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A Comparison of Exercise Intensity in Hybrid Versus Standard Phase Two Cardiac Rehabilitation

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Purpose: To compare exercise training intensity during standard cardiac rehabilitation (S-CR) versus hybrid-CR (combined clinic- and remote home-/community-based).

Methods: The iATTEND (improving ATTENDance to cardiac rehabilitation) trial is currently enrolling subjects and randomizing patients to S-CR versus hybrid-CR. This substudy involves the first 47 subjects who completed ≥ 18 CR sessions. Patients in S-CR completed all visits in a typical phase II clinic-based setting and patients in hybrid-CR completed up to 17 of their sessions remotely using telehealth (TH). Exercise training intensity in both CR settings is based on heart rate (HR) data from each CR session, expressed as percent HR reserve.

Results: Among patients in both study groups, there were no serious adverse events or falls that required hospitalization during or within 3 hr after completing a CR session. Expressed as a percentage of HR reserve, the overall mean exercise training intensities during both the S-CR sessions and the TH-CR sessions from hybrid-CR were not significantly different at $63 \pm 12\%$ and $65 \pm 10\%$, respectively ($P = .29$).

Conclusion: This study showed that hybrid-CR delivered using remote TH results in exercise training intensities that are not significantly different from S-CR.

Key Words: exercise programming • home-based cardiac rehabilitation • telehealth • telemedicine

Enrollment in standard facility-based phase II cardiac rehabilitation (S-CR) is, on average, $<30\%$ in the United States¹ and as a result, alternate delivery strategies to improve utilization are encouraged.²⁻⁴ To address this, the National Heart Lung and Blood Institute and the National Institute on Aging recently funded four trials that target the development of alternate methods for delivering CR.⁵ The coronavirus disease-2019 (COVID-19) pandemic reinforced the need for delivering CR outside the hospital- or clinic-based setting,⁶ evidenced by the fact that many programs closed operations for a period of time.

To improve patient access and engagement in CR in the Detroit metropolitan area, in 2016 Henry Ford Hospital started a hybrid-CR (combined clinic- and home-/community-based) program using video synchronized telehealth (TH). Although this program has expanded over time, potential concerns exist relative to any offering of hybrid-CR in-

cluding lack of third-party reimbursement; limited patient access to needed equipment; insufficient evidence about equivalency of improvement in exercise training workloads during CR; and a lower exercise intensity achieved by patients when training at home. To address the latter issue, this study compared exercise training intensity during S-CR versus the remote TH sessions in hybrid-CR. We hypothesized that training intensity measured in hybrid-CR would not be significantly different from S-CR.

METHODS

The iATTEND (improving ATTENDance to cardiac rehabilitation) trial (NCT identifier: 03646760) is currently enrolling subjects (target enrollment: $n = 270$) and randomizing patients to S-CR or hybrid-CR. The primary endpoint for the iATTEND trial is the total number of CR visits completed. This article describes a substudy of iATTEND that includes the first 47 patients enrolled into the trial who completed ≥ 18 CR visits between March 2019 and March 2020. Eligibility criteria included the following: experienced a CR qualifying event, >18 yr of age, demonstrated connectivity to the internet via smartphone or tablet, and access to home- or community-based exercise equipment. Patients with a left ventricular assist device; receiving continuous inotropic support or dialysis; with angina at low functional capacity (≤ 2 metabolic equivalents of task, [METs]); or unable to exercise independently due to medical, behavioral or cognitive reasons were excluded. This study received approval from the Institutional Review Board of Henry Ford Health System.

Following informed consent, patients completed a symptom-limited cardiopulmonary exercise (CPX) test and were then scheduled to begin CR. Patients assigned to the S-CR group completed all sessions in the early-outpatient phase II, clinic-based program at the hospital. This included electrocardiogram (ECG) telemetry and before and after exercise blood pressure and blood glucose monitoring for at least the first three sessions.

Patients assigned to hybrid-CR were asked to complete ≥ 1 and ≤ 12 of their 18 sessions in the CR clinic facility, with the remaining sessions completed remotely at home or in the community using TH. The number of in-facility CR visits was based on individual patient preference and any clinical need(s) for additional in-person supervision identified by the CR staff; patients were asked to limit in-facility CR visits to ≤ 1 /wk. The exercise prescription for both groups included ≥ 30 min/session 3 d/wk, using aerobic-type exercise equipment. In patients free of atrial fibrillation ($n = 45$), an exercise target heart rate range (THRR) was determined by the Henry Ford CPX/exercise training core laboratory, set at 60-80% using the heart rate (HR) reserve (peak – rest) method.^{7,8} All patients were instructed on how to self-titrate exercise intensity using ratings of perceived exertion (RPE, 6-20 scale), and in

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patients with atrial fibrillation (n = 2), intensity was based on RPE alone (set at 11-14).

