Failure
Out patient care

Piyanuj Ruckpanich, MD.
Cardiac Rehabilitation &
Perfect Heart Fitness Center
Perfect Heart Institute@Piyavate

Present

1960-1980: Bed Rest; No exercise!

1980-1990: Exercise training in LV dysfunction

2003: HF-Action
RCT Exercise study in HF [LVEF≤35%]; 3000pts
Exercise Training (> 1x/wk)
at moderate to vigorous exercise
Mortality, Morbidity, Mechanisms
Long term FU: 4 years

All Guidelines

Exercise based cardiac rehabilitation in chronic heart failure

Australia

ople with chronic heart failure often present to their general practitioner with questions about their participation cardiac rehabilitation programs. This article outlines the risk and benefits of such programs.

orking Group on Cardiac Rehabilitation & Exercise Physiology and Workin Group on Heart Failure of the European Society of Cardiology

AHA Scientific Statement

Exercise and Heart Failure

A Statement From the American Heart Association Committee on Exercise, Rehabilitation, and Prevention

ACC/AHA Practice Guideline

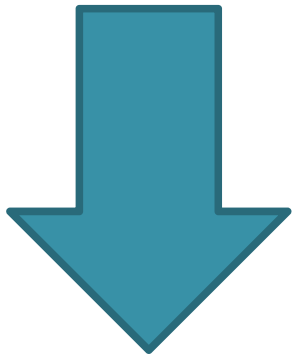
ACC/AHA 2005 Guideline Update for the Diagnosis and Management of Chronic Heart Failure in the Adult - Summary Article

A Report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Writing Committee to Update the 2001 Guidelines for the Evaluation and Management of Heart Failure)

