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Developing and delivering a hybrid Cardiac Rehabilitation Phase II exercise program during the COVID-19 pandemic: a quality improvement program

Javier Loureiro Diaz [1], Liam David Foster,[2] Praveen Jayaprabha Surendran [1], Prasobh Jacob [1], Omar Ibrahim,[1] Poonam Gupta [3]

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[1]Cardiac Rehabilitation Department, Heart Hospital, Hamad Medical Corporation, Doha, Qatar
[2]Cardiac Rehabilitation Department, Cardiff and Vale University Health Board, Cardiff, UK
[3]Performance Improvement Department, Heart Hospital, Hamad Medical Corporation, Doha, Qatar

Correspondence to
Mr Javier Loureiro Diaz; JLOUREIRODIAZ@GMAIL.COM

ABSTRACT

The COVID-19 pandemic resulted in the cessation of approximately 75% of cardiac rehabilitation (CR) programmes worldwide. In March 2020, CR phase II (CRP2) services were stopped in Qatar. Multiple studies had shown safety, effectiveness, reduced cost of delivery and improved participation with hybrid CR. A multidisciplinary team reviewed various alternative models for delivery and decided to implement a hybrid CRP2 exercise programme (HCRP2-EP) to ensure continuation of our patient care. Our aim was to enrol in the HCRP2-EP 70% of all eligible patients by 30 September 2020. Institute for Health Care Improvement's collaborative model was adopted. Multiple plan–do–study–act cycles were used to test change ideas. The outcomes of the project were analysed using standard run chart rules to detect the changes in outcomes over time. This project was implemented from March 2020, and the male patients enrolled between August 2020 and April 2021, with sustained monthly median enrolment above target of 70% throughout. As for our secondary outcome, 75.8% of the male patients who completed HCRP2-EP showed a meaningful change in peak exercise capacity of ≥10% (mean change 17%±6%). There were no major adverse events reported, and the median Patient Satisfaction Score was 96% well above the institutional target of 90%. This shows a well-designed quality improvement programme is an appropriate strategy for implementing HCRP2-EP in a clinical setting, and HCRP2-EP is a feasible, effective and safe intervention in eligible male patients with cardiovascular disease.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Multiple studies have shown safety, effectiveness, reduction in the cost of delivery and improved participation with hybrid cardiac rehabilitation phase II exercise programme (HCRP2-EP). This quality improvement (QI) needed implementation to ensure continuity of cardiac rehabilitation patient care in the time of the COVID-19 pandemic.

WHAT THIS STUDY ADDS

⇒ A well-designed QI program is a feasible and effective strategy for implementing an HCRP2-EP intervention in a clinical setting through the means of providing a guiding structure and outcome follow up.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ HCRP2-EP may be adopted as a standard practice outside the context of COVID-19 pandemic as a feasible, effective, safe, cost-saving intervention, which may lower barriers of access for patients. This practice should be incorporated into institutional policy.

BACKGROUND

Cardiac rehabilitation (CR) is a coordinated multifaceted intervention designed to optimise a cardiac patient's physical, psychological and social functioning, in addition to stabilising, slowing or even reversing the progression of their underlying cardiac condition, thereby reducing morbidity and mortality.[1] CR is recommended after acute coronary syndrome, chronic coronary syndrome, heart failure, percutaneous coronary intervention and coronary artery bypass graft surgery.[1–3] Benefits of CR are broad and include lower risk of cardiovascular mortality,[4] decrease in rehospitalisations over 1 year and an increase in physical function and quality of life.[2 3] Much of the clinical benefit of CR has been attributed to an increase in peak exercise capacity from participation in a structured exercise programme[5 6] and the associated physiological effects on coronary endothelial function, insulin resistance, blood pressure (BP), inflammatory markers and fibrinolytic state.[6–8]

CR is usually divided in three distinct phases. Phase I is an inpatient acute care management intervention. Phase II is an outpatient comprehensive programme including exercise training and non-exercise components,

which aims to improve peak exercise capacity and overall cardiovascular health. Phase III is a community-based continuation of phase II.[9 10] CR programmes have also evolved to become disease management and secondary prevention services.[8 11–13] Traditionally, the first choice for CR remains hospital-based, however, various alternatives such as all-virtual and hybrid CR are available.[14–16]

The COVID-19 pandemic impacted CR delivery around the globe. Approximately 75% of CR programmes worldwide stopped services, with others reducing components delivered, and/or changing mode of delivery with little opportunity for planning and training.[17 18] CR components most affected were supervised exercise training, inclusion of family and informal caregivers, end of programme reassessment and peak exercise capacity testing.[18]

Multiple studies have shown the safety, effectiveness, reduced cost of delivery and improved participation with hybrid CR phase II exercise programme (HCRP2-EP), therefore it became imperative to implement it locally to ensure continuation of patient care.[2 13 15 19–24]

PROBLEM DESCRIPTION

The COVID-19 pandemic stressed the capabilities of Qatar's Healthcare System as a whole and had long-lasting implications on the delivery of CRP2. CRP2 services at our facility stopped on 16 March 2020. The unexpected stoppage affected new patient enrolment, continuation of CR delivery for the currently enrolled patients, and significantly impacted our ability to measure the efficacy of the intervention at both patient and programme management level. Hospital-based sessions resumed on 24 August 2020. In addition, patients with pre-existing cardiovascular disease (CVD) had an increased risk of severe COVID-19 disease and worse outcomes, including death, compared with other clinical populations.[25] Infection Control (IC) measures implemented limited hospital-based capacity to 25%. Our team identified this as an area for improvement and decided to run a quality improvement (QI) project to develop and implement an HCRP2-EP.

SETTING

In our hospital, CRP2 involves a multidisciplinary team (MDT) of cardiologists, exercise physiologists, physiotherapists, nurses, pharmacists, occupational therapists and dietitians. The exercise-related intervention includes initial and final assessment of peak exercise capacity via symptom-limited exercise test and supervised exercise training.

Exercise intervention is group-based up to eight patients per group, separated by gender. There are 2 days or a 3 days per week programmes. Exercise duration is 60 min, comprising a 10 min warm-up and cool-down, with an exercise circuit of 3–6 exercises, 6–12 min per exercise, of a combination of cardiovascular machines and dumbbells. Programmes are individually tailored to match patient's requirements. Exercise intensity is determined based on the symptom-limited exercise test, as a percentage of heart rate reserve ranging from 40% to 90% depending on the patient's characteristics, clinical status, risk category, and current and past level of physical activity (PA).

Patients are categorised as low, intermediate or high risk according to American Association of Cardiovascular and Pulmonary Rehabilitation guidelines for the risk stratification for cardiac events during exercise prescription[10] and Canadian Association of Cardiac Rehabilitation guidelines[26] for metabolic risk stratification. Our programme includes 18–36 supervised exercise sessions depending on the patient's risk category,[10] over a period of 12 weeks, with a target compliance of more than 80%. ECG is continuously monitored for all patients and may be discontinued after a minimum number of ECG supervised sessions[10] with the approval of the MDT.

Moreover, patients receive assessment and counselling by the MDT and is referred to psychiatric clinics, smoking cessation clinics and cardiometabolic clinics when necessary.

RATIONALE

There is a positive association reported between time of enrolment, total number of sessions attended and compliance to CR with improved health outcomes.[27–30] There is compelling evidence that delaying the start of CR is associated with less improvement in peak exercise capacity, poorer uptake, attendance and completion rates.[17 31 32] Temporary interruptions to CRP2 may yield major unintended negative consequences associated with the progression of disease coupled with an increased risk of recurrent cardiac events.[33]

AIM STATEMENT

To enrol 70% of eligible patients into HCRP2-EP at our cardiac centre by 30 September 2020.

OBJECTIVES

1. To ensure uninterrupted provision of supervised CRP2 exercise sessions during the COVID-19 pandemic via HCRP2-EP.
2. To implement a new CRP2 delivery structure.
3. To achieve equal or more than 10% improvement in the peak exercise capacity after completion of the HCRP2-EP programme.

INCLUSION CRITERIA

All CVD patients with a diagnosis of acute coronary syndrome (ST-elevation myocardial infarction, non-ST-elevation myocardial infarction, unstable angina), chronic coronary syndrome (coronary artery disease, stable angina), coronary intervention (coronary artery bypass grafting, percutaneous coronary intervention), heart failure, valve disease/valve repair, or cardiomyopathy enrolled in CRP2.

