Value of Cardiac Rehabilitation for Improving Patient Outcomes

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Disclosures

- There are no conflict of interests related to the products described in this talk
Overview of Talk

• The current state of cardiac rehabilitation
  • Review of patients eligible for cardiac rehabilitation
  • Cellular mechanisms associated with exercise
  • Outcome data supporting the use of cardiac rehabilitation
  • Intensive versus traditional cardiac rehabilitation
• Future directions in cardiac rehabilitation
  • Extending cardiac rehabilitation to the home through digital and wearable technologies to reduce readmission rates
  • Expanding scope of cardiac rehabilitation to HFPEF, POTS,
• Our program at UCSD
Cardiac Rehabilitation and Risk Reduction

Time to “Rebrand and Reinvigorate”

Pratik B. Sandesara, MD,* Cameron T. Lambert, MD,* Neil F. Gordon, MD, PhD, MPH,† Gerald F. Fletcher, MD,‡ Barry A. Franklin, PhD,§ Nanette K. Wenger, MD,* Laurence Sperling, MD*

ABSTRACT

Atherosclerotic cardiovascular disease (ASCVD) continues to increase annually in the United States along with its associated enormous costs. A multidisciplinary cardiac rehabilitation (CR) and risk reduction program is an essential component of ASCVD prevention and management. Despite the strong evidence for CR in the secondary prevention of ASCVD, it remains vastly underutilized due to significant barriers. The current model of CR delivery is unsustainable and needs significant improvement to provide cost-effective, patient-centered, comprehensive secondary ASCVD prevention. (J Am Coll Cardiol 2015;65:389-95) © 2015 by the American College of Cardiology Foundation.
CENTRAL ILLUSTRATION  Cardiac Rehabilitation and the ASCVD Prevention Pyramid

First event
Clinical Disease
Angina, MI, CHF, PAD, stroke, sudden death

Subclinical Disease
Left ventricular dysfunction, carotid stenosis, coronary calcification, myocardial ischemia, more vulnerable plaque, potential for thrombosis

Traditional
Age, family history, hypertension, dyslipidemia, diabetes, obesity

Risk Factors
Nontraditional
Psychosocial stressors, air pollution, inflammation, other (?)

Primary Prevention

POOR DIETARY HABITS  PHYSICAL INACTIVITY  CIGARETTE SMOKING

Secondary Prevention

Exercise Training  Patient Assessment  Nutrition Counseling

Physical Activity Counseling  Weight Management  Blood Pressure Management

Psychosocial Management  Tobacco Cessation  Lipid Management

Primordial Prevention

Unhealthy Lifestyle Practices

Currently Covered Indications for Cardiac Rehabilitation (CR)

- Recent myocardial infarction (within 1 year)
- Post Percutaneous coronary intervention (PCI)
- Coronary artery bypass grafting (CABG)
- Chronic stable angina
- Cardiac transplantation
- Heart valve repair or replacement
- Stable, chronic heart failure (EF<35%)
- Peripheral Arterial Disease
Overview of Cardiac Rehabilitation Programs

- **Nutrition Education**
- **Physician-Supervised Exercise**
- **Stress Management**
- **Group Support**

**Traditional Cardiac Rehabilitation**
- Mainly exercise with some education
- 36 sessions over 12 weeks

**Intensive Cardiac Rehabilitation**
- 72 sessions over 18 weeks

**Cardiac Rehab for Secondary Prevention Indications:**
1. Stable angina pectoris
2. Prior coronary artery bypass surgery
3. Prior angioplasty or stent
4. Prior heart valve repair or replacement
5. Prior heart transplant or heart-lung transplant or LVAD
6. Acute myocardial infarction within the last 12 months

**TCR ONLY:**
7. Systolic congestive heart failure*
8. Peripheral Arterial Disease

*Provided that the patient has New York Heart Association class II to IV symptoms, left ventricular ejection fraction ≤35%, has been on optimal medical therapy for at least 6 weeks, and has not had recent (<6 weeks) or planned (<6 months) hospitalizations or procedures
Exercise Training in PAD

The magnitude of functional benefit derived from exercise training exceeds that observed in drug therapy trials with both pentoxifylline and cilostazol (Circulation. 2011;123:87-97)