Stage C: Symptomatic HF Exercise Training is Class I Recommendation

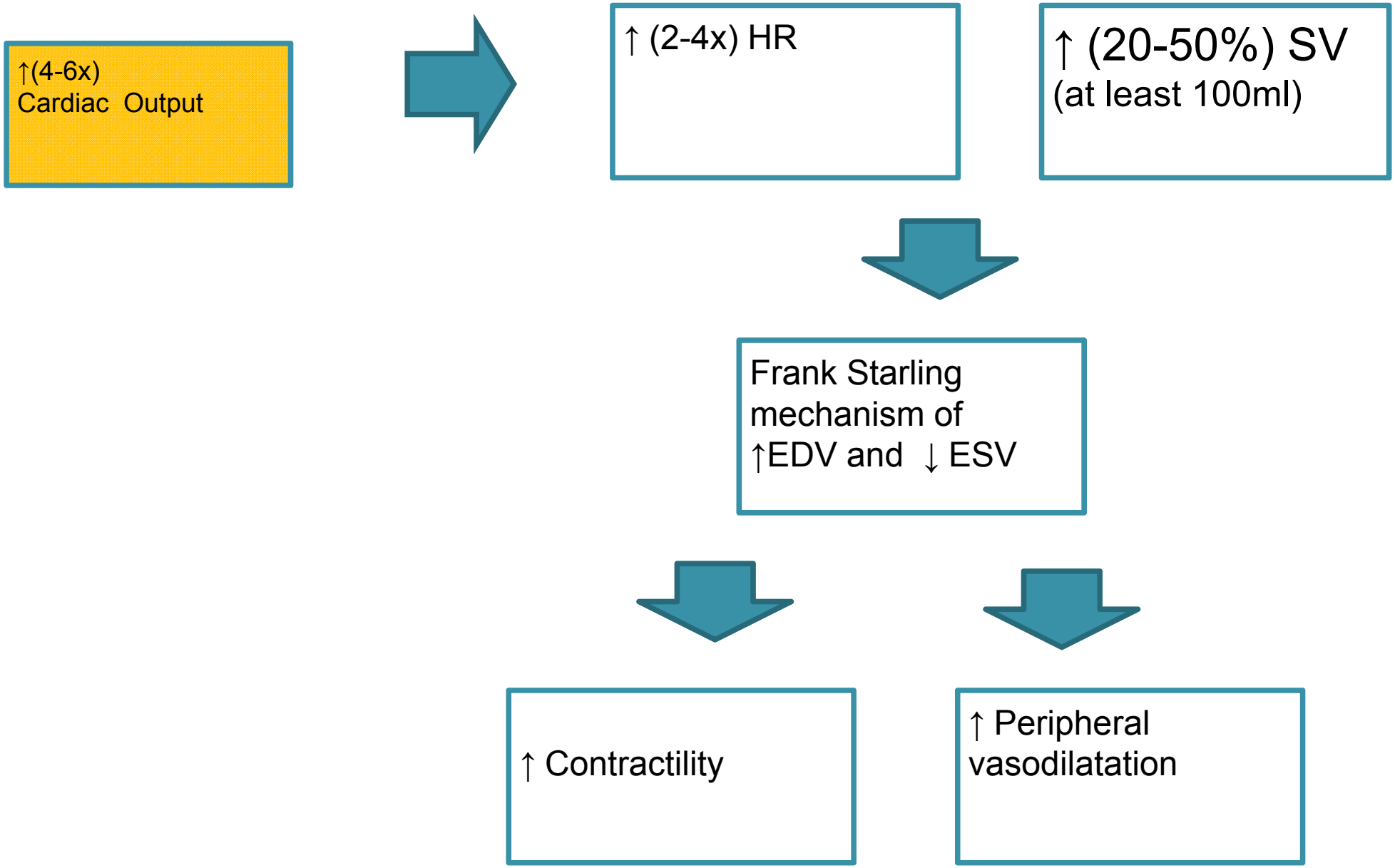
Chronic Heart Failure

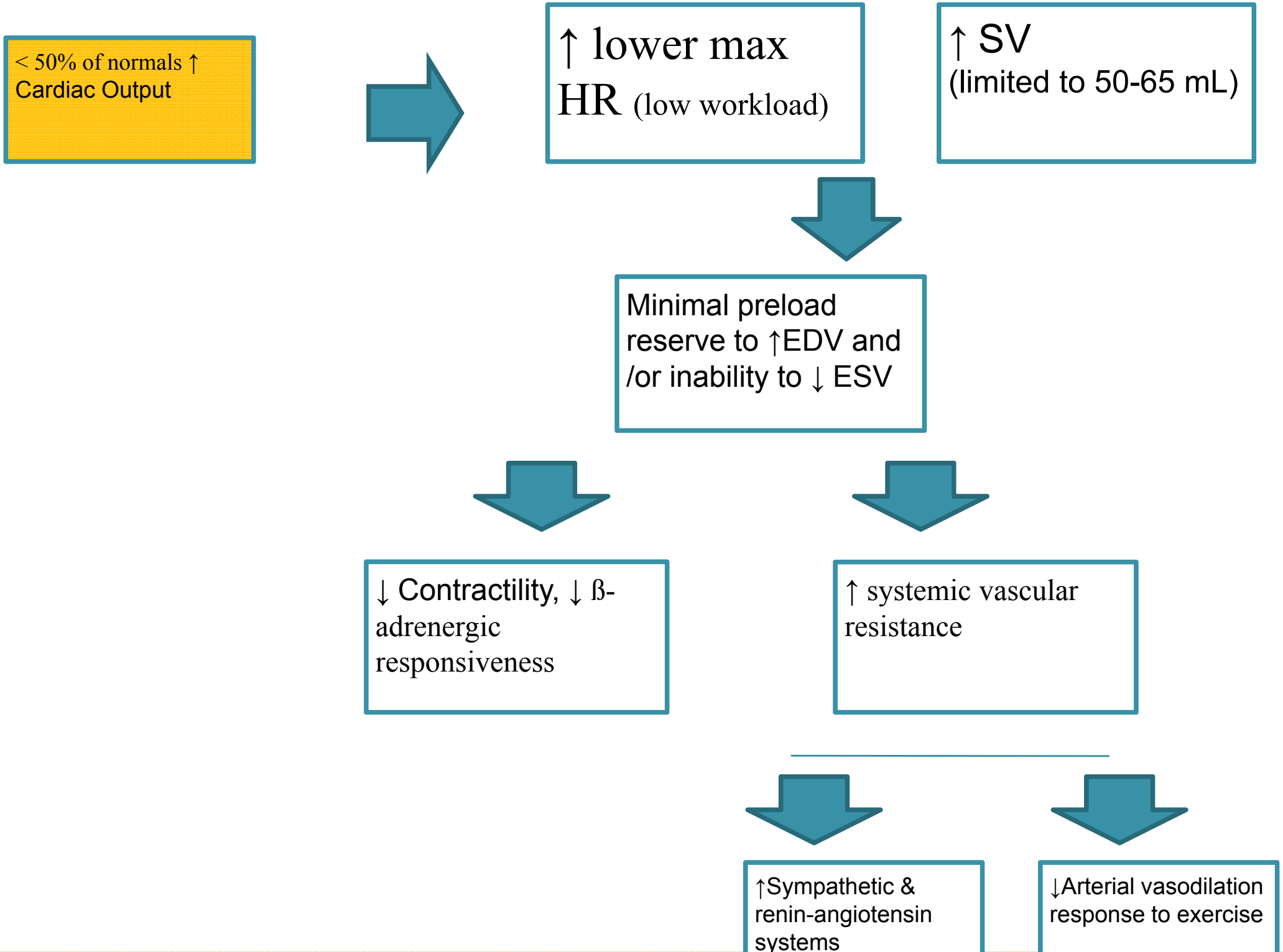
Dyspnea & Fatigue



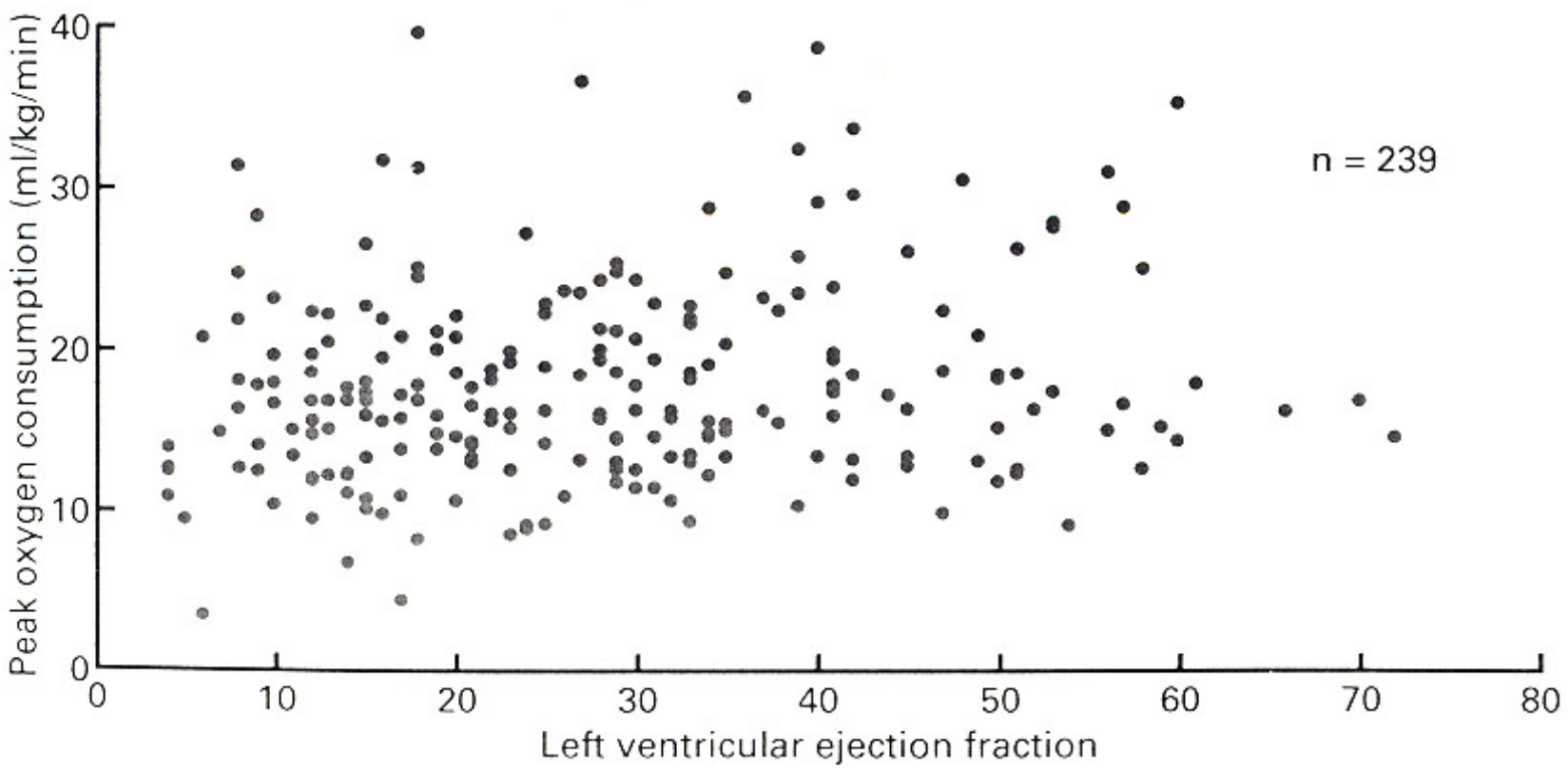
Exercise intolerance

Cardiovascular response to exercise: Healthy Person




< 50% of normals ↑ Cardiac Output
↑ lower max HR (low workload)
↑ SV (limited to 50-65 mL)
Minimal preload reserve to ↑EDV and /or inability to ↓ ESV
↓ Contractility, ↓ ß-adrenergic responsiveness
↑ systemic vascular resistance
↑Sympathetic & renin-angiotensin systems
↓Arterial vasodilation response to exercise

CHF



Lack of correlation between resting LVEF

HF

- Abnormal skeletal muscle metabolis
- Skeletal muscle atrophy
- Decreased skeletal muscle enduranc
- Type II skeletal muscle atrophy and decreased oxidative enzyme concentration
- Decreased mitochondrial volume
- Reduced respiratory muscle strengt
- Reduced respiratory muscle endurance

BENEFITS OF EXERCIS TRAINING IN HEART FAILURE

ORIGINAL CONTRIBUTION

Efficacy and Safety of Exercise Training in Patients With Chronic Heart Failure

HF-ACTION Randomized Controlled Trial

Christopher M. O'Connor, MD
David J. Whellan, MD, MHS
Kerry L. Lee, PhD
Steven J. Keteyian, PhD
Lawton S. Cooper, MD, MPH
Stephen J. Ellis, PhD
Eric S. Leifer, PhD
William E. Kraus, MD

Context Guidelines recommend that exercise training be considered for medically stable outpatients with heart failure. Previous studies have not had adequate statistical power to measure the effects of exercise training on clinical outcomes.

Objective To test the efficacy and safety of exercise training among patients with heart failure.

Design, Setting, and Patients Multicenter, randomized controlled trial of 2331 medically stable outpatients with heart failure and reduced ejection fraction. Participants in Heart Failure: A Controlled Trial Investigating Outcomes of Exercise Training (HF-ACTION) were randomized from April 2003 through February 2007 at 82 centers within the United States, Canada, and France; median follow-up was 30 months.

ummary of Clinical End-point Results from HF-ACTION

End point	Hazard ratio	95%	p
All-cause mortality/ hospitalization	0.93	0.84–1.02	0.13
After adjustment	0.89	0.81–0.99	0.03
CV mortality/CV hospitalizations	0.92	0.83–1.03	0.14
After adjustment	0.91	0.82–1.01	0.09
CV mortality/HF hospitalizations	0.87	0.75–1.00	0.06
After adjustment	0.85	0.74–0.99	0.03

ffects of Exercise Training on Health Statu
n Patients With Chronic Heart Failure
F-ACTION Randomized Controlled Trial

hryn E. Flynn, PhD
na L. Piña, MD
id J. Whellan, MD, MHS
in, MS

Context Findings from previous studies of the effects of exercise training on p
reported health status have been inconsistent.

