Guidelines in Transition: Major Updates and Practice Recommendations from ACSM's 12th edition

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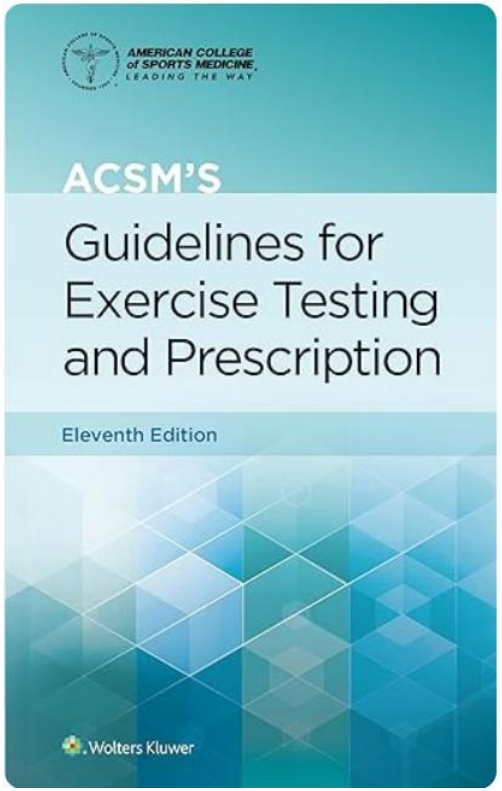
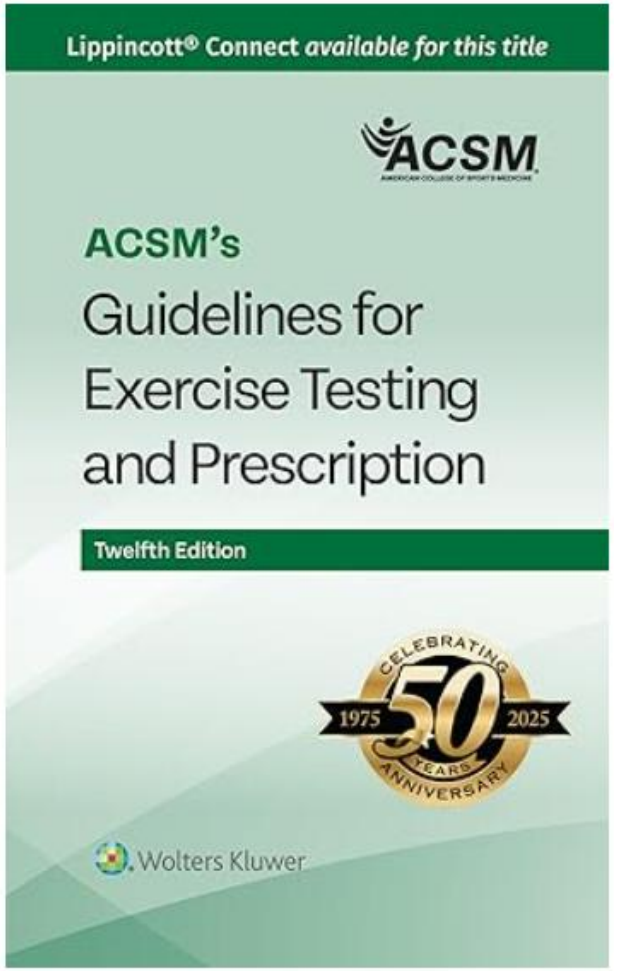
What's NEW?





Ozemek, C. (2025). *ACSM's guidelines for exercise testing and prescription.* Twelfth edition. Wolters Kluwer.

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Chapter 4 – Clinical Exercise Testing and Interpretation

NEW - Table 4.4 p. 130

TABLE 4.4 Typical Exercise Test Responses in Differentiating a Normal Response and Patients Limited by Cardiovascular and Pulmonary Disease

	Condition		
Exercise Response	**Deconditioning**	**Cardiovascular Disease**	**Pulmonary Disease**
Typical limiting symptom	Fatigue/leg fatigue	May have angina	Dyspnea
Peak $\dot{V}O_2$	Decreased	Decreased	Decreased
Ventilatory threshold	Normal	Decreased	Decreased or normal
Oxygen pulse	Normal	Decreased or plateau	Normal
Exercise ECG	Normal	May be abnormal	Normal
$\dot{V}O_2$ /work rate slope	Normal	Decreased	Normal
Breathing reserve	Normal	Normal	<30%
O_2 saturation	Normal	Normal	May decrease
$\dot{V}E/\dot{V}CO_2$ slope	Normal	May be abnormal	Abnormal

