CARDIAC REHABILITATION FOR CORONARY HEART DISEASE & HEART FAILURE IN ELDERLY

Piyanuj Ruckpanich, MD

Cardiac Rehabilitation Center, Perfect Heart Institute, Piyavate Hospital, Thailand
Cardiac Rehabilitation Society of Thailand (CARESTHAI)

สถาบันหัวใจเพอร์เฟคฮาร์ท-ปิยะเวท

Definition

- Definition of older adults
  > 65 years or those aged 50-64 which clinically significant medical conditions or functional limitations

Prevalence in US

- In year 2000: 13% of population age > 65 years old (35 million)
- By year 2030: 20% of population will turn 65 years old (approx. 70 million)
- By year 2050: 5% of population will be in age group of > 85 years old

ผู้สูงอายุในไทย

- จากการสำรวจของคณะกรรมการพัฒนาการเศรษฐกิจและสังคมแห่งชาติ(สศช.)พบว่า ในปี 2547 กลุ่มประชากรผู้สูงอายุที่มีอายุตั้งแต่ 60 ปีขึ้นไปเริ่มมีสัดส่วนมากกว่า 10% และเพิ่มขึ้นเป็น 11% หรือประมาณ 7 ล้านคนในปัจจุบัน ซึ่งคาดการณ์ว่า ในปี 2567 ประชากรอายุ 60 ปีขึ้นไป จะมีสัดส่วนมาก กว่า 20% ซึ่งจะเท่ากับสัดส่วนของกลุ่มเด็ก และในปี 2573 จะเพิ่มขึ้นเป็น 2 เท่าของกลุ่ม เด็ก หรือประมาณ 1 ใน 5 ของประชากรทั้งประเทศ

เขตการปกครองและภาค	จำนวนประชากรทั้งสิ้น Number of population				ประชากรสูงอายุ Number of the elderly				อัตราร้อยละของประชากรสูงอายุ The elderly rate				Area and region
	รวม Total	ชาย Male	หญิง Female		รวม Total	ชาย Male	หญิง Female		รวม Total	ชาย Male	หญิง Female		
ทั่วราชอาณาจักร	65,684,004	32,232,705	33,451,299		7,020,959	3,130,736	3,890,223		10.7	9.7	11.6		Whole Kingdom
ในเขตเทศบาล	19,946,289	9,542,316	10,403,973		2,005,218	868,789	1,136,429		10.1	.1	10.9		Municipal Area
นอกเขตเทศบาล	45,737,715	22,690,389	23,047,326		5,015,741	2,261,948	2,753,794		11.0	10.0	11.9		Non-municipal Area
กรุงเทพมหานคร	6,905,699	3,250,892	3,654,807		647,366	273,103	374,263		9.4	8.4	10.2		Bangkok Metropolis

New AHA & ACSM Guideline 2007

Guidelines for adults over age 65 or adults 50-64 with chronic conditions

Do moderately intense aerobic exercise accumulated 30 min a day or up to 60 min/day, in bouts of at least 10 min, total 150-300 min/wk, Intensity 5-6 (10 point scale); five days a week

Or /combination

Do vigorously intense aerobic exercise 20 minutes a day, 3 days a week, 75 to 150 min/wk, Intensity 7-8 (10 point scale)

And

Do 8 to 10 strength-training exercises, 10-15 repetitions of each exercise at least 2 times/wk

And

Flexibilty exercise at least 2 days/wk

And

If you are at risk of falling, perform balance exercises

And

Have a physical activity plan.

Encourage to exceed minimum recommendation for: Further improve fitness, reduce risk chronic disease, prevent unhealthy weight gain

Cardiac Rehab in Elderly

- More extensive CAD
- More likely to have previous MI
- Atypical symptoms
- More complex arrhythmias
- Reduction in functional capacity
- More co-morbidity problems/diseases

Cardiac Rehab for elderly

Same concepts of prescribing exercise for cardiac patients, special care for elderly

- Start with lower intensity of exercise and gradually increase intensity
- Resistance exercise: perform 10-15 repetitions (rather than 8-12) of 8-10 muscle group.
- Flexibility exercise: at least 2 days/week, at least 10 min each day.
- Balance exercise, Tai-chi, etc
- Facilitate for any convenience, social support, positive reinforcement

Contents

- Cardiac rehabilitation in CAD and Heart Failure: Overview, Update and Application for elderly

- Cardiac Rehabilitation for Special groups: AF, PAD, Pace maker, ICD, etc

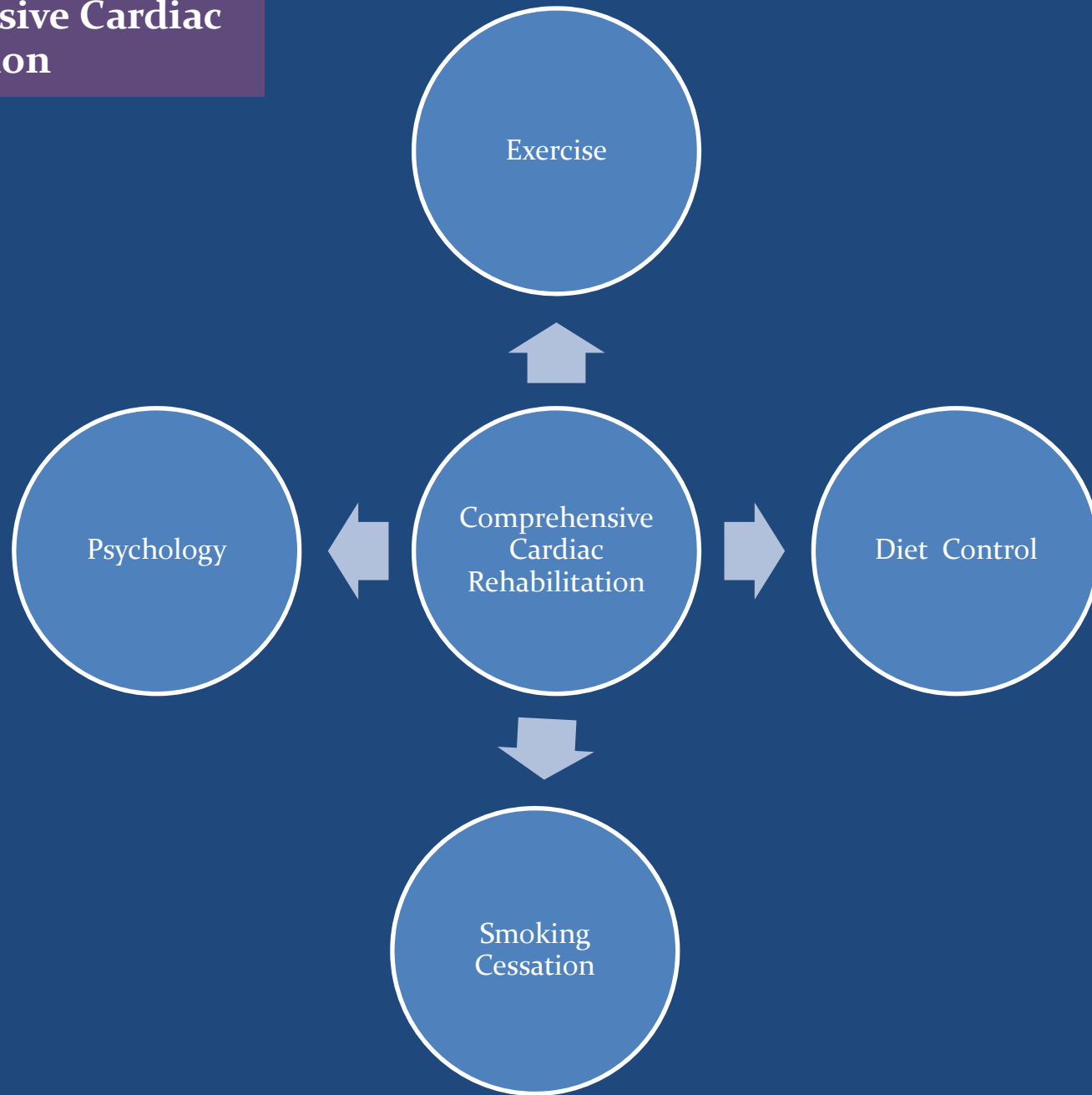- Introduce integrative cardiac rehabilitation program for individualize elderly patient

Guidelines

AHA & ACC & ESC & AACVPR & ACSM Guidelines for Cardiac Rehabilitation (Class I)

- CABG
- Chronic Stable Angina
- Chronic Stable Heart Failure
- ST-elevation/Non-ST elevation MI
- Primary Prevention
- PAD

Indications

- Medically stable post MI
- Stable Angina
- CABG
- PTCA and other transcatheter procedure
- Compensated CHF
- Cardiomyopathy
- Heart & other organ transplant
- Other Cardiac Surgery, including valvular & pacemaker insertion, ICD

ACSM guidelines, 8th edition: 2010

Indications

- Peripheral Artery Disease (PAD)
- High risk CAD ineligible for surgical intervention
- Sudden Cardiac Death Syndrome
- End Stage Renal Disease
- CAD risk factors
- Other patients who may get benefit from structured exercise and/or patient education

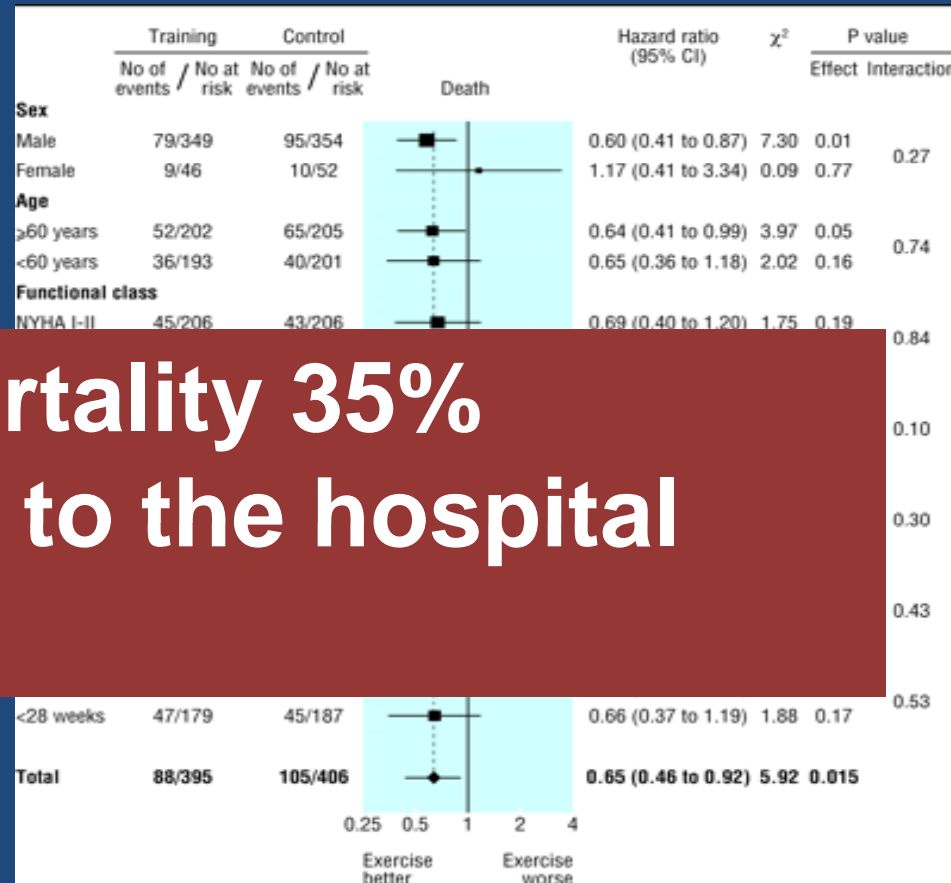# Exercise and Cardiovascular Benefit

Cardiac Rehabilitation: Effect on Mortality

	Reduce All cause mortality	Cardiac Mortality
Taylor RS, et al. Am J Med. 2004	20%	26%
Jolliffee JA. Cochrane 2003. : Comprehensive : Exercise Only	13% 27%	26% 31%
O'connor GT, et al. Circulation 1989	20%	22%

Exercise training meta-analysis of trials in patients with HF (ExTraMATCH)

- 9 RCT, 801 patients
- Follow up 2 years

	Training		Control		Death	Hazard ratio (95% CI)	χ²	P value Effect	P value Interaction
	No of events	No at risk	No of events	No at risk					
Sex									
Male	79/349		95/354			0.60 (0.41 to 0.87)	7.30	0.01	0.27
Female	9/46		10/52			1.17 (0.41 to 3.34)	0.09	0.77	
Age									
≥60 years	52/202		65/205			0.64 (0.41 to 0.99)	3.97	0.05	0.74
<60 years	36/193		40/201			0.65 (0.36 to 1.18)	2.02	0.16	
Functional class									
NYHA I-II	45/206		43/206			0.69 (0.40 to 1.20)	1.75	0.19	0.84
									0.10
									0.30
									0.43
									0.53
<28 weeks	47/179		45/187			0.66 (0.37 to 1.19)	1.88	0.17	
Total	88/395		105/406			**0.65 (0.46 to 0.92)**	5.92	0.015	

0.25 0.5 1 2 4

Exercise better — Exercise worse

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

Piepoli MF, et al. BMJ 2004;328:189

Exercise based rehabilitation for HF

- 29 RCT; 1,126 HF patients (NYHA II, 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]**
- **6 minute walk test [40.9 metres]**
- **HRQoL [7/9 trials]**

Rees K, et al. The Cochrane Database of Systematic Reviews 2004

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.

Summary 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

O'Connor CM, et al. JAMA 2009;301:1439-50

Effects of Exercise Training on Health Status in Patients With Chronic Heart Failure
HF-ACTION Randomized Controlled Trial

Kathryn E. Flynn, PhD
Ileana L. Piña, MD
David J. Whellan, MD, MHS
Li Lin, MS

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

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

Conclusions Exercise training conferred modest but statistically significant improvements in self-reported health status compared with usual care without training. Improvements occurred early and persisted over time.

overall summary scale and key subscales at baseline, every 3 months for 12 months, and annually thereafter for up to 4 years. The KCCQ is scored from 0 to 100 with higher scores corresponding to better health status. Treatment group effects were estimated using linear mixed models according to the intention-to-treat principle.