Objective To test the effects of exercise training on health status among p
with heart failure.

nclusions Exercise training conferred modest but statistically significant im
nts in self-reported health status compared with usual care without trainin
vements occurred early and persisted over time.

iam E. Kraus, MD
cy Houston Miller, RN, BSN
in A. Schulman, MD
n A. Spertus, MD, MPH
istopher M. O'Connor, MD
in P. Weinfurt, PhD

overall summary scale and key subscales at baseline, every 3 months for 12 m
and annually thereafter for up to 4 years. The KCCQ is scored from 0 to 10
higher scores corresponding to better health status. Treatment group effects w
timated using linear mixed models according to the intention-to-treat principl

Results Median follow-up was 2.5 years. At 3 months, usual care plus exercis
ing led to greater improvement in the KCCQ overall summary score (mean, 5.2
confidence interval, 4.42 to 6.00) compared with usual care alone (3.28; 95%
dence interval, 2.48 to 4.09). The additional 1.93-point increase (95% confide
terval, 0.84 to 3.01) in the exercise training group was statistically significant ($P<$
After 3 months, there were no further significant changes in KCCQ score for
group ($P=.85$ for the difference between slopes), resulting in a sustained, grea
provement overall for the exercise group ($P<.001$). Results were similar on the
subscales, and no subgroup interactions were detected.

HEART FAILURE IS A SYNDROME characterized by dyspnea and fatigue; however, pa-

Abstract

Background: The large randomized controlled multicentre clinical trial, HF-ACT recently demonstrated that a programme of recommendation of regular exercis training at moderate intensity is safe, improves quality of life, and reduces the combined endpoint of all-cause death and hospitalization in patients with chron heart failure. However, the size of beneficial effects was modest compared to results published in smaller single studies and meta-analyses. Objective: Base

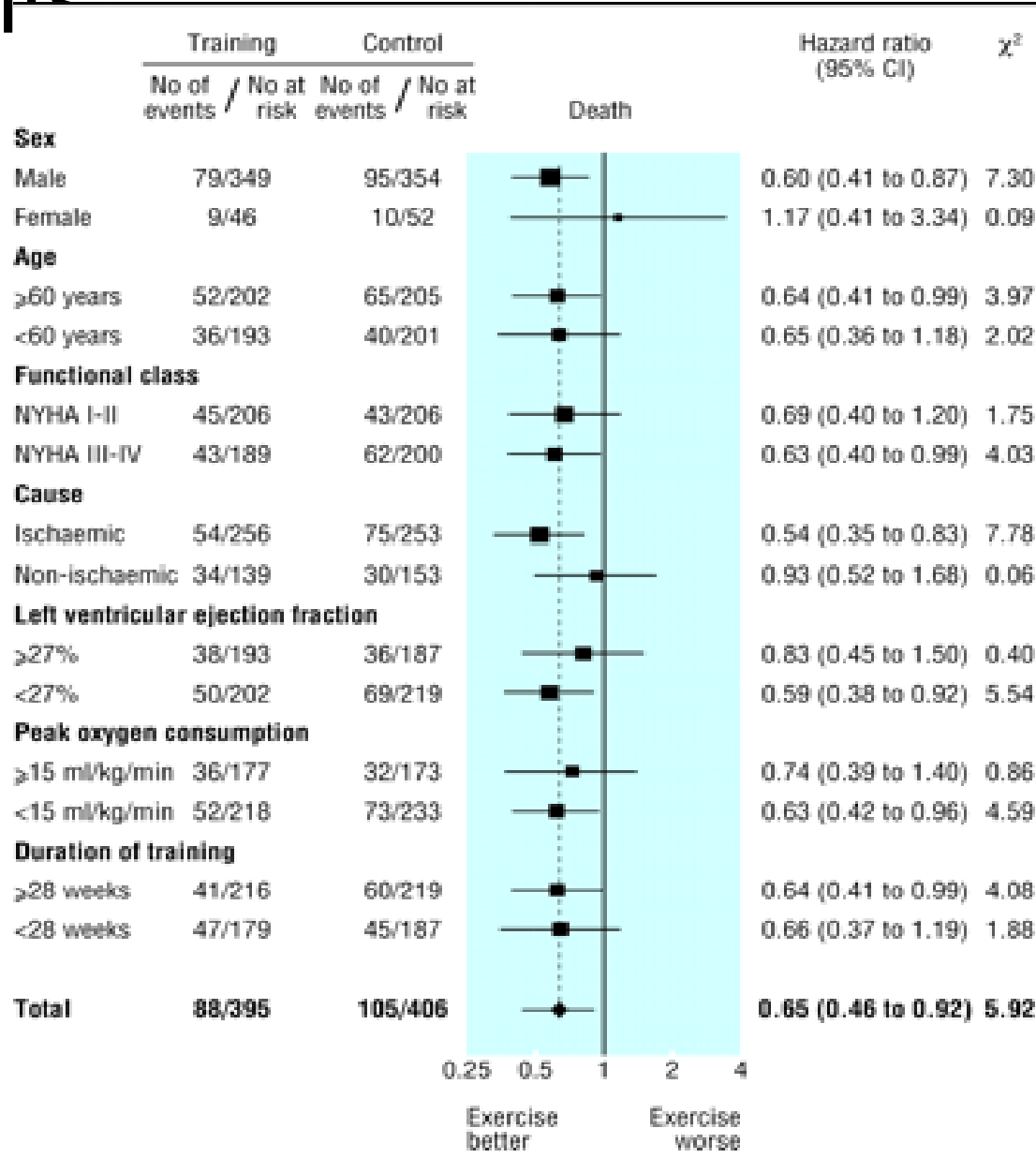
ypothesis:programme comprising interval training
high relative intensity would yield significantly larg
ects in terms of left ventricular remodelling
mpared to moderate continuous exercise training.

practice at the local centre. The primary endpoint is reverse remodelling, defin change in left ventricular end-diastolic diameter assessed by echocardiography Secondary endpoints include peak oxygen uptake (VO(2peak)), biomarkers, q of life, and level of physical activity assessed by questionnaires. In addition, lo term maintenance of effects after the supervised training period will be determ Assessments will be made at baseline, after the 12-week intervention program and at 1-year follow up. A total number of 200 patients on treatment per protoc randomized to the three groups in a 1 : 1 : 1 manner, is estimated to detect cli relevant differences in effect with HIT vs. MCT and RE ($p < 0.05$; statistical po 0.90) for the primary endpoint. Inclusion of patients started May 2009 and will

in patients with HF (ExTraMATCH)

- 9 RCT, 801 patients
- Follow up 2 years

↓ Overall mortality 35%
↓ Admission to the hospital 28%



HF

- Exercise Capacity
- Myocardial function
- Ventilatory function
- Autonomic Nervous System & neuroendocrine
- Peripheral blood flow
- Skeletal muscle function
- Health-Related Quality of Life

Exercise based rehabilitation for H

- 29 RCT; 1,126 HF patients (NYHA I III)
- 23 aerobic exercise; 6 resistance exercise
- FU 4-60 weeks
- Significant Improvement in
- VO_{2max} **[2.16 ml/kg/min]**
- **Exercise duration [2.38 minutes]**
- **Work capacity [15.1 watts]**

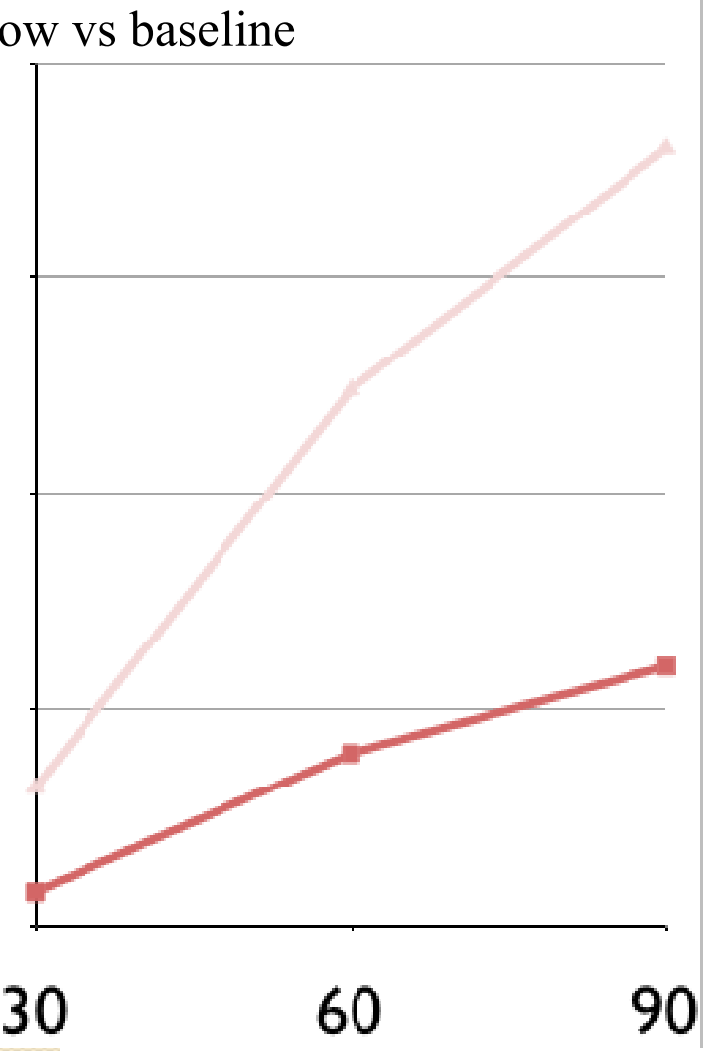
Clinical & Biological Parameters other than V