<table>
<thead>
<tr>
<th>Frequency</th>
<th>3–5 d/wk</th>
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<tbody>
<tr>
<td>Modality</td>
<td>Treadmill walking</td>
</tr>
<tr>
<td>Intensity</td>
<td>Exercise at a given work rate at which the patient experiences the onset of claudication; continue walking until the patient has an ischemic leg pain symptom score of mild to moderate (3–4 of maximum 5 points); then stop until pain completely subsides; resume exercise again at similar intensity; repeat rest/exercise bouts. Progress to a higher work rate when the patient is able to walk for 8-minute bouts without the need to stop for leg symptoms</td>
</tr>
<tr>
<td>Duration</td>
<td>Total exercise time (including rest periods) should equal 50 min/d</td>
</tr>
</tbody>
</table>
CMS Lauded for Coverage Decision on Supervised Exercise Therapy for PAD

“Long overdue” coverage should have a major impact on patients’ quality of life, but needs to be monitored closely, experts say.
REACH Registry: Risk for Arterial Thrombotic Events Among Patients With CAD or PAD at 1 Year and 3 Years\textsuperscript{1,2}

**CAD**
- 1 Year: 4.5%
- 3 Years: 11.6%

**PAD**
- 1 Year: 5.4%
- 3 Years: 14.8%

**CAD** (≥1 criterion must apply):
- Stable angina, history of UA, history of coronary angioplasty/stenting, history of CABG, previous MI

**PAD**
- Current IC with ABI <0.9
- History of IC together with previous related intervention (angioplasty, bypass graft, and other vascular intervention, including amputation)

Event rates are age- and sex-adjusted.
CABG=coronary artery bypass graft; UA=unstable angina.
### Table 1: Potential Cardioprotective Effects of Increased Lifestyle Activity, Structured Exercise, and/or Improved Cardiorespiratory Fitness

<table>
<thead>
<tr>
<th>Effect Type</th>
<th>Potential Effects</th>
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</thead>
<tbody>
<tr>
<td>Anti-inflammatory</td>
<td>Reduced plasma level of C-reactive protein, which is a biomarker of inflammation (10)</td>
</tr>
<tr>
<td>Antithrombotic</td>
<td>Decreased platelet aggregation (11)</td>
</tr>
<tr>
<td></td>
<td>Enhanced fibrinolysis activity (12)</td>
</tr>
<tr>
<td>Antiarrhythmic</td>
<td>Improved cardiac autonomic function (13,14)</td>
</tr>
<tr>
<td></td>
<td>Increased vagal tone and decreased sympathetic activity (14)</td>
</tr>
<tr>
<td>Antiatherogenic</td>
<td>Improvement in established ASCVD risk factors</td>
</tr>
<tr>
<td></td>
<td>Improved endothelial function due to increased blood flow and shear stress on arterial walls (15,16)</td>
</tr>
<tr>
<td></td>
<td>Enhanced synthesis and release of nitric oxide, which is responsible for the inhibition of processes involved in atherogenesis (15)</td>
</tr>
<tr>
<td>Improved ASCVD risk factors</td>
<td>Decrease in total cholesterol, LDL-C, and triglycerides (17)</td>
</tr>
<tr>
<td></td>
<td>Increase in HDL-C levels (17)</td>
</tr>
<tr>
<td></td>
<td>Reduced blood pressure (18)</td>
</tr>
<tr>
<td></td>
<td>Increased insulin sensitivity (19)</td>
</tr>
<tr>
<td></td>
<td>Weight reduction (19)</td>
</tr>
<tr>
<td>Anti-ischemic</td>
<td>Improved myocardial perfusion (20)</td>
</tr>
<tr>
<td></td>
<td>Raised ischemic threshold (11)</td>
</tr>
<tr>
<td></td>
<td>Ischemic preconditioning of the myocardium (21)</td>
</tr>
</tbody>
</table>
Cellular Mechanisms Associated with Exercise

