AQUATIC THERAPY IN CARDIAC REHABILITATION

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Introduction

- “Physical activity both prevents and helps treat many established atherosclerotic risk factors, including elevated blood pressure, insulin resistance and glucose intolerance, elevated triglyceride concentrations, low high-density lipoprotein cholesterol (HDL-C) concentrations and obesity”

(Thompson et al., 2003).

Intro…

- “exercise training in patients with cardiovascular disease increases exercise capacity, reduces cardiac ischemia, delays the onset of or eliminates angina pectoris, and improves endothelial function.”

Thompson (2005)

Intro…

- Water exercise is another example of exercise that is becoming more popular for cardiac patients and it “has been reported that water aerobics could be performed at an intensity to improve cardiovascular fitness”

(Darby & Yaekle, 2000)

- “due to the buoyancy of water, hydrotherapy exercises can improve mobility, strength, as well as cardiovascular fitness in patients with congestive heart failure (CHF).”

Cider, Schaufelberger, Sunnerhagen & Andersson (2003)

Definition

It’s a multi depth immersion pool or tank that facilitates the application of various established therapeutic interventions, including stretching, strengthening, joint mobilization, balance and gait training and endurance training.

Aquatic Therapy

- Useful tool to facilitate training & fitness
  - Movement skill & strength can be enhanced
- Effects
  - ↓ joint compression
  - ↓ muscular guarding
  - Useful in improving movement and fitness
- Basic Concepts as Land-based Rehab
  - Warm-up
  - Strengthening/mobility activities
  - Endurance/cardiovascular
  - Cool down/stretch

Land Versus Water Exercise

- Many different forms of exercise that people can perform to stay active once completing Phase II of cardiac rehab
- Water exercise is becoming a more popular choice among cardiac patients
- To track exercise intensity throughout water exercise can be difficult compared to land activities
- One reason for this is that “the density of water is about 800 times that of air and generates an increase in ambient hydrostatic pressure”

(Ayme, Rossi, Gavarry, Chaumet, & Boussuges, 2015)

Land Versus Water Exercise

- Darby and Yaekle (2000) : “comparing and contrasting of land and water exercise research results is sometimes difficult because a number of factors can affect HR and VO2 responses on land and in the water: cadence of movements, water depth, body position (prone, standing or floating upright with a wet vest), type of movement (arm and legs vs legs only exercises), percentage of body fat, or other extraneous variables.

Aquatic Exercise

- “Whole-body head-up immersion leads to a significant shift of blood into the intrathoracic circulation, followed by an increase in central venous pressure, heart volume and cardiac output”

(Schmid et al. 2007)

- Meyer and Bucking (2004) explained that the pressure of water as “during head-out water immersion, a 100-cm column of water exerts a pressure of 76 mm Hg on the body surface.”

Aquatic Exercise

- Some significant results from exercise training in water include
  - decreases in blood pressure (both systolic and diastolic)
  - decreases in resting and exercise heart rate
  - increases in muscular strength and endurance (exercise capacity)
  - increase in oxygen consumption, heart and ventricular function
  - increase in overall cardiovascular fitness

Cider, Schaufelberger, Sunnerhagen & Andersson, 2003; Tokmakidis, Spassis & Volaklis, 2008; Tanaka et al., 1997; Farahani et al., 2010; Magdar, Linnarsson & Gullstrand, 1981; Svealv et al., 2009

Aquatic Exercise

- Water temperature was a key factor when understanding the physiological differences between land and water exercise
- There are significance of the temperature as it pertains to thermoregulation and how the body reduces heat during exercise
- If water is cooler, then the body does not have to work as hard to regulate the body temperature
- Exercise factors during water exercise (type of movements in water, depth of immersion, water temperature) for cardiac patients need to be considered carefully when prescribing exercise

Heithold and Glass (2002)

Benefits of Aquatic Exercise

- Reduce stress on joints
- Increase muscle strength and tone
- Decrease pain
- Increase cardiovascular function
- Improve balance and coordination
- Decrease edema
- Improve posture and trunk control
- Increase in limited range of motion
- Improve circulation due to hydrostatic pressure

Benefits of Aquatic Exercise (cont.)