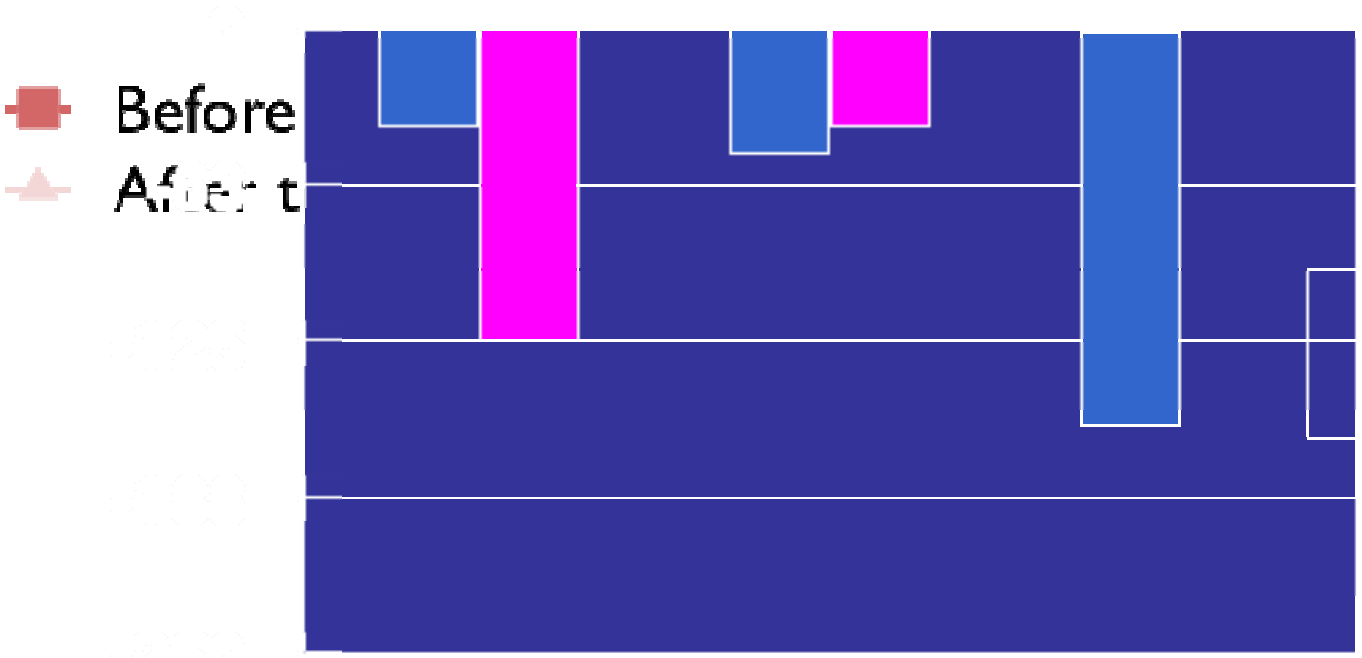
hors /years	Exercise Program	Improvement
auori (1999)	*Cycle 30 min 3x/wk at 50%-60%VO_{2max} mo*	Plasma NE decreased at rest; no adverse effects on catabolic hormone
ts (1992)	*Cycle 20 min 3x/wk at 60%-80% max HI wk*	**Improved HRV: decrease ventilation**
ardinelli (1995)	*Cycle 40 min 3x/wk at 60%VO_{2max} for 8*	
hbrecht (1995)	*Walk 10 mVO_{2max}in 6 x/d at 70% for 3 w*	Increase muscle mitochondria volume dens
aelli (1996)	*Cycle 20 min 5 d/wk for 5 wk*	
ardinelli (1999)	*Cycle 3x/wk at 60% for 8 wk. then 2x/w 12 mo.*	**Improved ejection fractio and stroke volume**
alevo (2006)	*Strength training 3x/wk for 8 wks*	
eyian (1999)	*Treadmill, cycle, arm ergometry 33 mi*	Improved endothelial funct

function

**cetylcholine-induced increase
f peripheral blood flow**

Change in peripheral blood flow response to administration of L-NMMA





*** Augmented endothelium-mediated vasodilatation**

*** Improve of Nitric oxide formation**

HOW TO TRAIN THE FAILING HEART?

Pre-exercise evaluation

- Controlled heart failure
- Exercise test
- Pre-morbid status
- Associated symptoms or diseases
- Contraindication to exercise

Absolute Contraindications

- Progressive worsening of exercise tolerance or dyspnea at rest or on exertion over 3-5 days
- Significant ischemia at low work rates (<2METs)
- Uncontrolled diabetes
- Acute systemic illness or fever
- Recent Embolism
- Thrombophlebitis
- Active myocarditis or pericarditis
- Moderate to severe aortic stenosis
- Regurgitant valvular heart disease required surg
- Myocardial infarction within previous 3 weeks
- New onset atrial fibrillation

Initiation of Aerobic exercise Progra

- Ability to speak without signs or symptoms of dyspnea (RR < 30 breaths/min)
- Patients is only modestly fatigue generally
- Crackles present in < ½ of the lungs
- Resting heart rate < 120 bpm
- Cardiac index > 2 L/min/m2 (for invasively monitored patients)
- Central venous pressure < 12 mmHg (for invasively monitored patients)

Exercise Prescription

- Type: aerobic, resistance/strengthening
- Mode: cycling, walking, [less evidence: aqua exercise, yoga, tai chi, etc.]
- Intensity:
- Duration:
- Frequency:
- Progression:

Exercise Test

- Maximum Exercise Test
- Sub-maximum Exercise Test
  - 6 minute walk test
  - Treadmill or bicycle test