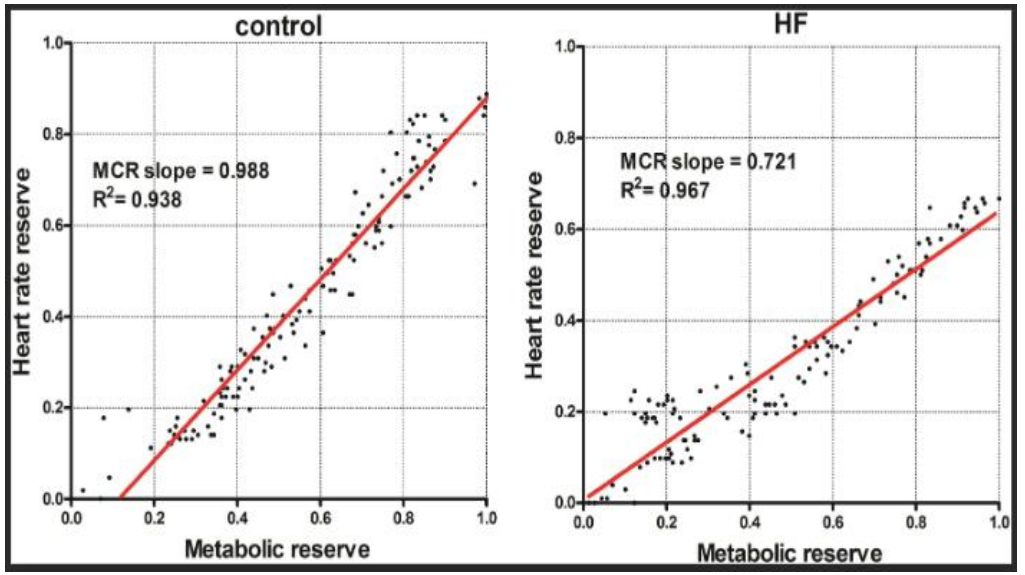
Heart Rate Response p. 133

Metabolic Chronotropic Reserve (MCR)

Ratio Heart Rate Reserve to Metabolic Reserve

during submaximal exercise

MCR < 0.8 = abnormal chronotropic response



https://www.internationaljournalofcardiology.com/article/S0167-5273(16)33529-X/fulltext

$$\mathbf{HR}\text{stage}=[(\mathbf{220}-\text{age}-\mathbf{HR}\text{rest})]\times(\mathbf{METs}\text{stage}-\mathbf{1})/(\mathbf{METs}\text{peak}-\mathbf{1})+\mathbf{HR}\text{rest}$$

Brubaker, P. H., & Kitzman, D. W. (2011).

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Cardiopulmonary Exercise Testing (CPET) p. 139 - 140

- Important tool to evaluate operative risks
- Heart Failure / Transplant Guidelines
  - VO_2peak > 14 ml.kg.min
  - VO_2peak > 12 ml.kg.min w/ β-Blockers
- Strong predictors of adverse outcomes: VE/VCO_2 slope, OUES, oscillatory breathing
- VAT, O_2 pulse, $\Delta VO_2/\Delta WR$, $PetCO_2$, breathing reserve, RER

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Cardiopulmonary Exercise Testing (CPET)

- Prehabilitation = exercise intervention to optimize peak VO_2 and other CPET measures prior to surgery

- Assessment of Dyspnea –
  - CVD patients = breathing reserve > 30%
  - Pulmonary patients = very little breathing reserve

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NEW - Common CPET-Derived Responses and Applications p. 140

TABLE 4.5 Common CPET-Derived Responses and Their Applications

CPET Response	Application
Peak $\dot{V}O_2$	Defines the limits of the cardiopulmonary system; gold standard for fitness; prognostic marker
Breathing reserve Absolute MVV – VE_{max} Relative $\left(\dot{V}E_{max}/MVV\right) \times 100\%$	Marker of ventilatory limitation; distinguish between cardiac and pulmonary limitation to exercise
$\dot{V}E/\dot{V}CO_2$ slope	Ventilatory efficiency; prognostic marker
Oxygen uptake efficiency slope	Ventilatory efficiency; prognostic marker
Oscillatory ventilation	Impaired ventilatory control and ventilatory efficiency
O_2 pulse	Surrogate for stroke volume and ventricular function
End-tidal CO_2	Ventilation-perfusion mismatch, impaired lung function, and control of ventilation
Ventilatory threshold	Prognostic marker, ability to perform ADLs, distinguish cardiac and pulmonary limitation to exercise
Respiratory exchange ratio	Indicator of effort proportion of fuel used
Ventilatory equivalent for O_2	Ventilatory efficiency, detection of VAT

MVV, maximal voluntary ventilation; VAT, ventilatory anaerobic threshold; $\dot{V}E$, minute ventilation.

Chapter 8 – Exercise Prescription for Individuals with Cardiovascular and Pulmonary Diseases

NEW - Coronary Heart Disease p. 278 - 282

Exercise Testing

- Exercise stress test with ECG only

- "may be appropriate" – "rarely appropriate"
  - Patients with prior coronary revascularization or MI

- "appropriate"
  - CHD patients initiating unsupervised exercise program
  - Patients participating in Cardiac Rehab

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NEW - Coronary Heart Disease p. 278 - 282

Exercise Prescription

- Exercise training in CHD patients associated with
  - 26% lower risk CV-related mortality
  - 23% lower risk all-cause hospitalization
  - 18% lower risk of MI
- Increases:
  - Exercise capacity
  - QoL
  - Reduces angina pectoris
  - Return to work
- Class 1 recommendation from AHA and ACC

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NEW - Coronary Heart Disease p. 278 - 282

Special Considerations

- General Recommendations:
  - Warm-up and cool-down
  - Large muscle group aerobic exercise modes
  - Addition of resistance training
- Symptoms and Medications:
  - Educate on symptoms of exercise intolerance
  - Medications on schedule
  - β-blocker Δ affect on exercise HR – new THR
    - New THR estimated = previous HR ± 5 beats
- Target Heart Rate (THR):
  - Based on S/S-limited exercise test
  - Not appropriate to use 220 -age
- Myocardial Ischemia:
  - Chest discomfort should be considered angina – intensity reduced
  - THR - upper limit set at 10 bpm under ischemic threshold
  - Prolonged warm-up / nitroglycerin prior to exercise

NEW - Coronary Heart Disease p. 278 - 282

Special Considerations

- Resistance Training:
  - Safe for CHD patients
  - Begin after 2 – 4 weeks regular aerobic exercise training

- HITT:
  - NO universally accepted guidelines at this time
  - *4 x 4 method* most studied protocol
  - HITT ExR_x established from S/S-limited maximal exercise test

NEW - Box 8.1 p. 281

Box 8.1 Contraindications to Resistance Training in Patients With CHD From the American Heart Association (11)