- Improved mitochondrial function
- Increased nitric oxide production

Figure 2. Electron micrographs of cytochrome c oxidase in a patient with severe heart failure (left panel) and in a normal subject (right panel). Enzyme activity within the mitochondria (black) is reduced in heart failure.
Cachexia of Heart Failure

HF patients have:

- Lower capillary density vs. normal subjects (due to low levels of nitric oxide)
- Shifts in muscle fiber types from the oxidative type I to the more glycolytic type II
- Decreases in mitochondrial oxidative enzymes (citrate synthase)
- The muscle wasting typically observed in HF patients, commonly referred to as cachexia, is associated with elevated levels of inflammatory biomarkers

Taub et al, Clin Sci 2013
Outcomes Associated with Cardiac Rehabilitation

- Meta-analysis of 34 randomized controlled trials showed that exercise-based CR programs are associated with:
  - A lower risk of reinfarction (OR 0.53; 95% CI: 0.38 to 0.76)
  - Decreased cardiac mortality (OR 0.64; 95% CI: 0.46 to 0.88)
  - Decreased all-cause mortality (OR 0.74; 95% CI: 0.58 to 0.95)
- CR reduces 90 day hospital readmission rate after acute MI or PCI
- Class IA recommendation by AHA/ACC Guidelines

Exercise Training in CHF: Mortality and Morbidity Effects

- HF-ACTION
- RCT: usual care vs structured exercise training
  - 50 sites in US and Canada with 2331 patients enrolled
- 5 year follow-up
- Outcomes: death, hospitalization

JAMA 2009; 301:1439
Study Design

- Chronic heart failure, NYHA Class II-IV, LVEF ≤ 35%, optimal medical therapy, and capable of exercising

- Pre-randomization CPX and ECHO

- Randomization 1:1 (Stratified by center and HF etiology)

**Usual Care**
- Optimized medical treatment
- Patient education
- Phone calls
- Recommendation: Moderate intensity activity 30 minutes/day

**Exercise Training**
- Optimized medical treatment
- Patient education
- Phone calls
- Supervised training
- Home training
HF-ACTION Results

**All-Cause Mortality or All-Cause Hospitalization**

HR, 0.93 (95% CI, 0.84-1.02); \( P = .13 \)
Adjusted HR, 0.89 (95% CI, 0.81-0.99); \( P = .03 \)

**All-Cause Mortality**

HR, 0.96 (95% CI, 0.79-1.17); \( P = .70 \)

Cl indicates confidence interval; HR, hazard ratio.

\(^a\)Adjusted for key prognostic factors.

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**JAMA 2009; 301:1439**
## Summary of Major Outcomes

<table>
<thead>
<tr>
<th></th>
<th>Hazard Ratio</th>
<th>95% CI</th>
<th>p-value</th>
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</thead>
<tbody>
<tr>
<td>All-cause mortality and hospitalization (primary)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Main analysis</td>
<td>0.93</td>
<td>0.84, 1.02</td>
<td>0.13</td>
</tr>
<tr>
<td>Adjusted analysis</td>
<td>0.89</td>
<td>0.81, 0.99</td>
<td>0.03</td>
</tr>
<tr>
<td>CV mortality and CV hospitalization</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Main analysis</td>
<td>0.92</td>
<td>0.83, 1.03</td>
<td>0.14</td>
</tr>
<tr>
<td>Adjusted analysis</td>
<td>0.91</td>
<td>0.82, 1.01</td>
<td>0.09</td>
</tr>
<tr>
<td>CV mortality and HF hospitalization</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Main analysis</td>
<td>0.87</td>
<td>0.75, 1.00</td>
<td>0.06</td>
</tr>
<tr>
<td>Adjusted analysis</td>
<td>0.85</td>
<td>0.74, 0.99</td>
<td>0.03</td>
</tr>
</tbody>
</table>
Barriers to Utilization of Cardiac Rehabilitation

- Fewer than 20% of all eligible patients participate in a CR
  - Of those who are referred to CR only 34% actually enroll
- Factors contributing to poor utilization
  1) lack of a centralized method for referral
  2) inadequate communication among treatment teams, patients, and CR facilities
  3) unfamiliarity with CR among potential referring physicians
  4) limited access, and perceived inconvenience for the patient (e.g. Copays)
Current Reimbursement for Cardiac Rehabilitation