Results Median follow-up was 2.5 years. At 3 months, usual care plus exercise training led to greater improvement in the KCCQ overall summary score (mean, 5.21; 95% confidence interval, 4.42 to 6.00) compared with usual care alone (3.28; 95% confidence interval, 2.48 to 4.09). The additional 1.93-point increase (95% confidence interval, 0.84 to 3.01) in the exercise training group was statistically significant ($P < .001$). After 3 months, there were no further significant changes in KCCQ score for either group ($P = .85$ for the difference between slopes), resulting in a sustained, greater improvement overall for the exercise group ($P < .001$). Results were similar on the KCCQ subscales, and no subgroup interactions were detected.

Conclusions Exercise training conferred modest but statistically significant improvements in self-reported health status compared with usual care without training. Improvements occurred early and persisted over time.

Trial Registration clinicaltrials.gov Identifier: NCT00047437.

William E. Kraus, MD
Nancy Houston Miller, RN, BSN
Kevin A. Schulman, MD
John A. Spertus, MD, MPH
Christopher M. O'Connor, MD
Kevin P. Weinfurt, PhD

HEART FAILURE IS A SYNDROME characterized by dyspnea and fatigue; however, patients with heart failure often also experience diminished health status, including reductions in physical and social functioning and other dimensions of health-related quality of life.[1,2] Pharmacological and device interven-

PTCA vs Exercise Training in patients with stable CAD

- RCT; male age ≤ 70 years
- Stable CAD at least 1 native artery stenosis ≥ 75%
- CCS class I-III
- Documented myocardial ischemia (stress ECG or Tc scintigraphy)

Hambrecht R, et al Circulation. 2004;109:1371-78

PTCA vs Exercise Training in patients with stable CAD

- Exclusion
  - LM stenosis > 25%
  - High grade proximal LAD stenosis
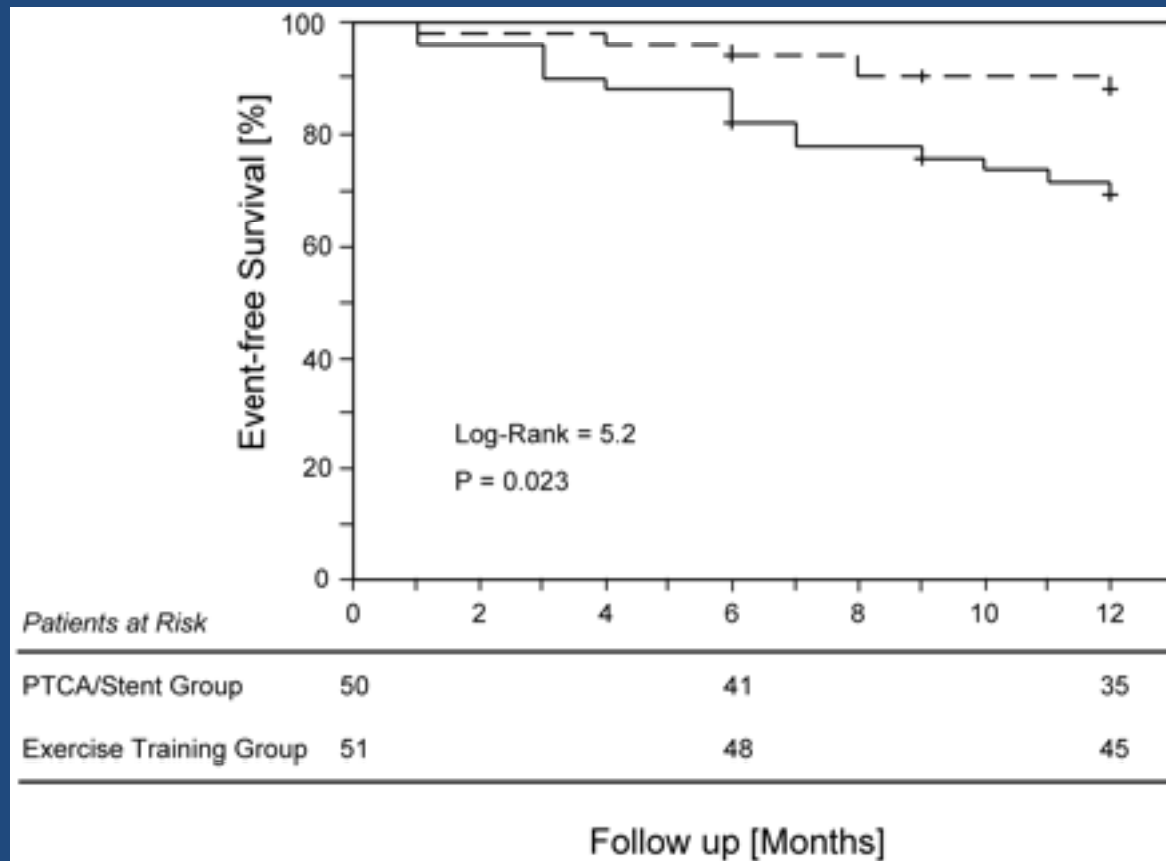 - LVEF < 40%
- Mean EF > 60%
- Approx. 60% SVD; 25% DVD; 15%TVD

Hambrecht R, et al Circulation. 2004;109:1371-78

Patient flow diagram of events and dropouts during clinical phases of present randomized trial
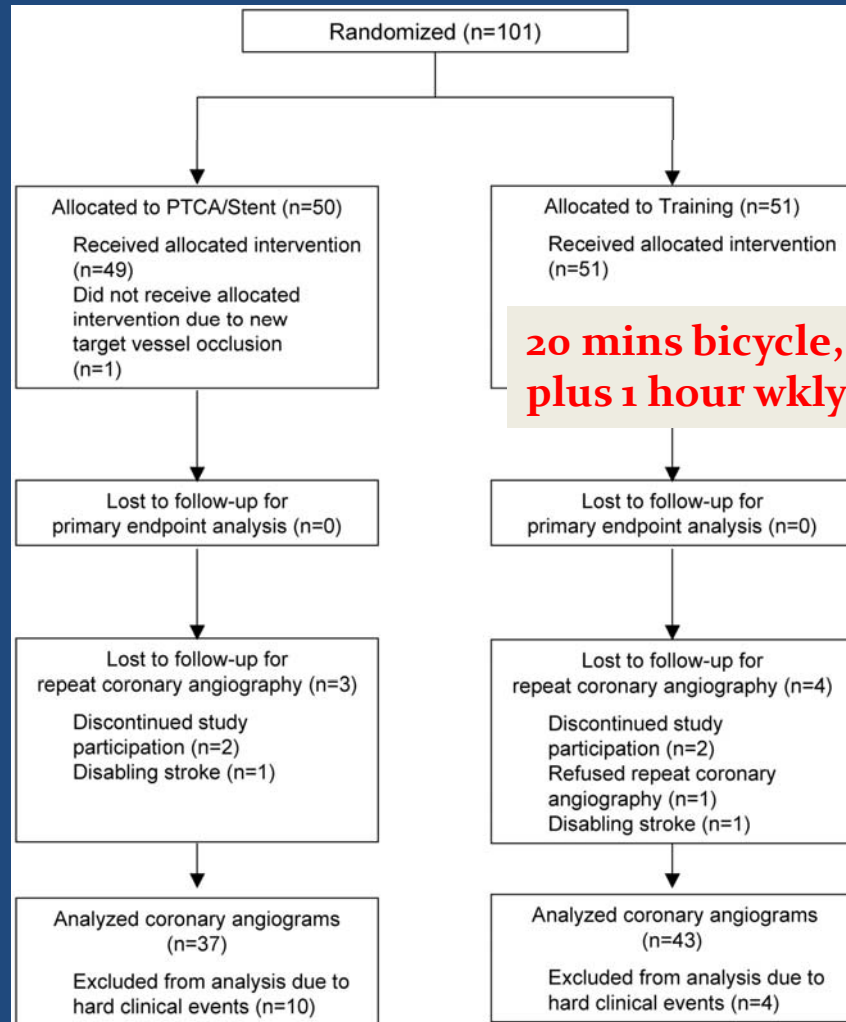
20 mins bicycle, Home program, moderate intensity Ex plus 1 hour wkly Supervised Rehab at hospital

Hambrecht, R. et al. Circulation 2004;109:1371-1378

----Exercise group
__PCI group

88% vs 70%, p=0.023

Event-free survival after 12 months was significantly superior in exercise training group versus PCI group (*P=0.023 by log-rank test*).

Hambrecht R, et al Circulation. 2004;109:1371-78

	Exercise training		PCI	
	Baseline	End study	Baseline	End study
RHR;bpm	71±2	65±1	70±2	70±1
Ischemic threshold;w	98±6	127±8	99±5	119±7
MHR;bpm	131±5	137±3	132±3	133±3
Work capacity;w	133±5	159±5	130±5	130±5
VO_2max	22.6±0.7	26.2±0.8	22.3±0.6	22.8±0.9

Hambrecht R, et al Circulation. 2004;109:1371-78

Benefit of Exercise Training
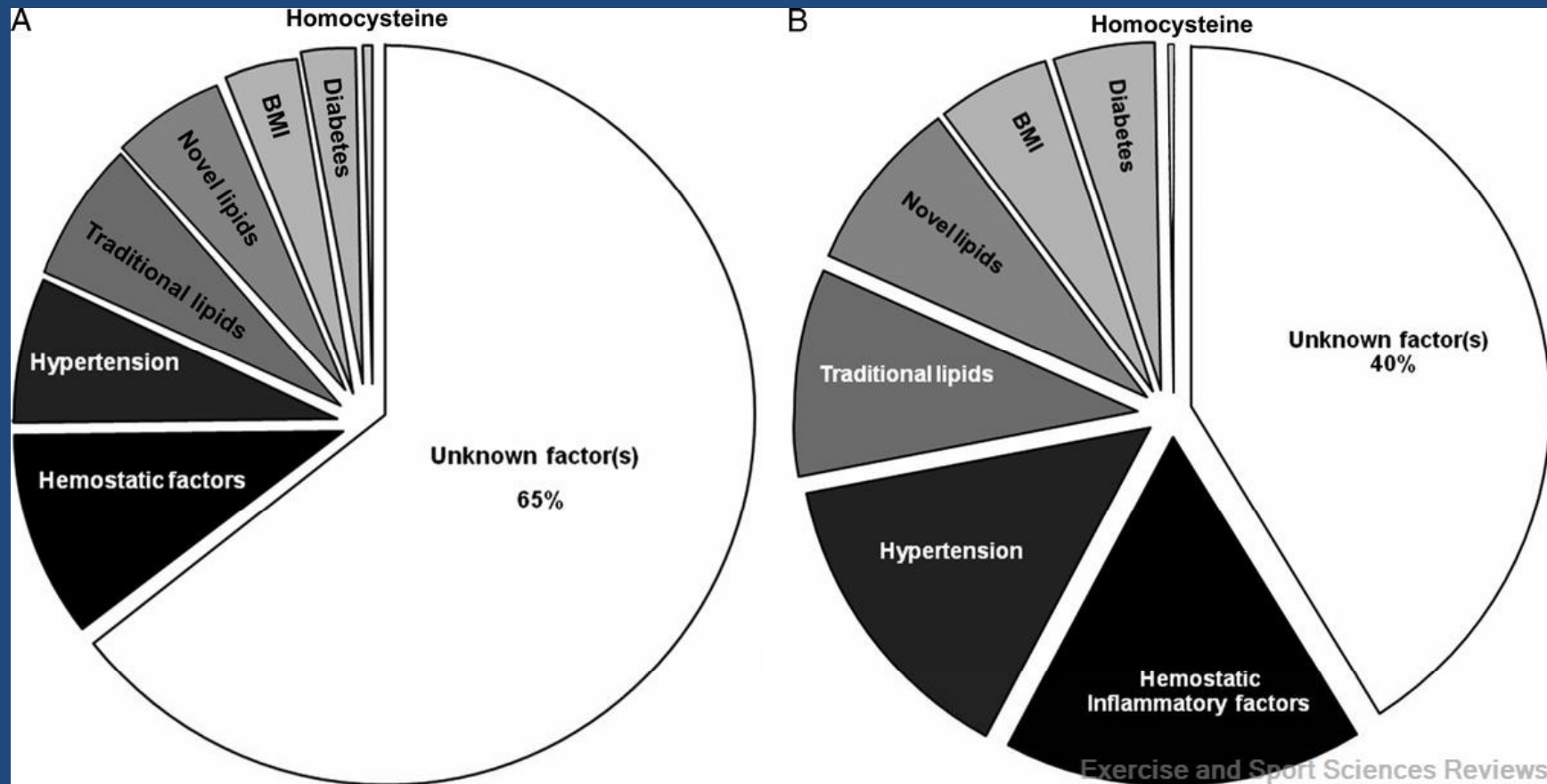
A — coronary heart disease

B — cardiovascular events

Green, Daniel J., Exercise and Sport Sciences Reviews. 2009, 37(4):196-202.

