Exercise Prescription 101

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Principles of Exercise Training
Key Components of Exercise Prescription
Application to CAD, HF, COPD, PAD

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- Katrina Riggin and her staff at the IUH-Ball Memorial Hospital Cardiopulmonary Rehabilitation Program
- ISCVPR
- BSU CEP Program Staff and Students

Objectives

1 – to review basic principles of Exercise Prescription, with specific application to CAD

2– to review unique differences in developing Exercise Prescriptions for patients with HF, COPD, and PAD

Principles of Exercise Training

- Overload
- the body (muscles, systems) will make adaptations (response) when repeatedly stimulated (stressed) beyond what it is normally accustomed to
  - improved ability and capacity
- continued improvements require Progressive Overload

Principles of Exercise Training

- Specificity - exercise training responses are specific to:
- the muscle or muscle groups involved
- the energy systems utilized
- the speed of the movement
- the mode of exercise

Developing the Ex Rx

- Need a plan – specific Goals are Important
- Health Goals
  - risk factor modification
  - secondary prevention
- Fitness Goals
  - improvement / maintenance
  - Remember low CRF is a risk factor and CRF is a powerful prognostic indicator
- Individualized - consider personal preferences
  - Unfortunately, often ignored

Art of Ex Rx

- The successful integration of exercise science w/ behavioral techniques that result in long-term program compliance and attainment of the individual's goals
- Individual diversity necessitates an art to developing an Ex Rx
  - Don't lose sight of the person behind the Ex Rx
- Primary goal should be help ALL individuals adopt a lifelong habit of being physically active

Art of Ex Rx

- Physiologic and perceptual responses to acute exercise vary between individuals
- Adaptations vary in terms of magnitude and rate of progression
- Individual needs are diverse
- There is no such thing as a one size fits all exercise prescription

Long-term objective – produce behavior change that results in habitual physical activity

Developing an Exercise Prescription

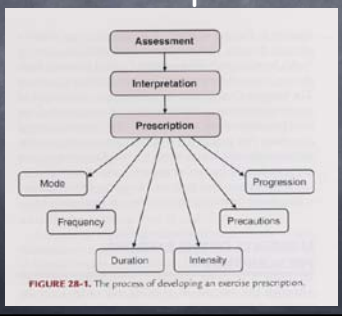


FIGURE 28-1. The process of developing an exercise prescription.

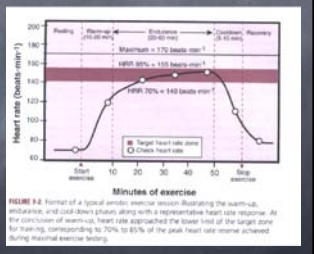
BOX 7.1 Components of the Exercise Training Session

- Warm-up: At least 5 to 10 minutes of low- (<40% $\dot{V}O_2R$) to moderate- (40%-<60% $\dot{V}O_2R$) intensity cardiovascular and muscular endurance activities
- Conditioning: 20 to 60 minutes of aerobic, resistance, neuromuscular, and/or sport activities (exercise bouts of 10 minutes are acceptable if the individual accumulates at least 20 to 60 min · d^{-1} of daily exercise)
- Cool-down: At least 5 to 10 minutes of low- (<40% $\dot{V}O_2R$) to moderate- (40%-<60% $\dot{V}O_2R$) intensity cardiovascular and muscular endurance activities
- Stretching: At least 10 minutes of stretching exercises performed after the warm-up or cool-down phase

Note: These recommendations are consistent with the United States Department of Health & Human Services Physical Activity Guidelines for Americans, available at http://www.health.gov/PAGuidelines/pdf/paguide.pdf (October 7, 2008).

Conditioning Phase

- What is traditionally thought of as the exercise bout
- Stimulus to improve health and/or fitness



Exercise RX Components

- Mode (Type of activity)
- Intensity (How hard)
- Duration (How long - Time)
- Frequency (How often)
- Progression (Rate of increase of stimulus)

Modes

- large muscle groups, used continuously and in a rhythmical nature
  - walking, jogging, cycling, elliptical, XC skiing, stair climbing, swimming, rope skipping, rowing
  - Sports play?
    - both the skill and intensity can be highly variable
    - Competitive factors must also be considered and should be minimized

Mode Selection Factors

- Client/Patient preferences
- M/S restrictions
- Cross training to prevent overuse injuries
- Availability - schedule flexibility
- Consider long-term barriers
  - Travel, family care concerns, resources- $
- Weight Dependent Benefits
  - Energy Expenditure
  - Bone health

How Much?