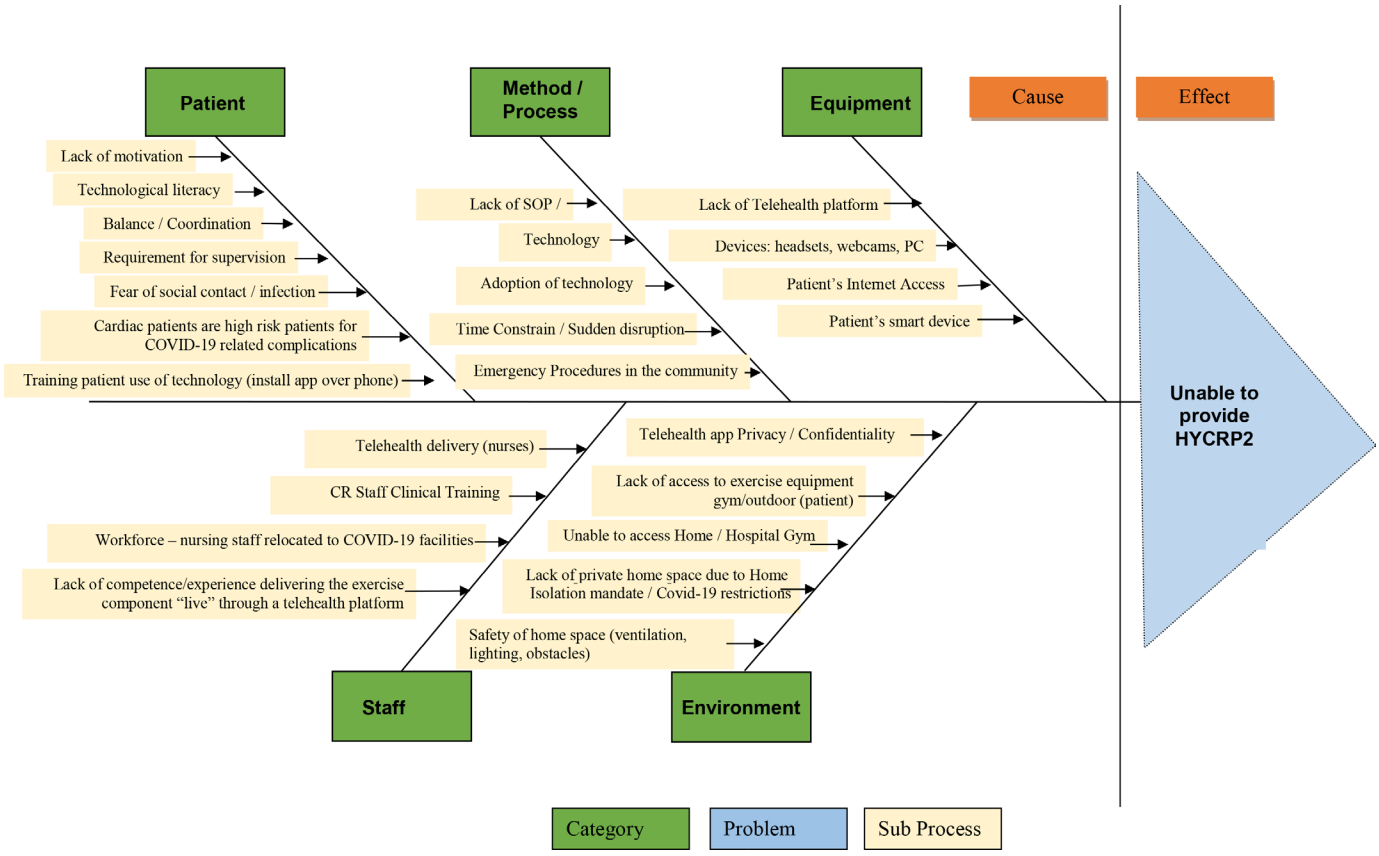

Figure 1 Cause and effect ('fishbone') diagram. CR, cardiac rehabilitation; HYCRP2, hybrid cardiac rehabilitation phase II; PC: personal computer; SOP, standard operational procedure.

EXCLUSION CRITERIA

- Not clinically stable.
- History of cardiac arrest (not in the context of acute coronary syndrome), ventricular tachycardia and/or other life-threatening arrhythmias.
- Left ventricle ejection fraction<30%.
- Horizontal or down-slopping ST depression or other significant ECG changes during the initial exercise test.
- Identified risk of fall at initial screening.
- The patient did not complete the minimum number of hospital-based supervised exercise sessions (table 1).
- Presence of technological barrier (poor computer literacy and/or lack of access to internet connection).
- The patient is not interested and or does not give consent for participation.

METHODOLOGY

Institute for Health Care Improvement's collaborative model for improvement was adopted.[34] Multiple plan–do–study–act (PDSA) cycles were used to test change ideas. The MDT together with a quality adviser reviewed various global models of alternative CRP2 delivery systems to identify an appropriate model. The team decided to implement HCRP2-EP. We identified barriers to implementation using a fishbone diagram (figure 1). Pareto analysis categorised the most significant barriers (online supplemental material).

CHANGES TESTED

We tested various small changes in order to continue to support patients who were enrolled in CRP2 during the time-of-service suspension.

PDSA 1: remote PA counselling

Immediately after the suspension of services, PA counselling via telephone started including assessment of PA status via International Physical Activity Questionnaire (IPAQ), advice on types of indoor exercise programmes, intensity, progression of exercise and safety measures. Of 63 active patients, 100% were phone counselled within 3 days of CRP2 stoppage.

Feedback from clinicians and patients was collected, which showed this intervention helped patients to continue exercising at home. A meeting was conducted to reach agreement on components and guiding principles of counselling,[35–42] and a common guiding script was formulated (online supplemental material). This change was adopted.

Within 4 weeks, all patients were phone counselled two times. Sedentary and minimally active patients (IPAQ<600 metabolic equivalent of task (MET)-min/week) were identified, and an additional weekly phone counselling was performed.

PDSA 2: creation of short video 'CR at home during COVID-19'

The main patient feedback during PDSA 1 was 'difficulty in performing correct and safe exercise at home'. MDT, in

Table 1 Criteria to partake in home-based exercise sessions, including the minimum number of hospital-based sessions before transfer

	With remote ECG monitoring (both supervised via telehealth platform and unsupervised)	With RPE-only monitoring and supervised via telehealth platform
Low risk	If >3 ECG hospital based	If >6 ECG hospital based
Moderate risk	If >3 ECG hospital based	If>8 ECG hospital based and >2 RPE-only hospital based
High risk (due to other criteria other than high CDS)	If >12 ECG hospital based	If >12 ECG hospital based and >2 RPE-only hospital based
Symptomatic	If approved by MDT	If approved by MDT
Peak exercise capacity<5 MET (at initial maximal test)	If approved by MDT	If approved by MDT
Poor understanding of RPE	X	X
Diabetes with history of hypoglycaemic/hyperglycaemic events associated to exercise	If glucometer available and approved by MDT	If glucometer available and approved by MDT
High BP with documented hypotensive/hypertensive events associated to exercise	If BP monitor available and approved by MDT	If BP monitor available and approved by MDT

BP, blood pressure; CDS, Cardiac Depression Scale; MDT, multidisciplinary team; MET, metabolic equivalent of task; RPE, rate of perceived exertion.

collaboration with the corporate communications department created a 5 min educational video explaining:

1. Precautions: space, medication, self-monitoring of symptoms.
2. Reinforcing public health policies regarding infection control.
3. Appropriate warm-up and cool-down exercises.
4. Demonstration of various home-based exercises for the conditioning phase, at different intensity levels.
5. Self-monitoring of exercise intensity via rate of perceived exertion (RPE).[43–47]
6. Emergency management.

This video was sent via email to two patients with written instructions. Follow-up calls were given to get their feedback. PDSA was adopted, and the video was sent to all patients.

PDSA 3: implementing the home-based exercise component

PDSA 3a: selection and customisation of the telehealth platform

Four popular teleconference platforms commercially available were tested. Difficulty in connectivity, lack of customisation and non-compliance with Health Insurance Portability and Accountability Act (HIPAA) privacy requirements, made these platforms unsuitable. Therefore, these changes were abandoned.

An HIPAA-compliant telehealth platform was provided and approved by Ministry of Public Health (MOPH). Clinic workflows were customisable. Workflows for a group exercise clinic, a group education clinic, and one-to-one counselling clinic were developed. We received technical support from our institution and from an external contractor. Group exercise clinic privacy rules (clinician can see and hear all patients; patients can see and hear only the clinician) were specifically developed for our clinic by software developers.

PDSA 3b: designing the exercise component of the home-based sessions

The exercise physiology and physiotherapy team agreed on an initial draft for a home-based no-equipment required moderate intensity exercise programme. Every clinician had at least one practice session as an instructor and one acting as a patient. After every session, a team meeting was conducted, and modifications were incorporated if unanimous agreement was reached. The final model was tested on the other CR department staff and their family members, and feedback was incorporated. To accommodate all patients irrespective of their risk category and physical ability, standard exercise regressions and progressions for each exercise were adopted. Finally, we successfully piloted it in two patients and then applied it to all active eligible patients.

PDSA 3c: optimisation of access to the telehealth platform

After implementing PDSA 3b, the login process was found to be difficult for the patients. We engaged in collaboration with Ithe Information Technologies (IT) department, MOPH and software developers, and the login interface was modified. In the meantime, to mitigate the issue, several strategies were implemented:

- Email support: standardised download links, installation instructions, troubleshooting guide were sent to patients from corporate group email address.
- Phone support: an installation call was done via regular phone call, followed via a test call through the telehealth platform to ensure correct functioning.

- One-to-one introductory counselling session to explain check-in and check-out process, exercise component, safety of the room environment, clinical considerations as medicine compliance, availability of machines to check blood sugars, BP and emergency procedures were done.
- To facilitate bookings and notifications, a short messaging service gateway was also incorporated.

PDSA 4: remote telemetric ECG monitoring during home-based exercise

The telehealth platform did not fully support patients who required additional ECG monitoring. We supplemented the telehealth platform with a remote ECG telemetry monitoring system. This change was adopted as it allowed for selected patients who needed close monitoring of ECG and heart rate during exercise to enrol in the HCRP2-EP.