Benefits Of Exercise

Risk Factors

Increase HDL
Reduce TG and LDL
Reduce Adiposity
Reduce BP
Improve Insulin Sensitivity and FPG

Improve Endot

Helps smoking cessati
Reduces psychologica

Hematologic

Decreases Hct and blood viscosity
Expands blood plasma volume
Increase RBC deformability and tissue level perfusion
Increase circulartory fibrinolytic activity

Anti-Inflammation
Improve Endothelial
Function

Increase Coronary flow reserve
Increase coronary collateral circulation
Increase tolerance of ischemia
Increase myocardial capillary density
Increase ventricular fibrillation threshold
Reduce atherosclerosis / Inflammation
Possibly increase epicardial coronary artery size
Reduce major morbidity and mortality

Carl J Lavie, et al. Mayo Clin Proc.2009;84:373-383

Exercise and regression of coronary atherosclerosis

- **RCT, 60 pts, CAG pre & post intervention**
- **Diet control, no lipid lowering medication**
- **Supervised 1 year, moderate exercise program with home program**
- **Regression of disease observe only in pt who expanded > 2,200 kcal/week**
- **5-6 hour of moderate intensity exercise /week**

Energy Expenditure (Kcal) = Mets of activity x Body weight (kg) x Time of activity (hours)
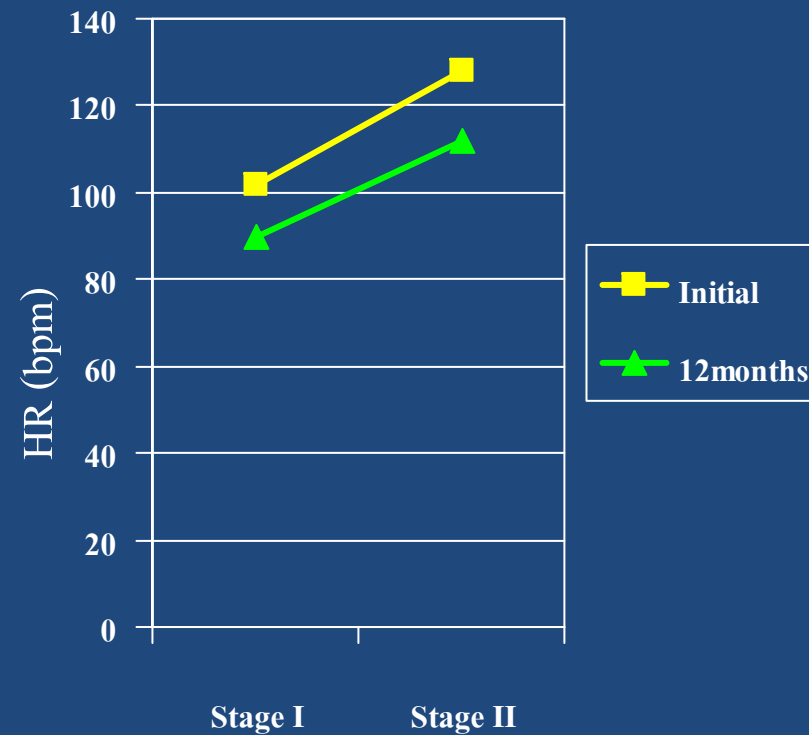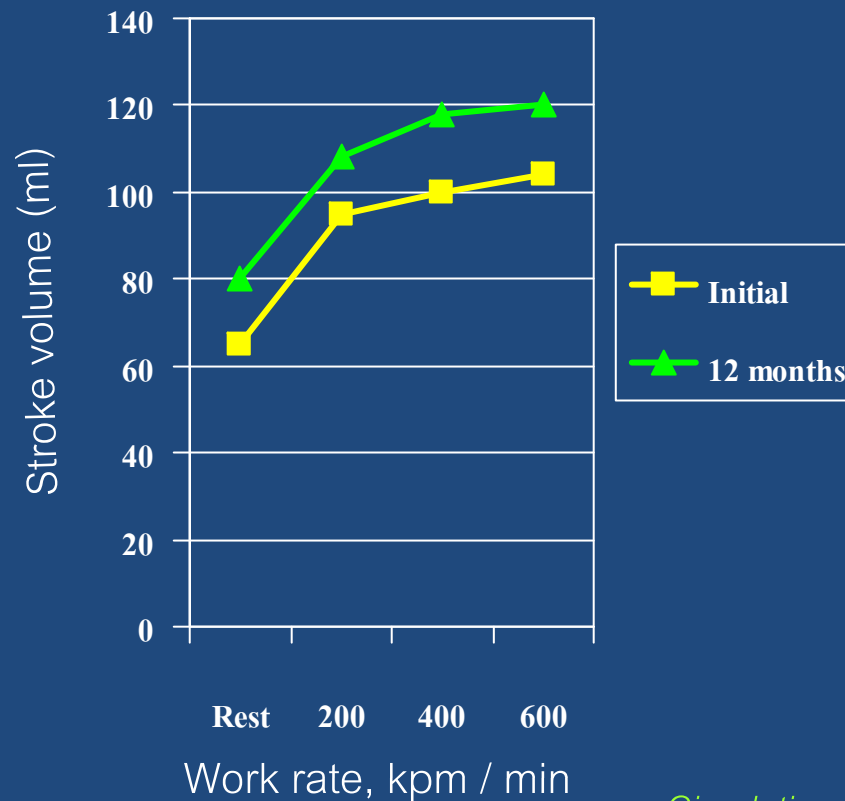
Exercise training in CAD:

Effects on ventilatory oxygen consumption

P = 0.001

Moderate intensity

20 - 40 minutes

3 - 6 months
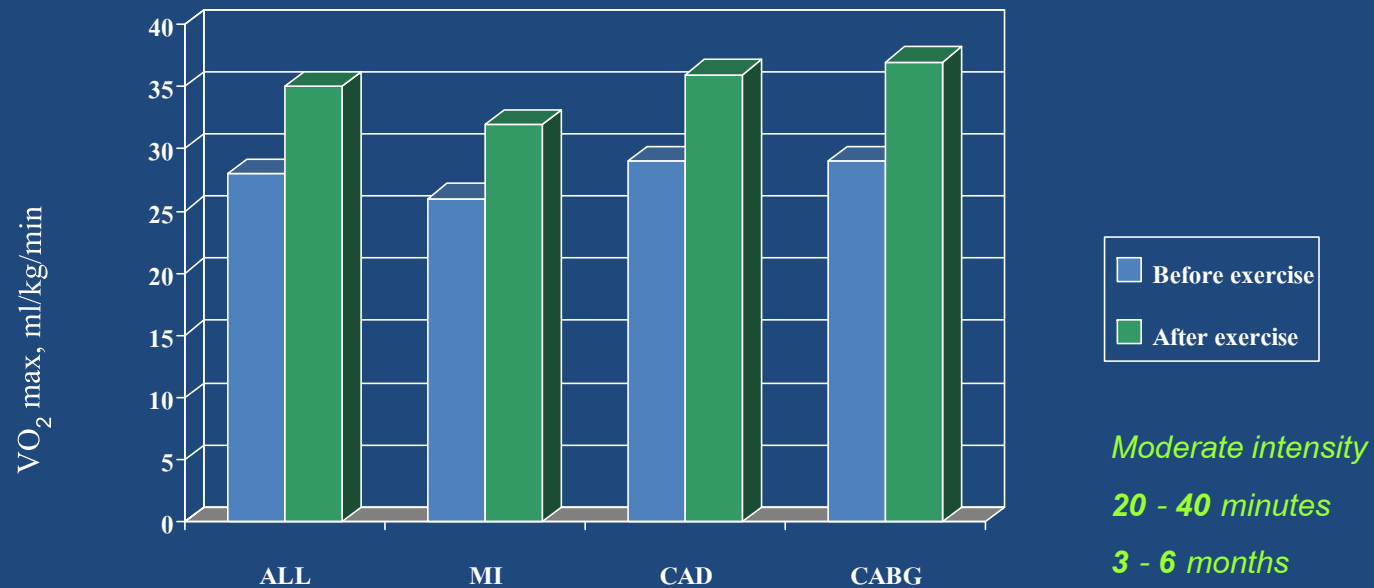
Hartung, GH.Arch Phys Med Rehab 1981;62:147-150
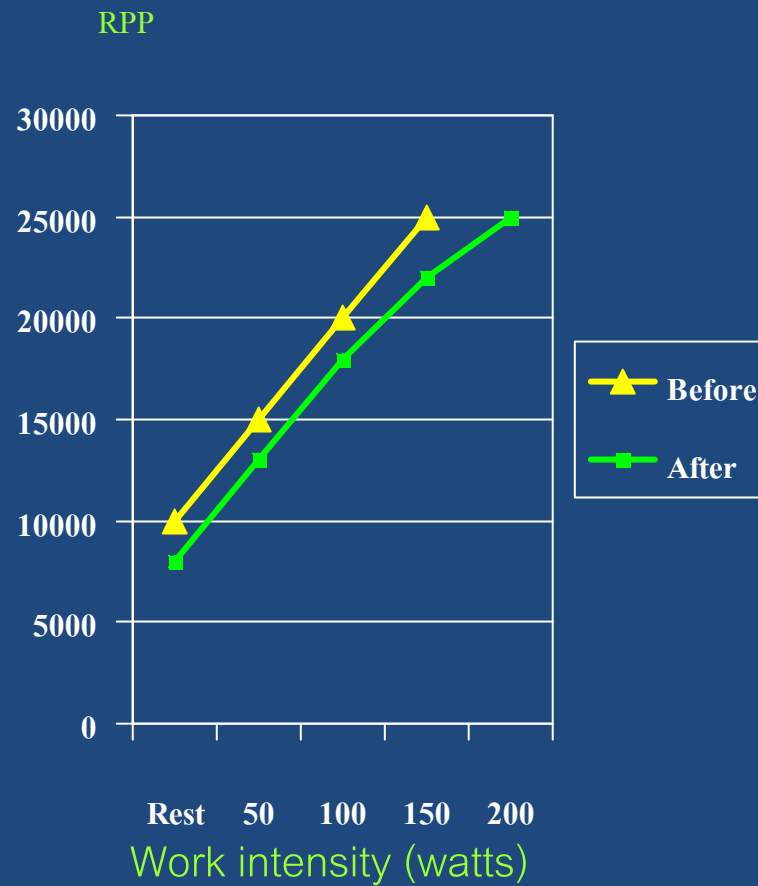
Exercise training in CAD:
Effects on stoke volume, HR

Myocardial Oxygen Demand; MVO_2

- Rate Pressure Product: RPP
- RPP = SBP x HR

Exercise training in CAD: Effects on myocardial oxygen demand
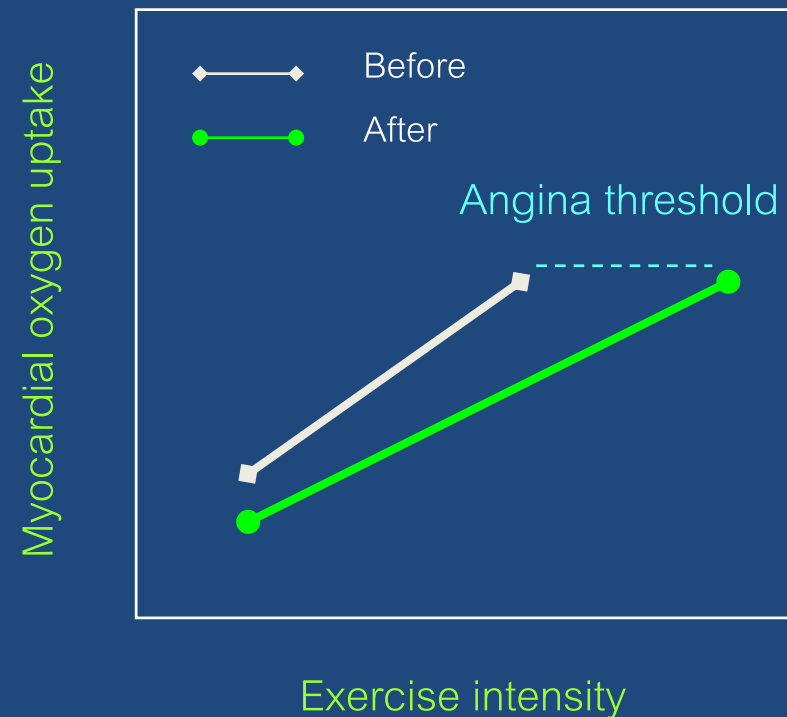
Cardiac Rehabilitation : Phase

Weeks•   0   1   2   3   4   5   6   7   8   9   10   11   12   Beyond

Inpatient *(Phase I)*

**Transitional care - homecare
pre training at home**

Outpatient programing - Cardiac Rehab center *(Phase II)*

Maintenance - lifelong, community facility, at home
(Phase III)

- Phase I
- Phase II (ECG Mornitoring)
- Phase III
- Balance Training Program
- Weight Reduction Program
- Class Exercise: Tai Chi, chair exercise, etc

CONCEPTS OF EXERCISE PRESCRIPTION

Assessment

- **History, PE, Lab, Special investigation**
- **Risk factors, others health problems**
- *Pre-morbid status - physical activity level, exercise*
- **Contra-indication to exercise (heart disease, etc)**
- **Patients's Goal**

การสั่งการรักษาด้วยการออกกำลังกาย

- มีข้อห้ามในการออกกำลังกายหรือไม่
- แบ่งกลุ่มผู้ป่วยตามระดับความเสี่ยง **(monitoring)**
- มีข้อระวังเพิ่มเติมหรือไม่
- สั่งการรักษาด้วยการออกกำลังกาย
    - **Aerobic**
    - **Resistance**
    - **Flexibility**
    - **Balance**
    - **Group exercise: chair exercise, tai-chi, qi-kong**
- ติดตามผล
- การปรับเปลี่ยนการออกกำลังกาย

Contraindications for exercise

- **Unstable angina**
- **Resting SBP > 200 mmHg, DBP > 100 mmHg**
- **Orthostatic BP drop > 20 mmHg with symptoms**
- **Critical Aortic Stenosis**
- **Acute systemic illness or fever**
- **Uncontrolled sinus tachycardia > 120 BPM**
- **Uncontrolled atrial or ventricular dysrhythmia**
- **Uncompensated heart failure**

Contraindications for exercise

- **Third degree AV block without pacemaker**
- **Active pericarditis, myocarditis**
- **Recent embolism, Thrombophlebitis**
- **Resting ST-segment depression or elevation (> 2mm)**
- **Uncontrolled DM**
- **Severe orthopedic condition that would prohibit exercise**

All of these CI need to be treated and controlled before starting exercise program

Risk stratification

Low risk
- EF > 50%
- No resting or exercise induced complex dysrhythmias
- Uncomplicated cardiac events
- Asymptomatic & normal hemodynamic response to exercise
- FC > 7 METs
- Absence of clinical

Moderate risk
- EF 40 - 49%
- Signs/symptoms at 5-6.9 METs or in recovery

Highest risk
- EF < 40%
- Hx of cardiac arrest or sudden death
- Complex ventricular arrhythmia at rest or with exercise
- Complicated cardiac events
- Symptomatic & abnormal hemodynamic response to exercise
- Signs/symptoms < 5 METs
- Clinically significant depression

Supervised exercise ± ECG monitoring for High risk

AACVPR 1999

Risk stratification for exercise training in cardiac patients: do the proposed guidelines work?