- Health benefits & training adaptations are related to volume of PA/exercise
- Total volume = Frequency + Intensity + Duration (Time)
  - Thus, the decisions about the F-I-T are not separate, but are done interactively

Frequency Considerations

- Deconditioned individuals may improve CRF by exercising 2 d/wk
- Some evidence of health benefits with 1 – 2 d/wk of mod-vigorous intensity exercise (weekend warrior)
  - Risk for both M/S and CV events increase
    - Not advised for general public and certainly not for disease-based patients

Frequency Guidelines

- Generally, ACSM recommends 3-5 d/wk
  - Moderate intensity alone: 5 d/week
  - Vigorous intensity alone: 3 d/week
- Plateau in fitness improvement with > 5 d/wk
- Risk of lower extremity injuries increases with vigorous intensity with frequency >5 d/wk
- Exercise sessions per week depend on caloric goals, participant preferences, and limitations of participant's lifestyle

Frequency Decision

- final decision factor is the contribution to the TOTAL VOLUME

Duration

- ACSM recommendations - consistent with 2008 PA Guidelines
  - Continuous or intermittent
    - Should be at least 10 minutes (bouts) if intermittent
      - Extremely deconditioned – Multiple shorter 2 to 5-min bouts with 5 min rest intervals may be necessary
  - Dependent on intensity of exercise
- For those previously sedentary increase duration before intensity

Duration Threshold

- 150 minutes per week of moderate intensity
  - generally consider: 30 min/day on 5 days
- 75 minutes per week of vigorous intensity
  - generally consider: 25 min/day on 3 days
- Combination in a 2:1 ratio

Duration

- Duration interacts with intensity to determine volume of the PA/Exercise session
- Minimum Energy Expenditure Target: 1000 kcals/ week
  - Per session:
    - /5 200 kcals/session
    - or /4 250 kcals/session
    - or /3 333 kcals/session

Duration Goals

- More energy expenditure is associated with greater H/F benefits and to promote/maintain weight loss
- ≥ 2000 kcals/week would require
  - 300 min/week of moderate intensity (~4METs)
    - 60 min/day on 5 days
  - or 150 min/week of vigorous intensity (~7.5METs)
    - 50 min/day on 3 days
  - or Combination in a 2:1 ratio

Exercise Intensity

- intensity and duration determine total caloric expenditure
  - Inversely related
- Intensity can be prescribed according to HR, VO2 (METs), RPE
- ACSM intensity ranges are broad to allow for individual variability

Intensity Selection Factors

- Individual's fitness level
  - Low-fit, sedentary, and clinical populations can improve, especially when starting a program, with low-intensity, longer-duration exercise sessions
- Medications
  - Certain medications affect HR's
  - Adjustments in exercise prescription are necessary when medications change
- Adherence - lower with higher-intensity exercise
  - Individual preferences related to adherence

Intensity Methods

BOX 7.2 Summary of Methods for Prescribing Exercise Intensity Using Heart Rate (HR), Oxygen Uptake ($\dot{V}O_2$), and Metabolic Equivalents (METs)

- HR reserve (HRR) method: Target HR (THR) = $[(HR_{max} - HR_{rest}) \times$ % intensity desired$] + HR_{rest}$
- $\dot{V}O_2$ reserve ($\dot{V}O_2R$) method: Target $\dot{V}O_2R^a = [(\dot{V}O_{2max} - \dot{V}O_{2rest}) \times$ % intensity desired$] + \dot{V}O_{2rest}$
- Peak HR method: Target HR = $HR_{max}{}^b \times$ % intensity desired
- Peak $\dot{V}O_2$ method: Target $\dot{V}O_2{}^a = \dot{V}O_{2max}{}^c \times$ % intensity desired
- Peak MET × (% MET) method: Target $MET^a = [(\dot{V}O_{2max}{}^c)/3.5\ mL \cdot kg^{-1} \cdot min^{-1}]^c \times$ % intensity desired

[a]Activities at the target $\dot{V}O_2$ and MET can be determined using a compendium of physical activity (8,9) or metabolic calculations (6) (Table 7.2).