For remote patients, we scheduled individual hospital visits to collect the ECG equipment and test it. For those transitioning from hospital-based to home-based sessions, we performed the final two sessions on the remote telemetric ECG monitoring system, instead of the usual ECG telemetry system, to familiarise the patients with the equipment before the transfer.

PDSA 5: modification of CRP2 delivery structure (criteria for transfer and timing)

CRP2 delivery structure was modified to provide a clear understanding of the optimal patient pathway towards HCRP2-EP, depending on risk category and patient performance during the hospital-based sessions. The following is based on available guidelines and MDT's input:

- Five types of sessions were defined: hospital-based ECG monitored, hospital-based RPE Scale monitored only, home-based non-supervised remote ECG monitored, home-based supervised and remote ECG monitored, home-based supervised and RPE Scale monitored only.
- Criteria to partake in home-based exercise sessions, including establishing the minimum number of hospital-based sessions before transfer,[10] were agreed on (table 1).

To ensure safety, approval by MDT for transfer to home-based exercise was required. A transfer eligibility criteria checklist was developed (online supplemental appendix A).

Since patients would be exercising away from hospital, clinical emergency protocol was modified as to follow MOPH protocol. For technological issues (critical and non-critical), the instructor issued verbal instructions at the beginning of each session.

PDSA 6: staff training

Two members of the MDT became the champions for the adoption of the telehealth platform. Their responsibilities include leading the telehealth platform workflow customisation with the institutional IT and software developers, and the dissemination of technology to the other clinical staff. Multiple online and one-to-one training sessions were conducted to introduce all staff to the telehealth platform. Additionally, to support staff, the following was developed:

- A guide on the necessary preparations before home-based exercise sessions.
- A guide on how to lead a home-based group exercise session via telehealth platform.
- Two checklists for the nursing team to guide online check-in and check-out.

The effectiveness of the education and the knowledge of the staff was evaluated using the teach-back method.

PDSA 7: minimising risk of COVID-19 infection during the hospital-based sessions

IC practices were implemented under guidance from an IC department to ensure safe environment for hospital-based exercise sessions:

- Phone triage on the previous day to hospital-based exercise.
- Traige by the nursing team on the day of exercise, outside of the exercise space, including checking status of official COVID-19 contact tracing application of Ministry of Interior of Qatar.
- Individual assessment rooms outside the exercise area.
- Installation of high efficiency particle arresting filter.
- Segregation of gym floor into individual exercise areas.
- Installation of hand sanitiser dispensers in each individual exercise area.
- Use of personal protective equipment (PPE) as per institutional policies and implementation of PPE donning and doffing areas.
- Increasing cleaning measures after each session as per institutional policies.

PDSA 8: video support to promote long-term engagement in PA

The scope of the original CR at home exercise video (see PDSA 2) was expanded:

- A written script for a full 1-hour home exercise video was submitted for approval by institutional patient and family education (PFE) committee and media department.
- The video link was sent via email to the patient if: unable to attend hospital-based sessions due to COVID-19 restrictions, unable to attend the hospital-based or home-based sessions due to incompatibility with class timings, or to promote PA engagement after discharge from HCRP2-EP

After successful implementation we expanded video support in two ways:

- Tailoring to the patient: four full 1-hour videos of four different levels of intensity.

Table 2 Summary of HCRP2-EP elegibility, enrollment and completion

Patient Flow	n	%
All patients enrolled into CRP2	n=96	
Non-eligible for HCRP2-EP	n=40	41.7%
Eligible for HCRP2-EP	n=56	58.3%
Enrolled in HCRP2-EP	n=51	91.1%
Completed HCRP2-EP	n=43	84.3%
Completed with final assessment	n=35	68.6%
Completed with symptom limited test	n=33	64.7%
Improved peak exercise capacity>10%	n=25	75.8%

CRP2, cardiac rehabilitation phase 2; HCRP2-EP, hybrid cardiac rehabilitation phase II exercise programme.

- Language: initially recorded in English, we prepared voice-over and subtitles in Arabic for all videos.

PDSA 9: tracking technical issues

To understand the sustainability, scalability and quality of the HCRP2-EP, an online technical issue tracking form was developed. The MDT logged any technical issues through a QR code, which automatically sent a notification to one of the technology adoption champions.

We started to track technology-related issues from January 2021 only. Non-critical issues were defined as any issues which did not prevent treatment from being completed. Critical issues were defined as any issue which may prevent a session from starting or completing. For all issues, we specified origin (patient side, clinician side, both sides) and the technology affected.

Main critical-issues reported affected the privacy settings or the capacity of the telehealth application. These were solved by liaising with our institution's IT team to downgrade the software version until the main architecture of the software supported our specific needs.

STUDY OF INTERVENTION

Data were retrospectively and weekly gathered. Tested changes were assessed using qualitative and quantitative measures.

Outcome measures

- Enrolment in HCRP2-EP.
- Improvement of peak exercise capacity.

Process measures

- Compliance with hospital-based versus home-based exercise sessions.
- Timing of transfer to home-based exercise sessions.
- Reliability of technology.

Balance measures

- Patient Satisfaction Score (PSS).
- Rate of exercise-related major and minor adverse events.[10]
- Estimated savings in the cost of clinical and non-clinical consumables.

RESULTS

HCRP2-EP was initiated in March 2020, and the patients enrolled between July 2020 and April 2021. A total of 96 male patients enrolled in CRP2, of which at initial assessment, 56 (58.3%) were eligible for HCRP2-EP (table 2).

The clinical characteristics of all participants in HCRP2-EP are shown in table 3. This table is split into improvers (those who achieved benchmark percentage improvement as per our institutional clinical protocol of ≥10% increase in peak exercise capacity) and those who did not (non-improvers).

For those who participated and completed there was a total of 1135 hospital-based exercise hours and 529 home-based exercise hours.

Primary outcome: enrolment in HCRP2-EP

Home-based sessions started from July 2020, and first participating patients were discharged from August 2020 onwards (figure 2, table 2). We audited every patient file for eligibility and enrolment at date of discharge. From July 2020 to April 2021, there were 56 eligible patients. A total of 51 patients (91.1%) enrolled and 43 (84.3%) completed HCRP2-EP. Only on February 2021 were there no discharged patients. Overall, monthly median enrolment was 90%.

Of the 40 non-eligible patients, 9 (23%) completed hospital-based before the home based-component effective implementation, 15 (38%) did not complete the required number of hospital-based sessions, 6 (15%) did not give consent to participate in home-based sessions, 5 (13%) due to medical advice and 4 (10%) due to technological barrier (computer literacy and lack of access to internet connection) (online supplemental material).

Of the 5 non-enrolled patients, 3 (60%) dropped out of CRP2 before completing the required number of hospital-based exercise sessions before the transfer eligibility point and 2 (40%) declined due to non-convenient timing of the home-based sessions (online supplemental material).

Secondary outcome: improvement in exercise capacity

To test the HCRP2-EP effectiveness, symptom-limited exercise tests were performed pre-to-post intervention (online supplemental material). Out of the 33 patients who completed HCRP2-EP with a final symptom-limited exercise test, 25 patients (75.8%) showed ≥10% improvement in peak exercise capacity (mean 17%±6%), while 8 patients (24.2%) did not (mean 4%±5%) (table 3).

Process measures

Compliance to HCRP2-EP remained well above the institutional target of 80%, where monthly median was 95% for hospital-based sessions and 92% for home-based sessions (figure 3).

For the timing of transfer from hospital-based to home-based (table 1), MDT established a median target point of

Table 3 Clinical characteristics of patients who significantly improved or not their peak exercise capacity in a symptom-limited exercise test after participation in HCRP2-EP

Patient characteristics	Improvers, n=25	Non-improvers, n=8
Age (years), mean (SD)	57±10	54±7
Active smoking, n (%)	2 (8%)	3 (38%)
Diabetes, n (%)	14 (56%)	7 (88%)
Hypertension, n (%)	15 (60%)	6 (75%)
Dyslipidaemia, n (%)	7 (28%)	1 (13%)
Baseline % age-predicted exercise capacity, mean (SD)	79%±19%	80%±11%
Low risk category, n (%)	5 (20%)	4 (50%)
Intermediate risk category, n (%)	17 (68%)	3 (38%)
High risk category, n (%)	3 (12%)	1 (13%)
Baseline IPAQ, MET-min/week, mean (SD)	793±789	867±684
Baseline IPAQ<600 MET-min/week (sedentary/minimally active), n (%)	12 (48%)	3 (38%)
Baseline IPAQ 600–1500 MET-min/week (active), n (%)	10 (40%)	3 (38%)
Baseline IPAQ>1500 MET-min/week (highly active), n (%)	3 (12%)	2 (25%)
CDS, mean (SD)	68.6±23.3	80.8±15.5
CDS>90, n (%)	4 (16%)	3 (38%)
Language barrier (% of Arabic speaking only), n (%)	4 (16%)	1 (13%)
Number of completed sessions, mean (SD)	25.6±6.1	21.7±5.4
Number of completed home-based exercise sessions, mean (SD)	12.5±4.0	11.3±5.4
Number of completed hospital-based exercise sessions, mean (SD)	13.1±8.2	10.3±7.6
Point of transfer to home-based exercise (percentage based on total number of sessions), mean (SD)	46%±21%	46%±23%
Frequency of exercise (number of sessions/week), mean (SD)	1.7±0.98	1.6±0.28
Improvement in peak exercise capacity, mean (SD)	17%±6%	4%±5%
Compliance to home-based exercise sessions, mean (SD)	91%±12%	92%±13%
Compliance to hospital-based exercise sessions, mean (SD)	95%±8%	90%±14%

CDS, Cardiac Depression Scale; IPAQ, International Physical Activity Questionnaire; MET, metabolic equivalent of task.

before 50% of their prescribed total number of sessions. The overall monthly median transfer point was within target (46%) (online supplemental material).