- PURPOSE: Four authoritative organizations (American Association of Cardiovascular and Pulmonary Rehabilitation [AACVPR], the American College of Cardiology [ACC], the American College of Physicians [ACP], and the American Heart Association [AHA]) have risk stratification guidelines for supervised exercise in patients with cardiovascular disease. The ability of the guidelines to predict exercise complications is untested.

RESULTS: 12 patients experienced complications during supervised exercise. None of the guidelines was predictive of complications.
Current cigarette smoking was the only predictor of complications.

cigarette smoking was the only predictor of complications. There was reasonable correlation of patient risk stratification among the four guidelines (r = 0.19-0.47; P < 0.0001).

- CONCLUSIONS: Currently proposed exercise risk stratification guidelines are not predictive of complications during supervised exercise. Further work is needed before exercise risk stratification guidelines are used to adjudicate use of supervised services.

Risk Stratification: Lowest risk

- Absence of complex ventricular arrhythmias during exercise testing and recovery
- Absence of angina or other significant symptoms (e.g. unusual shortness of breath, light-headedness, or dizziness, during exercise testing and recovery
- Presence of normal hemodynamics during exercise testing and recovery (i.e., appropriate increase and decrease in HR and SBP with increasing HR, SBP with increasing workloads and recovery)
- Functional Capacity ≥ 7 METs

Non-exercise testing findings:

- Resting EF ≥ 50%
- Uncomplicated MI or revascularization procedure
- Absence of complicated ventricular arrhythmias at rest
- Absence of CHF
- Absence of sign & symptoms of postevent/post
  ischemia

Risk Stratification: Moderate risk

- Present of angina or other significant symptoms (e.g. unusual shortness of breath, light-headedness, or dizziness occurring at high level of exertion: $\geq$ 7 METs)
- Mild to moderate level of silence ischemia during exercise testing or recovery (ST-segment depression < 2mm from baseline)
- Functional Capacity $\leq$ 5 METs

Non-exercise testing findings:

- Resting EF = 40-49 %

Risk Stratification: High risk

- Presence of complex ventricular arrhythmias during exercise testing and recovery
- Present of angina or other significant symptoms (e.g. unusual shortness of breath, light-headedness, or dizziness occurring at low level of exertion: [$\leq$ 5 METs] or during recovery)
- High level of silence ischemia during exercise testing or recovery (ST-segment depression $\geq$ 2mm from baseline)
- Presence of abnormal hemodynamic during exercise testing (i.e., chronotropic incompetence or flat or decreasing systolic BP with increasing workloads) or recovery (i.e., severe post-exercise hypotension)

Risk Stratification: High risk

Non-exercise testing findings:

- Resting EF < 40%
- History of cardiac arrest or sudden death
- Complex dysrhythmias at rest
- Complicated MI or revascularization procedure
- Presence of CHF
- Presence of signs and symptoms of postevent/post procedure ischemia
- Presence of clinical depression

AACVPR 4TH ed., 2004

ECG Monitoring

กลุ่มความเสี่ยง	Supervised exercise & ECG monitored *(sessions) เริ่มด้วย continuous ECG monitor และค่อยๆ ลดเป็น intermittent ECG monitoring	Time of supervision (days post event)
Lowest	6 - 18 sessions	30
Moderate	12 - 24 sessions	60 - 90
High	18 - 24 sessions	90

Telemetry, Defibrillator paddle, etc

ปัจจัยส่งเสริมการทำให้เกิดภาวะหัวใจวาย

- Noncompliance with diet or therapy
- Arrhythmia
- Systemic infection
- Pulmonary embolism
- High-output state - anemia, pregnancy, hyperthyroid
- Unrelated illness - renal, pulmonary, GI
- Ischemia
- Hypertension
- Toxins - alcohol, street drug
- Inappropriate drug therapy

Inpatient - Phase I :Transitional care

- **Education - risk factors**
- **Early mobilization**
- **Discharge planning**
  - **Activities of daily living**
  - **Return to pre-morbid activity**
  - **Precautions**
  - **Home exercise program**
- **Pre operation program for surgery**

In-patient CR Program

Begin Cardiac Rehabilitation

"Stable" conditions
No new/recurrence chest pain in 8 hr
CK and/or troponin levels are not rising
No new signs of uncompensated failure (dyspnea at rest with bibasilar rales)
No new significant, abnormal rhythm or ECG changes in past 8 hr

Progress of Cardiac Rehabilitation

Adequate HR increase
Adequate SBP rise to within 10-40 mmHg
No new rhythm or ST changes are identified on telemetry rhythm strip
No cardiac symptoms such as palpitations, dyspnea, excessive fatigue or chest pain

Discontinue Cardiac Rehabilitation

DBP > 110 mmHg
Decrease in SBP > 10 mmHg
Significant ventricular or atrial arrhythmia
Second or third degree heart block
S & S of exercise intolerance including angina, marked dyspnea, ECG changed suggested ischemia

Activity	Method	METs	Average HR response
Toileting	Bedpan Commode Urinal (in bed) Urinal (standing)	1-2 1-2 1-2 1-2	5 – 15 beats from RHR
Bathing	Bed bath Tub bath Shower	2-3 2-3 2-3	10-20 beats from RHR

Walking	Flat surface
	  2 mph
	  2.5 mph
	  3 mph
		
		2-2.5
		2.5-2.9
		3-3.3
			5 – 15 beats from RHR

Upper body exercise	While standing
	  Arms
	  Trunk
		
		2.6-3.1
		2-2.2
			10-20 beats from RHR

Leg calisthenics		2.5-4.5	15 – 25 beats from RHR

Stair climbing	1 flight = 12 steps
	  Down 1 flight
	  Up 1-2 flights
		
		2.5
		4.0
			
			10 beats from RHR
			10-25 beates from RHR

Inpatient cardiac rehabilitation

Level	Exercise	METs level
Clinical stable / no CI to exercise		
Step I	Sitting in bed / sofa	1 - 2
Step II	Calisthenics exercise	2 - 3
Step III	Walking slow pace	2 - 3
	Gradually increase time	
	(Interval train) to 10 - 15 mins	
Step IV	Down 1- 2 flight of stairs	2- 4
Step V	Up 1 - 2 flight of stairs	4 - 5

Inpatient: Exercise program

FITT Component	Prescription
Frequency	Early mobilization: 2-4 times/day for the first 3 days Later mobilization: 2 times/day , increase duration
Intensity	To tolerance if asymptomatic RPE $\leq$ 13 Post MI, CHF: HR $\leq$ 120 bpm or HRrest + 20 bpm Post-surgery: HRrest + 30 bpm
Time	Begin with intermittent 3-5 minutes as tolerate Rest period may be slowere walk, complete rest. Attempt to achieve 2:1 ratio
Progression	When continuous exerecise duration reach 10 - 15 min, intensity as tolerated

Pre-discharge education

- ความรู้เรื่องโรคและปัจจัยเสี่ยงรวมทั้งการแนะนำในการปฏิบัติตัว เช่น เรื่องอาหาร
- ข้อควรระวังต่างๆ เช่นอาการที่ควรรีบมาพบแพทย์, เมื่อไรไม่ควรออกกำลังกาย เป็นต้น
- การมีกิจวัตรประจำวันและทำงานบ้าน
- มีเพศสัมพันธ์ได้เมื่อไร
- กลับไปทำงานได้เมื่อไร
- ควรออกกำลังกายอย่างไร
- อื่นๆ เช่นขับรถ, energy conservation technique เป็นต้น
- คำแนะนำในการฟื้นฟูหัวใจต่อเนื่อง ซึ่งอาจจะเป็นลักษณะผู้ป่วยนอก, หรือปฏิบัติที่บ้าน

Activity	Post MI (uncomplicated)	Post CABG
PADL	As soon as mobile	2-3 days post
Light ADL	No restriction	Avoid lifting 6 wks
Walking	If: imediately with progression	If: imediately with progression
Swimming	3-4 weeks graded	Wound; breaststroke >6wks
Golf	4 weeks graded	Walk 4-6 wks, putting/chipping upgrade Driving > 3 months
Driving	2 weeks (advised by doctor)	4 – 6 wks (advised by doctor)
Sexual activity	No restriction	No restriction
Work	Sedentary: 4 wks Moderate: 6 wks Heavy: 8-10 wks	6-8 wks 10-12 wks 12-16 wks

PHASE II

Exercise prescription

- Type   *aerobic; resistance; flexibility*

- Mode   *bike; treadmill; dumbbell*

- Intensity   *high; moderate; low*

- Duration   *60 minutes; 10 minutes x 3*

- Frequency   *3 times / wk*

- Progression   *increase 1 METs*

FITT

Ventilatory Oxygen Consumption: VO_2

= **Cardiac Output x (arterial – venous) Oxygen difference**

มิลลิลิตรออกซิเจน/กิโลกรัม/นาที

คือ ความสามารถของร่างกายในการนำออกซิเจนไปใช้

- **VO_2max** = maximal Ventilatory Oxygen Consumption

คือ ความสามารถของร่างกายในการนำออกซิเจนไปใช้ได้สูงสุด

- **VO_2rest** = resting Ventilatory Oxygen Consumption

คือ ความสามารถของร่างกายในการนำออกซิเจนไปใช้ในขณะพัก มีค่าเท่ากับ 3.5 มิลลิลิตรออกซิเจน/กิโลกรัม/นาที หรือ เท่ากับ 1 METs

- **VO_2R** = VO_2max - VO_2rest

Ventilatory Oxygen Consumption: VO_2

- Ventilatory Oxygen Consumption (VO_2)

- CO x $(A-V)O_2$ difference

- SV x HR x <u>$(A-V)O_2$ difference</u>

- METs = Metabolic Equivalent

- 1 METs = 3.5 mlO_2/kg/min = ปริมาณออกซิเจนที่ร่างกายใช้ในขณะนั่งพัก

INTENSITY OF EXERCISE

With Graded Exercise Test
Without Graded Exercise Test

Exercise Intensity without GXT

	No test available	Pharmacologic Test available; -ve for ischemia	Pharmacologic Test available; +ve for ischemia
Training HR	Upper limit HR rest + 20 b/m, gradually titrate according to RPE, S+S, normal physiologic response	If good HR increase: 70-85% Hrmax If HR doesn't increase: Hrrest + 20 b/m with gradually titrate	10 b/m below ischemic threshold (if determined). If not determined use procedure of no GXT
Initial MET Level	2-4	2-4	2-4
Monitoring	ECG, BP, RPE, S+S of ischemia	ECG, BP, RPE, S+S of ischemia	ECG, BP, RPE, S+S of ischemia
RPE (10)	3-5	3-5	3-4
MET Progression	1-2	1-2	1-2

Intensity of Exercise

- Heart Rate

- Oxygen consumption (VO_2, VO_{2R}, METs)

- Rate of perceived exertion scale   (Borg Scale)

Rate Pressure Product

SBP x HR

Intensity: Heart Rate

❑ **maximum heart rate from Exercise test**

❑ **maximum predicted heart rate**
MPHR = 220-age b/m

MPHR = 206.9 – (0.67x age) b/m (Gellish et al.)

❖ **Peak HR Method : % peak HR**

❖ **HR reserve (HRR) method (Karvonen Method)**

❖ [(HRmax - HR rest) x % (intensity)] + HRrest

Intensity: **Ventilatory Oxygen consumption (VO$_2$)**

- % VO$_2$max; % METsmax
- % VO$_2$R

  : [(VO$_2$ max - VO$_2$ rest) x (%intensity)] + VO$_2$ rest)

Prescription of Intensity of Exercise

Intensity	Relative intensity		
	% HRR or VO$_2$R	%HRmax	RPE
Very light	< 20	< 35	< 10
Light	20-39	35-54	10-11
Moderate	40-59	55-69	12-13
Hard	60-84	70-89	14-16
Very Hard	≥ 85	≥ 90	17-19
Maximal	100	100	20

ACSM 2005

Exercise Intensity

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

ACSM 2010

Intensity of exercise

การตรวจสมรรถภาพการทำงานของหัวใจ

- Results
- Cardiovascular response
- Maximum heart rate
- Maximum METs

Bruce Protocol; Total Exercise Time 7.30
Max HR 144 bpm (97% MPHR = 147 bpm)
Max BP: 178/72 Max Workload 9.3 METs
Max ST level -3.2 mm in V3
Exercise stage 3: 7 min
Reason for Termination: Dyspnea
Summary: Resting HR : normal, Functional Capacity: normal,
HR response to exercise: appropriate, BP response to exercise: normal ,
Chest Pain: none, arrhythmia: isolated PVC, ST-Change: depression Horizontal
Over-all Positive exercise stress test; good exercise tolerance

