios as described below:	10.a1 HICs—moderate level of evidence 10.a2 HICs—moderate level of evidence 10.a3 HICs—moderate quality of evidence 10.a4 Consensus based
	10a. Antiplatelet therapy	
	10.a1 Low-dose aspirin in doses from 75 to 150 mg a day is recommended for all patients with a history of CHD, including those who have been revascularised. <sup>w49</sup>	
	10.a2 Higher doses of aspirin have not demonstrated greater clinical benefit, and they increase the risk for gastrointestinal bleeding or ulcers. For patients intolerant or allergic to aspirin, clopidogrel at a dose of 75 mg a day can be used. <sup>w49</sup>	

Continued

Table 1 Continued

Core component	Recommendation	Level of evidence*
	10.a3 Dual antiplatelet therapy (aspirin plus clopidogrel or equivalent) is indicated in patients undergoing percutaneous coronary revascularisation with stents and is recommended for 1 year if they received a drug-eluting stent or for at least 3 months if they received a bare metal stent. <sup>w50</sup>	
	10.a4 Dual antiplatelet therapy is also recommended in patients with a history of recurrent coronary events despite appropriate medical therapy including aspirin.	
	10b. ACE inhibitors	10b.1 HICs—moderate level of evidence
	10b.1 ACE inhibitors are recommended in all patients with type 1 or type 2 diabetes mellitus, in patients with a left ventricular ejection fraction of <40% even in the absence of coronary or atherosclerotic vascular disease, and in patients with a recent anterior myocardial infarction <sup>w51</sup>	10b.2 HICs—moderate level of evidence
	10b.2 Angiotensin receptor blockers should also be considered. <sup>w52</sup>	
	10c. $\beta$ -Blockers	HICs—high level of evidence
	$\beta$ -Blockers are indicated in all patients after an ST elevation or non-ST elevation myocardial infarction, in patients with documented ischaemia or clinical angina, and in patients with a left ventricular ejection fraction below 40%, even in the absence of coronary disease. <sup>w51</sup>	
	10d. Statins	HICs—high level of evidence
	Statins are recommended in every patient with CHD regardless of pre-CR lipid values. Further details on the use of lipid-lowering therapy are provided in section 8.	
	10e. Patient education and counselling shall be provided to optimise patient medication adherence. <sup>w53</sup>	

\*References found in online supplementary file 2.

BMI, body mass index; BP, blood pressure; CHD, coronary heart disease; CR, cardiac rehabilitation; HICs, high-income countries; LDL, low-density lipoprotein; LMICs, low/middle-income countries; METS, metabolic equivalents; NRT, nicotine replacement therapy.

exercise programmes (eg, walking or cycling if the patient has their own bicycle) provides the most practical option. However, low-cost options to facilitate all forms of exercise training and monitoring of physical activity are available (eg, resistance bands, 'home-made' weights, gym/yoga mats and low-cost pedometers).

#### Basic exercise facility

To optimise affordability, unsupervised exercise is recommended where possible. However, the CR centre will likely be based in a basic facility, to enable initial assessment and training of new or high-risk patients. This facility can be located in a village or community (eg, local meeting place, hall, place of worship, school or field) and could be staffed by a trained community health worker or preferably a healthcare professional. Minimal equipment is needed, with a sphygmomanometer with stethoscope, a watch to measure heart rate, charts and simple recording equipment suggested. Weather conditions, altitude, pollution and general safety of the area are important considerations. Walking programmes and callisthenics, stretching, core stability and other light exercise (eg, resistance bands) can easily be undertaken at a basic exercise facility. Personnel should have at least basic life saving training, and it is strongly recommended that an automated external defibrillator is present, where possible.

#### Principles of exercise training

The principles of exercise training in low-resource settings are similar to those in well-resourced settings. However, as it is recognised that in many LMICs patients use the exercise mode of walking in their daily work or as their main means of transport, further aerobic training might not be warranted in these cases and the exercise prescription could, therefore, be adjusted to include other components of physical activity. Exercise rehabilitation should be patient-centred, based on patients' clinical status as determined during the pre-exercise assessment, personal preferences, with particular regard to baseline functional capacity. It is also important that the practitioner advises the appropriate exercise prescription for the appropriate stage of the disease and disability. The objective of exercise training in this setting is to limit the physiological and psychological effects

of cardiovascular disease, control cardiac symptoms, decrease physiological limitations and improve physical capacity through specific exercise therapy.

#### Frequency of exercise

The frequency goal should be to conduct exercise training at least 3, but preferably most days of the week. Once safety has been established, patients should be encouraged to exercise at home or outside the programme, to optimise economic efficiency.

#### Intensity of exercise

Exercise intensity should particularly be patient-centred and it is important that besides expected breathlessness of exercise, the patient remains asymptomatic during and after the exercise session. Many patients can be taught to monitor their own heart rate during exercise. If an exercise ECG has been conducted prior to exercise, the heart rate during exercise should be kept below the symptomatic threshold. If no exercise ECG is possible, then the presence of chest pain induced by exercise and relieved by rest or nitroglycerin is sufficient for the diagnosis of myocardial ischaemia, and this intensity of exercise should be avoided. A useful measure of exercise intensity, particularly in low-resourced settings, is a rating of perceived exertion which can be measured using the 20-point Borg scale.<sup>23</sup> Exercise should be performed at an intensity of 11–16 on this scale.

#### Type of exercise

The type of exercise conducted would depend on the functional capacity of the patient (eg, weight bearing vs non-weight bearing exercise), and the equipment available at the exercise facility, home or community setting. However, the components of exercise training should include: aerobic exercise training (ie, rhythmic, large muscle exercise of both upper and lower limbs that increases heart rate), resistance training, flexibility training, balance or proprioceptive training and core stability training. Walking programmes provide the most basic, inexpensive and effective form of exercise training. Dance and controlled games such as soccer are low-cost, and have been successfully used in CR in low-resource settings.<sup>24</sup> CR providers should consider culturally appropriate exercises in their region.

