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RESEARCH ARTICLE

Home-based cardiac rehabilitation in older adults: expert-recommendations for physiotherapist-led care to improve daily physical functioning and reduce comorbidity-related barriers

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ABSTRACT

Background: Cardiac rehabilitation (CR) can reduce mortality and improve physical functioning in older patients, but current programs do not support the needs of older patients with comorbidities or frailty, for example due to transport problems and physical limitations. Home-exercise-based cardiac rehabilitation (HEBCR) programs may better meet these needs, but physiotherapy guidelines for personalising HEBCR for older, frail patients with cardiovascular disease are lacking.

Purpose: To provide expert recommendations for physiotherapists on how to administer HEBCR to older adults with comorbidities or frailty.

Methods: This Delphi study involved a panel of Dutch experts in physiotherapy, exercise physiology, and cardiology. Three Delphi rounds were conducted between December 2020 and February 2022. In the first round panellists provided expertise on applicability and adaptability of existing CR-guidelines. In the second round panellists ranked the importance of statements about HEBCR for older adults. In the third round panellists re-ranked statements when individual scores were outside the semi-interquartile range. Consensus was defined as a semi-interquartile range of ≤ 1.0.

Results: Of 20 invited panellists, 11 (55%) participated. Panellists were clinical experts with a median (interquartile range) work experience of 20 (10.5) years. The panel reached a consensus on 89% of statements, identifying key topics such as implementing the patient perspective, assessing comorbidity and frailty barriers to exercise, and focusing on personal goals and preferences.

Conclusion: This Delphi study provides recommendations for personalised HEBCR for older, frail patients with cardiovascular disease, which can improve the effectiveness of CR-programs and address the needs of this patient population. Prioritising interventions aimed at enhancing balance, lower extremity strength, and daily activities over interventions targeting exercise capacity may contribute to a more holistic and effective approach, particularly for older adults.

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Introduction

Cardiac rehabilitation (CR) reduces mortality and improves physical functioning, even in older and frail patients [1–4]. The aim of CR is to reduce cardiovascular risk and disability and promote an active lifestyle [5]. CR typically includes exercise therapy, which is a core component and is often provided by physical therapists (PTs) in an outpatient hospital setting. However, current CR programs may not match the needs and preferences of older patients, leading to low participation rates or dropout [6]. Barriers that have been identified are, among others, transportation issues, comorbidity-related limitations, and frailty [2,3,6].

Frailty, defined as a syndrome of physiological decline, can lead to adverse health outcomes such as hospital readmission and mortality [7,8]. Older, frail patients and those with severe comorbidity are often excluded from clinical trials that CR-guidelines are based on, leaving PTs with insufficient guidance on how to adapt exercise therapy to the home environment in the presence of comorbidity and/or frailty [9–11]. Home-based rehabilitation programs may be more suitable for older patients. Home-exercise-based cardiac rehabilitation (HEBCR) programs are comparable in their effectiveness to center-based CR, yielding improvements in clinical outcomes and health-related quality of life [12–14]. Additionally, HEBCR-programs have demonstrated to be safe for older patients with high cardiovascular risks [15]. Nevertheless, HEBCR programs exhibit significant variation in their content, delivery methods, levels of support or supervision, and dosage [12]. Without proper guidance, PTs in the home environment lack knowledge to assess and monitor the safety and intensity of exercise, motivate patients, and to establish collaboration with other caregivers [16]. The lack of guidance on how to

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personalise CR for older, frail adults with cardiac disease can lead to suboptimal exercise treatment, limiting potential benefits and patients' motivation to participate [17].

In the absence of evidence-based guidelines and high-quality studies, Delphi methodology is frequently used to develop expert-based clinical practice recommendations. We therefore applied a Delphi study, aiming to supplement CR-guidelines for PTs with recommendations for home-exercise-based cardiac rehabilitation (HEBCR) for older adults with comorbidities or frailty.

Materials and methods

Design

This study was a Delphi consensus study. We used a scoping review [18] of existing research, Dutch physiotherapy guidelines, and the results from a pilot study on the feasibility of HEBCR in frail older patients [16] to identify topics important to this Delphi. These topics included: indication and referral of patients, hospital handover-information, specifics of exercise testing, and HEBCR intake, assessment, treatment, and evaluation. The panel included Dutch experts in physiotherapy, exercise physiology and cardiology. We followed the CREDES guidance on conducting and reporting Delphi studies [19]. This study followed the principles of the declaration of Helsinki.

Expert panel

For this Delphi consensus study, we approached Dutch experts in the fields of physiotherapy in CR, a prevalent (>5%) comorbid disease, or frailty, exercise physiology and cardiology. Experts were invited *via* email to participate, and if agreed, asked for consent for publication.

Delphi rounds

We conducted the Delphi rounds between December 2020 and February 2022. As there is a scarceness of CR studies in older patients with comorbidity and frailty, we decided, a priori, to apply a minimum of three rounds [20].

Round one

In the first round we investigated panellists' opinions on applicability and adaptability of existing CR-guidelines. We asked open-ended questions on five HEBCR-topics: 1) referral and handover from hospital, 2) exercise testing, 3) history taking, 4) treatment, and 5) evaluation. This round was used to categorise responses and identify key areas for further discussion and analysis.

Round two

Using the responses of the first round, we formulated 95 statements across the five topics: referral and handover (22), exercise testing (4), history taking (12), diagnostic testing (9), treatment (31), and evaluation of treatment (17). To assess the expert panel's judgement of the statements under uncertainty, we presented a case description (appendix 1) in the second round [21]. The case involved a 75-year-old patient admitted to the hospital for a transcatheter aorta valve implantation (TAVI) and exhibiting signs of frailty (e.g. reduced walking speed, strength, and risk of malnutrition) and multiple comorbidities (i.e. peripheral artery disease, diabetes, COPD, depressive symptoms). With this patient case in mind, we asked panellists to rank the importance of each statement on a 9-point Likert scale, where 1 was 'not essential' and 9 was 'absolutely essential'. Experts could score '0' if a statement was outside their area of expertise. Scores were grouped in 1–3 (not essential) 4–6 (neutral) and 7–9 (essential).

