Exercise Testing & Prescription: Keeping Pace with the Science

North Carolina Cardiopulmonary Rehabilitation Association

Laura A. Richardson, PhD, ACSM-CEP, FACSM, FCEPA
Registered Clinical Exercise Physiologist
Clinical Associate Professor

CHALLENGE THE IDLE STATE

SCHOOL OF KINESIOLOGY
UNIVERSITY OF MICHIGAN

1

KINESIOLOGY

Disclosures

- No relevant disclosures to report.
- Presentation developed using evidence-informed publications. All references included throughout presentation
  - Always use sound clinical reasoning and judgement when prescribing exercise programming for patients.

2

2

Learning Objectives

1. Review current literature on exercise assessments for exercise programming.
   a. Explore the role of testing for exercise capacity and functional testing
   b. Cardiopulmonary exercise testing and graded exercise test are not feasible
2. Discuss the art and science of precision medicine of exercise prescription
   a. Exercise intensity techniques
   b. Exercise progression
   c. Exercise volume
3. Important role of resistance training
   a. Review pathophysiology of skeletal muscle abnormalities and benefits of resistance training for CR/PR - sarcopenia and frailty
   b. Updated scientific statement on resistance training with CVD

3

3

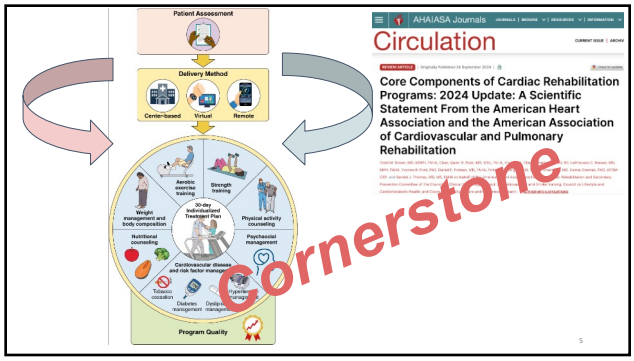
KINESIOLOGY

What is known?

- Many options for exercise testing & prescription
- Becoming familiar with multiple ways to program can assist with individualizing the patient experience
- Ex Rx precision medicine targeting risk factors
  - Synergistic effects helpful for all aspects of secondary prevention
- Unlimited benefits
  - Reduction cardiovascular disease mortality 26%-36%

Kachur S, Chongthammakun V, Lavie CJ, De Schutter A, Arena R, Milani RV, Franklin BA. Impact of cardiac rehabilitation and exercise training programs in coronary heart disease. Prog Cardiovasc Dis. 2017 Jan-Feb;60(1):103-114. doi: 10.1016/j.pcad.2017.07.002. Epub 2017 Jul 6. PMID: 28698054

4



5

Exercise Intensity

Exercise intensity is considered the most significant component for improving aerobic fitness in cardiac rehabilitation.

every 10% ↑in training intensity (as a percent of ˙VO2peak or peak heart rate, HRpeak) confers a mean ↑ in ˙VO2peak of 1.0 mL/kg/min

independent of age, sex, and baseline fitness

↑exercise intensity by 1.0 MET over the course of CR ↓ three-year all-cause mortality by 35%

6

6

Exercise Testing & Prescription

What is the effect of aerobic exercise intensity on cardiorespiratory fitness in those undergoing cardiac rehabilitation?

► CRF remains the single strongest predictor of all-cause and cardiovascular-related mortality, as well as future fatal and non-fatal coronary events ↑CRF appear to underscore reductions in mortality risk

► Exercise therapy during cardiac rehabilitation provides an opportunity to mitigate risk of rehospitalization, reoccurrence and mortality

► Recent reviews have highlighted the effectiveness of exercise based cardiac rehab to ↑CRF; however, little is known regarding the differential effects of prescribed exercise intensity

Mitchell BL, Lock MJ, Davison K, et al. Br J Sports Med 2019;53:1341–1352. 7

7

Exercise Intensity

Moderate (~ 46%-55% ˙VO2peak)	→	Increases in Δ˙VO2peak: 4.1 mL/kg/min
Moderate-to-vigorous (~ 56%-70% ˙VO2peak)	→	4.9 mL/kg/min
Vigorous (> 70% ˙VO2peak)	→	5.5 mL/kg/min

Mitchell BL, Lock MJ, Davison K, et al. Br J Sports Med 2019;53:1341–1352.