[b]HR_{max} is estimated by 220 − age or some other prediction equation.

[c]$\dot{V}O_{2max}$ is estimated by maximal or submaximal exercise testing.

Preferred Methods

- "HR Reserve and VO_2R reflect the rate of EE during PA more accurately than other methods" (p. 156)
- requires accurate resting and maximal HR or measurement of VO_2
- if not available then forced to use predicted HR or VO_2

Traditional Cardiac Rehab Exercise Prescriptions

- Do not take into consideration energy expenditure goals
- Expend less than 300 kcals per session (Schairer, et. al).

Energy Expenditure Goals

- Energy expenditure >1000 kcals/week is more effective in modifying risk factors associated with obesity and has also been proven to slow the progression of CAD.

Brubaker P, Kaminsky L, Whaley M. *Coronary Artery Disease: Essentials of Prevention and Rehabilitation Programs.* Champaign, IL: Human Kinetics, 2002.

Caloric Energy Expenditure Goals: Dose Response Relationship

- <1000 kcals/week
  - Progression of CAD lesions (Hambrecht et. al).
- >1000 kcals/week
  - Slowed progression of CAD lesions
- >1500 kcals/week
  - Stabilization of CAD lesions (Hambrecht et. al).
- >2200 kcals/week (Hambrecht et. al).
  - Regression of CAD lesions as compared to ≤1000 kcal/week
- >3,000 kcals/week (Ades, Savage et. al)
  - Double the weight loss when compared to <800 kcals/week.
  - Significantly decreased insulin resistance

Steps in Calculating Total Energy Expenditure of Exercise Session

- 1. Estimate MET level of exercise performed
  - ACSM Metabolic Equations
  - Use of ACSM Tables
  - Pre Calculated Using Cardiac Rehab Software
- 2. Calculate Average METs of exercise session
- 3. Use METs to calculate energy expenditure (kcals)
  - Total kcals =

({ [METs x 3.5 x BWkg]/200} x min)

Step 1: Estimating METs

TABLE D-3. Approximate Energy Requirements in METs for Horizontal and Grade Walking

	mi·h⁻¹	1.7	2.0	2.5	3.0	3.4	3.75
% Grade	m·min⁻¹	45.6	53.6	67.0	80.4	91.2	100.5
0		2.3	2.5	2.9	3.3	3.6	3.9
2.5		2.9	3.2	3.8	4.3	4.8	5.2
5.0		3.5	3.9	4.6	5.4	5.9	6.5
7.5		4.1	4.6	5.5	6.4	7.1	7.8
10.0		4.6	5.3	6.3	7.4	8.3	9.1
12.5		5.2	6.0	7.2	8.5	9.5	10.4
15.0		5.8	6.6	8.1	9.5	10.6	11.7
17.5		6.4	7.3	8.9	10.5	11.8	12.9
20.0		7.0	8.0	9.8	11.6	13.0	14.2
22.5		7.6	8.7	10.6	12.6	14.2	15.5
25.0		8.2	9.4	11.5	13.6	15.3	16.8

American College of Sports Medicine. *Guidelines for Exercise Testing and Prescription*, 6th ed. Baltimore: Lippincott Williams & Wilkins, 2000.

Step 2: Calculating Average METs of Exercise Session

- Treadmill = 2.9 METs
- Bike = 2.7 METs
- Arm Ergometer = 2.3 METs
- Average METs/session = 2.6 METs
  - Assuming all done for equal time periods

Step 3: Calculating Energy Expenditure

- METS = 2.6 - Intensity
- Body Weight = 100 kg
- Duration = 43 minutes - Duration
  - **Total kcals =**

({ [METs x 3.5 x BWkg]/200} x min)

Total kcals =
({ [METs x 3.5 x BWkg]/200} x min)

- Total kcals = ({[2.6 x 3.5 x 100]/200} x 43]
  - 2.6 x 3.5 x 100 = 910 ml O_2/min
  - 910/200 = 4.55 kcals/min
  - 4.55 x 43 = 196 kcals/session
- 196 kcals/session x 3 days/week provides a weekly energy expenditure of only 588 kcals/week

How can this patient increase her/his energy expenditure?

Need to Increase the Total Volume!

Increase intensity

and/or

Increase Frequency

and/or

Increase Duration

Now for applying this to

- Heart Failure
- COPD
- PAD