ACSM Guidelines for Exercise Testing and Prescription 7th edition

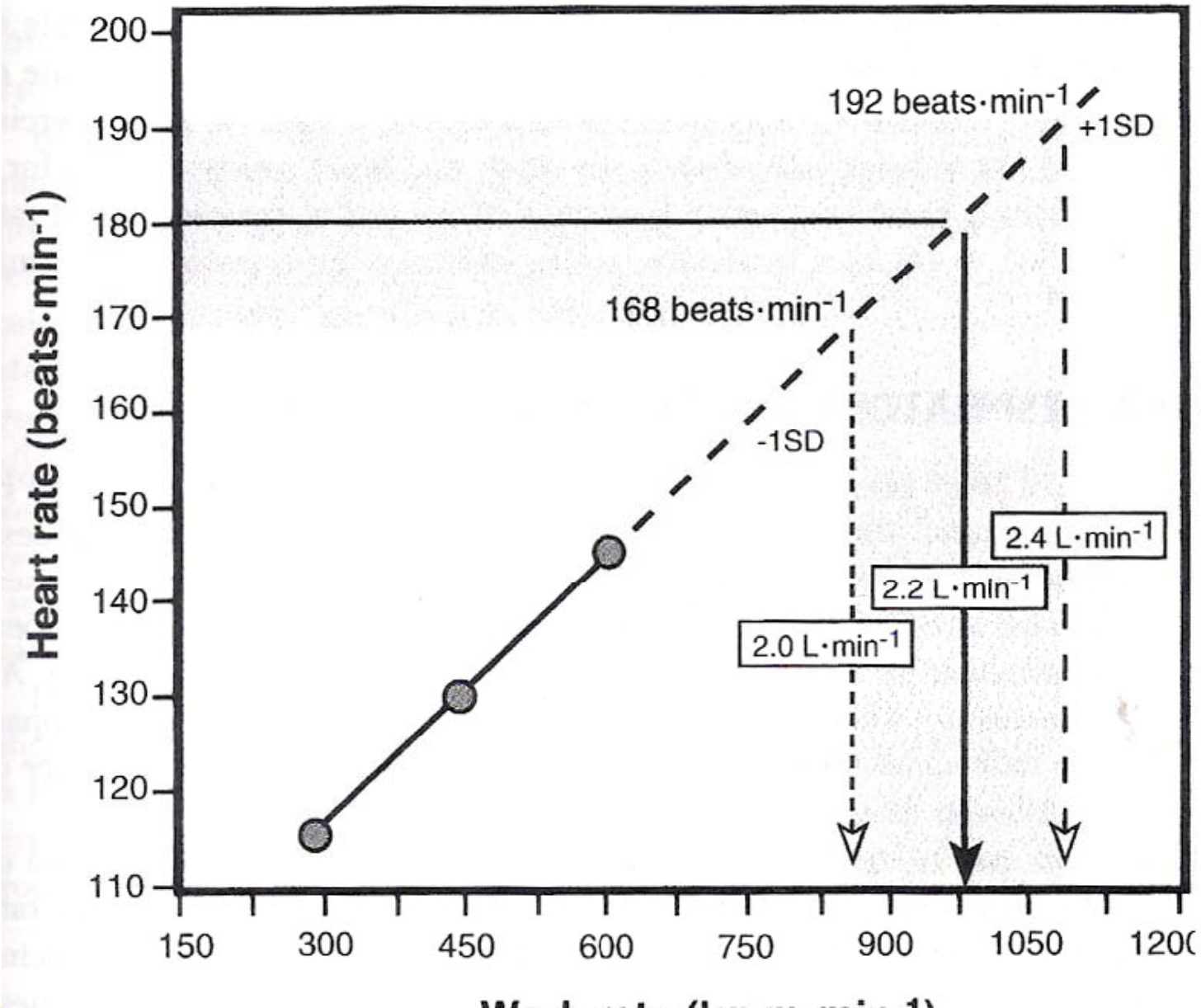
Six Minute Walk Test

Peak VO_2 = Distance

Peak VO_2 max = 0.03 x distance (m) + 3.98

Estimated $VO_{2\ Max}$

CA Protocol

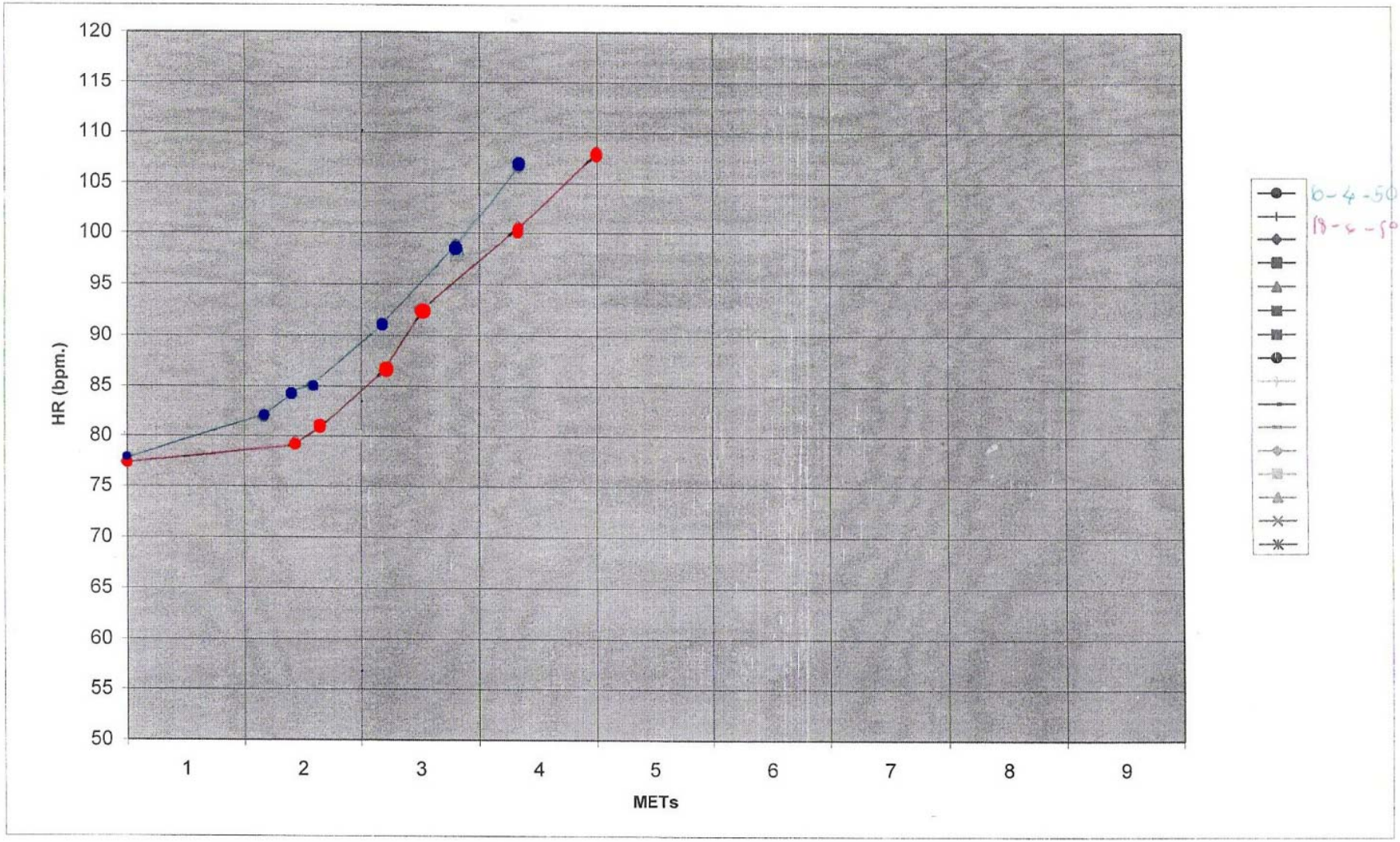


Sub-maximum Exercise Tes

Treadmill Sub-maximum Exercise Test

Stage	Speed(m/h)	Grade(%)	METs	Time
1	*2*	*3.5*	*3*	*3*
2	*2*	*7*	*4*	*3*
3	*2*	*10.5*	*5*	*3*
4	*2*	*14*	*6*	*3*