Round three

If a panelist's individual score fell outside the semi-interquartile range (SIQR), they were asked to re-rank the statements in the third round. The SIQR was defined as half the numerical distance between the first and third quarter of the interquartile range. Panel members were asked to explain their choice if they did not adjust their score in line with the group consensus.

Data analysis

For each statement, we calculated the median score, SIQR, and the level of agreement (LA) as the percentage of panel members who scored the median value of the statement [22,23]. Consensus was defined a priori as an SIQR of ≤ 1.0.

Table 1. Delphi panel characteristics.

	Field of expertise/Title	Experience (years)	Peer reviewed publications	Specializations
1	Physiotherapy, PhD	15	45	Osteoarthritis and comorbidity adapted exercise interventions
2	Exercise physiology, PhD	45	278	Exercise testing
3	Physiotherapy, PhD	19	8	Chronic widespread pain
4	Cardiologist, MD, PhD	40	153	Cardiovascular interventions
5	Physiotherapy, PhD	20	151	Functional recovery from cancer and exercise interventions
6	Physiotherapy, MSc	14	0	Psychosomatic disorders
7	Physiotherapy, PhD	20	26	Chronic Obstructive Pulmonary Disease and exercise
8	Physiotherapy, PhD	21	7	Cardiac rehabilitation
9	Physiotherapy, PhD	12	61	Connective tissue diseases
10	Physiotherapy, MSc	7	0	Sports rehabilitation and cardiac rehabilitation
11	Physiotherapy, exercise physiology, PhD	29	170	Exercise testing, cardiac rehabilitation

Abbreviations: PhD = Doctor of Philosophy, MD = Medical Doctor, MSc = Master of Science.

Table 2. Statements and ranking outcomes Delphi round 2 and 3.

Statement	Round 2	Round 3	Consensus
(1–3 = not essential, 4–6 = important, but not essential, 7–9 is essential)	Median (semi-interquartile range) % agreement		
Information for decision to refer to home-based cardiac rehabilitation			
Extent and severity of comorbidity	9 (1.0) 82	9 (0.5) 82	Yes
Safety to perform exercise	9 (1.5) 91	9 (1.0) 91	Yes
Informed consent	9 (0.5) 91	8 (1.0) 91	Yes
Level of frailty	8 (1.0) 91	8 (1.0) 91	Yes
Informal caregiver resilience	8 (1.0) 91	8 (1.0) 91	Yes
Issues with transportation to hospital	7 (1.5) 82	8 (1.0) 82	Yes
Patients' preferences	9 (1.5) 73	8 (1.0) 73	Yes
Personal goals	8 (1.0) 73	8 (1.0) 73	Yes
Social interaction with peers	8 (1.5) 36	6 (1.5) 44	No
Presence of physician during exercise program	5 (3.0) 27	6 (2.0) 44	No
Handover information from hospital to home-based cardiac rehabilitation providers			
Absolute and relative contra-indications to exercise	9 (0.5) 100	9 (0) 100	Yes
What to monitor during/after exercise, e.g. weight, blood pressure, heart frequency, saturation	9 (0.5) 91	9 (0.5) 91	Yes
Expert (physician or physical therapist) advice on comorbidity and frailty related exercise restrictions	9 (0.5) 82	9 (1.0) 82	Yes
Signs of cardiac pathology, e.g. cardiac ischaemia, cardiac decompensation, and arrhythmias.	9 (0.5) 91	8 (0.5) 91	Yes
Severity comorbidities	8 (0.5) 91	8, 0.5) 91	Yes
Contact details next of kin	8 (0.5) 82	8 (0.5) 82	Yes
Influence comorbidities on physical functioning	9 (0.5) 73	8 (0.5) 73	Yes
Cognitive status	8 (1.0) 91	8 (1.0) 91	Yes
Risk of falling	8 (0.5) 91	8 (1.0) 91	Yes
Contact details other caregivers e.g. nurse specialist	7 (1.0) 100	8 (1.0) 100	Yes
Presence of 'Do not resuscitate'	8 (1.5) 73	8 (1.0) 73	Yes
Joint reporting and access to each other's patient records	8 (1.5) 73	7 (1.5) 73	No
Testing exercise safety and limits prior to home-based cardiac rehabilitation			
Symptom-limited exercise test with ECG recording (X-ECG)	9 (0.5) 73	9 (0.5) 73	Yes
Recommendation on comorbidity/frailty adapted field exercise tests to evaluate exercise capacity	8 (1.0) 100	8 (1.0) 100	Yes
Symptom-limited exercise test with gas exchange measurement	8 (1.5) 55	7 (1.0) 55	Yes
Symptom-limited exercise test with ECG recording (X-ECG), when musculoskeletal or psychological exercise limit exercise capacity	9 (1.0) 64	6 (1.0) 64	Yes
Related to the intake for home-based cardiac rehabilitation			
During history taking			
Recommendations questionnaires based on comorbidity	7 (1.5) 82	8 (0.5) 82	Yes
Comorbidity related barriers for physical functioning	8 (1.0) 100	8 (1.0) 100	Yes
The possibility to consult an expert in existent comorbidities	7 (1.0) 100	8 (1.0) 100	Yes
Motivation for physical activity	9 (1.0) 91	8 (1.0) 91	Yes
Daily physical activity levels	8 (1.0) 91	8 (1.0) 91	Yes
Opinion which factors contribute to quality of life	8 (1.0) 82	8 (1.0) 82	Yes
Patients' insight in their physical limitations	7 (1.0) 73	8 (1.0) 73	Yes
Health literacy	8 (1.5) 73	8 (1.0) 73	Yes
Using the Patient Specific Goalsetting questionnaire	7 (1.0) 73	8 (1.0) 73	Yes
Using the Patient Specific Complaints questionnaire	7 (1.0) 46	8 (1.0) 55	Yes
The presence of anxiety and depression	8 (1.0) 82	7 (1.0) 82	Yes
Sleep quality	8 (1.5) 73	7 (1.5) 73	No
During physical examination			
Assessing balance and risk of falling	8 (1.0) 100	8 (1.0) 100	Yes
Assessing muscle status, existent sarcopenia	8 (1.0) 100	8 (1.0) 100	Yes
The timed up and go test	7 (1.5) 55	8 (1.0) 55	Yes
Assessing joint functioning and capacity	7 (1.5) 82	7 (1.0) 82	Yes
Activity tracker to gain insight in level of daily physical activity	8 (1.5) 73	7 (1.0) 73	Yes
Assessing vascular status of lower extremity	7 (1.0) 64	7 (1.0) 64	Yes
Assessing sensitivity of lower extremity	7 (1.0) 64	7 (1.0) 64	Yes
Submaximal exercise test (field test: e.g. 2-minute step or walk test)	8 (2.0) 73	8 (1.5) 73	No
The Short Physical Performance Battery	7 (2.0) 64	8 (1.5) 64	No
Related to exercise treatment at home			
Focusing on patients' daily physical functioning	9 (0.5) 100	9 (0.5) 100	Yes
Focusing on patients' daily activities (ADL)	8 (0.5) 100	9 (0.5) 100	Yes
Agreements on multidisciplinary collaboration	8 (1.0) 82	9 (0.5) 82	Yes
Focusing on reducing movement anxiety	8 (0.5) 91	8 (0.5) 91	Yes
Focusing on patients' muscle strength	8 (1.0) 82	8 (0.5) 82	Yes
Recommendations evaluation measurements for comorbidity	8 (1.0) 73	8 (0.5) 73	Yes
Insight in and complying with limits for physical exertion	8 (1.0) 100	8 (1.0) 100	Yes
Focusing on patients' health literacy	8 (1.0) 91	8 (1.0) 91	Yes
Focusing on patients' aerobic capacity	7 (1.0) 64	8 (0.5) 64	Yes
Recommendations exercise adjustments to comorbidity	7 (1.0) 73	7 (0.5) 73	Yes
Measurement instruments			
Functional capacity			
6-minute walk test	7 (1.0) 55	7 (0.5) 55	Yes
Incremental shuttle walk test	6 (0.5) 36	7 (0.5) 36	Yes
2-minute step test	6 (1.0) 27	6 (1.0) 27	Yes