8

Exercise Testing & Prescription

What is the effect of aerobic exercise intensity on cardiorespiratory fitness in those undergoing cardiac rehabilitation?

► Majority of CR studies report prescribing large ranges of exercise intensities based on HR responses to exercise

► Was little consistency across studies in the change in CRF following cardiac rehabilitation

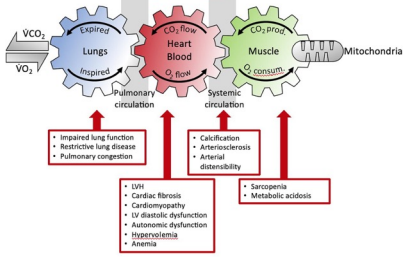
► Vigorous-intensity exercise during cardiac rehabilitation may provide greater benefits over moderate or moderate-to vigorous intensities, but additional benefits are unlikely to be clinically significant

Mitchell BL, Lock MJ, Davison K, et al. Br J Sports Med 2019;53:1341–1352. 9

9

CPET Utility

$\dot{V}O_{2\,peak} = (SV_{max} \times HR_{max}) \times (CaO_2 - CvO_2)_{max}$

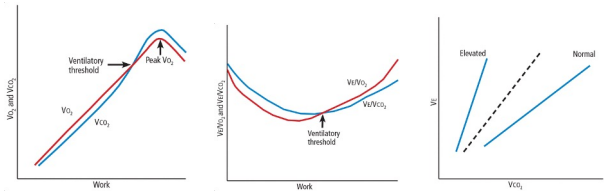


Lim et al (2020) Cardiovascular Functional Changes in Chronic Kidney Disease: Integrative Physiology, Pathophysiology and Applications of Cardiopulmonary Exercise Testing. Front. Physiol. , 14 September 2020 Sec. Renal Physiology and Pathophysiolo Volume 11

adapted from Wasserman, 1997

10

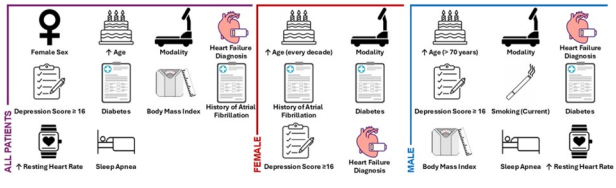
CPET Utility



LECLERC 2017 Cardiopulmonary exercise testing: A contemporary and versatile clinical tool Cleveland Clinic Journal of Medicine February 2017, 84 (2) 161-168 11

11

Sex Differences and Correlates of the Utility of the Cardiopulmonary Exercise Test for Prescribing Exercise at Entry to Cardiac Rehabilitation



Marcotte, Suzen et al.(2020) Sex Differences and Correlates of the Utility of the Cardiopulmonary Exercise Test for Prescribing Exercise at Entry to Cardiac Rehabilitation Canadian Journal of Cardiology, Volume 41, Issue 3, 487 – 490 12

12

CPET Utility

- **Cost and Resource Intensity**
  - Equipment and Maintenance
    - expensive to purchase and maintain
  - Trained Personnel
- **Patient Compliance and Tolerance**
  - Physical limitations
  - Patient Anxiety
- **Interpretation**
  - Variability
  - Advanced training
- **Time Constraints**
  - staffing medical supervison
  - infrastructure
- **Standardization and Protocols**
  - Not one size fits all

- **Versatile**
- **Mechanistic**
- **Physiological**
- **Prognositc**

Reeves, Gordon R. MD, MPT; Gupta, Shuchita MD; Forman, Daniel E. MD. Evolving Role of Exercise Testing in Contemporary Cardiac Rehabilitation. Journal of Cardiopulmonary Rehabilitation and Prevention 36(5):p 359-369, September/October 2016. 13

13

CONUNDRUMS OF TESTING IN CLINICAL PRACTICE

THE ROLE FOR "SUBMAXIMAL" WALK TESTS

6MWT

Symptom-Limited (Maximal) Exercise Test

Exercise tolerance test (ETT) or GXT

Cardiopulmonary Exercise Test (CPET)

Frailty and Functional Performance Assessments

Short Physical Performance Battery

The Timed Up and Go (TUG)

14

14

How to monitor variables to design and titrate precision exercise?

