Symposium: Innovative Cardiovascular Secondary Prevention Interventions

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Laura Redwine, PhD
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Symposium Summary

This symposium presents three innovative, theoretically-grounded interventions for the secondary prevention of the global burden of cardiovascular disease.

The interventions have implications for global reach and implementation into evidence-based practice to improve the care and outcomes of cardiovascular patients.
A Behavior Change Theory-Based mHealth Cardiac Rehabilitation Program for Women

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Disclosure

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• NSF I-Corps
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  Health Faculty Research Award
• USF Strategic Investment Pool Award

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Objective

Describe the development and feasibility testing of an innovative behavior change theory-based home-based cardiac rehabilitation program for women
Traditional Cardiac Rehabilitation

Center-based Cardiac Rehabilitation
- 36 sessions
- 12 weeks

- Adopt a healthy diet
- Regular exercise
- Follow medical therapy
- Reduce stress
- Medication adherence
- Stop smoking

Medication adherence
Traditional Cardiac Rehabilitation

- Regular exercise
- Follow medication adherence
- Stop smoking
- Adopt a healthy diet
- Reduce stress
- 36 sessions over 12 weeks

Only 10-20% of eligible women participate!
Barriers to Center-Based Cardiac Rehabilitation

- Up to 60 minutes
- Geographically Inaccessible
- $1800-$6000 program costs
- Work
- Dislike group exercise
- Caregivers of others
Rebrand and Reinvigorate

- Create alternative approaches
  - Home-based
  - Web dashboard, smartphone
  - Wearable sensors
  - Life-long vs. program completion

Financially unsustainable
Limited capacity

Lavie, CL et al. JACC. 2016; 67:13-15
Sandesara, PB et al. JACC. 2015; 65:389-395
Home-Based Cardiac Rehabilitation

A Scientific Statement From the American Association of Cardiovascular and Pulmonary Rehabilitation, the American Heart Association, and the American College of Cardiology

ABSTRACT: Cardiac rehabilitation (CR) is an evidence-based intervention that uses patient education, health behavior modification, and exercise training to improve secondary prevention outcomes in patients with cardiovascular disease. CR programs reduce morbidity and mortality rates in adults with ischemic heart disease, heart failure, or cardiac surgery but are significantly underused, with only a minority of eligible patients participating in CR in the United States. New delivery strategies are urgently needed to improve participation. One potential strategy is home-based CR (HBCR). In contrast to center-based CR services, which are provided in a medically supervised facility, HBCR relies on remote coaching with indirect exercise supervision and is provided mostly or entirely outside of the traditional center-based setting. Although HBCR has been successfully deployed in the United Kingdom, Canada, and other countries, most US healthcare organizations have little to no experience with such programs. The purpose of this scientific statement is to identify the core components, efficacy, strengths, limitations, evidence gaps, and research necessary to guide the future delivery of HBCR in the United States. Previous randomized trials have generated low- to moderate-strength evidence that HBCR and center-based CR can achieve similar improvements in 3- to 12-month clinical outcomes. Although HBCR appears to hold promise in expanding the use of CR to eligible patients, additional research and demonstration projects are needed to clarify...
Home-Based Cardiac Rehabilitation

Mobile Health

- Smartphone
- Smartwatch
- Education videos
- Chat function
- Health coach
- Just-in-time interventions

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Taxonomy of Behavior Change Techniques

1. Goals and planning
2. Feedback and monitoring
3. Social support
4. Shaping knowledge
5. Natural consequences
6. Comparison of Behavior
7. Associations
8. Repetition and substitution
9. Comparison of Outcomes
10. Reward and threat
11. Regulation
12. Antecedents
13. Identity
14. Scheduled consequences
15. Self-Belief
16. Covert learning

Ecological Momentary Assessments

HerBeat
what are you doing now?
- Physical Activity
- Sitting
- Standing
- Lying Down
- Other

Submit

HerBeat™
Which physical activity were you doing right before you saw this question?
- Walking
- Running / Jogging
- Bicycling
- Swimming
- Stair Climber / Elliptical
- Strength Training
- Tennis
- Golf
- Other

Submit

HerBeat
what are you doing now?
- Physical Activity
- Sitting
- Standing
- Lying Down
- Other

Submit

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## Theoretical Framework
2.3 Self-Monitoring of Behavior

### Establish a method for individual to monitor their behaviors as part of a BCT.

### Design strategy/content example
- Wearable sensor records steps taken, distance covered, and sedentary behavior instantly and viewed on dashboard by health coach.

### Table: Behavior Change Techniques for Patient Engagement

<table>
<thead>
<tr>
<th>Theoretical Framework</th>
<th>Behavior change technique</th>
<th>Description of BCT</th>
<th>Design strategy/content example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control Theory</td>
<td>2.3 Self-monitoring of behavior</td>
<td>Establish a method for individual to monitor their behaviors as part of a BCT.</td>
<td>Wearable sensor records steps taken, distance covered, and sedentary behavior instantly and viewed on dashboard by health coach.</td>
</tr>
</tbody>
</table>

### HerBeat™
- **Physical Activity**
  - **Walking**: 40 min
  - **Steps**: 4000
  - **Distance**: 2.8 miles
  - **Sedentary**: 231 min

- **Time to finish**

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## Implementing Behavior Change Techniques for Patient Engagement

<table>
<thead>
<tr>
<th>Theoretical Framework / Construct</th>
<th>Behavior Change Technique (BCT)</th>
<th>Description of BCT</th>
<th>Design Strategy/Content Example</th>
</tr>
</thead>
</table>
| Transtheoretical model Construct: Helping relationships | 3.1 Social Support | Advise on, arrange or provide social support for the performance of the behavior | Content message “spend time with friends who like to exercise”  
Decision rule: send on Monday at 8 AM |

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Just-In-Time Adaptive Interventions

Ecological Momentary Assessments (e.g., activity)
Tailoring Variables (e.g., mood)
Decision points (e.g., time of day)
Behavior Change Techniques (BCT) (e.g. self-monitoring of outcome behaviors)
Proximal Outcomes (e.g. physical activity)

Deploy BCT at 4 PM if no activity detected from wearable sensor

EMA

How many days this week did you reduce your food portions?