(*Continued*)

Table 1. Continued.

Statement	Round 2	Round 3	Consensus
(1–3 = not essential, 4–6 = important, but not essential, 7–9 is essential)	Median (semi-interquartile range) % agreement		
Aerobic capacity			
A cardiopulmonary symptom-limited exercise test with gas exchange measurement (CPET)	9 (0.5) 73	8 (0.5) 73	Yes
A symptom-limited exercise test with ECG recording (X-ECG)	9 (0.5) 73	8 (0.5) 73	Yes
A submaximal cycle or walking test	6 (1.0) 55	7 (0.5) 55	Yes
Physical functioning			
The Short form 36 (SF-36) physical functioning	7 (0.5) 73	7 (0,5) 73	Yes
The Patients Specific Complaints questionnaire	7 (0.5) 73	7 (0.5) 73	Yes
The timed up and go test	7 (1.0) 64	7 (1.0) 64	Yes
The Short Physical Performance Battery	7 (1.5) 73	7 (1.5) 73	No
Components exercise training program			
Functional (ADL) training	8 (1.0) 100	9 (1.0) 100	Yes
Strength training	9 (1.0) 100	8 (1.0) 100	Yes
Balance training	7 (1.0) 100	8 (1.0) 100	Yes
Graded Activity	7 (1.5) 64	8 (1.0) 64	Yes
Aerobic training (continuous)	7 (1.0) 55	7 (0.5) 55	Yes
Inspiratory muscle strength training (IMT)	7 (1.0) 55	7 (0.5) 55	Yes
Aerobic training (interval)	8 (1.0) 64	7 (1.0) 64	Yes
Circuit training	7 (1.0) 55	7 (1.0) 55	Yes
Relaxation exercises	7 (1.0) 55	7 (1.0) 55	Yes
Determination of exercise intensity			
Focus on lengthening functional training aimed at daily activities	7 (1.0) 91	8 (1.0) 91	Yes
Start muscle strength training at 2–3 (light-moderate) of modified BORG	7 (1.5) 36	7 (1.0) 36	Yes
Start aerobic training at modified BORG 2–3 (light-moderate)	6 (1.5) 27	6 (0.5) 27	Yes
Start aerobic training at 40–50% of VO2-max as identified by CPET	6 (2.5) 36	7 (2.0) 36	No
Improving quality of life			
Coach the patient (e.g. on coping with barriers)	9 (1.0) 100	9 (1.0) 100	Yes
Educate patients about the importance of physical activity	9 (1.0) 100	9 (1.0) 100	Yes
Educate patients on risk of losing physical independence	9 (1.0) 91	9 (1.0) 91	Yes
Perform motivational interviewing	8 (1.0) 91	8 (1.0) 91	Yes
Educate patients on potential risks of hospital readmission	6 (1.5) 64	7 (1.0) 64	Yes
Coach informal caregivers (e.g. on how to stimulate patient's daily activities	8 (1.5) 91	8 (1.5) 91	No
Educate patients on cardiovascular risks	7 (1.5) 82	8 (1.5) 82	No
Educate patients about which care providers are involved in home-based cardiac rehabilitation	7 (1.5) 91	8 (1.5) 91	No
Monitoring changes and evaluating physical functioning and health status			
Physical parameters, e.g. blood pressure, heart frequency	9 (1.0) 82	9 (1.0) 82	Yes
Personal goals with Patients Specific Complaints- or Patients Specific Goalsetting questionnaire	8 (1.0) 100	8 (1.0) 100	Yes
Evaluate functional capacity (e.g. with 6-minute walk test)	7 (1.5) 82	8 (1.0) 82	Yes
Nutritional status with Malnutrition Universal Screening tool	7 (1.5) 55	7 (0.5) 55	Yes
Physical activity with an activity tracker	8 (1.5) 64	7 (1.0) 64	Yes
Nutritional status with Short Nutritional Assessment Questionnaire	7 (1.5) 46	7 (1.0) 46	Yes
Fatigue with numeric rating scale 1–10	7 (2.5) 82	8 (2.5) 82	No

Abbreviations: SIQR = semi-interquartile range, note: essential scored on 9-point Likert scale: 1–3 = not essential, 4–6 = important, but not essential, 7–9 is essential, Yes = consensus threshold reached (SIQR ≤ 1.0), No = no consensus reached. The transparant grey in this table emphasises items where no consensus was reached.