- Low risk: median 7th session (39%).
- Moderate risk: median of 10th session (41%).
- High risk: median of 22nd session (61%).

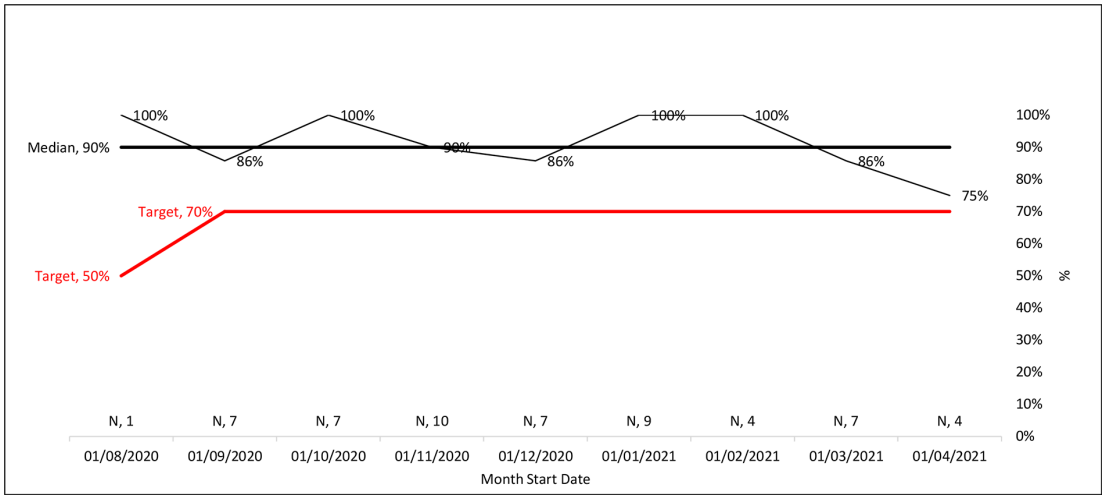

Figure 2 Percentage of eligible patients who enrolled in hybrid cardiac rehabilitation phase II exercise programme.

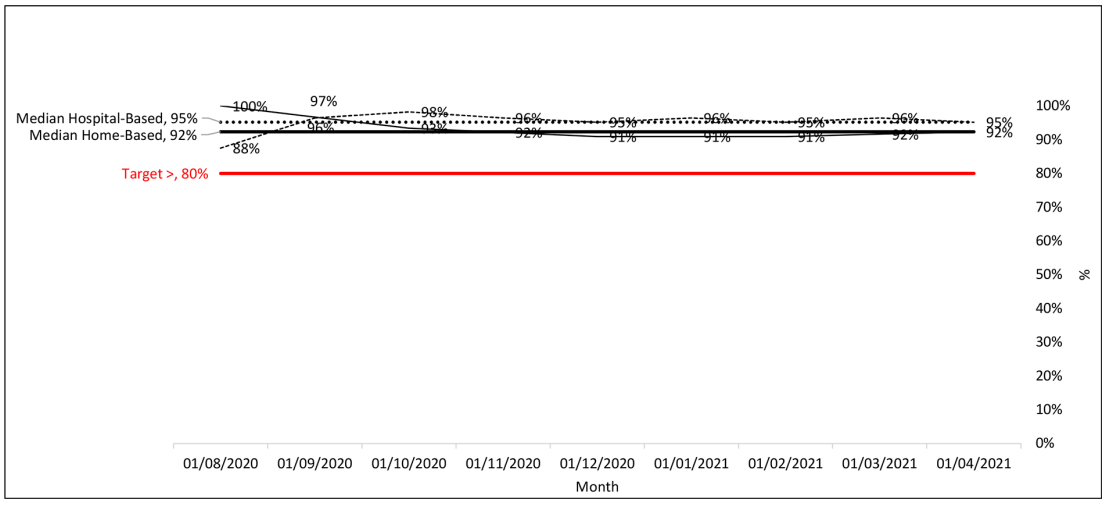

Figure 3 Percentage compliance to hospital-based and home-based exercise sessions in patients participating in hybrid cardiac rehabilitation phase 2 exercise program.

To assess the reliability of the adopted technology, from January 2021 we monitored 217 sessions (41% of total home-based individual exercise sessions). A total of 32 (14.7%) sessions experienced non-critical issues and 21 (9.6%) had critical issues that prevented the planned treatment from being completed. Overall, we had a median of 14 issues per month, of which, the critical issues monthly median accounted for 29% of all issues. In regard to equipment at fault, either solely or various pieces of equipment simultaneously failing at the same session, 57% of the time an issue was reported, the telehealth platform was at fault, 33% of the times it was related to the remote ECG telemetry device and 14% was due to the internet connection on either the patient or the providers side.

Balance measures

PSS remained above institutional target of 90%. Preintervention 2019 median was 95% and during intervention median it was 96% (online supplemental material).

We monitored 1135 hospital-based patient exercise/hours and 529 home-based patient exercise/hours. There were no major adverse events reported for hospital or home-based exercise sessions. Overall, 1.94% of the hospital-based sessions had minor adverse events reported versus 0.76% for home-based.

Cost of consumables was reduced by a monthly median of 34%.

DISCUSSION

HCRP2-EP enabled continuity of patient care at the time of the most intensive restrictions during the pandemic. The key for a successful implementation of HCRP2-EP was underpinned in two factors: clinical staff leading the adoption of the technology by assuming the role of technology champions within the CR department and second, the tailoring of the telehealth platform clinics to fit the specific needs of the CR service and patients.

At the time of service stoppage, we had six female patients, three had already completed the minimum number of sessions and were discharged. Two were ineligible and only one patient was eligible for HCRP2-P. Over the 10 months of this QI project, only 11 (10.5%) additional female patients were assessed compared with the 96 (89.5%) males. This is in line with our historical female participation rate, which for the period 2016–2023 (n=1315) was 9.5%. It is worth noting that in our programme, we offer women-only sessions as the CR option for female patients. In Arab countries such as Qatar, women-only CR is related to religious beliefs and cultural values around gender segregation, so females can exercise comfortably.[48] Generally, women participating in women-only CR programmes are significantly more comfortable in their workout attire and perceive the environment as less competitive.[49] There is also a growing trend toward implementation of women-only CR in Western countries. While the International Council of Cardiovascular Prevention and Rehabilitation 2022 Clinical Practice Guideline for Women-Focused Cardiovascular Rehabilitation does recommend that women should be provided the choice of participating in hospital-based or a hybrid model…. it also states among its recommendations that 'the CR environment should be optimised to meet women's preferences, values and goals', including consideration of privacy and that 'inclusion of male support persons in some elements of women-only programmes might not be appropriate'.[48] Furthermore, lack of human resources is perceived as the greatest barrier to CR provision overall. Therefore, pairing the above culturally relevant cricumtances, concerns surrounding privacy, and staffing constraints due to lack of female therapist due to COVID facility deployment, resulted in no female patients enrolling in HCRP2-EP. All women participated in the reduced capacity hospital-based CR, of which 63% completed.

The feasibility of the home-based component of HCRP2-EP was proven by; the high level of enrolment (91.1% of eligible male patients, 90% monthly median enrolment) (figure 2), the low technological barrier reported with only 4 out of 40 (10%) ineligible patients, and moreover, the high compliance (92%) to the home-based component of HCRP2-EP (figure 3). It should be acknowledged that compliance rates for both home-based and hospital-based were abnormally high when compared with available evidence.[23 50] We hypothesised this was due to patients having more time available at home due to pandemic restrictions, and a likelihood that only motivated and engaged patients would have chosen to participate in exercise during the pandemic period, among other factors.

In terms of intervention effectiveness, the monthly median percentage of patients who improved their peak exercise capacity more than the departmental target of 10% pre-to-post intervention was 75%, which is above both our institutional target of 70%, and our historical median for the period 2013–2019 of 68%. These results are also in line with what has previously been reported in several studies.[51 52]

For technology-related critical issues that prevented the planned treatment from being completed, the source of the problem was always on the clinician side (100%) and represented 9.6% of total observed home-based exercises sessions. Overall, 3.2% of total sessions experienced issues with the remote ECG telemonitoring equipment and 6.4% on the telehealth platform. For non-critical issues 10.1% of the sessions experienced issues from patient's side, 2.3% from clinician side and 2.3% from patient and clinician side simultaneously.

There were no major adverse events reported neither during hospital-based nor home-based exercise sessions. Hospital-based sessions had a rate of 1 minor adverse event in every 51 individual sessions and home-based exercise sessions a rate of 1 in every 132 individual sessions (online supplemental material). These rates may purely reflect the earlier point of treatment for the patient during hospital-based exercise sessions, and the strict transfer criteria needed to be met for home-based exercise sessions (see PDSA 5). During the programme, only 1 patient out of 51 enrolled (2%) had to return to hospital-based sessions due to post exercise dizziness related to hypoglycaemia and hypotension.