- 0
- 1
- 2
- 3
- 4
- 5 or More

Submit

On Click <Submit> If the value <0> or <1>or<2> or<3> trigger Intervention EB 1.6, Else trigger Intervention EB 6.3

Intervention: EB 1.6

If you are not losing weight, perhaps your portion sizes are too large

OK

Intervention: EB 6.3

Your doctor will be so please with your healthy eating

OK

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On Click <Ok Button>
If the value <0> or <1> trigger Intervention EB 10.2,
Else trigger Intervention EB 13.3
Design of System Architecture

**Machine Learning Algorithm** & Activity Recognition

- **Gyro (X,Y,Z)**
- **Accel (X,Y,X)**
- Activity
- Step Count
- Heart Rate

**Smart Phone App**

- Receive activity from Smartwatch, accept EMA responses & trigger Interventions
- Interventions

**Health Coach Dashboard**

- Health Coach Feedback to Patients
- Health Coach Interaction with Dashboard

**BlueTooth**

- Wi-Fi / 4G

**Analytic Processing**

- Servers
- Summary Data
- Azure HIPPA Compliant Private Cloud

**Patient Interaction with App + EMA**

**Patient Interaction**

**Health Coach Interaction with Dashboard**

**Health Coach Feedback to Patients**
Feasibility Study

Purpose: Evaluated the feasibility and usability of a mobile health innovation among 10 women with coronary heart disease over 12 weeks. A health coach monitored the participant’s ecological momentary assessment data, their behavioral data, and their heart rate and step count for 12 weeks.

Mean age was 64 years (range 53-75)
## Feasibility Study

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Baseline</th>
<th>12-weeks</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waist (cm)</td>
<td>97.72 ± 14.74</td>
<td>95.43 ± 12.66</td>
<td>.048</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>80.46 ± 19.68</td>
<td>79.09 ± 18.66</td>
<td>.016</td>
</tr>
<tr>
<td>Body Mass Index (BMI, kg/m²)</td>
<td>29.22 ± 6.04</td>
<td>28.74 ± 5.76</td>
<td>.012</td>
</tr>
<tr>
<td>Patient Health Questionnaire (PHQ)-9</td>
<td>5.50 ± 5.38</td>
<td>2.90 ± 3.8</td>
<td>.038</td>
</tr>
<tr>
<td>Self-Efficacy Scale for Managing Chronic Disease</td>
<td>45.40 ± 12.51</td>
<td>48.20 ± 7.60</td>
<td>NS</td>
</tr>
<tr>
<td>Self-Efficacy for Exercise</td>
<td>52.50 ± 7.58</td>
<td>54.40 ± 6.20</td>
<td>NS</td>
</tr>
<tr>
<td>Self-Efficacy for Diet</td>
<td>88.80 ± 6.05</td>
<td>89.60 ± 6.77</td>
<td>NS</td>
</tr>
<tr>
<td>Perceived Stress Scale</td>
<td>13.30 ± 6.68</td>
<td>9.90 ± 6.95</td>
<td>NS</td>
</tr>
<tr>
<td>System Usability Score</td>
<td>---</td>
<td>83.60 ± 16.4</td>
<td></td>
</tr>
</tbody>
</table>
## Participant Engagement

<table>
<thead>
<tr>
<th>HerBeat™ Feature</th>
<th>Total</th>
<th>Mean ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goals set</td>
<td>132</td>
<td>16.5 ± 17.24</td>
</tr>
<tr>
<td>Videos accessed</td>
<td>165</td>
<td>23.51 ± 21.21</td>
</tr>
<tr>
<td>EMA Survey Responses</td>
<td>830</td>
<td>103.75 ± 113.41</td>
</tr>
</tbody>
</table>

**EMA - Activity**

<table>
<thead>
<tr>
<th>Activity</th>
<th>Total</th>
<th>Mean ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sitting</td>
<td>424</td>
<td>53 ± 81.46</td>
</tr>
<tr>
<td>Walking</td>
<td>226</td>
<td>28.25 ± 45.16</td>
</tr>
<tr>
<td>Standing</td>
<td>153</td>
<td>19.12 ± 25.12</td>
</tr>
</tbody>
</table>

**Progress – walking completed (minutes)**

| Total     | 4933   | 616.62 ± 989.5 |
Lessons Learned

• HerBeat™ was acceptable and usable
• Behavior change was promising even if it was not targeted in this study
• Participants as co-designers is essential
• Avoiding data entry burden was wise
• Dashboard monitoring fostered accountability
Trial of Technology-Enhanced Life-Long Cardiac Rehabilitation for Women (TOTAL CARE)

Randomized trial comparing HerBeat™ to an educational usual care comparison group
Technology-enhanced, behavior theory-based cardiovascular interventions holds promise for expanding the reach to women without access to cardiac rehabilitation services globally, offering just-in-time assistance with behavior change that is personalized to their circumstances and integrated seamlessly into their lives.
Team

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PhD Student

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Chair of Advisory Board

Avijit Sengupta, ISDS
PhD Candidate
Thank you for the privilege of your time! Questions??