Results

Flow of participants

Of 20 invited panellists 11 (55%) agreed to participate (Figure 1). Participants had a median (interquartile range) work experience of 20 (10.5) years in a wide range of areas of expertise and specialties (Table 1). The response rates for rounds 1, 2 and 3 were 100%, 100%, and 91% respectively. After rounds 2 and 3, consensus was reached on 68% and 89% of the statements, respectively (Table 2). On 10 statements, no consensus was reached.

Information for decision to refer to home-based cardiac rehabilitation

To make an informed decision if patients should be referred to home-based or outpatient center-based cardiac rehabilitation, the panellists judged medical information on frailty (score (SIQR) 8 (1); LA 91%), comorbidity (9 (0.5) 82%), and exercise safety (9 (1) 91%) as essential. The importance of social interaction with peers (6 (1.5) 44%) and the presence of a medical doctor during training (6 (2) 44%) was not consensually judged as essential. Patient-related factors (consent (8 (1) 91%), transportation (8 (1) 82%), preferences (8 (1) 73%), and goals (8 (1) 73%)) were ranked as essential for decision making, as was resilience of informal caregivers (8 (1) 91%). The panel recommended a shared decision-making process, considering patients' specific contexts to determine the optimal course of action.

Handover information from hospital staff to home-based cardiac rehabilitation providers

The panel reached consensus on the importance of items related to comorbidity (score (SIQR) 8 (0.5); LA 91%), frailty (9 (1) 82%), and geriatric conditions (8 (1) 91%) for

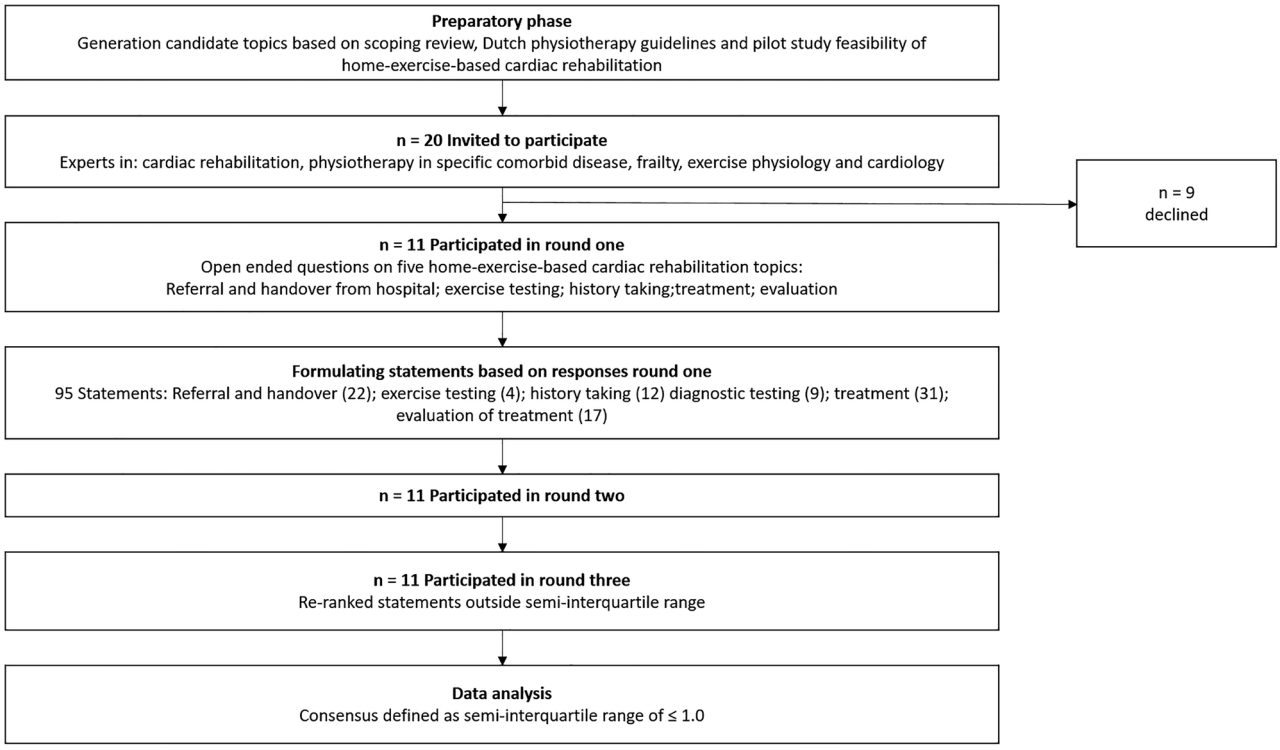

Figure 1. Flowchart Delphi process.

handover information. No consensus was reached on the importance of joint reporting and having access to patient records kept by other medical specialists (7 (1.5) 73%). Panellists also indicated that numerous items would need to be updated during the CR-intake, e.g. whether a 'do not resuscitate (DNR)' is indicated.