The intervention proved to be cost-saving. Cost of consumables was calculated by determining the cost per unit for all clinical and non-clinical consumables used in hospital-based sessions. The savings were calculated at patient discharge as the difference between the projected cost if the patient had completed all sessions as hospital-based versus actual cost after participation in HCRP2-EP. Monthly median cost in consumables was reduced by 34%.

LIMITATIONS

Comparison of our primary outcome measure could not be done, since we do not have baseline data as HCRP2-EP was a newly implemented intervention.

Only male patients participated in HCRP2-EP due to the intrinsic constrains related to the cultural and religious background of the country, and the lack of female therapist available to conduct women-only sessions during the pandemic due to COVID-19 deployment. Further research should be conducted to assess feasibility, effectiveness, safety and acceptance of HCRP2-EP to include a larger and more diverse population, including women.

Regarding our secondary outcome, the number of patients who completed the programme represented only 17.9% of completed patients in the previous year, therefore a larger sample is needed to confirm our results.

Tracking of technical issues started only after January 2021.

Ultimately, with our model, the exercise physiologist or physiotherapist performs each exercise for each session alongside the patients. This model may impose additional physical strain on staff if they must lead multiple sessions daily. Staff well-being should perhaps be considered for implementation as a balance measure.

LESSONS LEARNED

There is currently a wide range of technology available for clinical use. Careful consideration and test trialling is paramount for successful implementation and adoption among patients and staff. Selected technology must allow customisation to allow scalability, and continuous development and QI. Identification of potential technology champions among clinical staff is key for adapting technology and fostering adoption within their peers. Giving adequate patient information about risks, safety and benefits of HCRP2-EP is important.As is training the patients in the use of technology under supervision before transfer to ensure a smooth transition from hospital-based to home-based sessions.

It is important to also identify other non-traditional non-clinical stakeholders that may bring complementary knowledge and expertise (IT, communications, PFE…).

HCRP2-EP affords another option for CR delivery, which may enhance participation and completion. Depending on human resources availability and home-based exercise sessions demand, the physical workload imposed on staff may become a limitation to the expansion of the programme.

CONCLUSION

HCRP2-EP is well accepted by male patients and clinicians as a feasible, cost-saving, effective and safe intervention in eligible male patients with CVD irrespective of their risk category. A well-designed QI programme is effective in implementing HCRP2-EP in a clinical setting.

Twitter Javier Loureiro Diaz @jloureirodiaz

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Contributors All authors were involved in the drafting the article or revising it critically for important intellectual content, and all authors approved the final version to be published. JLD and LDF were responsible for the concept, design, development and implementation and led the work testing the change ideas. PJS and PJ contributed to the delivery of the intervention. PJS and JLD were responsible for data collection. JLD completed the data processing and analysis for assessing the outcome measures interpretation and produced all tables, figure and appendixes. Contributors PJS and PJ prepared the initial draft of the manuscript and played a most significant role in the preparation of the final manuscript. OI acted as a clinical advisor and contributed to the design and implementation of the quality improvement project and revised the final version of the manuscript. PG served as an Improvement advisor and assisted in data analysis. JLD accepts the role of guarantor and takes responsibility for the integrity of the work as a whole from inception to the published paper.

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Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

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ORCID iDs
Javier Loureiro Diaz http://orcid.org/0000-0003-1727-9135
Praveen Jayaprabha Surendran http://orcid.org/0000-0002-7417-3559
Prasobh Jacob http://orcid.org/0000-0003-1153-6305
Poonam Gupta http://orcid.org/0000-0001-8737-8804

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APPENDIX A - TRANSFER TO CRP2 HOME-BASED EXERCISE SESSIONS CHECKLIST

PATIENT DETAILS
HC#_____ Name: _____ Risk Cat: _____ Current Group: _____

REVIEWER
Name: _____ Corporation Number _____

TRANSFER DETAILS:

1. Number of completed sessions:
2. Proposed Transfer date:
3. Transfer to Program Type:
    a. □ Home Unsupervised and Monitored by remote ECG telemetry
    b. □ Home Supervised via Telehealth platform and Monitored by remote ECG telemetry
    c. □ Home Supervised via Telehealth platform and Monitored by RPE-only
4. Timing:
    a. □MW0730 □MW0900 □MW1030 □MW1200 □MW1330 □MW1600 □MW1730
    b. □STT0730 □STT0900 □ STT1030 □STT1200 □STT1330 □STT1600 □STT1730
5. Location: □ Home □ Work □ Home Gym □ Work Gym
   (Public areas such as parks or public gyms are not allowed)
6. Equipment available: □None □Treadmill □Cycle □Other:

PATIENTS CLINICAL STATUS:

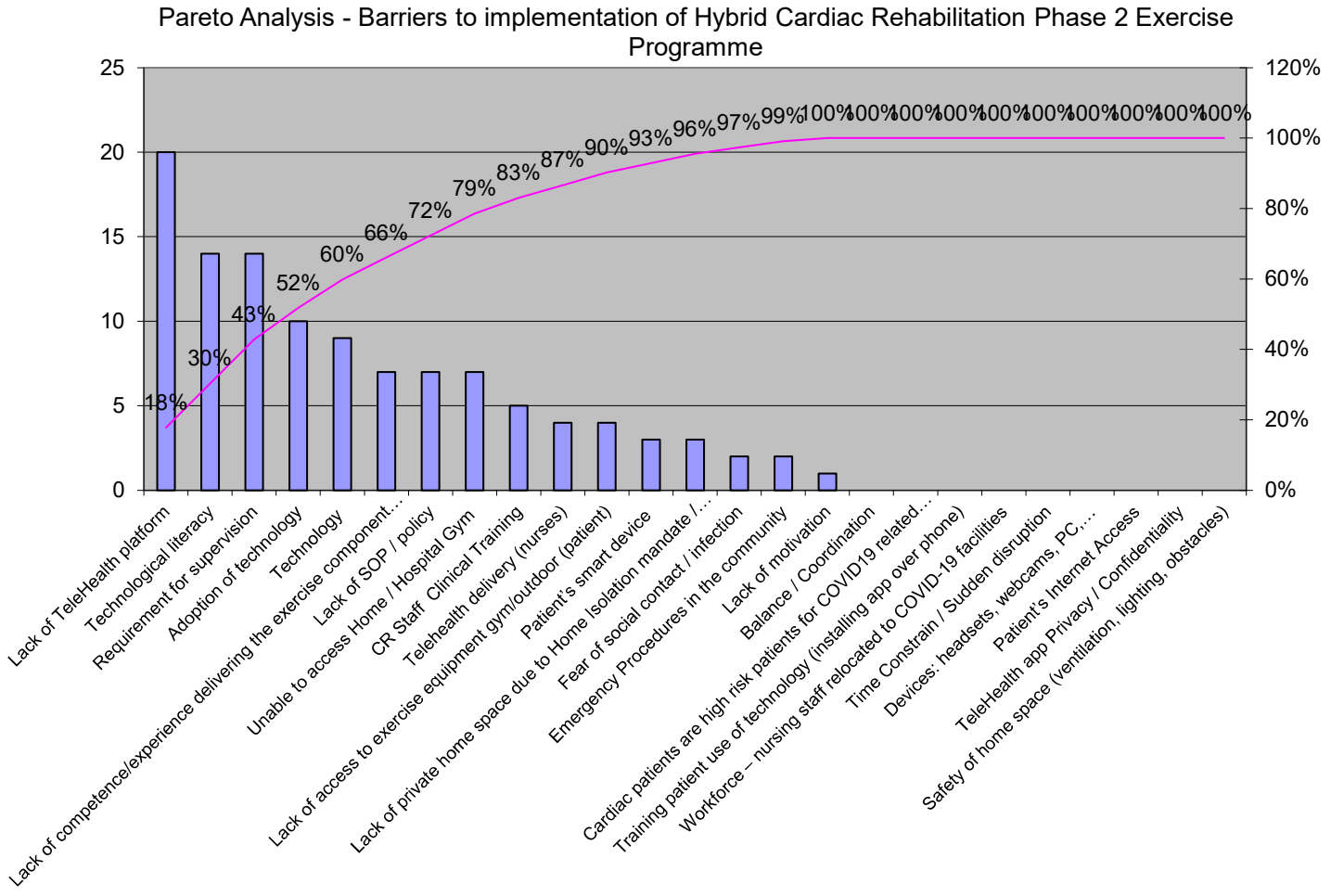
1. Eligible to exercise without ECG monitoring? □ Yes □ No
    a. No History of Cardiac Arrest outside the context of ACS
    b. No history of v-tach or other life-threatening arrhythmia
    c. LVEF ≥ 30%
    d. No cardiac symptoms
2. Eligible for Home Program? □ Yes □ No
    a. No complex arrhythmias at rest or exercise
    b. No significant ST depression / ECG changes on exercise
    c. No other investigations pending (i.e Holter ECG, Labs,…)
    d. No Falls Risk identified
3. Is the patient Diabetic? □ Yes □ No
    a. Is his/her blood sugar well controlled? □ Yes □ No
    b. Any episodes of exercise related hypo/hyper glycaemia reported? □ Yes □ No
    c. Does the patient have a Glucometer at home? □ Yes □ No
    d. Comments:_____
4. Is the patient Hypertensive? □ Yes □ No
    a. Is his/her BP well controlled? □ Yes □ No
    b. Any episodes of exercise related hypo/hypertensive responses? □ Yes □ No
    c. Does the patient have a Blood Pressure machine at home? □ Yes □ No
    d. Comments:_____
5. Any recent changes to related interventions?
    a. Recent change in medications □ Yes □ No