Absolute

- Unstable CHD
- Decompensated heart failure
- Uncontrolled hypertension
- Severe pulmonary hypertension (mean pulmonary arterial pressure >55 mm Hg)
- Severe and symptomatic aortic stenosis
- Acute myocarditis, endocarditis, or pericarditis
- Uncontrolled hypertension (>180/110 mm Hg)
- Aortic dissection
- Marfan syndrome
- High-intensity RT (80%–100% of 1-RM) in patients with active proliferative retinopathy or moderate or worse nonproliferative diabetic retinopathy

Relative (consult a physician before participation)

- Major risk factors for CHD
- Diabetes at any age
- Uncontrolled hypertension (>160/>100 mm Hg)
- Low functional capacity (<4 METs)
- Musculoskeletal limitations
- Individuals who have implanted pacemakers or defibrillators

CHD, coronary heart disease; 1-RM, one repetition maximum; MET, metabolic equivalent of task.

Combined FITT Recommendations p. 282

FITT RECOMMENDATIONS FOR INDIVIDUALS WITH HISTORY OF CORONARY ARTERY DISEASE (6, 11, 12, 15, 17) OR HEART FAILURE (11, 26)

	Aerobic	Resistance	Flexibility
Frequency	≥3–5 d · wk^{-1}	2–3 nonconsecutive d · wk^{-1}	≥2–3 d · wk^{-1} with daily being most effective
Intensity	Consider starting at 40%–60% HRR during first few weeks and progressing to 60%–80% of HRR as tolerated by the patient 10 beats below the HR at ischemic threshold, when present Without an exercise test, titrate intensity based on a combination of the Talk Test, RPE, and clinical judgement	Perform 10–15 repetitions at 60%–70% 1-RM	Stretch to the point of feeling tightness or slight discomfort.
Time	≥20–60 min	1–2 sets	10–30 s hold for static stretching; 2–4 repetitions of each exercise
Type (mode)	Walking (jogging if able), leg ergometer, combination of upper and lower (dual action) extremity cycle ergometer, upright and recumbent cycle ergometer, recumbent stepper, rower, elliptical, stair climber, treadmill	Multijoint and single-joint exercises focusing on major muscle groups using multiple modalities	Exercise for each of the major muscle-tendon units

1-RM, one repetition maximum; HR, heart rate; HRR, heart rate reserve; RPE, rating of perceived exertion; $\dot{V}O_2R$, volume of oxygen uptake reserve.

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Inpatient / Outpatient Cardiac Rehabilitation p. 283 - 288

- Inpatient CR:
  - FITT for Inpatient and Outpatient CR **REMOVED**

- Outpatient CR:
  - Virtual and Hybrid CR – options to address low adherence rates
  - Hybrid results in similar participation rates and improvements in exercise capacity

- Continuous ECG Monitoring:
- Varies between programs and is determined by –
  - Patient's risk
  - S/S-limited maximal exercise test
  - Third-party health insurance providers

NEW - Individuals with History of Spontaneous Coronary Artery Dissection (SCAD) p. 288 - 290

Exercise Testing

- Can give insight regarding:
  - Arrhythmia
  - Chronotropic incompetence
  - Cardiopulmonary limitations
  - Overall exertional capacity
- Help to plan exercise regimens

Exercise Prescription

- Varying patient fitness levels
- Moderate (12 – 14 RPE) intensity

Special Considerations

- RT – light weight/high rep
- Avoid Valsalva maneuver
- Avoid hyperextensions of head and neck
- Avoid chiropractic treatments of the head and neck
- Psychosocial support important

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Chronic Heart Failure p. 290 - 292

Exercise Testing

- VE/VCO_2 slope information **REMOVED**

Exercise Prescription

- Exercise training improves exercise capacity 10 – 30% in HFrEF patients
- 17% improvement from exercise training
- HFpEF can also benefit from exercise training

- FITT for Heart Failure **COMBINED** with CHD

Special Considerations

- THR range – based on PEAK HR from S/S-limited exercise test
- HITT appropriate in stable HFrEF
- Volume increased over time up to 7 MET.h.wk
- RT incorporated after 4 weeks aerobic training
- Around 40% of patients compliant after 1 year

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Heart Transplantation p. 293 - 294

FITT RECOMMENDATIONS FOR INDIVIDUALS WITH CARDIAC TRANSPLANT (61, 81, 82)