Exercise testing

The panel reached consensus that an exercise test with ECG recording was essential (score (SIQR) 9 (0.5); LA 73%) prior to home-based CR, as well as gas exchange measurement during exercise testing (7 (1) 55%). However, if patients' exercise capacity was limited by musculoskeletal or psychological constraints the panel scored important but not essential (6 (1) 64%). Furthermore, panellists noted that the knowledge gained from this test should be weighed against the burden for the patient, as the result of the test is often inconclusive. An expert-based recommendation on which field exercise test would be feasible for older frail patients was judged as essential (8 (1) 100%).

Intake home-based cardiac rehabilitation

All suggested items for history taking (comorbidity barriers (score (SIQR) 8 (1); LA 100%), insight in limitations (8 (1) 73%), motivation (8 (1) 91%), quality of life factors (8 (1) 82%), health literacy (8 91) 73%), anxiety and depression (7 (1) 82%)) were ranked essential except for 'assessing patients' sleep quality' (7 (1.5) 73%). The panel reached a higher level of agreement on the Patient Specific Goalsetting method (8 (1) 73%) and preferred its use over the Patient Specific Complaints questionnaire (8 (1) 55%).

For the physical examination the panellists judged assessment of balance and risk of falling (8 (1) 100%), muscle status and sarcopenia (8 (1) 100%), joint functioning and capacity (7 (1) 82%), sensitivity (7 (1) 64%), and vascular status (7 (1) 64%) as essential. Panellists ranked the use of an activity tracker as essential (7 (1) 73%) for assessing physical activity levels. For exercise testing, the timed up and go test was ranked essential (7.5 (1) 55%), but no consensus was reached for a submaximal field test (e.g. walk test or 2-min step test) (8 (1.5) 73%) and the Short Physical Performance Battery (SPPB) (8 (1.5) 64%). Panellists noted that testing is important, but within the context of each individual patient and depending on their personal goals.

Recommendations for the home treatment program

For the content of exercise, the panel ranked training balance (score (SIQR) 8 (1) 100%), strength (8 (1) 100%), and daily physical functioning and activities (9 (1) 100%) as essential. With lower levels of agreement other exercise types (circuit training (7 (1) 55%), graded activity (8 (1) 64%), relaxation (7 (1) 55%), aerobic (7 (1) 64%), and inspiratory muscle training (7 (0.5) 55%) were also ranked as essential. Panellists recommended the type of training to be decided based on patients' personal goals and capacity to perform aerobic activity.

Setting exercise intensity

Panellists reached consensus that lengthening functional exercises aimed at improving daily activities is essential (score (SIQR) 8 (1); LA 91%) as is starting strength training at light to moderate intensity (7 (1) 36%), i.e. 2–3 on the modified

BORG-scale (1–10). For setting intensity of aerobic exercises, no consensus was reached for using the symptom limited test outcomes (7 (2) 36%), and the modified BORG was consensually ranked as neutral (6 (0.5) 27%).

Improving patients' quality of life

The panellists judged it essential to educate patients on their risk for hospital readmission (score (SIQR) 7 (1) 64%), losing physical independence (9 (1) 91%) and the importance of physical activity to prevent this (9 (1) 100%). No consensus was reached on the importance of education on cardiovascular risks (8 (1.5) 91%), information about the roles of involved care providers (8 (1.5) 91%) or coaching of the informal caregivers (8 (1.5) 91%).

Measurement instruments suitable for evaluating patients' progress at home

For evaluating improvement in aerobic capacity, panellists ranked a cardio-pulmonary exercise test (CPET) (score (SIQR) 8 (0.5) LA 73%) or symptom limited exercise electrocardiogram (X-ECG) essential (8 (0.5) 73%) as well as a submaximal test (7 (0.5) 55%). For assessing changes is functional capacity the panel ranked a 6-min walk test (7 (0.5) 55%) or incremental shuttle walk test essential (7 (0.5) 36%) and a 2-min step test as important, but not essential (6 (1) 27%). For evaluating physical functioning, a questionnaire (SF-36 (7 (0.5) 73%) or PSC (7 (0.5) 73%) and a Timed Up and Go test (7 (1) 64%) were consensually ranked essential, whereas no consensus was reached for the SPPB (7 (1.5) 73%).

Monitoring changes in patients' health status

According to the panel, systematically evaluating patients' personal goals (score (SIQR) 8 (1) LA 100%), functional capacity (8 (1) 82%), and PA with an activity tracker (7 (1) 64%), is essential for the successful application of HEBCR. Monitoring vital parameters such as blood pressure (9 (1) 82%) and regularly screening risk of malnutrition with the MUST (7 (0.5) 55%) or SNAQ (7 (1) 46%) were also ranked essential. No consensus (8 (2.5) 82%) was reached on monitoring fatigue.

Discussion

This Delphi study presents expert recommendations (Figure 2a and b) for physical therapists on home-exercise-based cardiac exercise rehabilitation (HEBCR) for older adults with comorbidity and/or frailty. We provide recommendations for each phase of HEBCR on acquiring specific information, making clinical decisions, and intervention focus and modalities. These suggestions may serve as a supplement to the existing physiotherapy guidelines for outpatient cardiac rehabilitation when these do not provide sufficient guidance for older adults in their home setting.

At hospital discharge, current CR-guidelines recommend providing a handover consisting of information on medical history and status, and cardiovascular risks. For older adults, our panel recommended also including risk factors for mortality and readmissions, such as frailty and comorbidity, and related limitations and contra-indications to exercise. These recommendations are in line with an evidence statement by the American Heart Association [24]. Moreover, we recommend that PTs educate older patients on these risk factors and focus on personal gains instead of risk aversion. They should also consider patients' preferences, goals, transportation options, and the ability of their informal caregivers to support their participation in HEBCR. Once elderly patients initiate HEBCR, their adherence and completion rates surpass those seen in center-based CR-programs [12,25,26]. The recommended comprehensive approach may improve older adults' participation in and adherence to a CR-program, as well as program outcomes.