Training Effects

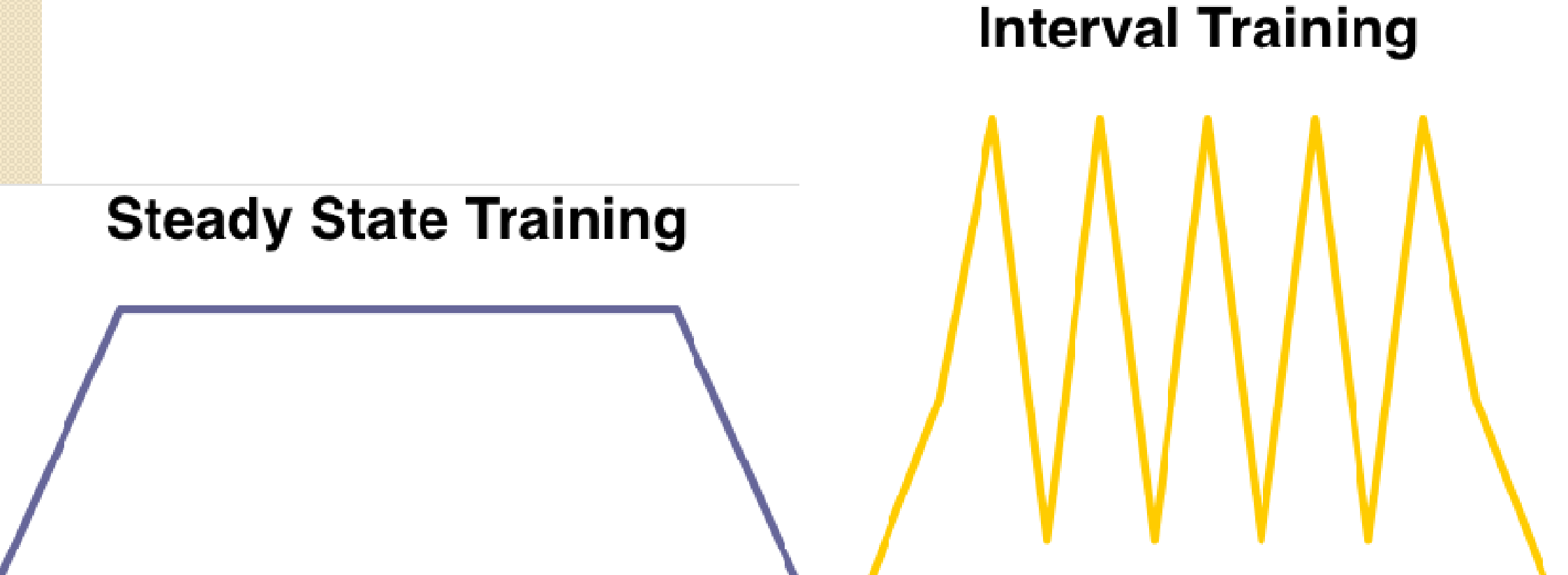



NUSTEP


NUSTEP
NUSTEP


CYBEX
CYBEX
PRECOR

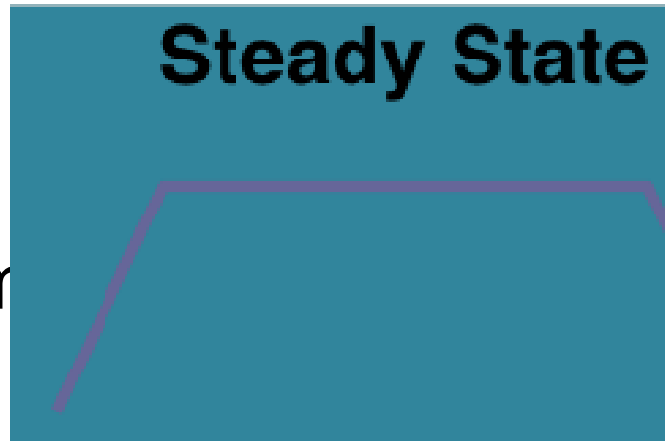
Aerobic Exercise Prescription Steady State vs. High Intensity Interval Training



Exercise Intensity

ntensity	Subject Measures		Physiological /Relative Measure		Absolut Measur
	Talk Test	***RPE***	***% HRR; VO_2R***	***%Max HR***	***METs, VO_2max***
Light	***Able to talk and/or sing***	***< 3***	***< 40***	***< 64***	***< 3***
loderate	***Able to talk but not sing***	***3-4 (12-13)***	***40-60***	***64-76***	***3-6***
igorous	***Difficulty talking***	***≥ 5***	***> 60***	***> 76***	***>6***

Steady State training



- Intensity: 40 –80% VO_{2m}
- RPE = 12-13
- Duration; Frequency;Progression
- Depend on functional capacity

  < 3 METs: 5-10 min; multiple sessions

  3-5 METs: 15 min bid

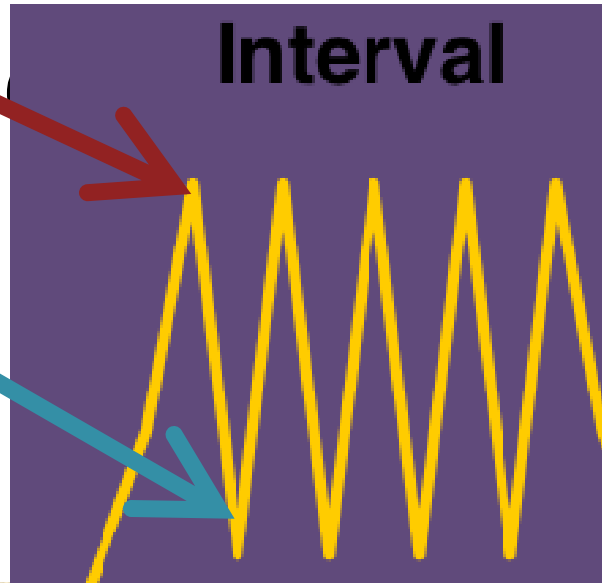
  > 5 METs: 20 – 30 min/ 3-5 times/week
- Increase time before intensity

Interval training

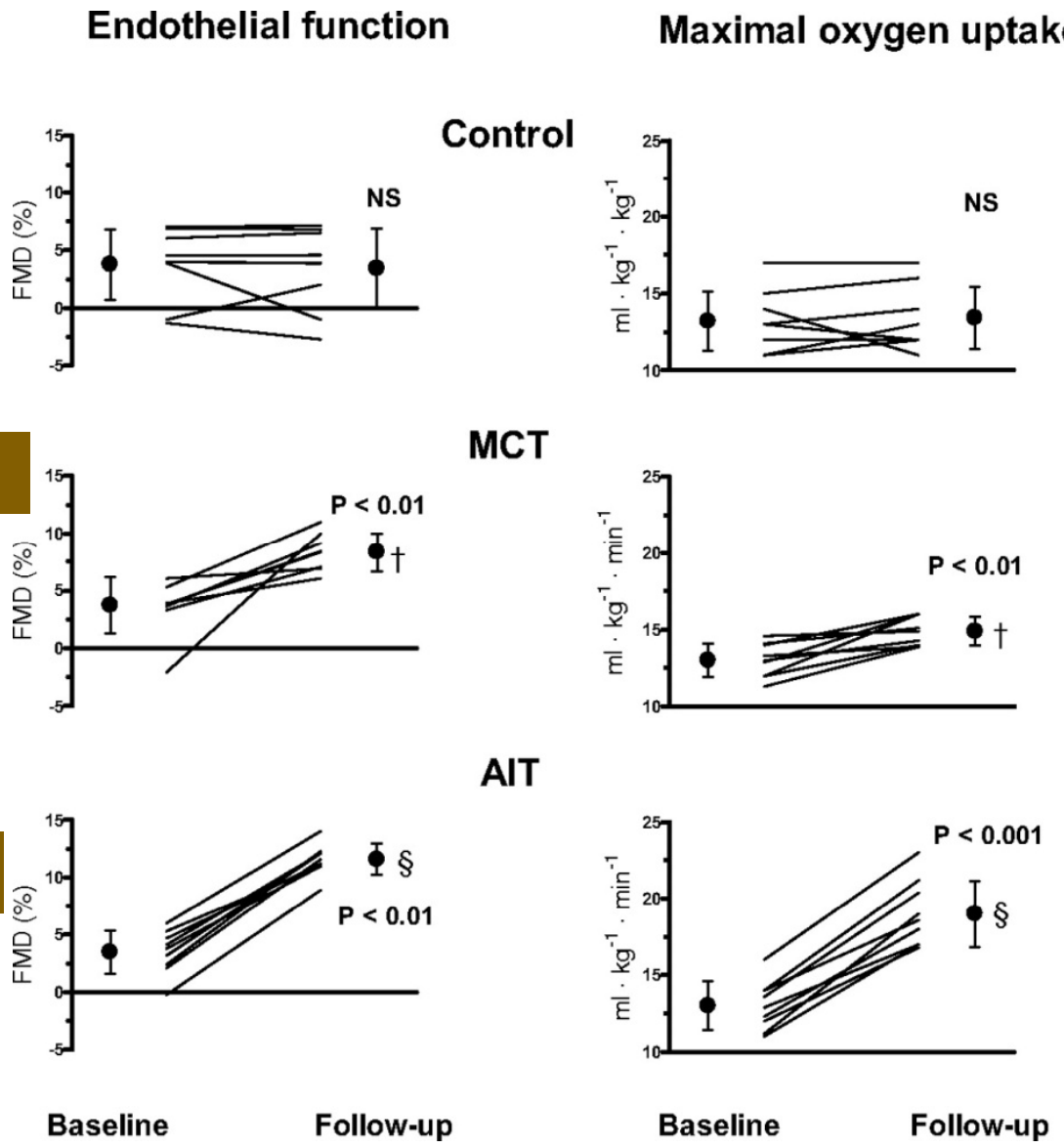
- Be able to apply more intense training
- Intense: ***25-95%*** VO_{2max}
- Interval time of Work Phase/Recovery Phase