15

15

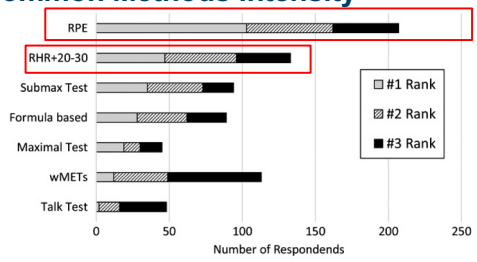
CR Exercise Prescription Variability

- ✅ **Exercise Duration**
- ✅ **Exercise Modality**
- 🤔 **Exercise Intensity**
- 🤔 **Exercise Progression**

Pack et all (2022). Exercise Prescription Methods and Attitudes in Cardiac Rehabilitation: A NATIONAL SURVEY. Journal of Cardiopulmonary Rehabilitation and Prevention 42(5):p 359-365, September 2022 16

16

Common Methods Intensity

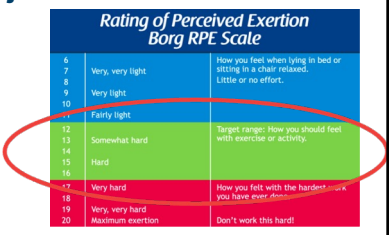


Pack et all (2022). Exercise Prescription Methods and Attitudes in Cardiac Rehabilitation: A NATIONAL SURVEY. Journal of Cardiopulmonary Rehabilitation and Prevention 42(5):p 359-365, September 2022 17

17

Intensity - Subjective

- ✅ **Reliable**
- ✅ **Proper instruction**
- 🤔 **Suboptimal**



Pack et all (2022). Exercise Prescription Methods and Attitudes in Cardiac Rehabilitation: A NATIONAL SURVEY. Journal of Cardiopulmonary Rehabilitation and Prevention 42(5):p 359-365, September 2022 18

Borg, Gunnar. The Borg Rating of Perceived Exertion (RPE) scale. Occupational Medicine. Volume 67, Issue 5, July 2017, Pages 404–405

18

Low fitness and/or elderly - underestimate

Fitter and/or younger - overestimate

Heart Rate Calculations Variability

Adapted from Shookster, et al.*Int. Jour. Exer. Sci* 2020

19

Intensity - Methods

HR+ Fixed Range

RHR +20 - 30 bpm

Safe starting point then titrated with exercise progression

Talk Test

TT strongly correlated with onset of Ventilatory Threshold (VT)

Talking provides insight to CO2 production and LA

Gauge and monitor breathless

. Pack et al 2022 Exercise prescription methods and attitudes in cardiac rehabilitation: A national survey. *Journal of Cardiopulmonary Rehabilitation and Prevention*, Volume 42 (5), 359-365

Sørensen et al 2020. Validity of the Talk Test as a Method to Estimate Ventilatory Threshold and Guide Exercise Intensity in Cardiac Patients. J Cardiopulm Rehabil Prev. 2020 Sep;40(5):330-334

20

20

Progression

Table 1. E… of a progressive exercise program in cardiac rehabilitation.

Exercise Session	Duration	RPE (6–20)	Heart Rate	Mode	Comment
1	10 min	11–14	Target: 92–102 bpm	Treadmill: begin patient at 1.5–2.5 mph	Record treadmill workload, heart rate achieved, and symptoms
2	15 min	11–14	Target: heart rate may need to be increased to meet RPE goal	Treadmill: increase walking speed or grade if appropriate. Cycle/recumbent: introduce new modality	Record exercise workloads, heart rate achieved, and symptoms.
3	20 min	11–14	Target: heart rate may need to be increased to meet RPE goal	Treadmill: increase walking speed or grade if appropriate. Cycle/recumbent: introduce new modality	Record exercise workloads, heart rate achieved, and symptoms
4	25 min	11–14	Target: heart rate may need to be increased to meet RPE goal	Treadmill: increase walking speed or grade if appropriate. Continue to introduce new exercise modes if appropriate	Record exercise workloads, heart rate achieved, and symptoms

Case study example: female patient, age 65, resting HR = 72 bpm, diagnosed CAD with PCI and coronary stent treatment 14 days ago. Min = minutes, RPE = rating of perceived exertion.

- Monitor symptoms
- 1st Duration
- 2nd Intensity
- RPE >14 as tolerated

Mytinger et al 2020. Exercise Prescription Guidelines for Cardiovascular Disease Patients in the Absence of a Baseline Stress Test. J Cardiovasc Dev Dis. 2020 Apr 27;7(2):15.