With respect to exercise testing, a symptom-limited exercise electrocardiogram (X-ECG), is standard practice before starting a CR-program and is considered essential by the expert panel [27]. However, our Delphi panel recommends considering the burden of a hospital-based exercise test for the patient, including transportation, against the expected value of the test. For instance, the risk of an inconclusive test which does not provide information on exercise capacity and safety of exercising should be assessed for each patient. Approximately 30–50% of exercise tests in the elderly are inconclusive, often due to low exercise capacity or arrhythmias such as left bundle branch block [28,29]. For a test to be conclusive, patients must be able to perform exercise for 8–12 min and reach their maximum aerobic capacity [30]. Furthermore, if a patient's activity goals do not involve aerobic activities, the added value of a symptom-limited exercise test is questionable. In this case, the absence of an exercise test does not limit an exercise program targeting muscle strength and daily physical functioning and a detailed analysis of limiting factors for aerobic exercise is unnecessary [30]. The lack of consensus regarding the appropriate intensity of aerobic exercise could potentially underscore the significance the panel attributed to improving daily activities that do not necessarily require improvement of older adults' aerobic fitness. The panel recommends a patient-centred decision whether an exercise test is necessary and feasible.

Regarding the intake for HEBCR, existing CR-guidelines recommend patients' cardiovascular risks, exercise capacity, and limitations for daily activities and physical activity. For older adults, our panel recommends the impact of exercise and physical activity on patients' quality of life. Older adults prioritise maintaining their quality of life and social activities over the reduction of cardiovascular risks [31]. The panel also suggest evaluating comorbidity-related barriers to physical functioning, as older adults may be more limited by for example musculoskeletal problems than cardiovascular issues. Older patients who perceive a risk of injury often avoid engaging in physical activities [32]. Risk of falling is also important, as this is highly prevalent among older adults [33]. Additionally, evaluating personal factors such as health literacy and cognitive functioning can greatly impact a

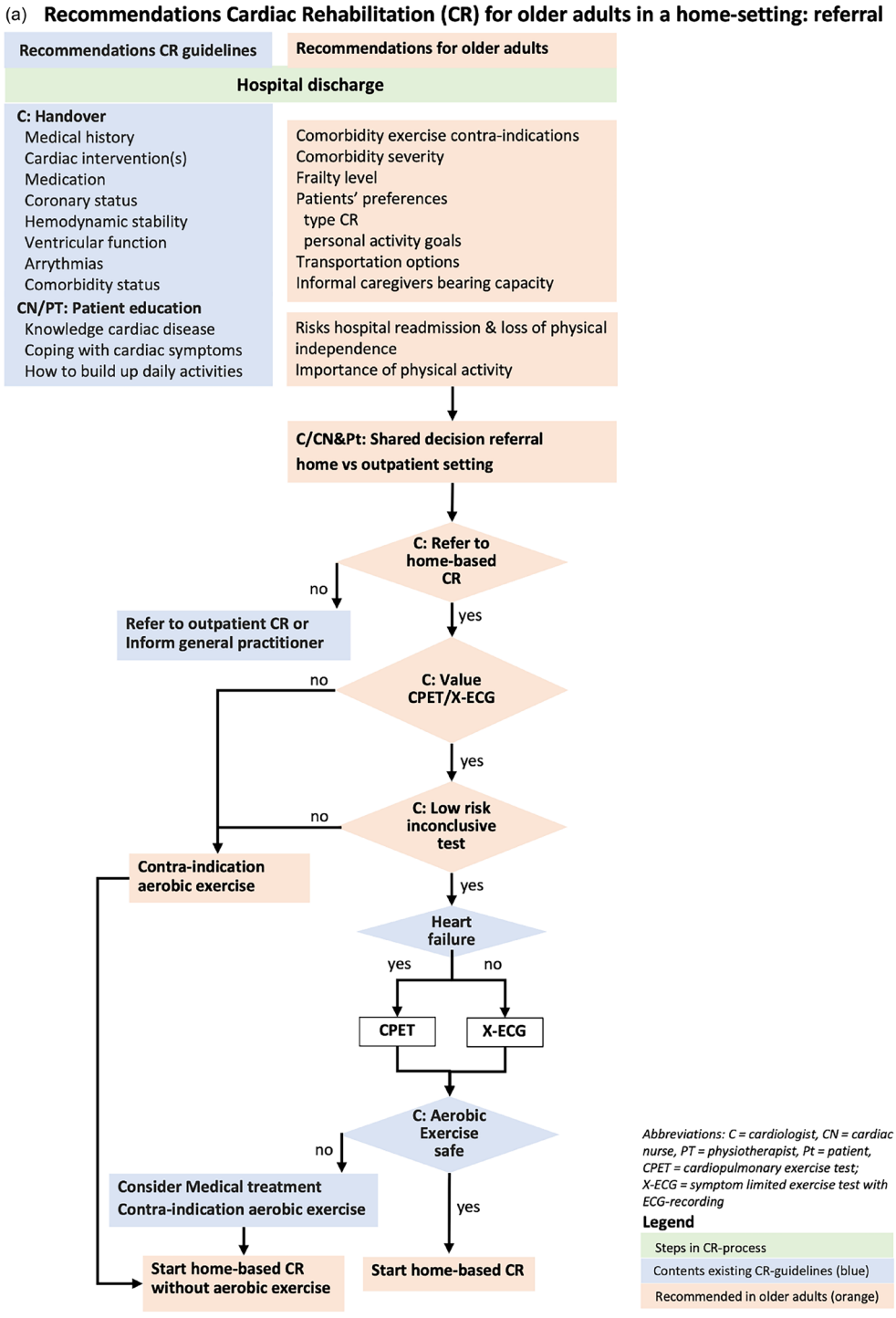

Figure 2a. A framework for Home-Exercise based cardiac rehabilitation in older adults: Expert recommendations on discharge and referral. Note: Process flow diagram of expert recommendations for cardiac rehabilitation for older adults in a home-setting. Depicted on the left side are known recommendations from existing guidelines, starting with what handover information and patient education is needed at hospital discharge. On the right the additionally required information and education for older adults is described, such as comorbidity severity. Thereafter, for older adults, the process flow shows the action of a shared decision to refer to home-based or outpatient cardiac rehabilitation. Next, the decision to request a cardiopulmonary exercise test is based on the estimated value and risk of an inconclusive test. If no exercise test is performed, or if aerobic exercise is not safe, the process flow leads to home-based cardiac rehabilitation without aerobic exercise.

patient's self-efficacy and dependence on caregivers [34,35]. By considering these factors during history taking, PTs can effectively identify and reduce barriers to older adults' daily functioning and physical activities.