TRANSFER DECISION AT TEAM CONFERENCE (Date_____ Physician Present_____)

□ APPROVED
□ DENIED → Reason: _____
□ POSTPONED → Plan: _____

COMPLETING THE TRANSFER:

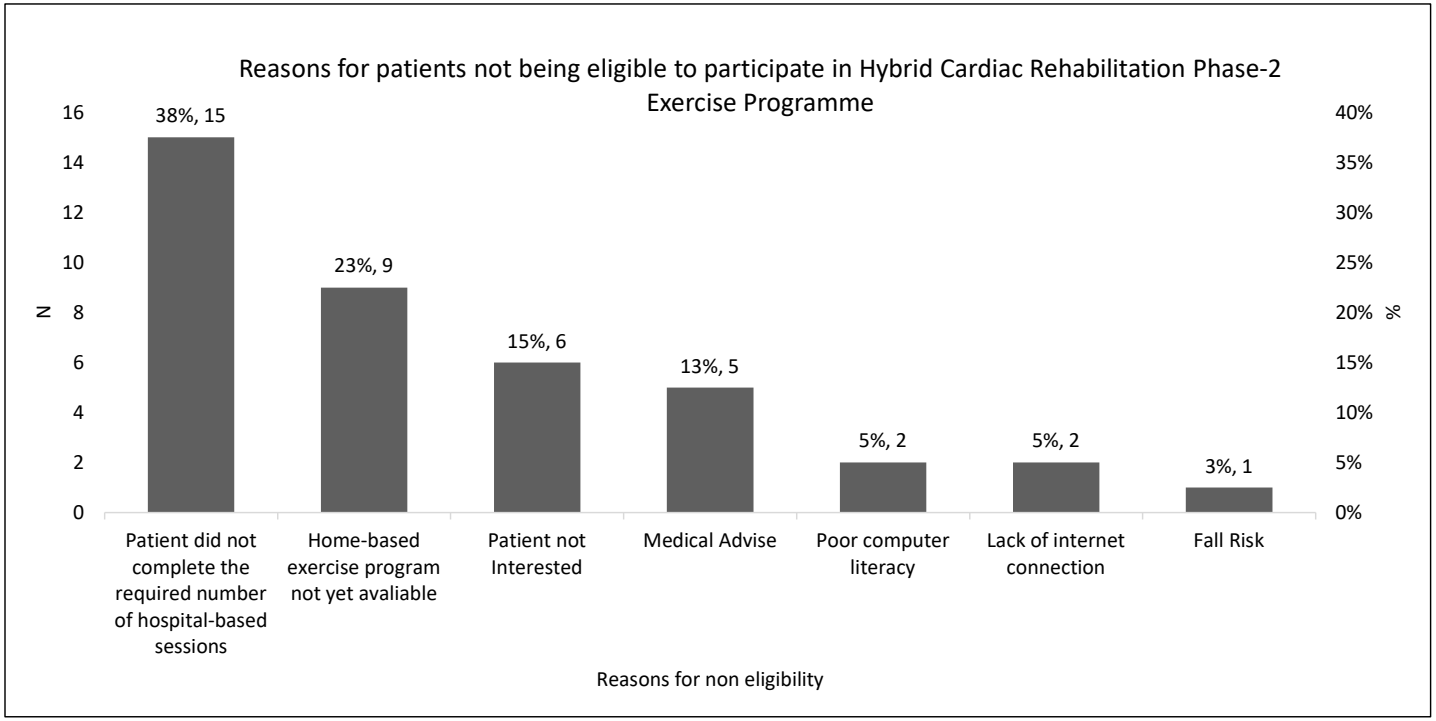
1. Has the patient been thoroughly explained the HYCRP2-EP requirements? □ Yes □ No
2. Has the patient agreed to the transfer under the above conditions? □ Yes □ No
3. Has Telehealth application been installed? □ Yes □ No
4. Has remote ECG telemetry unit been assigned & checked for correct functioning? □ Yes □ No
5. Contact information:
    □ Zone#:_____ Street#: _____ Building#: _____ Apt#: _____
    □ Phone#: _____ Email: _____
6. Progress Note on Electronic Medical Record system completed: □ Yes □ No


Pareto Analysis - Barriers to implementation of Hybrid Cardiac Rehabilitation Phase 2 Exercise Programme
25
20
15
10
5
0
120%
100%
80%
60%
40%
20%
0%
18%
30%
43%
52%
60%
66%
72%
79%
83%
87%
90%
93%
96%
97%
99%
100%
Lack of TeleHealth platform
Technological literacy
Requirement for supervision
Adoption of technology
Technology
Lack of competence/experience delivering the exercise component…
Lack of SOP / policy
Unable to access Home / Hospital Gym
CR Staff Clinical Training
Telehealth delivery (nurses)
Lack of access to exercise equipment gym/outdoor (patient)
Lack of private home space due to Home Isolation mandate /…
Patient's smart device
Fear of social contact / infection
Emergency Procedures in the community
Lack of motivation
Balance / Coordination
Cardiac patients are high risk patients for COVID19 related…
Training patient use of technology (installing app over phone)
Workforce – nursing staff relocated to COVID-19 facilities
Time Constrain / Sudden disruption
Devices: headsets, webcams, PC,…
Patient's Internet Access
TeleHealth app Privacy / Confidentiality
Safety of home space (ventilation, lighting, obstacles)

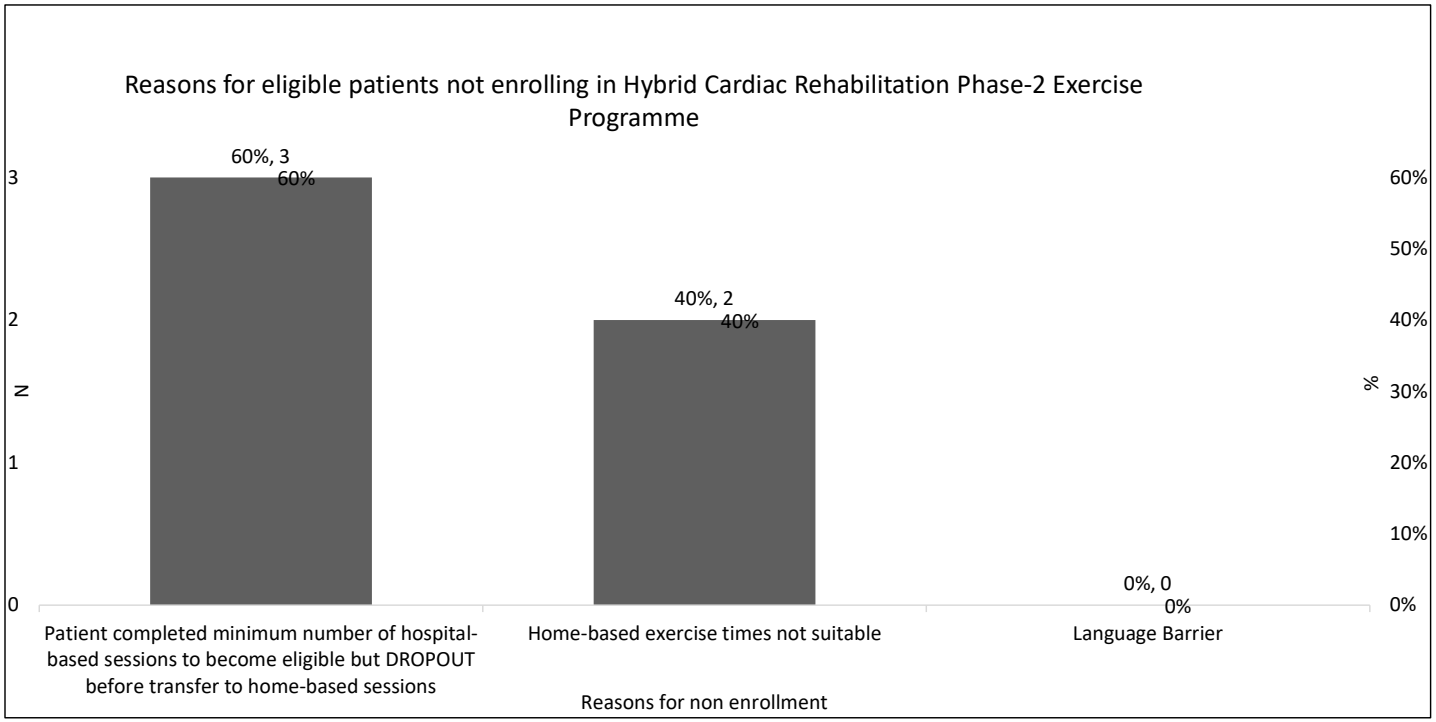
Remote Physical Activity Counselling Guiding Script