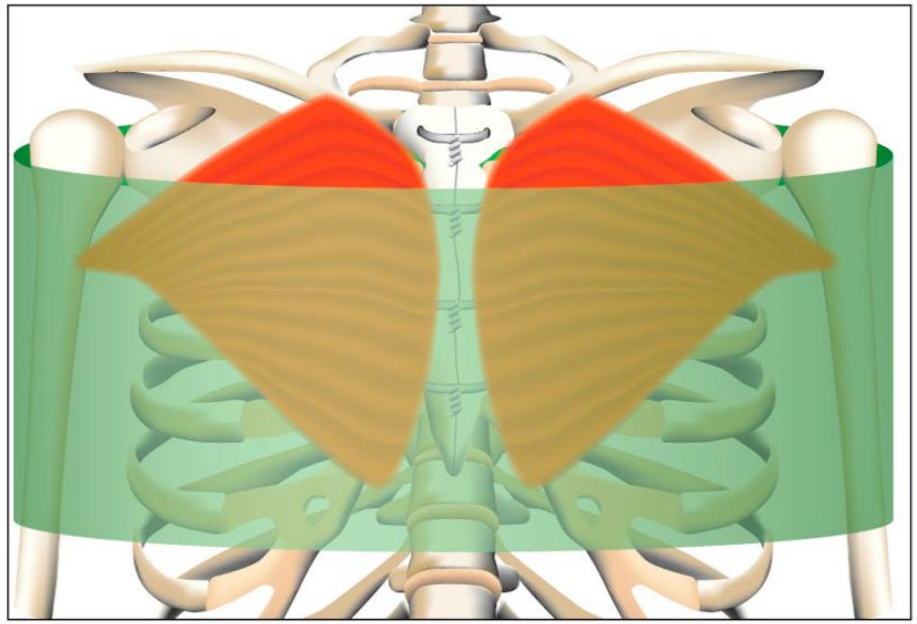
	Aerobic	Resistance	Flexibility
Frequency	Minimally 3 d · wk^{-1}; preferably up to 5 d · wk^{-1}	2–3 nonconsecutive d · wk^{-1}	≥2–3 d · wk^{-1} with daily being most effective
Intensity	With an exercise test, use 50%–80% of exercise capacity ($\dot{V}O_2R$) based on target workload Without an exercise test, titrate intensity based on a combination of the Talk Test, RPE, and clinical judgement	Perform 10–15 repetitions at 60%–70% 1-RM	Stretch to the point of feeling tightness or slight discomfort
Time	20–60 min · d^{-1}	1–2 sets	10–30 s hold for static stretching; 2–4 repetitions of each exercise
Type	Aerobic exercise, focusing on treadmill- or free-walking and stationary cycling as capable	Multijoint and single-joint exercises focusing on major muscle groups using multiple modalities	Exercise for each of the major muscle-tendon units

1-RM, one repetition maximum; RPE, rating of perceived exertion.

Sternotomy p. 295

Special Considerations

- “Keep Your Move in the Tube”
- Post sternotomy:
  - Lifting 5 – 10 lb limit for 8-12 weeks
  - Rhythmic upper limb activities (no strain) for first 12 weeks
  - Postpone RT for 12 weeks



Peripheral Artery Disease (PAD) p. 297 - 301

Epidemiology

- Atherosclerosis of the arteries in the periphery (lower extremities)
- Increases risk of stroke, MI, and mortality
- Risk Factors: hypertension, smoking, DM, chronic kidney disease

- Accelerated decline in physical function = increased disability
- Intermittent Claudication = cramping or tightness in lower extremities
- Ankle/brachial pressure index (ABI)

Exercise Prescription

- Supervised exercise training strongly recommended
- Walking (moderate to *near*-maximum claudication) with rest periods
  - Mild claudication within 5 min
  - Moderate – severe within 10 min
  - Rest
  - Repeat

Table 8.2 p. 298

TABLE 8.2 Classification of Peripheral Artery Disease

Fountaine Classification	
Stage	**Symptoms**
1	Asymptomatic
2	Intermittent claudication
2a	Distance to pain onset >200 m
2b	Distance to pain onset <200 m
3	Pain at rest
4	Gangrene, tissue loss

Rutherford Classification			
Grade	**Category**	**Clinical Description**	**Objective Criteria**
0	0	Asymptomatic no hemodynamically significant occlusive disease	Normal treadmill or reactive hyperemia test
	1	Mild claudication	Completes treadmill exercise; AP after exercise >50 mm Hg but at least 20 mm Hg lower than resting value
I	2	Moderate claudication	Between categories 1 and 3
	3	Severe claudication	Cannot complete standard treadmill exercise and AP after exercise <50 mm Hg
II	4	Ischemic rest pain	Resting AP < 40 mm Hg, flat or barely pulsatile ankle or metatarsal PVR; TP < 30 mm Hg
III	5	Minor tissue loss — nonhealing ulcer, focal gangrene with diffuse pedal ischemia	Resting AP < 60 mm Hg, ankle or metatarsal PVR flat or barely pulsatile; TP < 40 mm Hg
	6	Major tissue loss — extending above TM level, functional foot no longer salvageable	Same as category 5

AP, ankle pressure; PVR, pulse volume recording; TP, toe pressure; TM, transmetatarsal.

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Peripheral Artery Disease (PAD) p. 301

FITT RECOMMENDATIONS FOR INDIVIDUALS WITH LOWER EXTREMITY, SYMPTOMATIC PERIPHERAL ARTERIAL DISEASE (104, 107)

	Aerobic	Resistance	Flexibility
Frequency	Minimally 3 d · wk^{-1}; preferably up to 5 d · wk^{-1}	2–3 nonconsecutive d · wk^{-1}	≥2–3 d · wk^{-1} with daily being most effective
Intensity	Exercise workload that elicits moderate to moderate-severe claudication (*i.e.*, 3–4 out of 4 on the claudication pain scale) within 10 min, followed by rest with resumption of exercise when pain is *completely* alleviated	Perform 10–15 repetitions at 60%–70% 1-RM	Stretch to the point of feeling tightness or slight discomfort
Time	30–45 min · d^{-1} (excluding rest periods) for a minimum of 12 wk; may progress to 60 min · d^{-1}	1–2 sets	10–30 s hold for static stretching; 2–4 repetitions of each exercise
Type (mode)	Weight-bearing is preferred (free or treadmill walking is best). Consider non–weight-bearing as an adjunct or if weight-bearing exercise is not tolerated	Multijoint and single-joint exercises focusing on major muscle groups using multiple modalities	Exercise for each of the major muscle-tendon units