- With the affordable care act there is a focus on preventive services
- There has been a gradual increase in reimbursement for cardiac rehabilitation
- Currently in California
  - Medicare: $107 per session
  - Commercial Payers (e.g. Anthem Blue Cross): $132 per session
  - For intensive cardiac rehab (ICR), 72 covered sessions
    - revenue is $7700 to $9500 per patient
## Overview of ICR Programs

<table>
<thead>
<tr>
<th></th>
<th><strong>Ornish</strong></th>
<th><strong>Pritikin</strong></th>
</tr>
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<tbody>
<tr>
<td><strong>Total Number of Sessions Covered</strong>  *</td>
<td>72 sessions (divided into 18 sessions that are 4 hours each)</td>
<td>72 sessions (can customize how many sessions per day)</td>
</tr>
<tr>
<td>*72 (max per day is 6 sessions) over 18 weeks</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Diet</strong></td>
<td>100% plant-based with no oil</td>
<td>Allows for limited lean meat and fish</td>
</tr>
<tr>
<td><strong>Format</strong></td>
<td>Patients are in groups of 10-12 and stay with the same cohort throughout the program. All components are with live instructors:</td>
<td>Some parts are Video Instruction. There are also “hands-on workshops.” Session duration can be customized over 18 weeks</td>
</tr>
<tr>
<td></td>
<td>• 1 hour of exercise</td>
<td></td>
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<tr>
<td></td>
<td>• 1 hour of nutrition education with consumption of meal with cohort</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• 1 hour of yoga and</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• 1 hour of group support</td>
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</tbody>
</table>
| **Outcome Data**             | The Lifestyle Heart Trial showed significant regression of coronary atherosclerosis measured by angiography in the experimental group randomly assigned to intensive lifestyle changes. | Data from Pritikin residential treatment centers showed improvement in lipids, A1c, blood pressure and weight.
% Diameter Stenosis: Quantitative Coronary Arteriography

Baseline (n.s.)  1y (P.02)  5y (P.001)

Case Study of a Patient from UCLA-Enrolled in ICR

Improvement after only 9 weeks of ICR at UCLA

Case Study of a Patient from UCLA-Enrolled in ICR

A  June 26, 2015

B  September 1, 2015
Dr. Ornish's Program for Reversing Heart Disease®

Welcome to a whole new way of living! With the Ornish Reversal Program™, you can feel better and younger, and be more active.

Based on more than 30 years of research, this nationally recognized program is scientifically proven to stop and even reverse the effects of heart disease.

Who is the program for?

The Ornish Reversal Program is for people who are at risk for or who have heart disease. You may be eligible for this program if you’ve had any of the following:

- Balloon angioplasty or coronary stenting
- Chest pain
- Coronary artery bypass surgery
- Diabetes
- Heart attack within the last 12 months
- Heart or heart-lung transplant
- Heart valve repair or replacement
- High blood pressure or cholesterol
- Obesity

When used with current therapies, treatments, and medication, the program has been proven to reduce the amount of daily medication needed to manage heart disease and the risk of repeat procedures.
New Paradigm For Cardiac Rehabilitation

- “Living Lab” for research and secondary prevention
- Ideal population to deploy new technologies to prevent readmission
  - Good outcome trials needed
- Using devices/wearables to expand the length and scope of cardiac rehabilitation
1437 hospitalized patients for HF were randomized

Intervention Arm: n=715 patients

Usual Care Arm: n=722 patients

Patients followed for 180 days

No difference in outcomes

Intervention:
• Combined health coaching telephone calls and telemonitoring (BP, HR and weight)
• Centralized registered nurses conducted telemonitoring reviews, protocoted actions, and telephone calls
Mayo Clinic Study (Apps + Cardiac Rehab)

- 44 patients
  - 25 in the app + cardiac rehab arm
  - 19 in cardiac rehabilitation without the app arm

- The app tracked and monitored patient weight, BP, blood sugar and physical activity and provided educational content