For the physical examination in CR, existing guidelines focus largely on exercise capacity. The panel additionally recommends risk of falling, muscle status (sarcopenia) and comorbidity-related lower extremity problems such as reduced sensibility, vascularisation, and joint functioning. Some panellists noted that the SNAQ and the MUST could be used for muscle status, but that these do not assess the presence of sarcopenia. The panel recommends providing expert

(b) **Recommendations Cardiac Rehabilitation (CR) for older adults in a home-setting: intake & treatment**

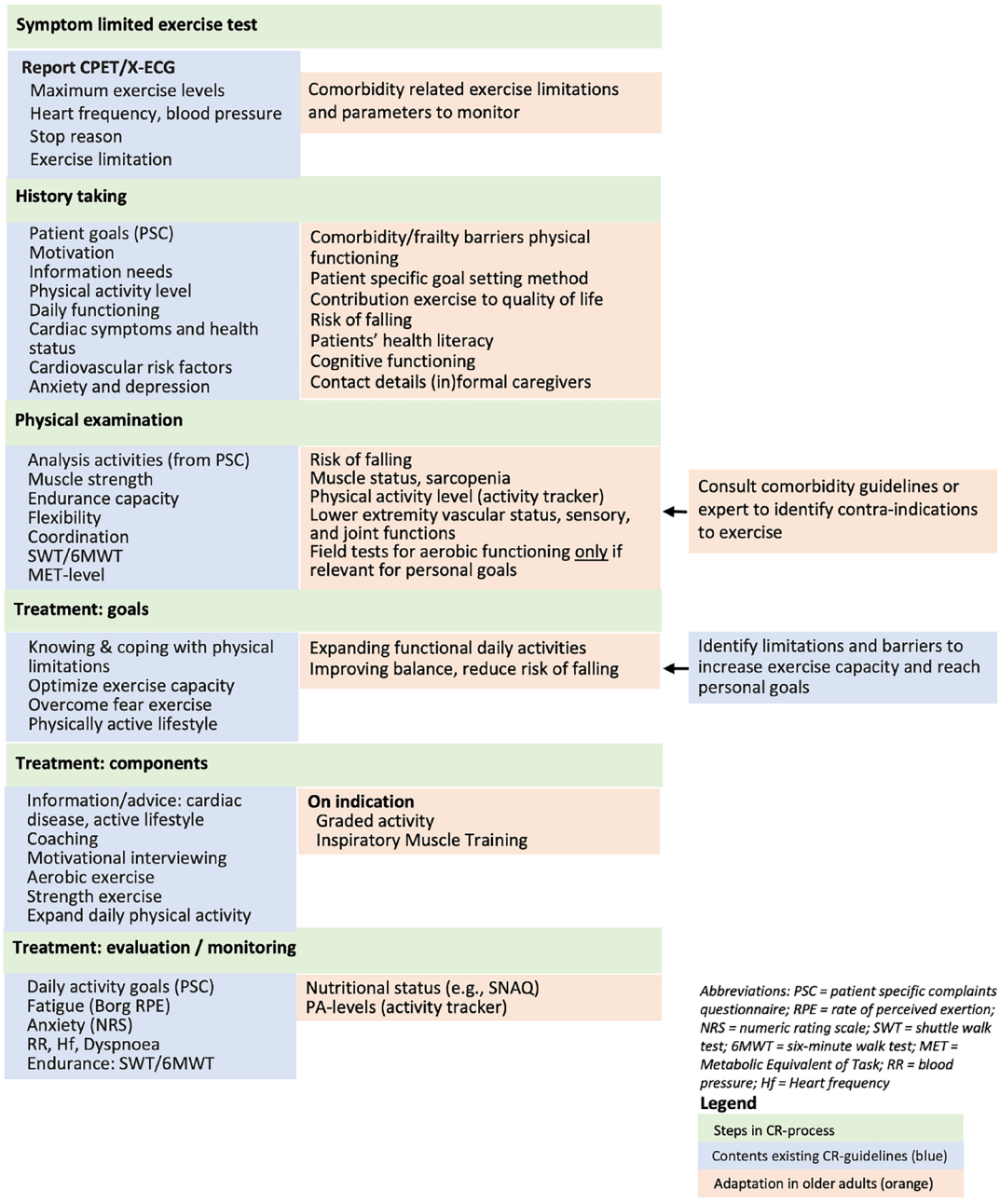

Figure 2b. A Framework for Home-Exercise based cardiac rehabilitation in older adults: Expert recommendations on intake and treatment. Note: Recommendations for cardiac rehabilitation for older adults in a home-setting are described. Depicted on the left side are known recommendations from existing guidelines for required items. In effect, items to include in: reporting from cardiopulmonary exercise testing, history taking, physical examination, treatment goals, treatment components and evaluation/monitoring of treatment. On the right side the additional items for older adults are described, such as comorbidity barriers to physical functioning in history taking and risk of falling, and sarcopenia in physical examination.

advice, indicating that primary care PTs' knowledge regarding comorbidity and frailty is often limited, therefore we suggest implementing a consultation from a comorbidity expert before the intake. It is important to educate the primary care PT, instead of adding a comorbidity expert to the CR-treatment because these PTs know the patients well and are aware of the specific situation and context. This also prevents over-involvement of healthcare providers, as patients often perceive this as a burden [16]. Consultation can occur through telephone or email, but research into online platforms where PTs can seek answers to questions about comorbidity shows promise [36]. Educating primary care PTs on physical examination of highly prevalent comorbid disease reduces PTs uncertainty in clinical decision making and optimises personalised treatment [37].