Work Phase: 30-120 Sec

Recovery Phase: 60-120 S



oderate Continuous Training in HF patients: A Randomize udy



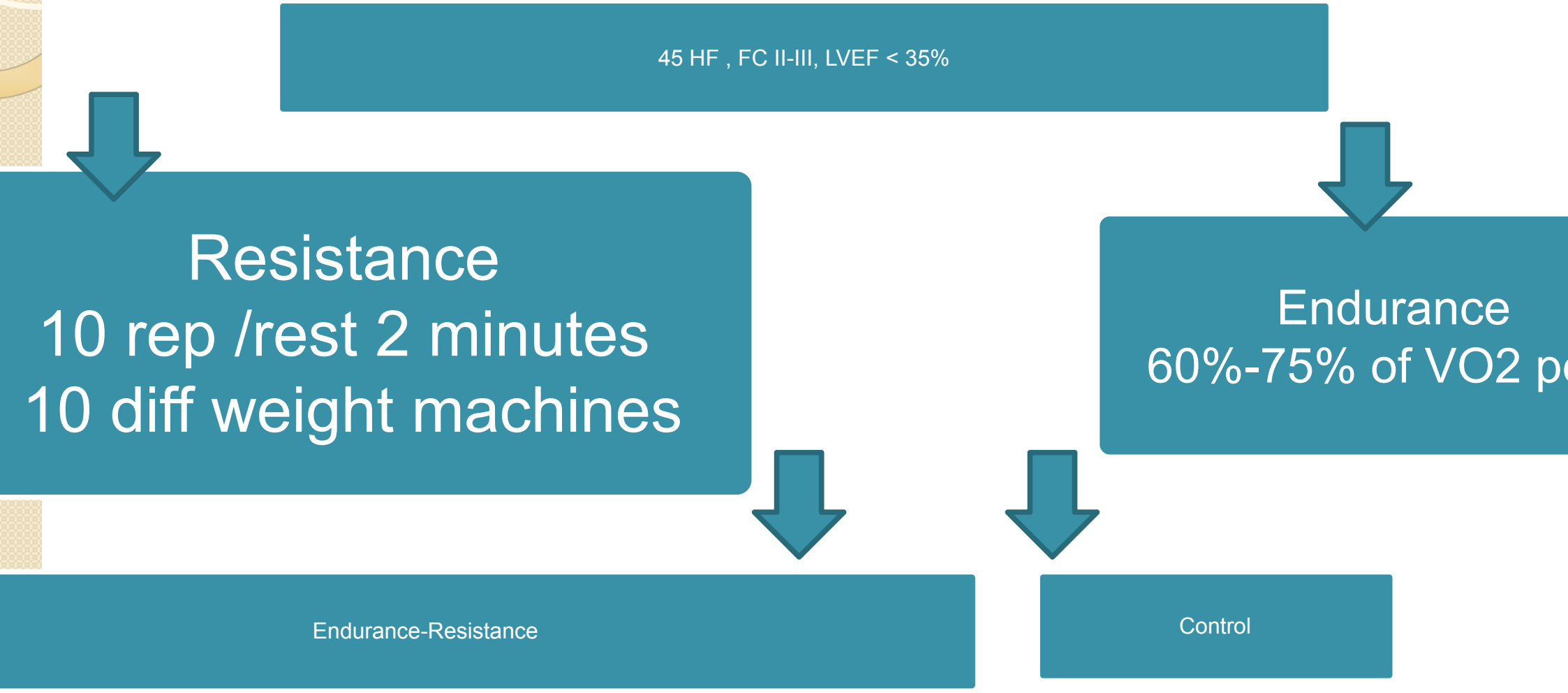
- 27 stable post-infarction HF with optimal medical treatment
- MCT: [70% peak HR
- AIT: [95% peak HR]
- Control group

3 times/week for 12 weeks

RESISTANCE TRAINING IN HF

Efficient Modality Training in HF?

ci Sports Exer 2007



No significant difference between group:
$VO_{2\ peak}$, peak workload

Cardiac Patients

uidelines	Sets	Repetitions	# of Exercise	Frequency (day/week)
000 AHA	*1*	*10-15*	*8-10*	*2-3*
004 AACVPR	*1*	*10-15*	*8-10*	*2-3*

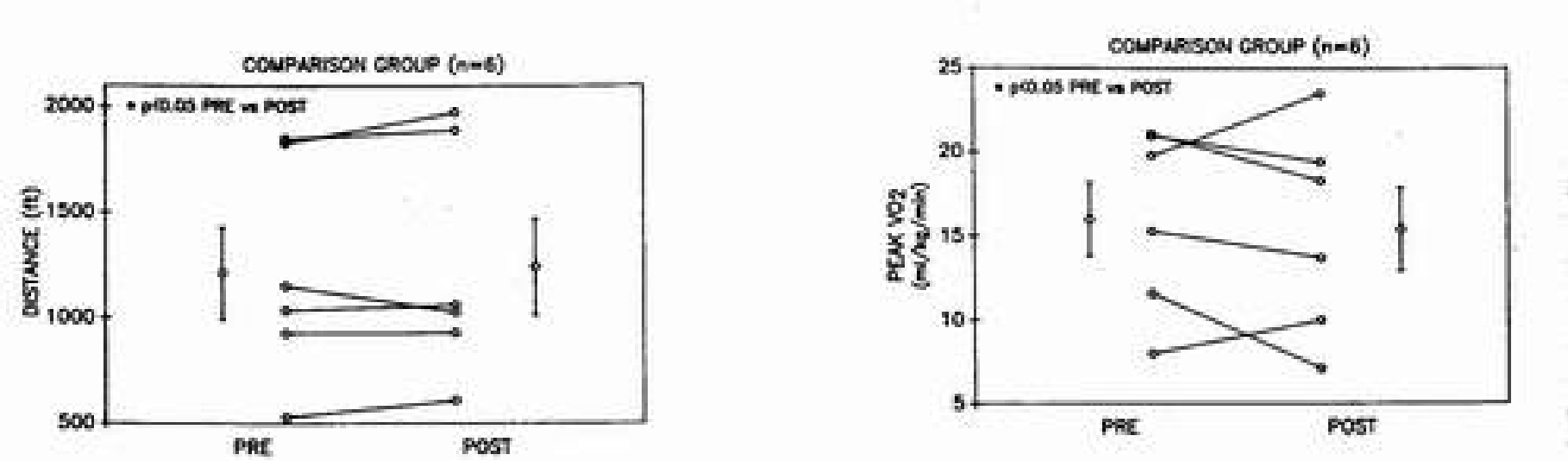
A: American Heart Association

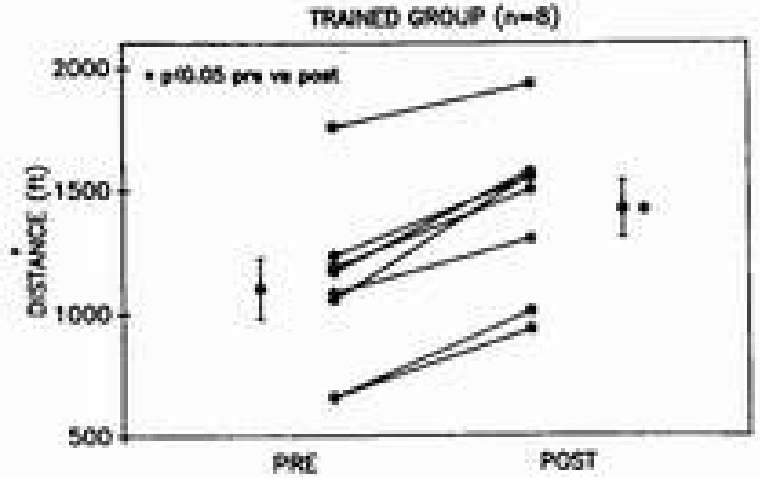
RESPIRATORY MUSCLE TRAINING

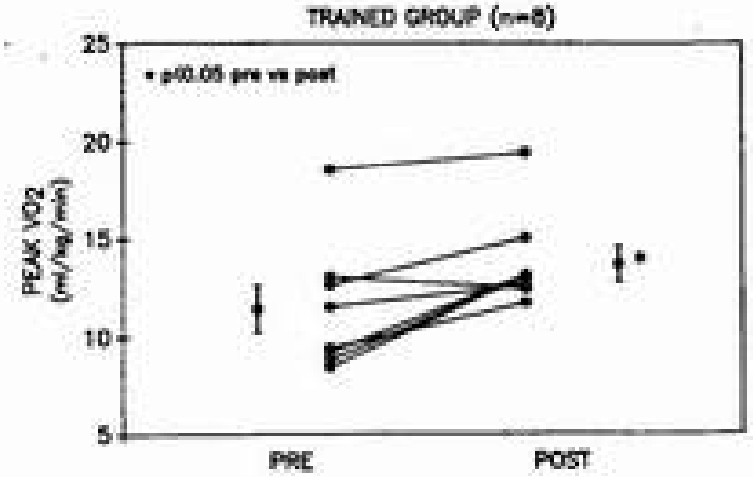
Failure

6 minute walk test

Peak VO_2







Failure

- **Inspiratory Muscle Training Improves Blood Flow**
- **to Resting and Exercising Limbs in Patients with CHF**

JACC 2008.