II	aVL	V2	V5	II	aVL	V2	V5
0.65	0.30	0.05	0.55	-0.50	0.45	-0.85	-0.90
0.01	-0.26	0.08	-0.11	1.58	-0.67	0.58	0.47

III	aVF	V3	V6	III	aVF	V3	V6
0.05	0.35	0.25	0.40	-0.55	-0.40	-3.00	-0.50
-0.24	-0.14	0.42	0.22	0.80	1.22	-2.65	-0.44

GE CASE V5.15 (0)
25mm/s 10mm/mV 50Hz 0.05Hz FRF+   Unconfirmed   Atten. g MD: Mallika W.   Page 1
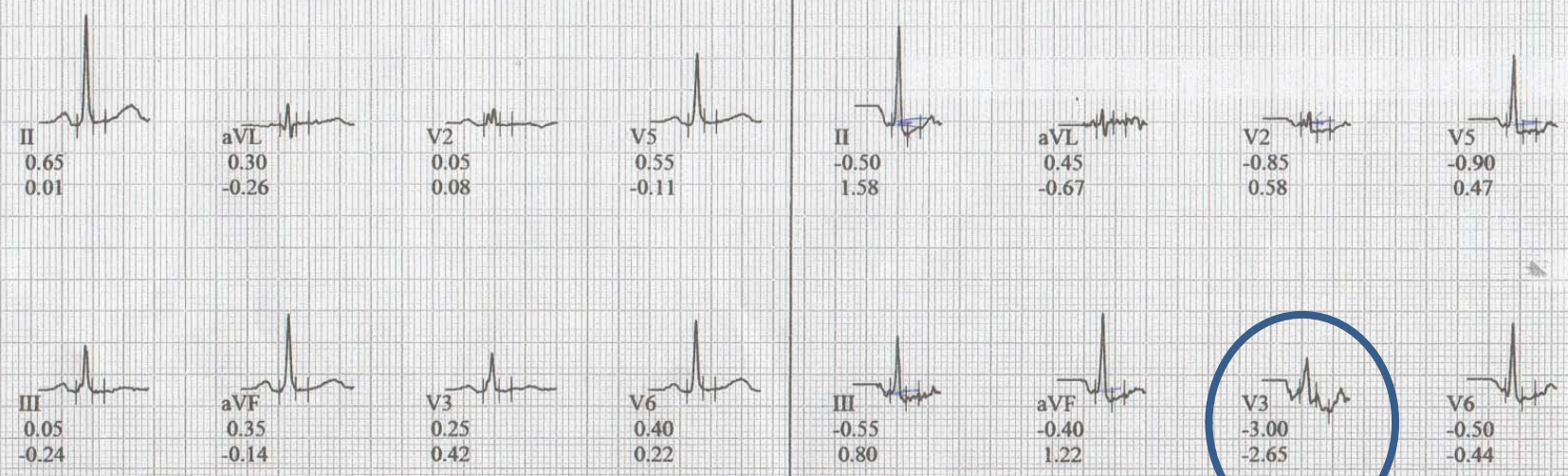
Exercise Prescription: heart rate

% of maximum heart rate

- ตรวจ EST,Max Heart Rate = **14**4 ครั้ง/นาที, Resting HR 65 ครั้ง/นาที Maximum METs = 9.3 METs, Max BP = 178/72 mmHg

- *Moderately Intensity Exercise = 64-76% maxHR*

- ผู้ป่วยสามารถออกกำลังกายจนระดับอัตราการเต้นของหัวใจ = 64-76% ของ **140** ครั้ง/นาที

    = 92 - 109 ครั้ง/นาที

    Karvonen's method (HRR)

Heart Rate Reserve Method: HRR

- Karvonen's method (HRR)

  = [(HRmax - HR rest) x % (intensity)] + HRrest

  = [(144 − 65) x (40-60%)] + 65

  = [(79) x (40-60%)] + 65

  = [32 − 47] + 65

  = 97 − 112 bpm

Ventilatory Oxygen consumption (VO$_2$)

- %HRR correlate with %VO$_2$R

- ตรวจ EST,Max Heart Rate = **14**4 ครั้ง/นาที, Resting HR 65 ครั้ง/นาที

  Maximum METs = 9.3 METs

- Moderate Exercise Intensity (40-60% of VO$_2$R)

  = [(VO$_2$ max-VO$_2$ rest) x (40-60%) +VO$_2$ rest

  = [(9.3 METs – 1 METs) x (40-60%)] + 1 METs

  = [3.3 – 5] + 1METs

  = 4.3 – 6 METs

Rate Pressure Product

- ตรวจ EST,Max Heart Rate = **14**4 ครั้ง/นาที, Resting HR 65 ครั้ง/นาที , Max BP 178/72 mmHg, Maximum METs = 9.3 METs, Positive for ischemia

- RPP: SBP x HR

- RPP: 178 x 144 =

- Prescribe exercise intensity: not exceed
    - ❑ Max HR – 10 bpm
    - ❑ Max RPP – 10%

PIYAVATE HOSPITAL
โรงพยาบาลปิยะเวท
Centers of Excellence

Perfect Heart Institute

Perfect Heart Institute at Piyavate
998 Rimklongsamsaen Rd., Bangkapi, Huay Kwang, Bangkok 10320
Tel: 0 2625 6786   Fax: 0 2625 6866

Exercise Stress Echo Report

Patient Information						
Patient Name:	Mr.Chamnong Songveeratham	**Date of study:**	June 4, 2006			
Patient ID:	05-002720	**Height :**	153	cm.	Weight	67.5 kg.
Age:	74 Yrs.	**BSA :**	1.85	m^2		
Gender:	Male	**Counter:**	282/2006			
Ward/Dept.	Heart Clinic	**Referred doctor:**	Prof. Nithi Mahanonda,M.D.			

M-Mode			**2D**			**Doppler**		
IVSd	13	mm.	LVOT Diam	–	mm.	MV E	1.15	m/s.
LVIDd	36	mm.				MV A	1.01	m/s.
LVPWd	12	mm.				MV DecT	236	ms.
IVSs	15	mm.				IVRT	–	ms.
LVIDs	24	mm.				LVOT velocity	0.97	m/s.
LVPWs	16	mm.				AV velocity	2.50	m/s.
EF (Teich)	63	%				TR Vmax	3.18	m/s.
Ao Diam	34	mm.				Max PG	40	mmHg.
LA Diam	46	mm.				RVSP	50	mmHg.
AV Cusp	14	mm.						
LA/AO	1.4							

Exercise Stress Echo Report

Bruce protocol: Exercise time 6.11 min, stage III, 7.2 METS, 94%MPHR
Normal HR and BP responses.
Termination due to dyspnea, no chest pain.

Rest EKG: Sinus bradycardia

Exercise EKG: Sinus tachycardia with occasional PAC, PVC. Horizontal ST depression > 1 mm in II, III, aVF, V4–V6 during recovery periods.

Rest Echo: Normal heart size. Good LV systolic function. No wall motion abnormality. Moderate AV calcification with mild AS, mild AR. Trivial MR. Trivial TR with moderate pulmonary HT.

Post exercise Echo: LV systolic contraction increased moderately with anteroapical and apicaoseptal walls hypokinesia.

Conclusion: Moderate AV calcification with mild AS, AR. Good LV systolic function.
Abnormal exercise stress echo suggestive of inducible ischemia in LAD territory.
Abnormal exercise ECG test.

Paisan Bunsiricomchai, MD.

June 4, 2006

Rate of Perceived Exertion Scale

Borg Scale; RPE Scale

ระดับคะแนนความเหนื่อย

6

7   รู้สึกสบาย *very very light*

8

9   ไม่เหนื่อย *very light*

10

11   เริ่มรู้สึกเหนื่อย *fairly light*

12

13   ค่อนข้างเหนื่อย *somewhat hard*

14

15   เหนื่อย *hard*

16

17   เหนื่อยมาก *very hard*

18

19   เหนื่อยที่สุด *very very hard*

20

Classification:

Intensity of endurance exercise; METs

Young (20 - 39)	Middle-Aged (40 - 64)	Old (65 - 79)	Very Old 80+	RPE	Level
< 2.4	< 2.0	< 1.6	< 1.0	< 10	Very light
2.4 - 4.7	2.0 - 3.9	1.6 - 3.1	1.1 - 1.9	10 - 11	Light
4.8 - 7.1	*4.0 - 5.9*	*3.2 - 4.7*	*2.0 - 2.9*	*12 - 13*	*Moderate*
7.2 - 10.1	6.0 - 8.4	4.8 - 6.7	3.0 - 4.2	14 - 16	Hard
> 10.2	> 8.5	> 6.8	> 4.25	17 - 19	Very hard
12	10	8	5	20	Maximum

ระยะเวลาในการออกกำลังกาย (Duration)

- Warm Up .... **10 นาที**
  - Stretching

- Conditioning .... **20 - 60 นาที**

- Cool Down .... **10 นาที**
  - Stretching

ความถี่ของการออกกำลังกาย (Frequency)

- **2 - 3 ครั้ง ต่อสัปดาห์**
- **เพิ่มขึ้นถ้าเป็นการออกกำลังกายแบบ Low Intensity**

การปรับเปลี่ยนการออกกำลังกาย
(Progression)

- **เพิ่ม** duration **แล้วค่อยเพิ่ม** intensity **ในการออกกำลังกาย**

- **การปรับ** intensity **ในการออกกำลังกายไม่ควรมากกว่าสัปดาห์ละ 1** METs

- **ควรให้ผู้ป่วยออกกำลังกายที่** intensity **เดิมอย่างน้อยอีก 1 ครั้งก่อนที่จะปรับเพิ่มความแรงในการออกกำลังกาย**
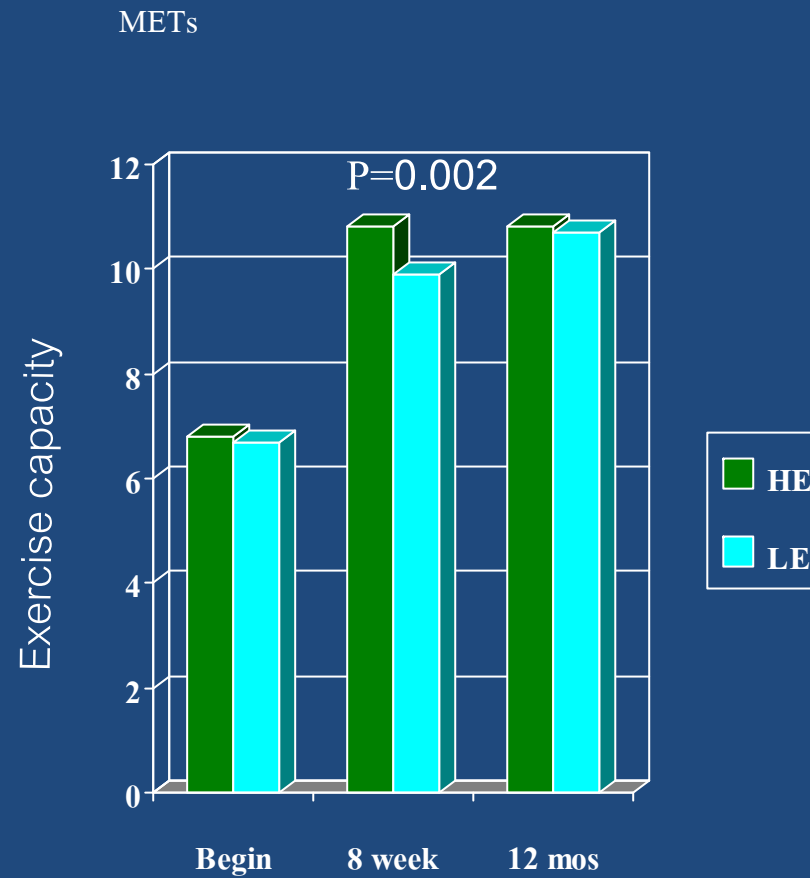
Interval Training

- ออกกำลังกายจนถึงจุดที่มีอาการ
- หยุดพักจนอาการดีขึ้น
- เริ่มออกกำลังกายใหม่จนได้ระยะเวลา
  ทั้งหมดตามที่กำหนดไว้

เช่น ผู้ป่วยที่มีอาการ ปวดขา เหนื่อยหอบ

Dose response:

High vs Low intensity exercise

METs

- **337** post acute MI
- exercise **2** months / FU **12** months
- Exercise capacity / EST
- HI : **75-85**% MHR; **3** d/w + walking
- LI : < RHR + **20**; **2**d/w + walking

Goble AJ, et al. Br Heart J 199195:126-131

Effect of low vs high intensity exercise

- 308 men, post-Q wave MI
- Exercise test before & after 8th week, 12th month
- High Intensity: 75-85% of MHR
- Low Intensity: < RHR + 20 BPM
- 8 weeks & follow up 12 months
- At 8 weeks: 0.9 METs less in LI
- At 12 months: non-significant difference in maximum METs

AJ Goble, et al. Br Heart J 1991;1665:126-31

Benefits of higher intensity exercise

- Improve LVEF (85% $VO_{2\,peak}$ compare to 50% VO_{2peak})
- Greater improvement of $VO_{2\,peak}$
- Greater improvement of VO_2 at Anaerobic threshold (60-70% $VO_{2\,peak}$)
- Improve endothelial function

Mortality & Exercise Capacity

Study	%↓mortality/1 METs
Blair, et al. (1989)	8
Dorn, et al. (1999)	8-14
Myers, et al. (2002)	12
CVD	9
Normal	16
Kavanagh T (2002)	9

1ml/kg/min VO_{2peak}

Resistance training

ตารางเปรียบเทียบผลของการออกกำลังกาย

:Aerobic endurance & resistance

ค่าชี้วัด	แบบแอโรบิก	แบบมีแรงต้าน
ความหนาแน่นกระดูก	↑↑	↑↑
% ไขมัน / LBM	↓↓ / ↔	↓ / ↑↑
ความแข็งแรง	↔	↑↑↑
ความไวต่ออินซูลิน	↑↑	↑↑
ไขมัน HDL	↑ ↔	↑ ↔
ค่าความดัน SBP / DBP	↓ ↔ | ↓ ↔	↔ | ↓ ↔
ปริมาณการใช้ออกซิเจนสูงสุด	↑↑↑	↑ ↔

Resistance Exercise

คำแนะนำของ	ระยะเวลาที่เริ่ม traditional resistance exercise (* > 50 1-RM)	Elastic band or light hand weights (1-5 lbs)	Exercise prescription
AACVPR	Post-MI : ≥ 5 สัปดาห์ Post-CABG : ≥ 8 สัปดาห์ Post -PTCA : ≥ 2 สัปดาห์	เริ่มได้ทันที่ที่เริ่มโปรแกรมระยะที่ 2	8 - 10 ท่า ท่าละ 12 - 15 ครั้ง
AHA	Post-MI : ≥ 4-6 สัปดาห์ Post-CABG : 12 สัปดาห์	Post - MI: ≥ 2 - 3 สัปดาห์	8 - 10 ท่า ท่าละ 10 - 15 ครั้ง
ACSM	Post-MI : ≥ 4 - 6 สัปดาห์ Post-CABG : 12 สัปดาห์ Post -PTCA : หลังจากเริ่ม aerobic exercise ≥ 2 สัปดาห์	เริ่มได้ทันที่ที่เริ่มโปรแกรมระยะที่ 2	8 - 10 ท่า ท่าละ 10 - 15 ครั้ง