The Henry Ford hybrid-CR program combines in-clinic and TH visits and has been previously described in a case series report,⁹ in which patients completed ≥ 3 in-clinic CR visits and up to 33 additional visits via TH. The TH component involves use of a video application (app) that is loaded to the smart device of the patient. The app uses the internet to connect the device to a portal within the Health System electronic health record (EHR, MyChart in EPIC), establishing a secure connection via a private network (Vidyo-Mobile, Vidyo, Inc). The CR staff person scheduled to conduct the TH visit is seated at a dual-monitor workstation, using one monitor for real-time video communication with the patient and the other to record data and comments into a template within the EHR. The hybrid-CR TH visits are approximately 20 min in duration; CR staff connect with the patient during their warm-up period and then remain in contact for 16-18 min of the 30-min aerobic portion of their exercise session.

For the present analysis, HR data while exercise training was included for only those patients (n = 38) in whom the THRR determined by the CPX Core laboratory at baseline remained unchanged throughout all 18 CR visits. Patients were excluded from the analysis if either their primary method for guiding training intensity was RPE alone (n = 2) or they had their initial THRR revised by the CPX Core laboratory due to a change in clinical status or medications (n = 7). While training in the clinic, patients in the S-CR and hybrid-CR groups who guided training intensity via HR, received verbal feedback from CR staff based on ECG telemetry information or visual feedback from a chest/wrist device (Polar Electro, Inc) that was loaned to them for use during exercise. During the remote TH visits for patients in hybrid-CR, exercise training HR was guided using the chest/wrist device. Exercise training intensity (expressed as a percent HR reserve) was calculated for each patient visit using the following equation:

$$\frac{\text{Exercise training HR} - \text{Seated resting HR}}{\text{Peak HR} - \text{Seated resting HR}} \times 100$$

where seated resting HR and peak exercise HR were measured prior to and during the CPX test, respectively, that was completed before randomization.

STATISTICS

Data are described using standard statistical summary measures such as mean \pm SD for continuous variables and percentages for count data. We compared these measures between S-CR and hybrid-CR using Student's *t* tests for continuous variables and χ^2 test for count variables. A two-sample Wilcoxon test was used for variables that were not normally distributed.

To avoid interfering with the primary endpoint of the iATTEND trial, the total number of visits used in the analysis was truncated at 18. Exercise training intensity and RPE were compared at each session between groups using a two-sample Wilcoxon test. The relative frequency that patients trained within their prescribed THRR or completed ≥ 30 min of aerobic-type exercise was compared for each exercise session using a χ^2 test. All statistical tests were 2-tailed, with a *P* level of .05.

RESULTS

Overall, the study cohort was 38% women and 75% Black race, with a median annual income of \$42,500. Table 1 summarizes the demographic information, clinical

Table 1

Patient Demographic Information, Clinical Characteristics, and Cardiopulmonary Exercise Test Data at Enrollment Into the iATTEND Trial^a

	S-CR (n = 21)	Hybrid-CR (n = 26)	<i>P</i> Value
Age, yr	58 \pm 11	63 \pm 13	.24
Sex—female	24	35	.42
Ethnicity—Hispanic	5	5	1.00
Race			
White	19	23	.94
Black	76	73	
Other	5	4	
Education			
High school or Less	24	19	.25
Some college	33	42	
4-yr college degree	33	27	
Advanced degree	10	12	
Marital status			
Married/partner	62	58	.49
Widowed	0	4	
Divorced	33	23	
Single	5	15	
Annual income			
<\$25 000	15	19	.92
\$25 000-\$50 000	38	40	
\$50 000-\$75 000	24	20	
\$75 000-\$100 000	0	6	
>\$100 000	24	15	
Primary reason for referral to CR			.34
Myocardial infarction	33	31	
Percutaneous coronary intervention	5	31	
Coronary artery bypass surgery	14	15	
Heart valve repair/replacement	10	8	
Heart failure	29	15	
Other	9	0	
Cardiopulmonary exercise test			
Peak heart rate, bpm	127 \pm 21	129 \pm 19	.08
Peak oxygen uptake, mL·kg ⁻¹ ·min ⁻¹	17.4 \pm 5	15.4 \pm 5	.24
Peak respiratory exchange ratio	1.23 \pm 0.08	1.19 \pm 0.11	.10
Peak ratings of perceived exertion	16 \pm 2	17 \pm 2	.14
Reason for stopping the test			.35
Fatigue	91	73	
Shortness of breath	5	15	
Musculoskeletal pain/discomfort	5	4	
Other	0	8	

Abbreviations: CR, cardiac rehabilitation; iATTEND, improving ATTENDance to cardiac rehabilitation; S-CR, standard cardiac rehabilitation.

^aData presented as mean \pm SD or %.

characteristics, and CPX data for patients in the S-CR and hybrid-CR arms of the study, with no significant differences observed between the groups. Among patients in hybrid-CR, 9 \pm 4 of their CR sessions were conducted via TH.