1. Identify myself
2. Explain to the patient the reason for this call: state objectives and outline of PA counselling
3. Explore patient's current situation:
    - "Can you tell me a little bit about in which ways you are staying active at home?"
    - Quantify IPAQ: How much activity: days and minutes per day as well as intensity (light/moderate/vigorous)
    - Describe the form or mode of activity.
    - Does he have exercise equipment at home? YES / NO, what equipment? If YES explore if use of equipment is correct or maximize and advice as possible based on the Exercise Card.
    - How much sedentary time: typically remind him/her of importance of breaking sedentary time.
4. Patient perceptions:
    - What does he think about his current levels of activity? Are they enough?
5. Counselling:
    - If ACTIVE:
        1. "That is great,… and How are you feeling about it?" Generate change talk, assess consistency, motivation, future potential issues, etc…
    - If NOT ACTIVE:
        1. Explore barriers: motivational vs practical (i.e lack of equipment)
        2. What is stopping him/her from being active?
        3. What things/ways does the patient think could help him/her start or increase his/her exercise levels?
        4. Explore his awareness of consequences of Inactivity for his/her Cardiovascular Health
        5. Work and explore with patient towards 5W of Exercising at Home:
            1. Why should he/her Exercise?
            2. What Exercise can he/she do?
            3. When to Exercise?
            4. Where to Exercise?
            5. Who can help him/her exercise?
        6. Explore readiness: regarding the 5W plan above: is the patient ready to commit to an immediate Action Step (i.e working out that same day or next)
        7. Is it possible to get him/her to generate a short term weekly SMART goal? i.e To exercise 2 times a week for 45 min at moderate intensity following the Cardiac Rehab Video.
        8. Record this goal on the Progress Note so whoever counsels him/her next can refer back to it
6. Remind patient of basic precautions and considerations
    - Monitor Signs and Symptoms
    - Warm-up and cool-down
    - Manage own intensity
    - Adherence to medications
    - Refraining from smoking
7. Follow-Up: When will we call the patient in 2 weeks? Record on the progress note.
1. Document Counselling / Assessment notes on Cerner