การสั่งการรักษาด้วยการออกกำลังกายแบบมีแรงต้าน

ชนิดของเครื่องมือ

- elastic bands, cuff and hand weights, free weights and dumbbells, wall pulleys, weight machine

ความแรง (intensity)

- เริ่มจากน้ำหนักน้อยสุดที่มี

- หรือเริ่มจากการคำนวณของ 1 repetition maximum: 1-RM (น้ำหนักมากที่สุดที่ผู้ป่วยสามารถยกได้ 1 ครั้ง) หรือ 90% 1-RM (ค่อยๆเพิ่มน้ำหนักที่ยกทุก 2 นาทีเพื่อหาน้ำหนักมากที่สุดที่ยกได้ 2 ครั้งแต่ไม่ถึง 3 ครั้ง) หลังจากนั้นคำนวณหาน้ำหนักประมาณ 30-50% 1-RM

- RPE $\leq$ 13 หรือน้อยกว่าที่ผู้ป่วยออกกำลังกายแบบแอโรบิค

<u>การสั่งการรักษาด้วยการออกกำลังกายแบบมีแรงต้าน</u>

ระยะเวลาและความถี่ (duration & frequency)

- ออกกำลังกาย set ละ 10-15 ครั้ง 8 - 10 ท่าของการออกกำลังกาย ความถี่ 2- 3 ครั้งต่อสัปดาห์

การปรับเปลี่ยนการออกกำลังกาย (progression)

- เพิ่มน้ำหนักเมื่อสามารถยกน้ำหนักเท่าเดิมที่ 10 - 15 ครั้งได้อย่างปลอดภัย ค่อยๆปรับน้ำหนักเพิ่มประมาณ 2 - 5 ปอนด์ต่อสัปดาห์สำหรับร่างกายส่วนบน และ 5 -10 ปอนด์ต่อสัปดาห์สำหรับร่างกายส่วนล่าง

After Surgery

- 5-8 weeks: lifting restricted to 5-8 lbs (2.27-3.63 kg)
- ROME and lifting 1-3 lbs (045-.136 kg) is permissible if there is no evidence of sternal instability
- ROME limit due to onset of the feeling of pulling/mild Pain.

Flexibility exercise:

AACVPR recommendations

- **Frequency** $\geq$ **3** days/week

- **Intensity**   To a position of mild discomfort

- **Duration**   **10** - **30** seconds for each stretch

- **Repetitions**   **3** - **5** for each stretch

- **Type**   static

AACVPR Guidelines for cardiac rehabilitation and secondary prevention

BALANCE TRAINING

Falling problems in elderly

- ผู้ที่อายุมากกว่า 65 ปี โอกาสที่จะหกล้มสูงถึงเกือบ 40%
- เพิ่มเป็น 60% ค่อปีในอายุมากกว่า 80 ปี
- สำหรับประเทศไทยพบว่าผู้ที่อายุมากกว่า 60 ปีมีโอกาสหกล้ม ประมาณเกือบ 20%
- ผู้หญิงมีโอกาสหกล้มมากกว่าผู้ชาย
- ปัญหาหลังจากหกล้มนั้นก็คือ ปัญหาทางสุขภาพอีกมากมาย เช่น กระดูกหัก โดยพบว่าในผู้ที่อายุเกิน 85 ปีโอกาสที่จะมีกระดูกหักคือ 1/10 ครั้งของการหกล้ม และ 1/4จะต้องมีผู้ดูแลตลไป อีก ¼ จะเสียชีวิตภายใน 6 เดือนหลังหกล้ม

ความผิดปกติที่มีส่วนทำให้หกล้ม	การป้องกัน/รักษา
ระบบตา — เช่นสายตาผิดปกติ ปรับการมองเห็นได้ไม่ดี	จัดสิ่งแวดล้อมที่บ้านให้เหมาะสม
ระบบประสาทและการทรงตัว — การรับรู้ความรู้สึกและการตอบสนองต่อสิ่งต่างๆลดลง การทำงานของสมองลดลง สูญเสียการทรงตัว	โปรแกรมการฝึกการทรงตัว
กล้ามเนื้อและกระดูก — กล้ามเนื้อลีบเล็กและติดยึด การทำงานประสานกันของระบบกล้ามเนื้อและข้อต่อเป็นไปอย่างลำบากมากขึ้น กระดูกบางและเสื่อม	ออกกำลังกายเพื่อความแข็งแรง ทนทานและการทรงตัว เลือกใช้เครื่องช่วยเดินที่เหมาะสม
หัวใจและหลอดเลือด - เวียนศรีษะโดยเฉพาะเมื่อมีการเปลี่ยนท่าทาง	ปรับท่าทางในการดำรงชีวิตประจำวันให้เหมาะสม, ใส่ถุงน่องพิเศษ
การเดิน — เปลี่ยนไปเนื่องจากหลายสาเหตุดังกล่าวข้างต้น ทำให้เดินไม่มั่นคง เดินก้าวสั้น ยกเท้าพ้นพื้นได้ไม่มาก	ฝึกออกกำลังกาย, ฝึกเดิน
ยาที่รับประทาน — ยาหลายชนิดอาจจะมีผลต่อระบบหัวใจและหลอดเลือด ความรู้สึกตัวและการทรงตัว	พบแพทย์

Balance training exercise

- May need to proceed aerobic training especially for frail individual (combine with strengthening exercise)
  - Progressively difficult posture, gradually reduce base of support
  - Dynamic movements that perturb center of gravity
  - Stressing postural muscles group
  - Reducing sensory input
- Many type of exercise : chair exercise, ball, tai-chi, etc

การออกกำลังกาย *Phase* **2**

ข้อบ่งชี้ของการสิ้นสุด Phase **2**

- Functional Capacity　5　METs (age, activity level)

- Normal hemodynamic response to exercise

- Absent or stable angina pectoris

- Stable and/or controlled resting heart rate and blood pressure (HR < **90** bpm, BP < **140/90** mmHg)

- Adequate level of physical fitness for daily activities and occupational tasks

Classification:

Intensity of endurance exercise; METs

Young (20 - 39)	Middle-Aged (40 - 64)	Old (65 - 79)	Very Old 80+	RPE	Level
< 2.4	< 2.0	< 1.6	< 1.0	< 10	Very light
2.4 - 4.7	2.0 - 3.9	1.6 - 3.1	1.1 - 1.9	10 - 11	Light
4.8 - 7.1	*4.0 - 5.9*	*3.2 - 4.7*	*2.0 - 2.9*	*12 - 13*	*Moderate*
7.2 - 10.1	6.0 - 8.4	4.8 - 6.7	3.0 - 4.2	14 - 16	Hard
> 10.2	> 8.5	> 6.8	> 4.25	17 - 19	Very hard
12	10	8	5	20	Maximum

การออกกำลังกาย *Phase 3*

- หลังจากจบ Phase **2**
- การควบคุมอย่างใกล้ชิดลดลง
- ไม่ต้อง monitor ECG อย่างต่อเนื่อง
- Intensity การออกกำลังกาย อย่างน้อย **5** METs
  จนถึง **6 - 8** METs (age, activity level)

HOW TO TRAIN THE FAILING HEART?

Exercise prescription:
Pre-exercise evaluation

o Controlled heart failure

o Exercise test

o Pre-morbid status

o Associated symptoms or diseases

o 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 surgery
- Myocardial infarction within previous 3 weeks
- New onset atrial fibrillation

AACVPR 2004

Initiation of Aerobic exericse Program

- 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)

AACVPR 2004

Exercise Prescription

o **Type:** aerobic, resistance/strengthening

o **Mode:** cycling, walking, [less evidence: aqua exercise, yoga, tai chi, etc.]

o **Intensity:**

o **Duration:**

o **Frequency:**

o **Progression:**

Pre-exercise evaluation
Exercise Test

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

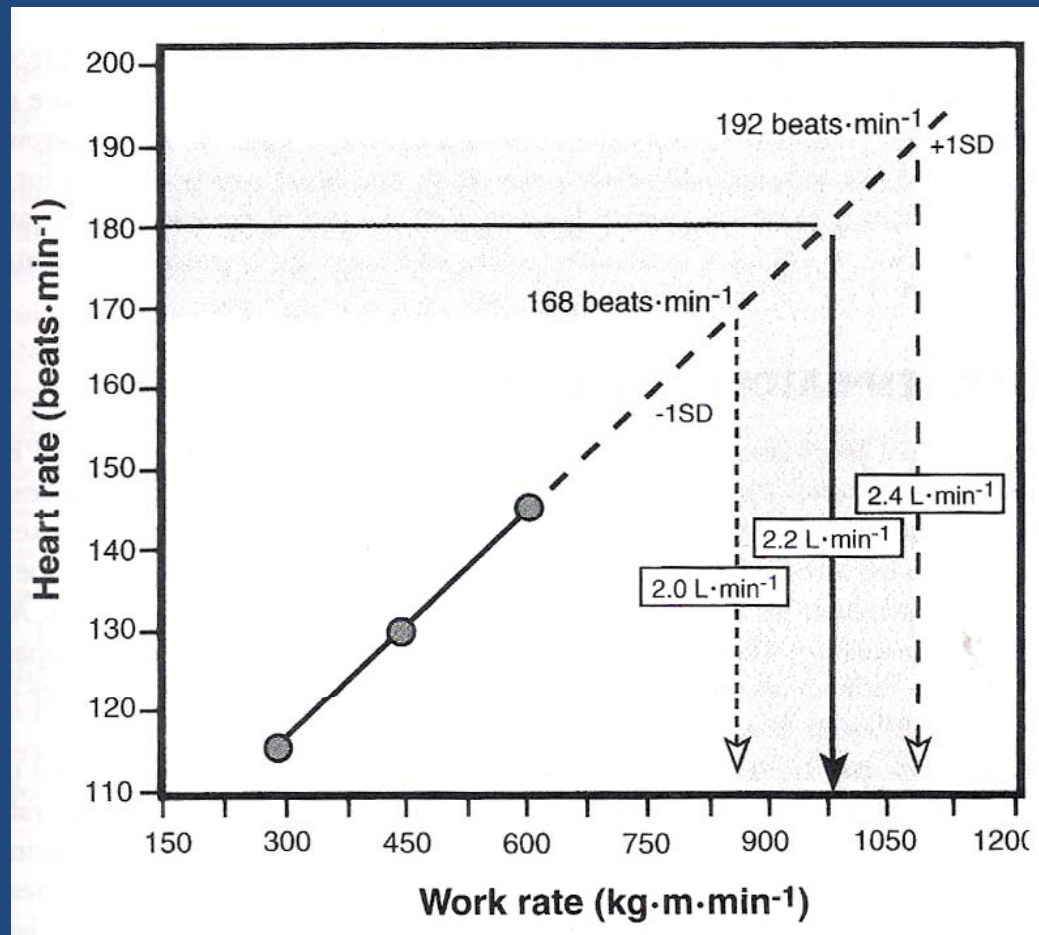ACSM Guidelines for Exercise Testing and Prescription 8th edition
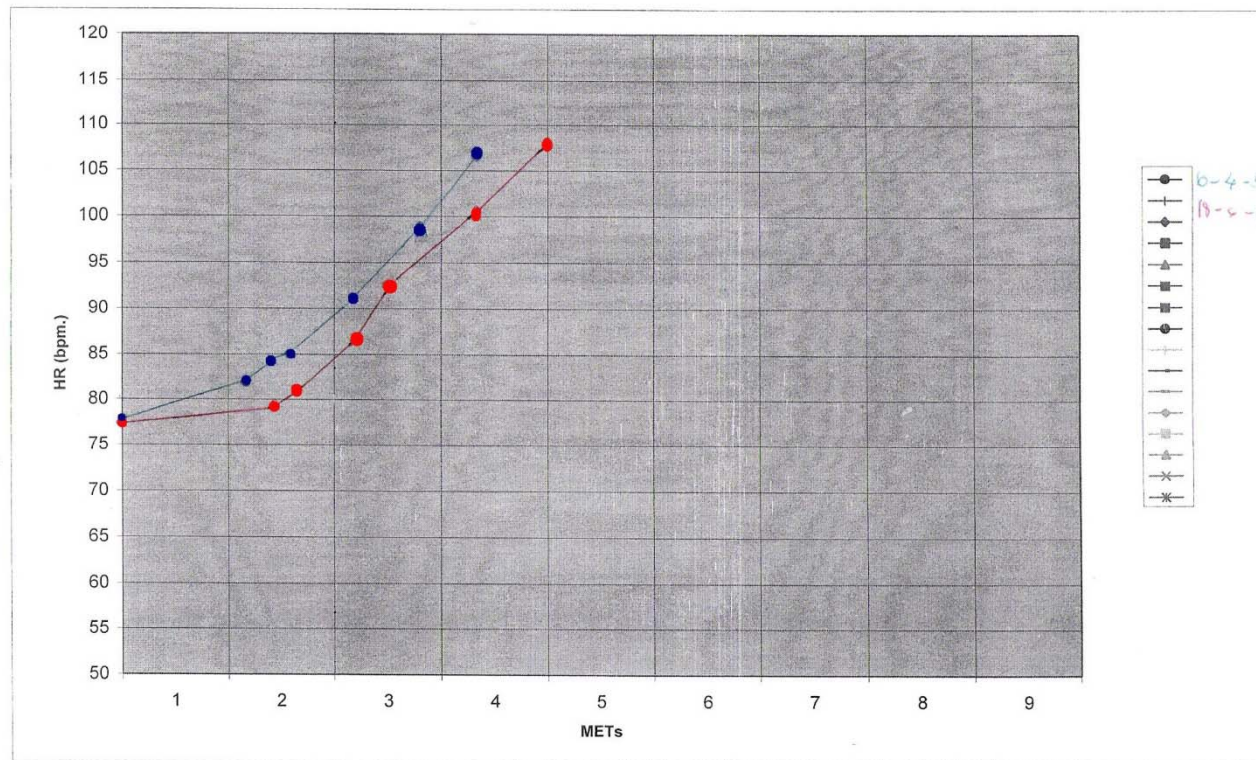
Six Minute Walk Test