- The app group had 40% less readmissions and lower blood pressure and weight
From: THE AUGMENTATION OF USUAL CARDIAC REHABILITATION WITH AN ONLINE AND SMARTPHONE-BASED PROGRAM IMPROVES CARDIOVASCULAR RISK FACTORS AND REDUCES REHOSPITALIZATIONS

Home based Cardiac Rehab

ATLANTA, GA (PRWEB) APRIL 10, 2017

Veterans who participated in a smartphone-enabled, home-based cardiac rehabilitation (CR) program delivered via the Moving Analytics platform showed high levels of engagement and significant improvements in fitness, according to the results of a study presented last month at the American College of Cardiology’s 2017 Scientific Sessions.
Reflexion Health

Tele-rehabilitation software platform that uses motion-tracking technology to coach patients through prescribed exercises.

**Motion-Tracking Technology**

The Kinect camera uses infrared and motion capturing technology to track approximately twenty-two joints in a three-dimensional space.

**Real-Time Feedback**

When patients perform their prescribed exercises, Vera counts their repetitions, provides exercise education, and delivers real-time feedback on exercise quality.
Primary Results of the HABIT Trial
(Heart Failure Assessment With BNP in the Home)

Alan Maisel, MD,*† Denise Barnard, MD,*† Brian Jaski, MD,‡ Geir Frivold, MD,§ John Marais, MD,¶ Maged Azer, MD,¶ Michael I. Miyamoto, MD,# Dawn Lombardo, DO, MS,** Damon Kelsay, MD,†† Kelly Borden, MD,*† Navaid Iqbal, MD,* Pam R. Taub, MD,*† Ken Kupfer, PhD,‡‡ Paul Clopton, MD,* Barry Greenberg, MD†

San Diego, Loma Linda, Banning, Orange, Mission Viejo, Irvine and Rancho Mirage, California

Objectives
This study was a multicenter, single-arm, double-blinded observational prospective clinical trial designed to monitor daily concentrations of B-type natriuretic peptide (BNP) and to determine how these concentrations correlate with acute clinical heart failure decompensation (ADHF) and related adverse clinical outcomes in at-risk HF patients.

Background
Although BNP at discharge is predictive of 30-day outcomes, outpatient serial testing may improve the risk of detecting early decompensation.

Methods
A total of 163 patients with HF signs and symptoms of ADHF discharged from the hospital or in an outpatient setting measured their weight and BNP levels daily for 60 days with a finger-stick test. Patients and physicians were blinded to BNP levels. The composite outcome was ADHF events: cardiovascular death, admission for decompensated HF, or clinical HF decompensation requiring either parenteral HF therapy or changes in oral HF medications.

Results
A total of 6,934 daily BNP values were recorded, with a median of 46 measures per patient over a monitoring period of 65 days. Forty patients had 56 events. Correlations between BNP measures weakened over time, and the dispersion between BNP measures grew. During 10,035 patient-days, there were 494 (4.9%) days of weight gain (≥5 lbs). The hazard ratio per unit increase of ln BNP was 1.84, and the hazard ratio on a day of weight gain was 3.63. These effects retained significance when controlling for symptoms. When the monitoring period for each subject was broken into intervals based on ADHF events, there were 39 (18.4%) intervals of upward trending BNP corresponding to a risk increase of 59.8% and 64 (30.2%) downward trending intervals corresponding to a risk decrease of 39.0%. There were 94 (44.3%) intervals with 1 or more days of weight gain corresponding to a risk increase of 26.1%.

Conclusions
This pilot study demonstrates that home BNP testing is feasible and that trials using home monitoring for guiding therapy are justifiable in high-risk patients. Daily weight monitoring is complementary to BNP, but BNP changes correspond to larger changes in risk, both upward and downward. (Heart Failure [HF] Assessment with B-type Natriuretic Peptide [BNP] In the Home [HABIT]; NCT00946231) (J Am Coll Cardiol 2013;61:1726–35) © 2013 by the American College of Cardiology Foundation
Exercise Training for POTS

- Physical deconditioning (i.e., low stroke volume and reduced LV mass) and reduced standing stroke volume may be important to the pathophysiology of POTS.