- **Effects of Inspiratory Muscle Training on Autonor Activity,**
- **Endothelial Vasodilator Function, and NT pro-BNP levels in CHF**

J Cardiopul Rehabil Prev 2008

- **Inspiratory Muscle Training in Patients with HF**
- **and Inspiratory Muscle Weakness:**

JACC 2006.

ELECTRICAL STIMULATION: BENEFIT O TRAINING IN HF

stimulation of the legs and conventional ***bicycle exercise training*** for patients with chronic heart failu

	Bike training group (n=24)	**FES group (n=2**
Exercise time(s)	544/654 < 0.001	501/568 0.02
Peak VO_2(ml/kg/min)	19.0/19.8 0.276	18.6/18.6 0.932
Quadriceps strength (kg)	48.8-54.1 <0.001	42.3/47.6 0.009
Quadriceps fatique	0.76/0.84 0.001	491/531 0.005
QOL score	0.105	0.094

conventional bicycle exercise on endothelium and functional status indices in patients with heart failure

cohort study; compare the effect of muscle functional electrical stimulation (FES) on endothelial function to that of conventional bicycle training.

NYHC class II or III; LVEF ≤ 35%

FES for 6 weeks, with a 6-week washout period then Bicycle training

Brachial artery flow-mediated dilation (FMD)

FES: significant improvement in FMD (5.9 ± 0.5% to 7.7 ± 0.5% , p <0.001).

Bicycle training: FMD (6.2 ± 0.4% to 9.2 ± 0.4% , p <0.001)

effect of muscle FES in patients with heart failure
ndothelial function, although not equivalent to that
nventional exercise, is substantial. Muscle FES protocols
e
useful in the treatment of patients with heart failure who
ot or

CAD

- Tai Chi: Reduced BP (Preventive Cardiol 2008)

Systolic: 3-32 mmHg; Diastolic 2-18 mmHg

- Review 29 studies (9 RCT) (J Cardiopulm Reha Prev 2009)

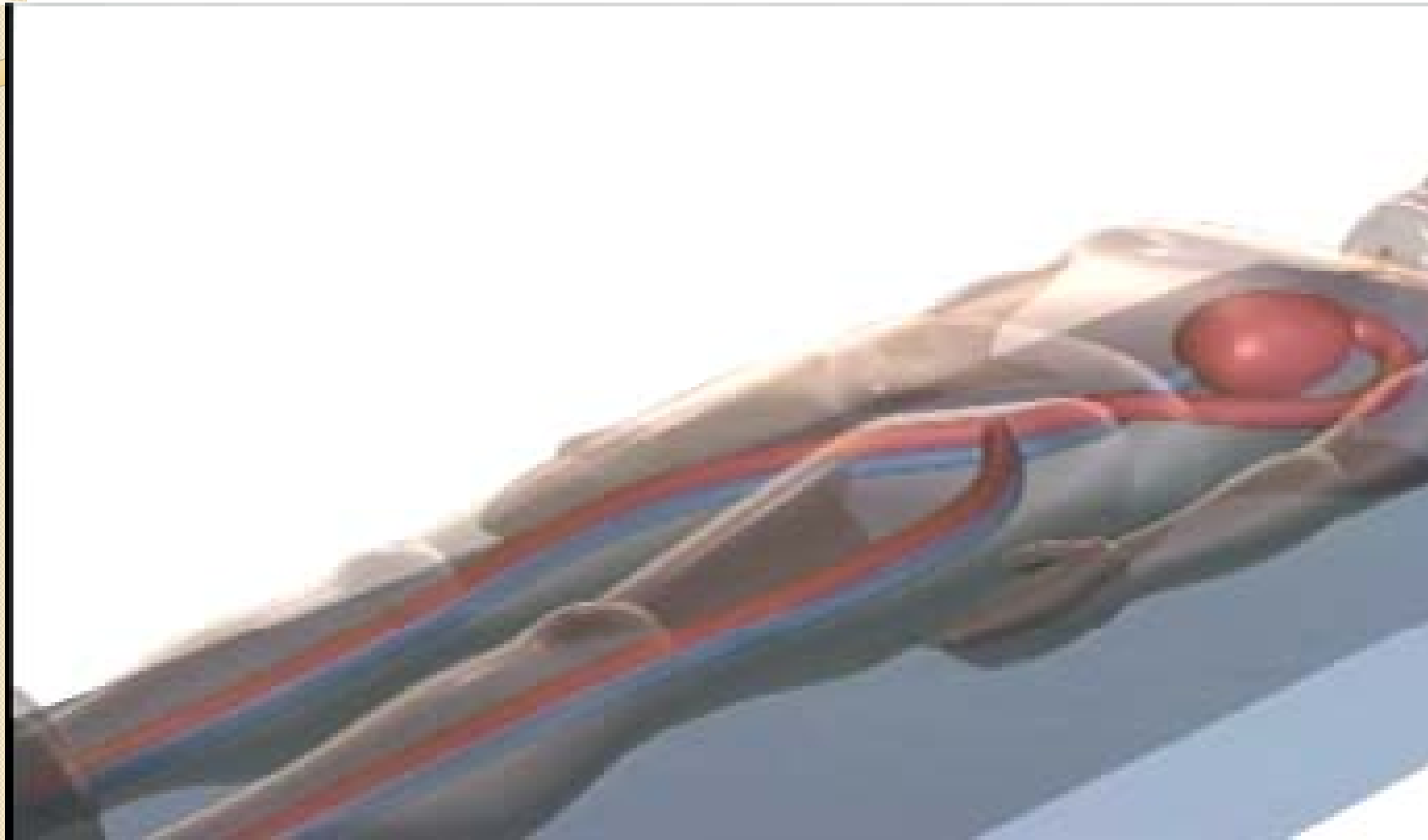
Reduced BP, Improve Exercise capacity

- Tai Chi in HF patients: (American J of Medicine 2004)

Improve functional capacity and reduce BNP lev

program

CounterPulsation: EECP



US FDA approved indications

- cardiogenic shock
- stable or unstable angina
- acute myocardial infarction
- congestive heart failure

PEECH trial

Prospective Evaluation of Enhanced External Couterpulsation in Congestive Heart Failure

RCT: 93 EECP + optimal medication

94 optimal medication

Mean LVEF 26% Ischemic: 2/3

- **Ex duration increase > 60 sec (35.4% vs 25.3%) at months (p = 0.016)**
- **QOL (Minnisota Living with HF Questionaire) at 1 wk, 3 mo significantly improve but not at 6 mo**

Peak VO_2 increase > 1.25 ml/kg/min: not sig. diff

Mechanism For Sustained Clinical Benefit With EECP

Physiologic Effects

- **Potential mechanisms include:**
  - **Recruitment of coronary collaterals.**
  - **Angiogenesis.**
  - **Improved endothelial function.**
  - **Training effects.**
  - **Other, yet unknown mechanism (s).**

With EECP: Physiologic effects

Training effects of Exercise

- Increase exercise capacity
- Reduce sympathetic activity
- Endothelial function
- Myocardial adaptation
- Peripheral adaptation
- Risk factors modification

SAFETY

HF (FC II, III)

- Meta-analysis of 29 RCT, 1126 patients only one trail report complication (Cochrane Database 2004)
- RCT of 110 patients: no complicatio (Circulation 1999)
- Home Exercise programs with low intensity/electrical stimulation are safe.

Summary

- Exercise training in HF is safe and has beneficial effects if perform properly.
- Benefits: reduce mortality, reduce morbidity, improve QOL, exercise capacity and etc.
- Every HF patients who had no contraindications to exercise should be encourage to engage in physical activity and prescribed exercise program
- Aerobic Exercise Training: Interval Training may has more benefit than Steady State training
- Respiratory Muscle Training and Electrical stimulation are recommended.
- ***Individualized exercise*** program is very important for successful exercise prescriptio

Goal of Management for HF Patient

ardiac Remodeling