Sub-maximum Exercise Test

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

Estimated VO$_{2 \, Max}$

Heart Rate Response to Exercise: Training Effects

Aerobic Exercise Prescription
Steady State vs. Interval

Interval Training

Steady State Training

| Warm Up | Cool Down | Warm Up | Cool Down |

Exercise Intensity

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

ACSM 2010

Aerobic Exercise Prescription: Steady State training

Steady State

- Intensity: 40 –80% VO_{2max}
- RPE = 12-13
- Duration; Frequency;Progression
- Depend on functional capacity
  < 3 METs: 5-10 min; multiple sessions
  3-5 METs: 15 min bid
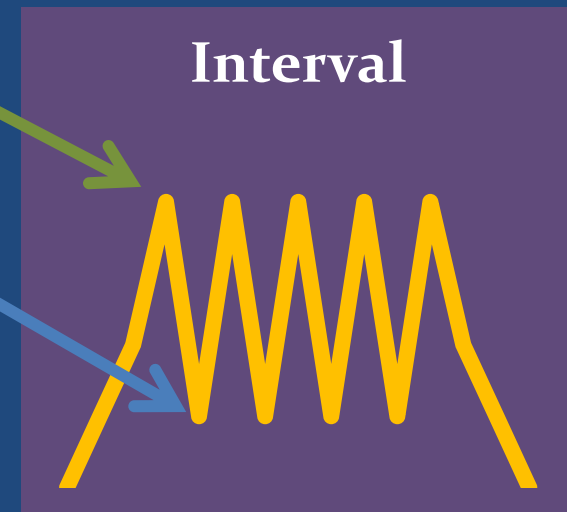 > 5 METs: 20 – 30 min/ 3-5 times/week
- Increase time before intensity

Aerobic Exercise Prescription: Interval training

o Be able to apply more intense training

o Intense: **25-95%** VO$_{2max}$

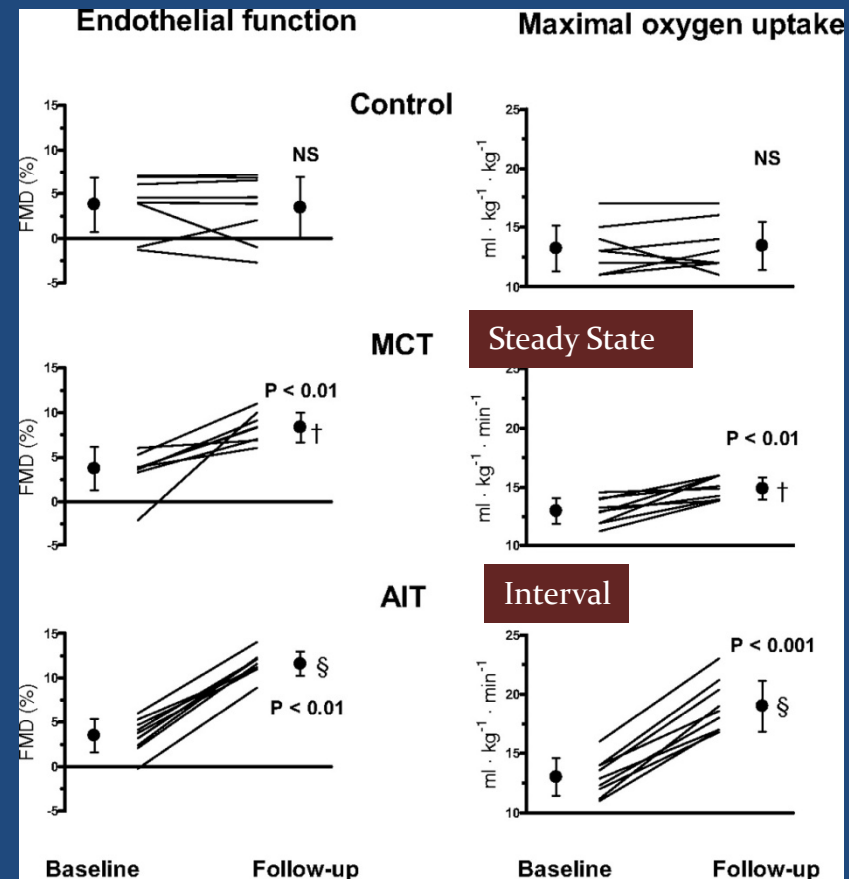o Interval time of Work Phase/Recovery Phase

Work Phase: 30-120 Sec

Recovery Phase: 60-120 Sec

Interval

Superior Cardiovascular Effect of Aerobic Interval training vs Moderate Continuous Training in HF patients: A Randomized study

- 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

Wisloff, U. et al. Circulation 2007

Is Resistance Training the More Efficient Modality Training in HF?

Med Sci Sports Exer 2007

45 HF , FC II-III, LVEF < 35%

Resistance

10 rep /rest 2 minutes
10 diff weight machines

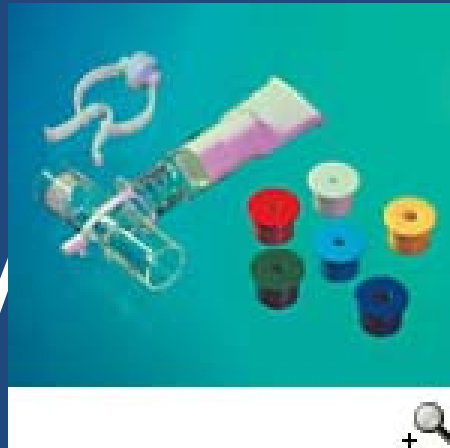Endurance
60%-75% of VO2 peak

Endurance-Resistance

Control

No significant difference between group:
$VO_{2\ peak}$, peak workload
knee extensor volume, knee extensor endurance

Resistance Training Guidelines for Cardiac Patients

Guidelines	Sets	Repetitions	# of Exercise	Frequency (day/week)
2000 AHA	1	10-15	8-10	2-3
2004 AACVPR	1	10-15	8-10	2-3

AHA: American Heart Association
AACVPR: American Association of Cardiovascular Pulmonary Rehabilitation

Antimicrobial
mouthpiece

Flap Valve

Spring
loaded valve

Calibrated
Spring

Transparent
grip with scale

Soft touch
load adjuster

Inspiratory Muscle Training in Heart Failure

6 minute walk test   **Peak VO$_2$**

- **Inspiratory Muscle Training Improves Blood Flow to Resting and Exercising Limbs in Patients with CHF** *JACC 2008*.
- **Effects of Inspiratory Muscle Training on Autonomic 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.*

14 pts; EF 22 ± 9% ;3 months

Mancini DM. Circulation 1995

ELECTRICAL STIMULATION: BENEFIT OF TRAINING IN HF

A randomized study of home-based *electrical stimulation of the legs* and conventional *bicycle exercise training* for patients with chronic heart failure

	Bike training group (n=24)	FES group (n=22)
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

Harris S, et al. Eur heart J 2003

Comparison of muscle functional electrical stimulation to 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 ($5.9 \pm 0.5\%$ to $7.7 \pm 0.5\%$, p <0.001).

The effect of muscle FES in patients with heart failure on endothelial function, although not equivalent to that of conventional exercise, is substantial. Muscle FES protocols may prove very useful in the treatment of patients with heart failure who cannot or will not adhere to conventional exercise programs.

CARDIAC REHABILITATION AND ATRIAL FIBRILLATION PATIENTS

Risk Factors for Atrial Fibrillation

- Heart Disease: CAD, IHD, VHD, Myocardial disease, etc
- Systemic disease effecting cardiac function: HT, hyperthyroid, chronic pulmonary disease, sympathetic/parasympathetic imbalance
- Perioperative period: post-CABG
- Structural and mechanical remodeling effecting atrium

Could Exercise be a new strategy to revert some patients with Atrial Fibrillation

- AF who were schedured to electrical cardioversion (18), age 36-74
- Role of Exercise stress test for reversion of AF: modified bruce protocal
- 5/18 (27%) had successful reverse to exercise

Atrial Fibrillation and exercise performance

- Reduce exercise capacity (15-20%)
- Increase resting HR and sub-maximal exercise HR
- Increase recovery heart rate

Cardiac Rehabilitation and Atrial Fibrillation

Mertens DJ, et al. J Cardiopulm Rehab 1996:16:193-6

Vanhees L, et al. J Cardiopulm Rehab 2000:20:346-352

Hegbom F, at al. J Cardiopulm Rehab 2006:26;24-29

Pippa L, et al. Prev Cardiol 2007: 10;22-5 (Qi gong)

- Improve exercise capacity, HRV, and QOL
- No Complications

Self-Cardioversion of Paroxysmal Lone Atrial Fibrillation with Exercise

- Approximately 30 episodes of atrial fibrillation occurred during the following eight years. *The patient successfully terminated all known episodes of atrial fibrillation through exercise,* with the use of either a cross-country ski machine or an elliptical trainer. The interval between the onset of atrial fibrillation and the initiation of exercise ranged from approximately 1 hour to 48 hours. *The total duration of exercise necessary for cardioversion ranged from approximately 20 minutes to 240 minutes. A ventricular rate of more than 160 beats per minute was achieved before successful cardioversion.* Episodes of paroxysmal atrial fibrillation terminated with exercise were recorded with a multiple-event recorder.

Peak Heart Rate
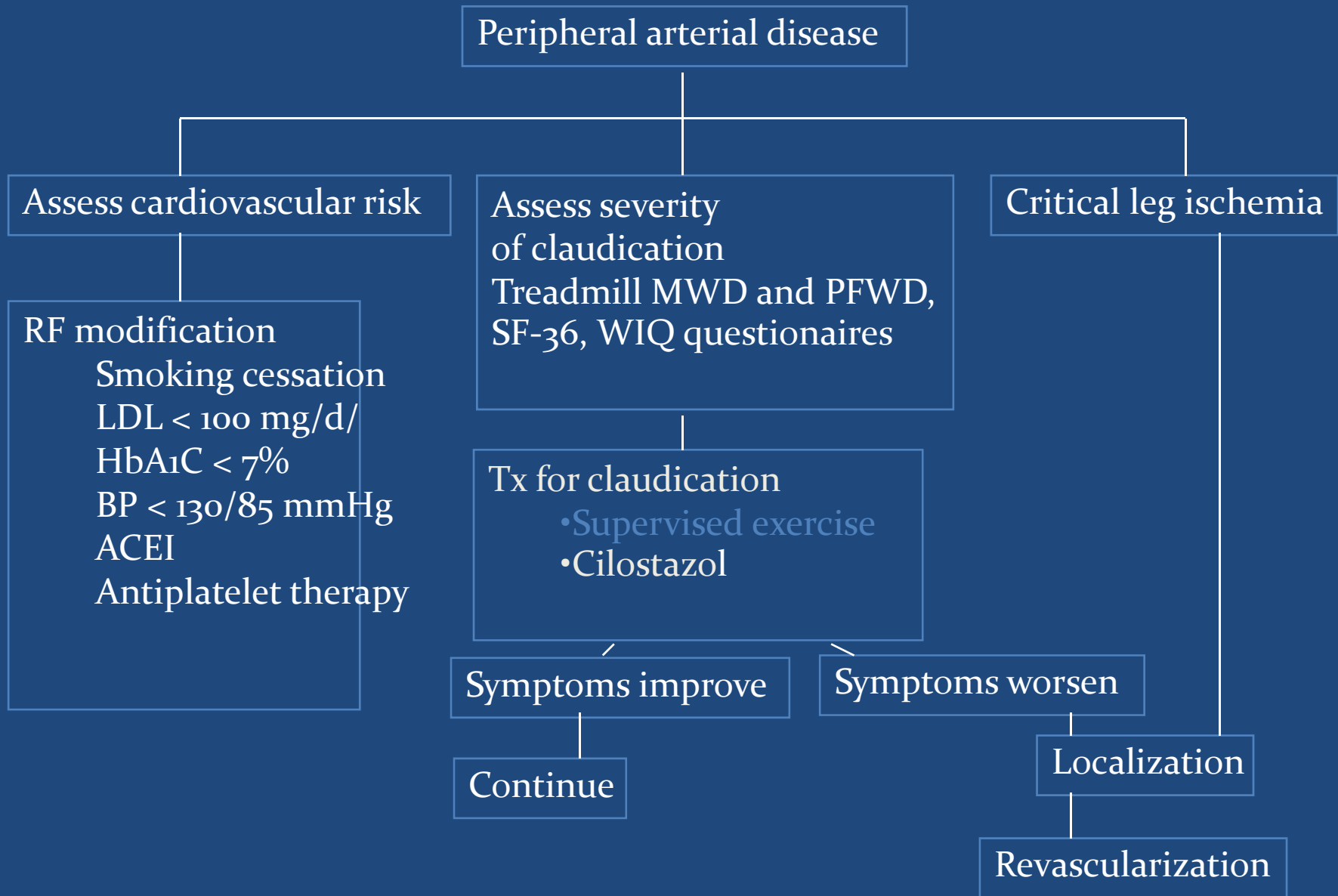Peak VO$_2$
Peak METs
CV resposnse to exercise
Result of the test

Precautions

- Uncontrolled atrial fibrillation is a Contraindication
- Bleeding Precautions
- Digitalis usage can cause ST segment depression that mimic ischemic response

CARDIAC REHAB FOR PAD PATIENTS

Peripheral arterial disease

Assess cardiovascular risk

RF modification
  Smoking cessation
  LDL < 100 mg/d/
  HbA1C < 7%
  BP < 130/85 mmHg
  ACEI
  Antiplatelet therapy

Assess severity
of claudication
Treadmill MWD and PFWD,
SF-36, WIQ questionaires

Tx for claudication
  •Supervised exercise
  •Cilostazol

Symptoms improve

Symptoms worsen

Continue

Critical leg ischemia

Localization

Revascularization

NEJM 2001:344;1608-21

Claudication:
Fontaine Classification

- **Stage**   **Symptoms**
  - I   Asymptomatic
  - II   Intermittent claudication
  - IIa   Claudication walking > 200m
  - IIb   Claudication walking < 200m
  - III   Rest/nocturnal pain
  - IV   Necrosis/gangrene