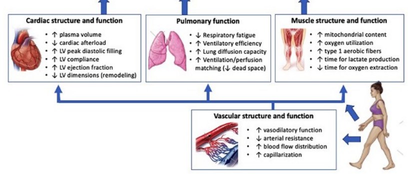
21

Science & Art of Exercise Prescription

- Monitor symptoms
- 1st Duration
- 2nd Intensity
- RPE >14 as tolerated

↑ VO_2peak

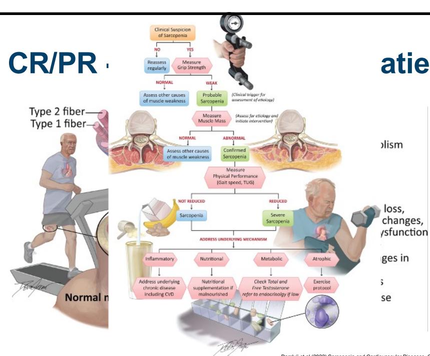
[= SV x HR x (a – v O_2 difference)]



Taylor et al 2021. Optimizing Outcomes in Cardiac Rehabilitation: The Importance of Exercise Intensit. yFront. Cardiovasc. Med. , 02 September 2021 Sec. General Cardiovascular Medicin Volume 8 - 2021

22

CR/PR … atients?



…lism

… loss,
… changes,
…sfunction

…ges in

…s

…se

Sarcopenia

flesh poverty

muscle strength (dynapenia)

mass (quantity)

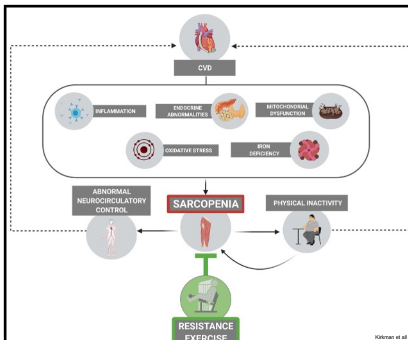
function (quality)

Damluji et al (2022) Sarcopenia and Cardiovascular Diseases. Circulation Vol 147, Number 20

23

23

Resistance Training



lean mass

abnormalities

vicious ↕ cycle

CVD

Kirkman et all 2022. Resistance exercise for cardiac rehabilitation. Prog Cardiovasc Dis. 2022 Jan-Feb;70:66-72

24

Table 1.

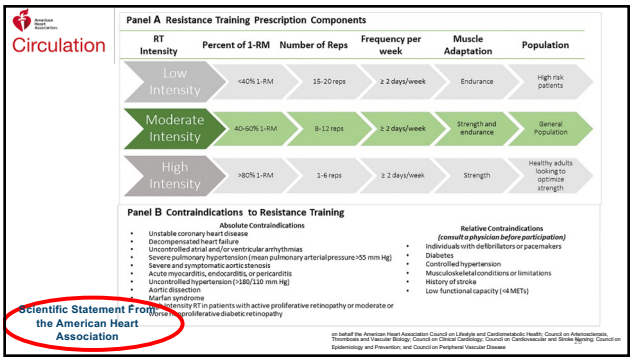
Current resistance training guidelines for cardiac patients and older individuals.

	Population	Frequency	Intensity	Time	Type
ACSM [4]	Outpatient Cardiac Rehabilitation	2-3 nonconsecutive d • wk^{-1}	- RPE 11-13 on a 6-20 scale - 40%-60% 1RM	- 1-3 sets - 10-15 repetitions - 8-10 exercises	- Focused on major muscle groups - Select equipment that is safe and comfortable for the individual to use
ACSM [71]	Older Adults				
	For Strength & Hypertrophy	2-3 nonconsecutive d • wk^{-1}	- 60-80% 1RM - Slow-moderate lifting velocity	-1-3 sets - 8-12 repetitions - 1-3 minutes rest between sets	- Multiple and single joint exercises - Free weights & machines
	For Power	2-3 nonconsecutive d • wk^{-1}	- 30-60% 1RM - High lifting velocity		
	For Muscular Endurance	2-3 nonconsecutive d • wk^{-1}	-Low-moderate intensity	-10-15 repetitions	
AHA [74]	Cardiac Patients	2-3 nonconsecutive d • wk^{-1}		- 1 set - 8-10 repetitions - 8-10 exercises	

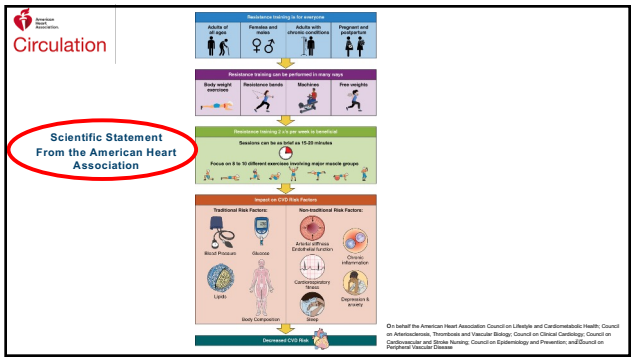
ACSM, American College of Sports Medicine; AHA, American Heart Association; RM, repetition maximum; RPE, ratings of perceived exertion.