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Resistance training is an important component of exercise in patients with CHD, to facilitate necessary muscle strength to perform activities of everyday living (eg, carrying wood, water or groceries), and prevent and manage type 2 diabetes and osteoporosis.<sup>25</sup> Briefly, resistance training can be performed with elastic bands, small weights or other objects, or using the patients' own body weight. More than one muscle group, as well as agonist and antagonist muscle groups should be targeted. The initial load or resistance should be able to be lifted, pulled or pushed without difficulty, and allow 10–15 repetitions of the exercise without the patient straining. Eight to 10 exercises of the major muscle groups should be performed on 2–3 days of the week with at least 48 h separating training sessions for the same muscle group. Detailed resistance training guidelines for patients with CHD and heart failure (HF) are available.<sup>25</sup>

### Duration of exercise

The duration of aerobic exercise training would depend on the patient's initial functional capacity and progression in the programme. It might start with a 10 min bout of aerobic exercise, and gradually progress to 60 min per session at a rate of about 10%–20% per week. Warm-up and cool-down activities would precede and follow the aerobic exercise bout.<sup>13</sup>

### Monitoring of exercise training

Besides monitoring of patient's exercise intensity, programme staff should closely monitor the patient's signs and symptoms prior to and during exercise to determine if exercise should be discontinued. These symptoms or signs include: patient feeling ill or febrile prior to exercise, musculoskeletal pain, excessive fatigue or any symptoms of exercise intolerance, failure of heart rate and BP increase during exercise, symptomatic arrhythmia or ischaemia. Furthermore, any change of the patient's medication (where available) should be documented.

The minimum equipment for monitoring would include a watch/stopwatch, sphygmomanometer, charts for patient's to rate dyspnoea or rating of perceived exertion, as well as a log book to chart exercise attendance, duration of exercise and heart rate.

### Reassessment and evaluation

Reassessment, audit and evaluation are also considered core components of CR. The goal is to test whether patients are meeting treatment targets at programme completion and have made significant changes through their participation.

Given that many recommendations for CR delivery herein are based on evidence stemming from HICs or consensus, the writing panel particularly encourages evaluation wherever these recommendations are applied. Indeed, the ICCPR plans to undertake field and feasibility tests of this model in future, using low-cost assessment tools, to inform future iterations of this consensus statement. If feasible, incorporation of a control or comparison group, and randomisation of participants to the consensus model versus a comparison group should be built into the evaluation design. It is hoped that in future all recommendations will be based on evidence from the MIC setting.

### Adaptation of CR model for greater reach and affordability

Herein a comprehensive model for CR delivery in low-resource settings has been initially proposed. Similar to the 'Secondary Prevention for All in Need' model previously forwarded,<sup>26</sup> the model is conceived as menu-based and flexible to be applicable in a variety of lower-income contexts and regions.

Given there are large variations in the levels of healthcare resources available in low-resource settings, the recommendations should be implemented as possible. Implementation will depend upon the health system structure of each country, as well as availability and type of trained healthcare providers.<sup>27</sup>

There is now ample evidence that CR is equivalently effective in HICs whether it is delivered in a formal facility or through a home-based model.<sup>19</sup> Clearly, CR delivery without requirement for a facility and the associated costs would be most feasible in low-resource settings. CR could be adapted to be more feasibly delivered through community, the home, the internet/mobile technology and within primary care settings.<sup>19 28</sup>

## CONCLUSION

CR remains insufficiently implemented in current clinical practice, whether in high or MICs.<sup>4</sup> According to the WHO report on CR in LMICs, all patients with CHD in all countries should have access to CR, and healthcare providers and patients and their families should be aware of CR. CR programmes, of a scope consistent with the available resources in each country, need to be part of every healthcare system.<sup>1 6</sup>

Political commitment and accountability are needed to achieve broad delivery of CR services in MICs. There are too few examples where CR is a sustained health priority on the national health agenda of an MIC.<sup>29</sup> Well-planned and organised advocacy programmes, including meetings and dissemination of targeted reports that highlight the importance of CR from an economic, social, developmental and health standpoint, may convince policy-makers to consider CR programmes among their priorities. Strong collaboration is needed between academic groups working in CR with their counterparts in Ministries of Health as well as Finance, the private sector and other-related parts of the healthcare system.

Identification of where CR programmes exist, and supporting these programmes to secure further resources and expand is tantamount. Then, developing national CR recommendations, based on the statement herein but tailored to the local situation, will greatly facilitate implementation.

## Key messages

### What is already known on this subject?

- ▶ Cardiac rehabilitation (CR), a comprehensive outpatient chronic disease management programme, has been established as cost-effective in high-resource settings.
- ▶ CR delivery in unsupervised settings such as the home and community has been shown to be as effective in mitigating mortality and morbidity as traditional supervised delivery.

### What might this study add?

- ▶ Each of the core components of cardiac rehabilitation (CR), namely assessment, lifestyle and medical risk factor management, patient education and return to work, can be delivered in more affordable and practical ways.
- ▶ In low-resource settings, CR may be more feasibly delivered by non-physician health workers, in non-clinical settings.

### How might this impact on clinical practice?

- ▶ Delivery of cardiac rehabilitation using the approaches proffered herein could result in greater reach while maintaining benefit, and hence mitigate the epidemic of cardiovascular diseases in lower-resource settings.

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## Cardiac rehabilitation delivery model for low-resource settings

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