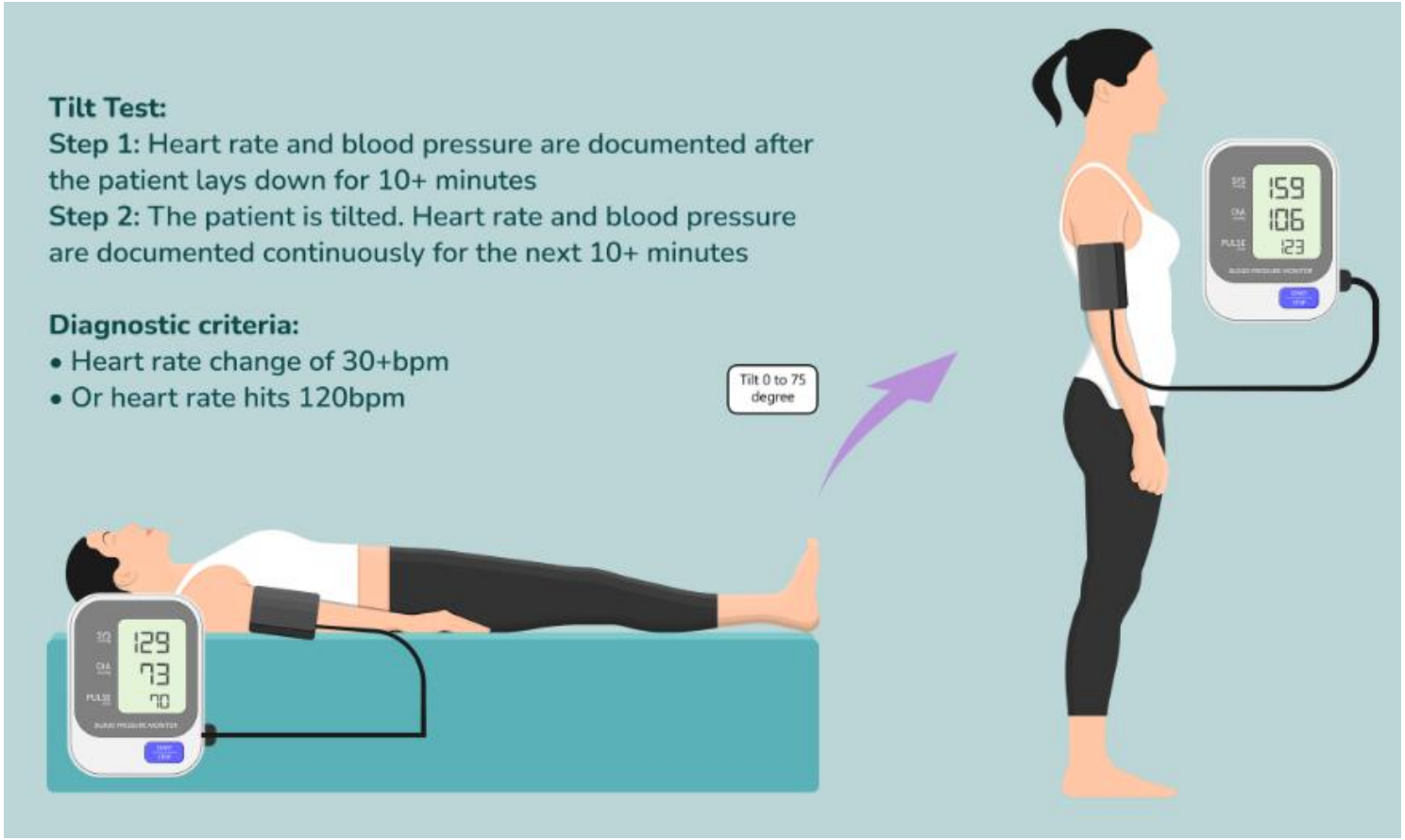
1-RM, one repetition maximum.

NEW - Postural Orthostatic Tachycardia Syndrome (POTS) p. 301 - 304

Pre-exercise Assessment

- 10-minute Stand Test
  - Supine HR and BP
  - Standing HR and BP
    - 1, 3, 5, and 10 minutes

- Maximal exercise test = higher HRs



NEW – Table 8.4 p. 301 - 304

Exercise Prescription

- Use HR Reserve
  - 5 beats each side of 75% HRR
  - RPE can be used
- Recumbent exercise
- Warm-up and cool-down
- RT – core and lower body

Table 8.4 Summary of Exercise Program for POTS

Exercise Session	Intensity	Month 1	Month 2	Month 3
Base Pace	RPE 13–15 HRR 60%	12 × 30 min	6 × 30 min 3 × 30–45 min	5 × 35 min 4 × 45–60 min
Max Steady State	RPE 16–18 HRR 75%	1 × 20 min 1 × 25 min	1 × 25 min 1 × 30 min 1 × 35 min	1 × 30 min 1 × 35 min 1 × 40 min
Recovery	RPE 9–12 HRR < 60%	2 × 40 min	1 × 40 min 1 × 30 min	3 × 25 min
Resistance training	RPE 13–15	8 × 30 min	8 × 30 min	8 × 30 min
Exercise Modality		Recumbent bike Rowing (preferred) Core, lower body	Month 1 modes plus upright bike Core, lower body	Month 1 and 2 modes plus elliptical and treadmill walking Core, lower body

Adapted from (114).

- 7,000 – 10,000 mg sodium with 2-3 L (noncaffeinated) fluids
- Remain upright throughout the day
- Bed in reverse Trendelenburg position (4 – 6 in elevation from supine)

NEW - Postural Orthostatic Tachycardia Syndrome (POTS) p. 301 - 304

Special Considerations

Iron deficiency (ID) — muscle function and oxygen transport depend on iron availability. ID can result in orthostatic intolerance, increased HRs and shortness of breath during exercise, fatigue, headaches, and reduced cognitive function (117–119).