- Physical reconditioning with short-term exercise training significantly increased:
  - peak oxygen uptake,
  - expanded blood and plasma volume,
  - improved POTS orthostatic intolerance symptoms,
  - and in most cases allowed these patients to be symptom free.
Study of Exercise in POTS

Table 2  Short-term exercise training program

<table>
<thead>
<tr>
<th>Training type</th>
<th>Month 1</th>
<th>Month 2</th>
<th>Month 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base pace (RPE 13–15)</td>
<td>10 × 30 min</td>
<td>6 × 30 min</td>
<td>5 × 35 min</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 × 35–40 min</td>
<td>4 × 45–60 min</td>
</tr>
<tr>
<td>Maximal steady state (RPE 16–18)</td>
<td>1 × 20 min</td>
<td>1 × 25 min</td>
<td>1 × 30 min</td>
</tr>
<tr>
<td></td>
<td>1 × 25 min</td>
<td>1 × 30 min</td>
<td>1 × 35 min</td>
</tr>
<tr>
<td></td>
<td>1 × 35 min</td>
<td>1 × 40 min</td>
<td></td>
</tr>
<tr>
<td>Recovery (RPE 6–12)</td>
<td>2 × 40 min</td>
<td>1 × 40 min</td>
<td>3 × 25 min</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 × 30 min</td>
<td></td>
</tr>
<tr>
<td>Strength training</td>
<td>8 × 15–20 min</td>
<td>8 × 20–25 min</td>
<td>8 × 30 min</td>
</tr>
<tr>
<td>Cardiovascular modes</td>
<td>Recumbent bike Swimming</td>
<td>Month 1 modes plus upright bike</td>
<td>Month 1 and 2 modes plus elliptical and treadmill walking</td>
</tr>
<tr>
<td></td>
<td>Rowing</td>
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</tbody>
</table>

RPE = rating of perceived exertion (subjective rating of the entire cardio workout on a scale of 6–20: 6 is very, very easy; 11 is fairly easy; 13 is somewhat hard; 15 is hard; 17 is very hard; 19 is very, very hard).

- 103 patients completed the exercise program
New Approaches to Cardiac Rehab

**Visceral Fat**

*Visceral Fat* wraps around your organs, creating inflammation and interfering with organ function. This fat causes a big belly.

**Disease**

Higher body fat is associated with type 2 diabetes, stroke, heart disease, and some cancers.

**Health**

Lower body fat is associated with lower cholesterol and better insulin sensitivity.

**Energy**

Lower body fat is associated with increased energy, brain function, and stamina.
Conclusion HIIT is a time-efficient strategy to decrease fat-mass deposits, including those of abdominal and visceral fat mass. There was some evidence of the greater effectiveness of HIIT running versus cycling, but owing to the wide variety of protocols used and the lack of full details about cycling training, further comparisons need to be made. Large, multicenter, prospective studies are required to establish the best HIIT protocols for reducing fat mass according to subject characteristics.
Landscape Site Plan
Patient Exam Room in Cardiac Wellness/Rehab Center
Intensive Cardiac Rehabilitation

UC San Diego is the only facility in San Diego offering Dr. Dean Ornish’s Program for Reversing Heart Disease for our intensive cardiac rehabilitation patients. This includes:

**Stress management:** Participants learn techniques to improve fitness and reduce stress through movement and relaxation exercises. The program not only helps with stress management but also makes participants more aware of what happens physically, emotionally and spiritually during stressful times.

**Group support:** By connecting with others and sharing experiences, participants gain confidence in their ability to improve their health and are more likely to maintain their progress.

**Nutrition:** During each session, participants share a nutritious, plant-based meal while learning about lifestyle behaviors. The program focuses on developing a low-fat, whole foods, plant-based eating plan.

**Fitness:** Participants exercise together with an emphasis on regular, moderate aerobic and strength training exercises.

Medicare and most insurances reimburse up to 18, 4-hour sessions, which meet twice weekly for a total of 9 weeks.
Conclusions

- New era in cardiac rehabilitation ushered in by change in focus and reimbursement of our health care system
- Appropriate use of cardiac rehabilitation can lead to improved outcomes
- Expansion of cardiac rehabilitation to diseases such as HFPEF and POTS in the future
- Many digital health devices/apps but need good outcome data