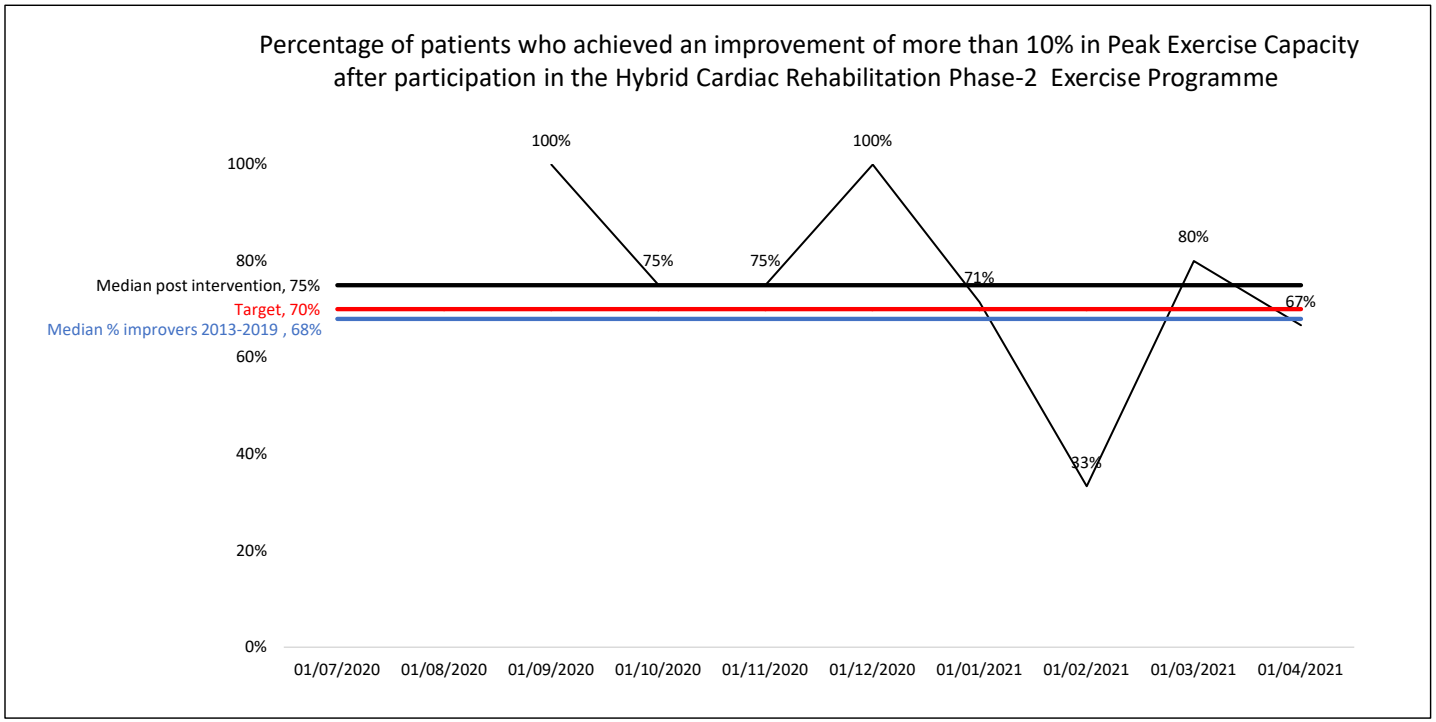
Reasons Not Eligible



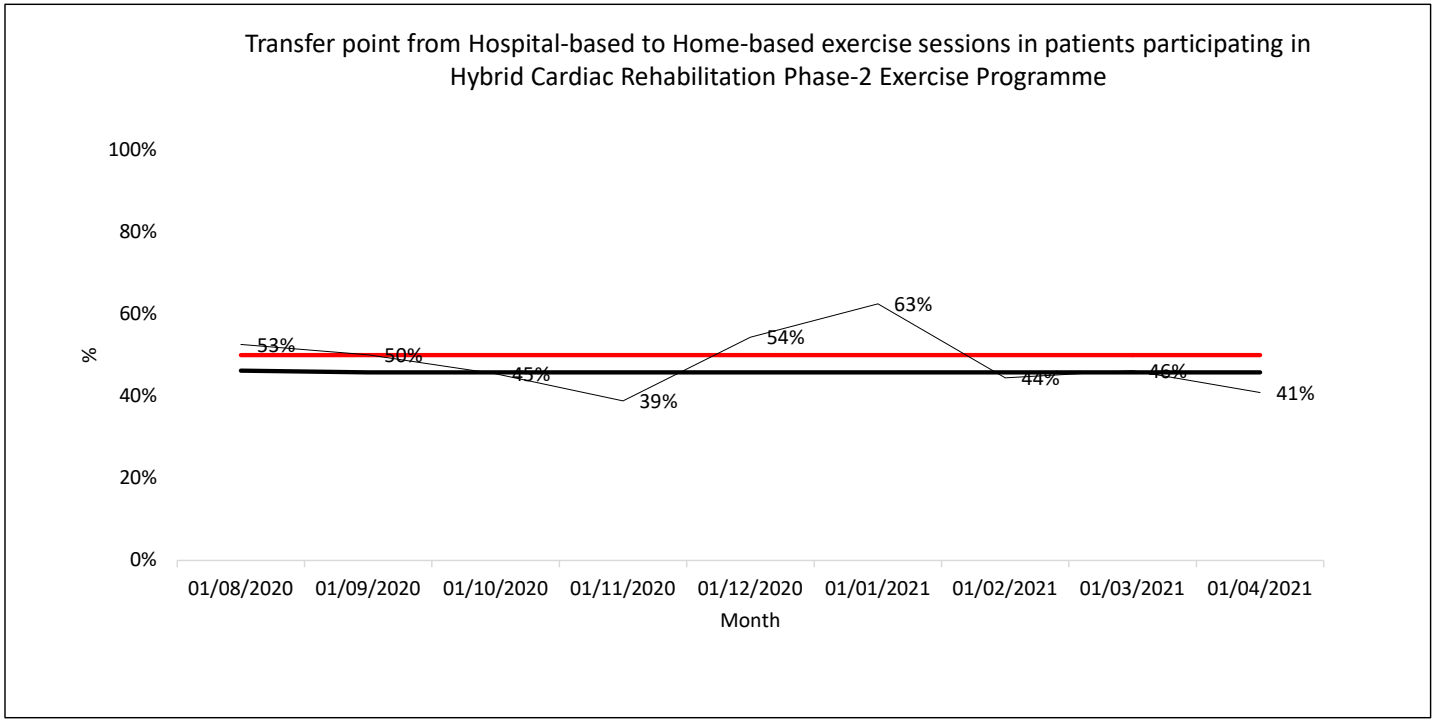
Reasons Not Enrolled



Secondary Outcome: Exercise Capacity Improvement

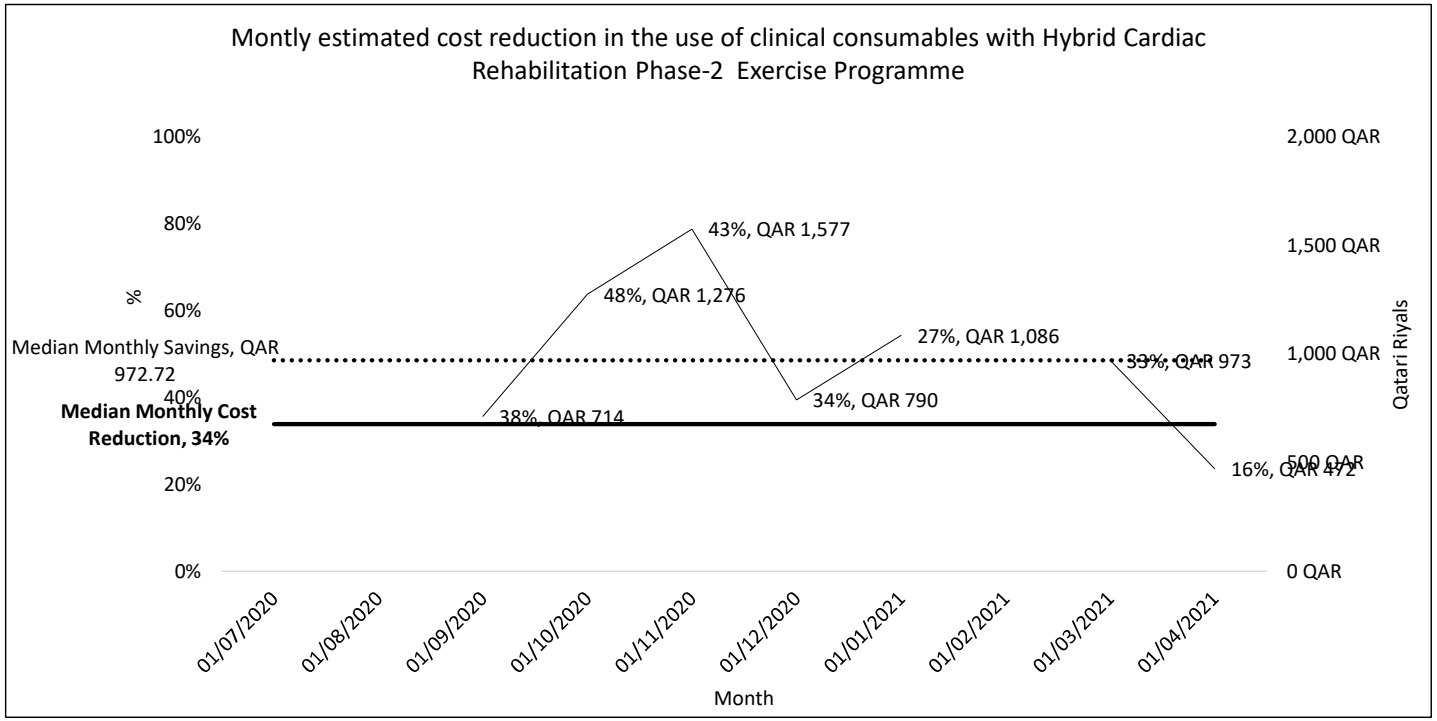


Process Measure: Timing of Transfer

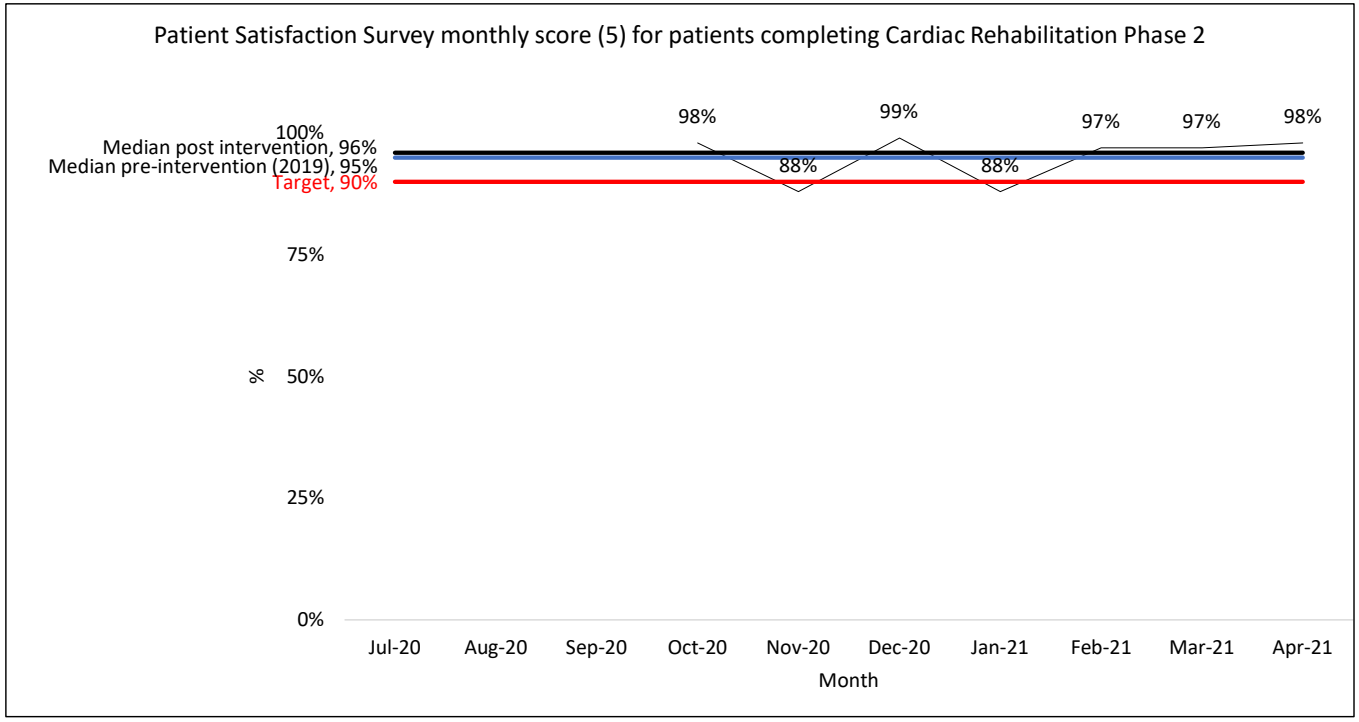


Balance Measure: Cost of Consumables

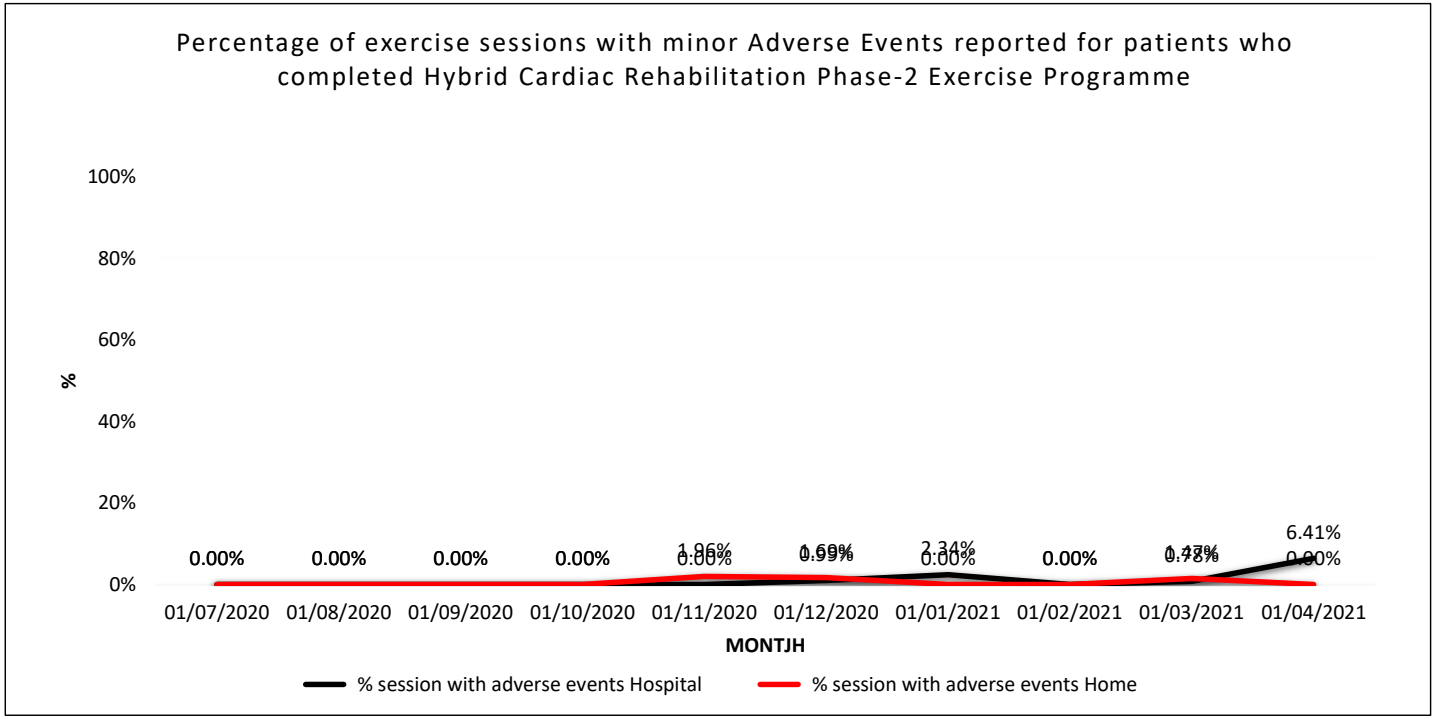
(Total Net Estimated Saving = 6889QAR ≈ 135 QAR/per patient enrolled)



Balance Measure: Patient Satisfaction



Balance Measure: Adverse Events



Balance Measure: Adverse Events