Kirkman et all 2022. Resistance exercise for cardiac rehabilitation. Prog Cardiovasc Dis. 2022 Jan-Feb;70:66-72

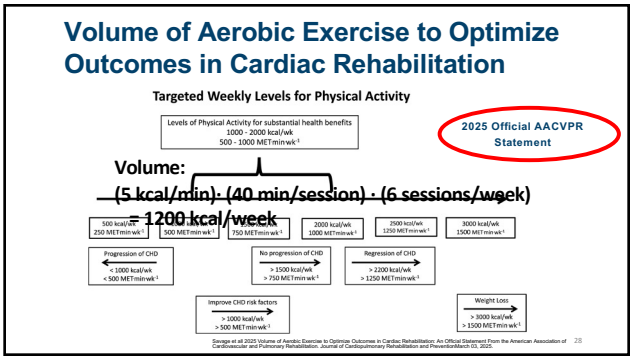
25



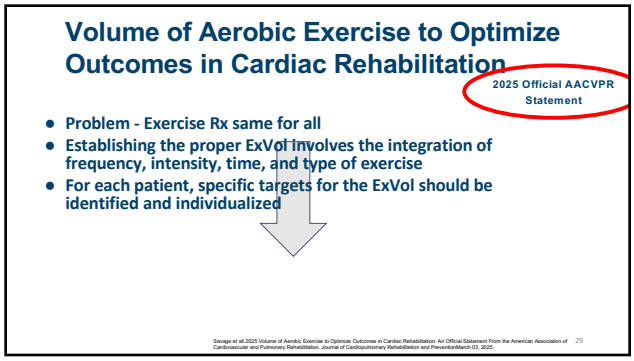
26



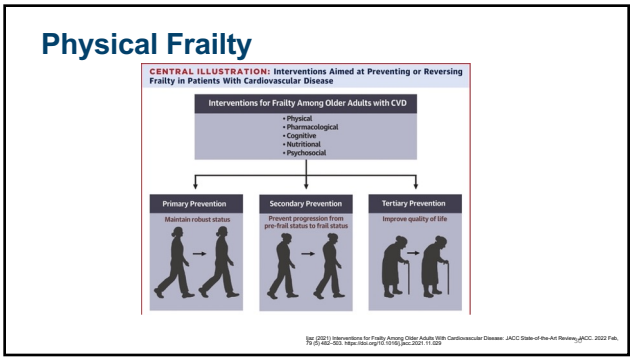
27



28

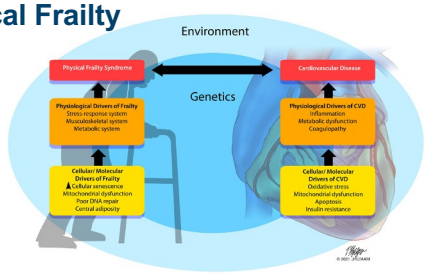


29



30

Physical Frailty



Ijaz (2021) Interventions for Frailty Among Older Adults With Cardiovascular Disease: JACC State-of-the-Art Review. JACC. 2022 Feb, 79 (5) 482–503. https://doi.org/10.1016/j.jacc.2021.11.026

31

31

Key takeaways ⇨ dosing for programming

- Mitigate undertraining? Personalized precision medicine
- INTENSITY
  - RPE and TT are beneficial principle of progression!
- VOLUME
  - Patient factors
  - Programmatic concerns
- EXERCISE TESTING
  - Facilitates broad spectrum assessment to optimize initial ExRx
- Counsel encourage to achieve optimal PA

32

32

Thank you

M KINESIOLOGY

33

33

Exercise Testing & Prescription: Keeping Pace with the Science

Laura A. Richardson, PhD, ACSM-CEP, FACSM, FCEPA
Registered Clinical Exercise Physiologist

CHALLENGE THE IDLE STATE

M SCHOOL OF KINESIOLOGY
UNIVERSITY OF MICHIGAN

34