Among patients in both study groups, there were no serious adverse events or falls requiring hospitalization during or within 3 hr after completing a CR session. Out of the 244 TH visits completed in hybrid-CR, there was one CR

Table 2**A Comparison of Mean Exercise Training Intensity During Telehealth-CR Visits for Patients in the Hybrid-CR Group Versus CR Visits for Patients in S-CR Group^a**

CR Session Number	S-CR ^b	Hybrid-CR ^b	P Value
2	55 ± 21	51 ± 9	.89
3	58 ± 18	60 ± 10	.84
4	65 ± 23	60 ± 20	.97
16	73 ± 14	67 ± 14	.31
17	60 ± 14	63 ± 13	.59
18	68 ± 14	64 ± 14	.46

Abbreviations: CR, cardiac rehabilitation; iATTEND, improving ATTENDance to cardiac rehabilitation; S-CR, standard cardiac rehabilitation.

^aData presented as mean ± SD.

^bExercise training intensity expressed as % heart rate reserve.

session-related fall not requiring hospitalization (0.4%) versus no such falls in S-CR ($P = .39$).

Expressed as a percentage of HR reserve, the overall mean exercise training intensity from the TH sessions for patients in hybrid-CR was $65 \pm 10\%$, versus $63 \pm 12\%$ for patients in S-CR ($P = .29$). The overall mean RPE across all 18 sessions for the TH-visits in hybrid-CR was 13 ± 4 , versus 13 ± 5 for patients in S-CR ($P = .10$). There were no significant differences ($P > .05$) in exercise training intensity between study groups for each of the 18 individual CR sessions. Table 2 exemplifies this finding showing data for sessions 2 through 4 and 16 through 18.

For both the TH sessions for patients in hybrid-CR and the clinic-based sessions for patients in S-CR, the overall percentage of patients that trained within their prescribed THRR during each session was $91 \pm 8\%$ and $90 \pm 7\%$, respectively ($P = .70$). The overall percentage of patients who completed ≥ 30 min during a session was $93 \pm 6\%$ for hybrid-CR and $92 \pm 7\%$ for S-CR ($P = .66$).

DISCUSSION

In a diverse cohort of patients (38% women, 75% Black race) enrolled in CR in Detroit, MI, this study showed that mean exercise intensity (ie, % HR reserve) during TH-CR conducted at home or in the community was not significantly different from what was observed during in-clinic training for patients in S-CR. This finding supports our original research hypothesis. Additionally, across all 18 sessions, the percentage of patients that regularly trained within their prescribed THRR was not different between study groups (S-CR = $90 \pm 7\%$, hybrid-CR = $91 \pm 8\%$).

Although similar exercise training intensities were achieved in both study groups (overall means: S-CR = $63 \pm 12\%$ HR reserve, hybrid-CR = $65 \pm 10\%$ HR reserve), neither group regularly trained near the upper (ie, 80%) end of their prescribed THRR (Table 2). This finding is important for two reasons. First, the staff working in CR could provide more focused instruction on the importance of exercising at a higher intensity, because vigorous exercise (ie, between 60 and 89% of HR reserve) is more effective for improving exercise capacity than is moderate (ie, between 40 and 59% of HR reserve) exercise.¹⁰ Another strategy to improve gains in exercise capacity in CR is the use of higher intensity interval training.¹¹ Second, and consistent with the above, the gain in exercise training MET level in CR is clinically important because each 1 MET higher exercise workload at the end of

CR is associated with an ~ 30 -40% reduction in the adjusted risk for subsequent clinical events.¹²⁻¹⁴

Our study is operationally important because it provides practical information that addresses a concern that is sometimes voiced about the home- or community-based component of hybrid-CR; specifically, that patients who exercise at home do so at a lower exercise intensity when compared to clinic-based-only CR. We trust that our observations to the contrary will support and guide the expanding momentum to develop and evaluate alternate models of CR. We acknowledge that our model for hybrid-CR using TH may not be feasible for some CR programs due to staff preparedness or limited access to the needed technology. That said, due to the COVID-19 pandemic, most health systems today are now better prepared to equip and assist CR program staff with operationalizing a remote CR model that incorporates virtual TH.¹⁵

A main reason that we chose to use a video-synchronized TH model to deliver CR remotely is that it allowed us to receive reimbursement from two health insurance providers (Blue Cross and Blue Shield of Michigan, Health Alliance Plan), a policy that currently differs from Medicare. The Henry Ford Hospital CR program in Detroit conducts between 50 and 60 TH visits monthly, accomplished within six, 3-hr blocks of time that are scheduled each week into the existing staffing matrix. To optimize efficiency of staff time, the TH visits are scheduled for 20 min each, allowing one clinician to connect with 3 patients/hr to perform essential TH components (eg, assessment of exercise intensity, workload progression, and education). From a practical perspective, the 20 min of individualized patient contact during a TH visit is often equal to or more than patients routinely receive during a clinic-based CR session that operates using a patient-to-staff ratio of 5 to 1.

The results observed in this single-site study are specific to our patient cohort, derived from residents of the Detroit, Michigan area, and therefore may not be generalizable to patients participating in CR programs in other regions.

CONCLUSION

To improve enrollment (and participation) in CR, alternate models of delivery (ie, hybrid-CR) need to be evaluated. We showed that hybrid-CR delivered with remote TH results in exercise training intensities that are not significantly different from S-CR.

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