- Ferritin less than 50 ng · dL^{-1}
- %SAT (transferrin saturation) less than 20%

ID with anemia (above markers plus) (120, 121)

- Hgb (hemoglobin) less than 12 g · dL^{-1}
- MCV (mean cell volume) less than 80 fL

Medications — commonly prescribed, but not a complete list

- SNRI (serotonin and norepinephrine reuptake inhibitor) — increased noradrenergic effects
- NDRI (norepinephrine-dopamine reuptake inhibitor) — increased sympathomimetic effects
- Drospirenone — diuretic effects leading to decreased fluid volume
- Stimulants — increased sympathomimetic effects

Ingested substances — increased sympathomimetic effects

- Cocaine
- Caffeine
- Workout supplements
- Energy drinks

Hyperthyroidism — excessive thyroid hormone production is associated with palpitations, increased HR, exercise intolerance, and widened pulse pressure. (↑HR, ↑cardiac output, ↓SVR, ↓diastolic blood pressure [DBP], ↓afterload) (122, 123).

- Thyroiditis
- Overmedicated
- Thyroid/pituitary tumor

Inappropriate sinus tachycardia — tachycardia (>100 bpm) unrelated to rest or positioning (112).

NEW - Pediatric Cardiac Rehabilitation p. 304 - 306

FITT RECOMMENDATIONS FOR PEDIATRIC CR (131)

	Aerobic	Resistance	Flexibility
Frequency	Minimally 2–3 d · wk^{-1}	Minimally 2–3 nonconsecutive d · wk^{-1}	Up to daily but as often as tolerated
Intensity	55%–80% of measured peak HR OR RPE 11–13 (most patients) and 15–16 (low-risk patients)	30%–70% of 1-RM Perform 10–15 repetitions of each exercise using a resistance that is 40%–70% of 1-RM Avoid Valsalva maneuver	To the point of feeling tightness or slight discomfort
Time	30 min per session gradually working up to 60 min per session	2–3 sets; 5–7 exercises per session; most complex movements first and a greater focus on lower-body exercises Rest periods between sets >60 s	20–30 s for static stretching
Type	Developmentally appropriate exercises such as walking, running, biking, swimming, and active play Greater focus on locomotor movement proficiency, balance, and coordination in younger children High-intensity interval training can be used in patients who are hemodynamically stable (active rest ratio of 1:2)	Developmentally and body size appropriate equipment or body weight exercises Tempo: 2 s eccentric/0 s isometric/2 s concentric Avoid excessive hand gripping and exercises with a high static component to mitigate exaggerated hemodynamic load	Static and dynamic stretches focused on major joints in limbs and lower back; focus on upper body Avoid breath holding during stretch Modifications if recent cardiac surgery (once cleared sternal precautions) or presence of epicardial pacemaker

- This exercise prescription represents general recommendations for youth with congenital heart disease. Considering the heterogeneity in pediatric and congenital heart diagnoses and age, exercise prescriptions for pediatric CR should be individualized based on the child's cardiac anatomy, relative risk, and developmental function.
- Exercise prescriptions should only be provided by exercise physiologists or healthcare providers with knowledge and experience in pediatric/congenital heart disease and exercise medicine. Exercise prescription may require consultation with a pediatric cardiologist with expertise in exercise medicine.

Cerebrovascular Accident (CVA; Stroke) p. 307

Exercise Testing

- Cycle ergometry
- Dual action semi-recumbent seated steppers (upper and lower body)
- Total Body Recumbent Stepper Maximal (mTBRS) / Submaximal Exercise tests
- Modified Bruce Protocol (if appropriate)

Exercise Training Considerations

- HR and RPE can be used
- ACSM HR equations can be used
  - If unable to conduct exercise test
- Consider adding neuromuscular training 2 – 3 times per week

Cerebrovascular Accident (CVA; Stroke) p. 309

FITT RECOMMENDATIONS FOR INDIVIDUALS WITH A CEREBROVASCULAR ACCIDENT (146)

	Aerobic	Resistance	Flexibility
Frequency	Minimally 3 d · wk^{-1}; preferably up to 5 d · wk^{-1}	2–3 d · wk^{-1}; performed on nonconsecutive days	≥2–3 d · wk^{-1} with daily being most effective
Intensity	If using HR data from a recent GXT or HR_{max} prediction equation, use 40%–70% of HRR/$\dot{V}O_2R$ or 55%–80% HR_{max}. If atrial fibrillation or chronotropic incompetence are present and/or continuous HR monitoring is not available, use RPE of 11–14 on a 6–20 scale	50%–80% of 1-RM	Stretch to the point of feeling tightness or slight discomfort
Time	Progressively increase from 20 to 60 min · d^{-1}. Consider multiple 10-min sessions	1–3 sets of 10–15 repetitions of 8–10 exercises	10–30 s hold for static stretching; 2–4 repetitions of each exercise
Type	Cycle ergometry and semirecumbent seated steppers; may need modification based on functional and cognitive demands. Treadmill and overground walking can be considered if individual has sufficient balance and ambulation with minimal to no assist	Use equipment and exercises that consider and improve safety in those with deficits: machine vs. free-weight, bar vs. hand weights; elastic bands; weight-bearing or partial weight-bearing; seated vs. standing as indicated	Static and/or dynamic

1-RM, one repetition maximum; GXT, graded exercise test; HR, heart rate; HRR, heart rate reserve; $\dot{V}O_2R$, $\dot{V}O_2$ reserve; HR_{max}, maximal HR; RPE, rating of perceived exertion.