Risk Factors for PAD & IC

- Smoking
- Hypertension
- Diabetes
- Lipid abnormalities
- Elevated homocysteine
- Age
- Increase fibrinogen & blood viscosity
- Male sex
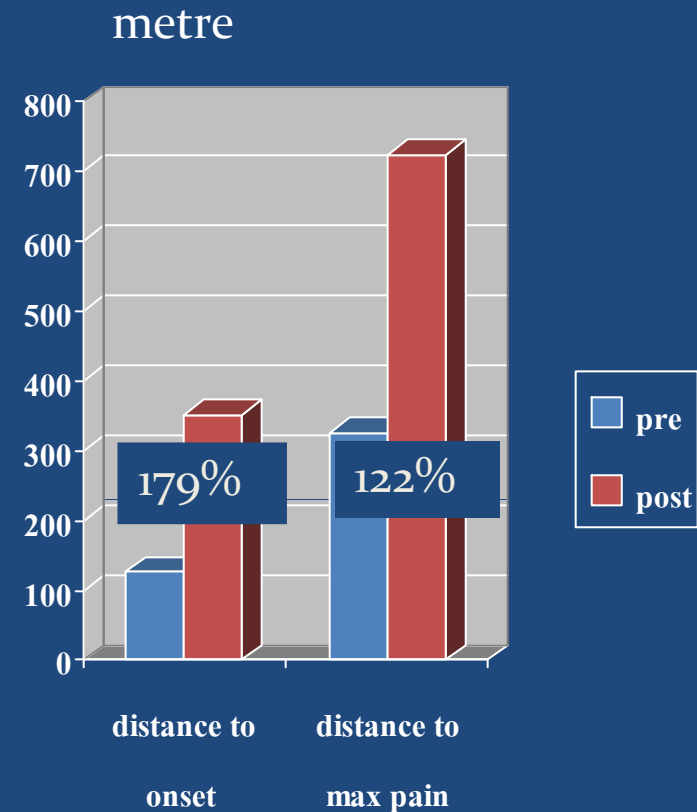- Lipoprotein(a)

Goal of treatment of PAD

- Relieve symptoms
- Improve functional status and quality of life
- Reduce progression of disease
- Reduce cardiovascular complications

Exercise and PAD

- Is it help PAD patients to
  - Improve intermittent claudication?
  - Improve functional status and quality of life?
  - Reduce progression of disease?
  - Reduce cardiovascular complications?
- What are the mechanisms?
- What is the recommendation?

Exercise Rehabilitation program for treatment claudication: meta-analysis

- 21 RCT (1966-93)
- Greatest improvement
  - > 30 minutes
  - ≥ 3 sessions/week
  - Walking exercise to near maximal pain
  - ≥ 6 months

metre

179% **122%**

pre
post

distance to onset

distance to max pain

Gardner AW, et al. JAMA 1995;274:975-80

Exercise & intermittent claudication

- 10 RCT (20-49 pts)
- FU: 12 weeks – 15 months
- Mostly treadmill testing & exercise
- ≥ 2 session / week with supervision

- Improve maximal walking time 150%
- Significant compare to
  – PAI at 6 months (3.3, 95% CI 2.21 – 4.39)
 – Antiplatelet (1.06, 95% CI 2.21 – 4.39)

Len GC, et al. Cochrane Database Sys Rev. 2000;(2):CD000990

Exercise and QOL, WIQ

- RCT; 64 pts(76 yrs)
- Exercise
  - Supervised
  - ≥ 30 minutes, 3 times/week, 12 weeks
  - Mild – moderate pain
- Outcome
  - Walking time, 6-MWT
  - WIQ (Walking Impairment Questionaire)
  - QOL questionaire (SF-36)

Tsai JC, et al. J Intern Med 2002:252;448-455
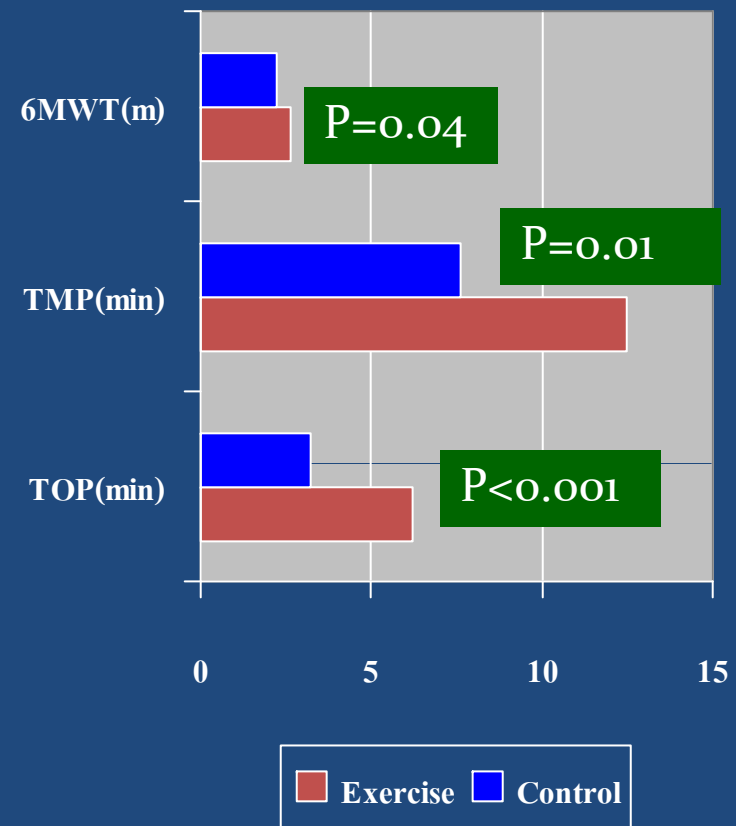
Exercise and risk factors

- 34 pts (68 years)
- Non-randomized
- 3 sessions/week, 15 – 40 minutes for 6 months
- Near maximal pain

Mg/dl

P < 0.01

P < 0.05

pre
post

SBP   TC   TG   LDL-C

Maria A, et al. J Vasc Surg 2000;31:670-7
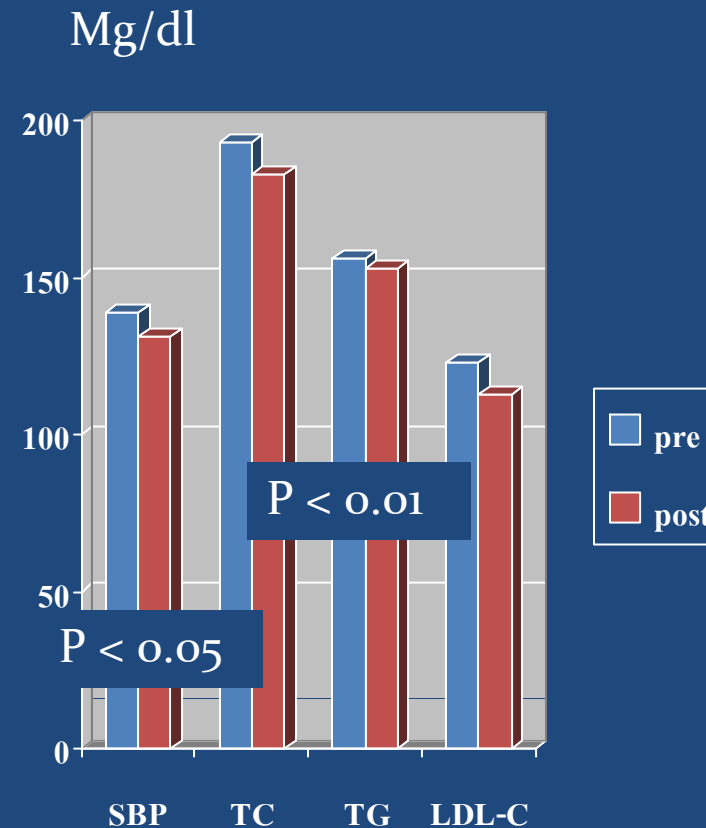
Percutaneous transluminal angioplasty & Intermittent claudication

- RCT; 62 pts
  - PTA & med
  - Med (aspirin) + RF + exercise
- FU 2 years

- No significant difference in
  - Pt's report of maximum walking
  - TM: maximal walking distance, onset to claudication

- Significant difference
  - PTA : fewer occluded arteries, lesser degree of stenosis

Whyman MR, et al. J Vasc Surg 1997;26:551-7

Exercise vs Angioplasty

- RCT, 56 pts
- 15 months, 6 years FU
- Outcome
  - ABPI: resting and after exercise
  - Treadmill claudication distance
  - Maximal walking distance
- Ex group significant improve walking compare to Angioplasty
- Especially in patients with superficial femoral artery

Perkins JM, et al. Eur J Vasc Endovascu Sur 1996;11(4)409-13

Mechanisms for benefits

- Improve endothelial function
- Improved oxidative metabolic capacity
- Redistribution of blood flow
- Increase collaterization
- Increase walking efficiency
- Improve oxygen consumption at submaximal workload
- Improve risk factors

What is the recommendation of exercise program?

- 33 exercise training; RCT
- Setting: supervised rehabilitation program
- Type: walking
- Intensity: near maximal pain
- Duration: intermittent
- Frequency: 3 session/week
- Total time: ≥ 6 months

Gardner AW, et al. JAMA 1995;274:975-80

What is the recommendation of exercise program?

Optimising exercise training in PAD

- 28 exercise training; RCT
- Setting: supervised rehabilitation program
- Type: walking
- Intensity: enough to cause pain
- Duration: 45 minutes, intermittent
- Frequency: 3 session/week
- Total time: $\geq$ 20 weeks

Bulmer AC, et al. Sports Med; 2004:34(14)983-1003

PAD: exercise prescription

Ex prescription	Details
Frequency	Weight-bearing aerobic exercise 3-5 days/week, resistance at least 2 days
Intensity	Moderate intensity (40-60%VO_2R), walk to reach pain score of 3 then rest until pain subside and resume exercise
Time	30-60 min / day, accumulative
Type	Mainly weight bearing type of exercise + resistance training

PAD: pain score

Score	Description
0	No pain
1	Onset of pain
2	Moderate pain
3	Intense pain
4	Maximal pain

Recent Pacemaker/Implant Cardioverter Defibrillator Implantation

- Pacemaker may improve FC as a result of improve HR response to exercise
- Upper HR limit of Dual-sensor rate responsive and VVIR pacemaker should set 10% below the ischemic threshold
- ICD implanted: intensity of exercise training should maintain at least 20 bpm below program HR threshold for defibrillation
- 3 weeks after implanted, should avoid activity that require raising hands above level of shoulders.

Cardiac Transplant

- Abnormally sympathetic nervous stimulation
- Resting HR and exercise HR
- Extend warm-up and cool-down
- Using RPE
- ROM and stretching exercise
- After 1 year: 1/3 of patients will have partial normalized HR response to exercise: THR from GXT can be used

Eastern Style of Exercise and CAD

- Tai Chi: Reduced BP (Preventive Cardiol 2008)
  - Systolic: 3-32 mmHg; Diastolic 2-18 mmHg
- Review 29 studies (9 RCT) (J Cardiopulm Rehabili Prev 2009)
  - Reduced BP, Improve Exercise capacity
- Tai Chi in HF patients: (American J of Medicine 2004)
  - improve functional capacity and reduce BNP level

Stress Management
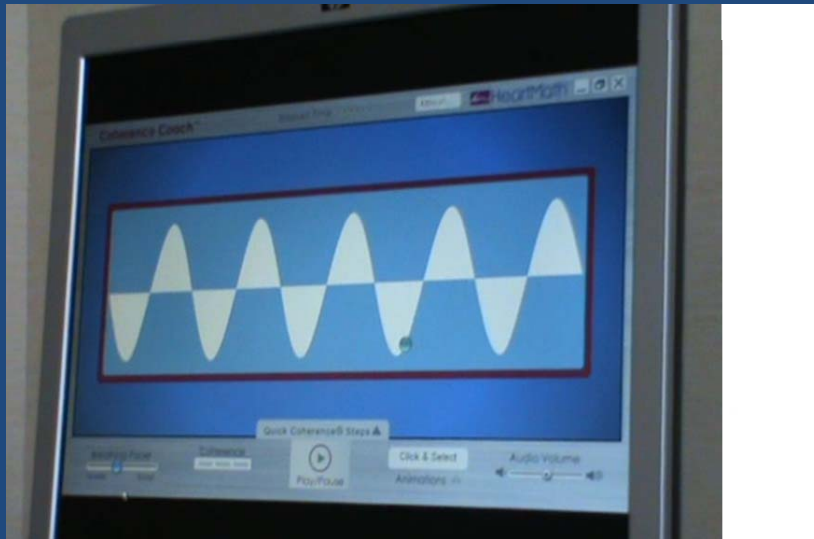
Biofeedback

Biofeedback & HRV

- Del Pozo JM, et al. Am Heart J 2004

Biofeedback treatment increase HRV in CAD patients

  – 63 CAD pts, RCT
  – Biofeedback increase HRV in CAD patients

- Swanson KS, et al. Apply Psychophysiol Biofeedback 2009.

The effect of biofeedback function in patients with heart failure

  – 29 HF pts, FC I-III, RCT
  – **Biofeedback is related to increase 6MWT but not HRV**

Meditation and Pray

Meditation & Pray

- **Effects of remote prayer on outcomes of patients in CCU:**
  - Arch Inter Med 1999;159
- Intercessory prayer for alleviation of ill health:
  - Cochrane Database 2007
- Effectiveness of transcendental meditation on functional capacity and quality of life in CHF: RCT:
  - Ethn Dis 2007
- Effects of RCT of TM on components of the metabolic syndrome in subjects with CHD:
  - **Arch Intern Med 2006**

Future Direction
of Cardiac Rehabilitation

Integrative Cardiac Rehabilitation

- Individualized
- Patients – Doctors/Medical staffs relationship
- Using the combination of various techniques, modalities, equipments
- Focus on physical, mind and spiritual
- Comprehensive including diet, education, etc