Existing CR programs are primarily focused on increasing exercise and increasing daily physical activity. While the impact of center-based CR tends to revert to baseline values after the intervention had ended, home-based programs typically yield more enduring effects that seamlessly integrate into older adults' regular home routine [38,39]. For older adults, the panel recommends prioritising improvement of

daily activities in line with patient's goals. To date, only one home-based CR intervention implemented goalsetting and behavioural change interventions, which showed potential for remote guidance of patients, although this study was focused on patients with an average age of 65 [40]. This supports our panel's recommendation to use the Specific Goalsetting method. It might be worthwhile to investigate the added value of digital health tools to HEBCR for facilitating goal setting and monitoring of changes in health or physical activity levels [41,42]. Panellists noted the SPPB to be less sensitive to change and having a ceiling effect, therefore being less able to evaluate progress of patients with higher levels of physical functioning. In addition, they suggested that other instruments could be chosen, depending on patients' capacity and goals, such as the Patient Reported Outcome Measurement Instruments (PROMIS). In addition to improving daily physical activity, attention should be paid to standing and walking balance and reducing the risk of falls. The incidence of falls is highly prevalent among older adults, making it essential to incorporate falls prevention strategies into HEBCR [33]. Balance and strength training of the lower extremities is important here and should often be given priority over endurance training. The nutritional status should also be monitored during treatment, because of the high prevalence of sarcopenia (up to 35%) and malnutrition (up to 34%) in elderly and its importance for muscle building [43–46]. Prioritising the treatment of balance, lower extremity strength, and daily activities is more appropriate for the treatment of older adults than focusing on improving exercise capacity.

Strengths and limitations

There are several strengths to this study, including the diversity of expertise among the expert panel, which included experts in cardiac rehabilitation and highly prevalent comorbidities and frailty. This allowed for a broad range of perspectives, reducing the risk of overlooking important issues, although we did not include patients in the panel. While the panellists were carefully recruited, only 55% of the experts who were invited agreed to participate, which may have introduced selection bias and limited the generalisability of our results. An explanation could be that the study was conducted during the COVID-19 pandemic, which may have caused high levels of work pressure for health care professionals in the Netherlands, potentially impacting their willingness to participate. The small sample size, lack of patient representation and recruitment of only Dutch experts are limitations of this study. However, the recommendations are formulated on a general level which may be applicable to international healthcare systems and the general older population. The results of this Delphi study should be used as recommendations when setting up HEBCR programs rather than a rigid framework.

Many items were ranked essential by the expert panel in the second round without discussion. This study used a 9-point Likert scale, which is recommended by the CREDES-guideline [19]. While this scale reduces the risk of 'scoring in the middle', it still only allows three categories: not essential, neutral, and essential. To create a manageable list of statements, we had to generalise the experts' input from the first round. This may have limited the ability to take a unique stance on individual statements. While the recommendations do not contain detailed adaptations for each specific comorbidity, we built expert consultation into the process to address this. To identify adaptations for specific comorbidities, we recommend conducting a systematic review of the literature followed by interviews with experts in each field of comorbidity. However, this was beyond the scope of our Delphi study.

Recommendations for further research and implementation

The expert recommendations from this study should be used as a supplement for PTs to use in their daily practice when current guidelines do not provide guidance. The recommendations should be incorporated into a protocol and then evaluated for their applicability and efficacy in improving physical functioning in older adults with cardiac disease. Subsequently, implementation studies are needed to investigate barriers and facilitators for HEBCR in primary care settings.

Conclusion

This Delphi study provides expert recommendations for home-based cardiac rehabilitation provided by PTs. The study emphasises the importance of focusing on improving patients' daily physical functioning at home and reducing comorbidity and frailty related barriers. Prioritising interventions aimed at enhancing balance, lower extremity strength, and daily activities over interventions targeting exercise capacity can contribute to a more holistic and effective approach, particularly for older adults. The recommendations can inform clinical physiotherapy practice where current CR-guidelines do not provide guidance. Further research is needed to evaluate the efficacy of the recommendations and feasibility to implement HEBCR in primary care settings.

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Disclosure statement

The authors report there are no competing interests to declare.

Ethics statement

Since this study did not involve any patients, it was not necessary to seek approval from the medical ethical committee.

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Data availability statement

Due to confidentiality agreements with research collaborators, data supporting this paper can only be made available to bona fide researchers subject to a non-disclosure agreement. Details of the data and how to request access are available by request at m.s.terbraak@hva.nl

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Appendix 1. Case description delphi round 2

To clarify the context of the statements, we will start by describing the type of patients that might be eligible for home-based cardiac rehabilitation. For the type of comorbidity in this case, you may imagine any type of comorbidity.

This case concerns a 75-year-old woman after an aortic valve replacement *via* the inguinal area (TAVI). The patient has been home for 2 weeks since the procedure. Her medical history includes:

- Aortic stenosis
- Heart failure
- Coronary disease for which two stents (PCI) were placed 9 years ago
- Peripheral arterial disease
- COPD GOLD III
- Diabetes
- Depression

In the hospital, she scored 8 points on the Short Physical Performance Battery (SPPB), had an increased risk of malnutrition (SN + 6) and slightly impaired cognitive function (MMSE 24).

She is independent in her ADLs. She is inactive, spends most of her time sitting. Before surgery, she walked short distances (50–100 meters) outside the house using a walker and she supported herself inside the house holding on to tables or cabinet edges while walking. She wants to be able to work in the garden independently and walk short distances with the walker. Her walking is mainly limited by pain in her legs and fatigue. Her partner is 75 years old and does the shopping, housework, and driving.

In this patient case, the characteristics of the vulnerable patient (frailty), such as reduced strength, walking speed, balance and fatigue, with a comorbidity that affects physical functioning, have been outlined. Try to keep this patient or similar patients in mind when answering the statements of this Delphi study.