Asthma p. 314

Special Considerations

- Inspiratory Muscle Training (IMT)
  - Shown to facilitate significant increases in inspiratory muscle strength
  - Unclear on other clinical benefits

FITT RECOMMENDATIONS FOR INDIVIDUALS WITH ASTHMA (201, 210)

	Aerobic	Resistance	Flexibility
Frequency	Minimally 3 d · wk^{-1}, preferably up to 5 d · wk^{-1}	At least 2 d · wk^{-1} performed on nonconsecutive days	≥2–3 d · wk^{-1} with daily being most effective
Intensity	Begin with moderate intensity (40%–59% HRR or $\dot{V}O_2R$). If well tolerated, progress to 60%–70% HRR or $\dot{V}O_2R$ after 1 mo	Strength: 60%–70% of 1-RM for beginners; ≥80% for experienced weight trainers Increase workload by 2%–10% if one to two repetitions over the desired number are well tolerated on two consecutive training sessions Endurance: <50% of 1-RM	Stretch to the point of feeling tightness or slight discomfort
Time	Progressively increase to at least 30–40 min · d^{-1}	Strength: 2–4 sets, 8–12 repetitions Endurance: ≤2 sets, 15–20 repetitions	10–30 s hold for static stretching; 2–4 repetitions of each exercise
Type	Aerobic activities using large muscle groups such as walking, running, cycling, swimming, or pool exercises	Weight machines, free weight, or body weight exercises	Static, dynamic, and/or PNF stretching

1-RM, one repetition maximum; HRR, heart rate reserve; PNF, proprioceptive neuromuscular facilitation; $\dot{V}O_2R$, oxygen uptake reserve.

Asthma p. 315

TABLE 8.5 Global Initiative for Chronic Obstructive Lung Disease (GOLD) and American Thoracic Society (ATS)/European Respiratory Society (ERS) Classification of Airflow Obstruction in Individuals With Chronic Obstructive Pulmonary Disease Based on the $FEV_{1.0}$ Obtained From Pulmonary Function Tests (219, 220)

Severity of Airflow Obstruction	GOLD[a]	ATS/ERS
	$FEV_{1.0}$ (% predicted)	$FEV_{1.0}$ (*z*-score)
Mild	≥80% predicted	−1.65 to −2.5
Moderate	50% ≤ $FEV_{1.0}$ < 80% of predicted	−2.51 to −4.0
Severe	30% ≤ $FEV_{1.0}$ < 50% of predicted	<−4.0
Very Severe	$FEV_{1.0}$ < 30% of predicted	

[a] Based on postbronchodilator $FEV_{1.0}$ when postbronchodilator $FEV_{1.0}$/FVC is <0.70.
$FEV_{1.0}$, forced expiratory volume in 1 s; FVC, forced vital capacity.

Chronic Obstructive Pulmonary Disease p. 317

Exercise Testing - ADDITION

- Resting SpO2 of ≤ 85% (breathing room air) should be considered a relative contraindication to exercise testing
- A ≥ 5% decrease in SpO2 during exercise suggests hypoxemia
- Evidence of oxyhemoglobin desaturation ≤ 80% should be used as test termination criteria in addition to standard criteria

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Chronic Obstructive Pulmonary Disease p. 321

FITT RECOMMENDATIONS FOR INDIVIDUALS WITH CHRONIC OBSTRUCTIVE PULMONARY DISEASE (169–171, 259, 260)

	Aerobic	Resistance	Flexibility
Frequency	Minimally 3 d · wk^{-1}; preferably up to 5 d · wk^{-1}	At least 2 d · wk^{-1} performed on nonconsecutive days	≥2–3 d · wk^{-1} with daily being most effective
Intensity	Moderate-to-vigorous intensity (50%–80% peak work rate as tolerated or 3–6 on the Borg CR10 scale)	Strength: 60%–70% of 1-RM for beginners; ≥80% for experienced weight trainers. Increase workload by 2%–10% if one to two repetitions over the desired number are well tolerated on two consecutive training sessions Endurance: <50% of 1-RM	Stretch to the point of feeling tightness or slight discomfort
Time	Initially 10–15 min · d^{-1} for first 3–5 exercise sessionsProgressively increase to 20–60 min · d^{-1} at moderate-to-high intensities as tolerated. If the 20- to 60-min durations are not achievable, accumulate ≥20 min of exercise interspersed with intermittent exercise rest periods of lower-intensity work or rest	Strength: 2–4 sets, 8–12 repetitions Endurance: ≤2 sets, 15–20 repetitions	10–30 s hold for static stretching; 2–4 repetitions of each exercise
Type	Common aerobic modes including walking (free or treadmill), stationary cycling, and upper body ergometry	Weight machines, free weight, resistance bands, or body weight exercises	Static, dynamic, and/or PNF stretching

1-RM, one repetition maximum; PNF, proprioceptive neuromuscular facilitation.

Pulmonary Arterial Hypertension p. 322 - 324

- PH – global term for elevated pulmonary arterial pressure
  - Mean pulmonary arterial pressure (mPAP) ≥ 25 mmHg at rest
  - ***Suggested diagnostic cut-of of mPAP > 20 mmHg with PVR ≥ 3 Wood Units**
- Low-dose, supervised exercise training improves 6-MWT distance, WHO functional class, QoL, and cardiorespiratory fitness
  - It has been suggested that aerobic exercise training targeting 40%–70% of HRR (RPE 11–14 on the Borg 6–20 scale) is achievable in people with PH
- Submaximal CPET can help identify the presence and severity of pulmonary arterial hypertension (PAH)
- IMT may be an effective, decreasing ambulatory BP and dyspnea, and enhancing inspiratory muscle strength and exercise capacity

Lung Transplantation p. 325 - 327

Lung Transplant Candidates (Prehabilitation)

- Aerobic exercise should be performed at least 2 d · wk^{-1}, preferably up to 5 d · wk^{-1}.
- Aerobic exercise intensity of 50%–80% HRR, 3–5 on the modified Borg Category-Ratio 0–10 (CR10) scale can be targeted. 60%–80% of 6-MWT speed can also be used.
- Supplemental O_2 may be needed to maintain SpO_2 greater than 85%–88%. Guidelines for O_2 supplementation for exercise are not clearly defined. As such, institutional policies/guidelines should be followed.
- Walking and/or leg or arm cycling exercise modalities can be used.
- Aerobic exercise can be performed for 15–30 minutes (*continuous*) or for 5–10 minutes × 2–3 bouts (*intermittent*).
- Resistance exercise should be performed on 2–3 d · wk^{-1} on nonconsecutive days; 1–2 sets of 8–15 repetitions at 30%–80% of 1-RM and targeting the major muscle groups of the upper and lower body is advised.

Lung Transplant Recipients (Rehabilitation)

- Aerobic exercise should be performed at least 3 d · wk^{-1}, preferably up to 5 d · wk^{-1}.
- Aerobic exercise intensity of 50%–80% HRR, 3–5 on the modified Borg Category-Ratio 0–10 (CR10) scale can be targeted (75%–100% of 6-MWT speed can also be used). Intensive aerobic or resistive exercise should be avoided for 4–6 weeks posttransplant.
- Walking and/or leg cycling exercise modalities can be used. Arm ergometry may need to be avoided for up to 3 months to allow incision healing.
- Aerobic exercise can be performed for 20–30 minutes (*continuous*).
- Resistance exercise should be performed on 2–3 d · wk^{-1} on nonconsecutive days: 1–3 sets of 8–15 repetitions at 50%–80% of 1-RM.
- In many settings, it is suggested that upper extremity lifting/pushing/pulling greater than 10 lb should be avoided in the first approximately 10–12 weeks after transplant, especially in the setting of sternal instability (302); however, accumulating evidence suggests that general poststernotomy movement strategies including modified sternal precautions and Keep Your Movement in the Tube allow safe, increased levels of lifting and activity that promotes improved functional status and confidence (85, 304). Reference and adherence to local institutional policy and surgeon guidance is advised.

Other Tests of Muscular Fitness for Individuals With Chronic Lung Disease p. 327 - 328

- Timed Up and Go test (306)
- Five-Times-Sit-To-Stand test (307)
- 30-Second Chair Stand test (308)
- 30-Second Arm Curl test (309)
- 6-Minute Pegboard and Ring test (310)
- Handgrip dynamometer test (311, 312)
- The seated medicine ball throw test (313)
- The gallon jug shelf transfer test (305)
- The Short Physical Performance Battery (314)
- 4-meter gait speed (315)

NEW - Telerehabilitation p. 328 - 329

- Use of communication mediums such as telephone calls, videoconferencing, and dedicated websites to deliver the essential components of PR
  - Difficult to deliver all key components of PR
- Similar improvements in functional exercise capacity, QoL, and dyspnea (compared to center-based PR)
- Technology barriers need to be overcome

NEW – Respiratory Muscle Testing and Training p. 329 - 331

Exercise Testing

- *Respiratory Muscle Strength*
- Noninvasive handheld manometers
  - Assess maximal inspiratory pressure (MIP) and expiratory pressure (MEP)

- *Respiratory Muscle Endurance*
- Constant load endurance test
  - Measured by the total time until task failure (seconds) or work expressed in pressure time units (i.e., pressure × time; e.g., cmH_2O × seconds)

NEW – Respiratory Muscle Testing and Training p. 329 - 331

TABLE 8.6 Normative Values for MIP (321)

Age (years)	Male	Female
18–29	128 (116.3–139.5)	97 (88.6–105.4)
30–39	128.5 (118.3–138.7)	89 (84.5–93.5)
40–49	117.1 (104.9–129.2)	92.9 (78.4–107.4)
50–59	108.1 (98.7–117.6)	79.7 (74.9–84.9)
60–69	92.7 (84.6–100.8)	75.1 (67.3–82.9)
70–83	76.2 (66.1–86.4)	65.3 (57.8–72.7)

Units in cmH_2O.

TABLE 8.7 Age- and Sex-Matched Thresholds for Inspiratory Muscle Weakness (321)

Age (years)	Male	Female
<40	63	58
40–60	55	50
61–80	47	43
>80	42	38

Units in cmH_2O. Reproduced with permission of the © ERS 2024: Laveneziana P, Albuquerque A, Aliverti A, et al. ERS statement on respiratory muscle testing at rest and during exercise. Eur Respir J. 2019;53(6):1801214. doi: 10.1183/13993003.01214-2018

Box 8.7 Prediction Equations for MIP and MEP (323)

$PImax\ (females) = 61.48 + 0.66 * age + 1.55 * BMI - 0.01 * age^2$

$PImax\ (males) = 98.60 + 1.18 * age + 0.76 * BMI - 0.02 * age^2$

$PEmax\ (females) = 74.75 + 1.67 * age + 1.75 * BMI - 0.02 * age^2$

$PEmax\ (males) = 58.11 + 3.71 * age + 2.64 * BMI - 0.04 * age^2$

Key: Age in years, BMI in $kg \cdot m^{-2}$

NEW – Respiratory Muscle Testing and Training p. 329 - 331

Exercise Training

- RMT has been shown to improve respiratory muscle strength, dyspnea, exercise capacity, and QoL
- Pressure threshold devices
  - 40 – 60% of MIP or MEP
  - 20 – 30 breaths per sessions / 2 x day
- *15 – 20% MIP or MEP
- *5 – 10-minute sessions / 2 x day

Box 8.8 Contraindications for Respiratory Muscle Testing and Training

Recent surgery (thoracic, abdominal, brain, ear, nose, or throat)
Pneumothorax
Myocardial infarction
Aortic aneurysm
Hemoptysis
Pulmonary embolism
Acute diarrhea
Stress incontinence
Hypertensive crisis (systolic >180 mm Hg, diastolic >120 mm Hg)
Confusion and dementia
Patient discomfort
Vomiting
Contagious infections
Retinopathy, glaucoma, and cataracts

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Thank you!