- Warm water promotes relaxation
- Improve proprioception
- Improve kidney functions
- Increase respiratory functions -due to hydrostatic pressure
- **FUN**

Goals

- Specific Goals:
  - Facilitate ROM
  - Initiate resistance training
  - Facilitate weight-bearing activities
  - Enhance delivery of manual techniques
  - Provide 3-dimensional access to patient
  - Facilitate cardiovascular fitness
  - Initiate functional activity
  - Minimize risk of injury/re-injury during rehab
  - Enhance patient relaxation

CONTRAINDICATIONS

- Onset of cardiac failure & unstable angina
- Respiratory dysfunction
- Severe peripheral vascular disease
- Danger of bleeding or hemorrhage
- Severe kidney disease
- Open wounds, skin infections
- Bowel or bladder incontinence
- Water & airborne infections or diseases
- Uncontrolled seizures
- Excessive fear of water
- Severely weakened or deconditioned state
- Colostomy bag or catheter used by patient
- Cognitive or functional impairment that would create a hazard to the patient in the pool
- Poor endurance
- Abnormal tone
- Severe or decreased range of motion that limits function

PRECAUTIONS

- Fear of water
- Impaired mobility getting in and out of pool
- Significant balance or vestibular disorder
- Orthostatic hypotension
- Recently healed surgical incision
- Absent or impaired peripheral sensation
- Respiratory dysfunction
- Colostomy/Tracheotomy tube
- Difficulty with bowel or bladder control
- Seizure disorder controlled well by medications
- Compromised vision without corrective lenses
- Compromised cardiac or respiratory system (poor endurance or asthma)

Water as a Medium for Exercise

- **Buoyancy**
  - Decreases the stress placed on joints resulting in less pain
  - Assists with movement by eliminating gravity
- **Resistance**
  - Allows for increased resistance without the use of weights, limiting the distraction of joints
- **Pressure**
  - Hydrostatic pressure reduces joint and soft tissue swelling
  - Improves joint position awareness
  - Assists with venous return
- **Relaxation**
  - Warm water allows for relaxation of muscles and blood vessels, improving blood flow

Properties of water

- **Buoyancy :**
  - it’s a upward force that work opposite to gravity

- **Clinical Significance:**
  - relative weightlessness and joint unloading
  - active motion with increased three-dimensional access to the patient

Properties of water

- **Hydrostatic pressure:**
  - it’s a pressure exerted on immersed object

- **Clinical Significance:**
  - reduces or limits effusion
  - centralizes peripheral blood flow
  - assists venous return, avoid DVT

- The proportionality of depth and pressure allows patients to perform exercise more easily when closer to the surface

Properties of water

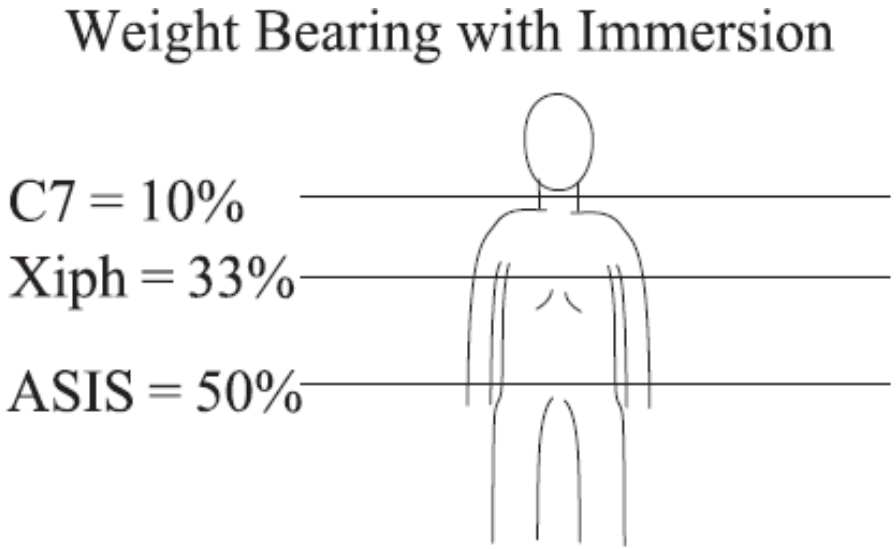
- **Viscosity :**
  - its is friction occuring between molecules of liquid resulting in resistance to flow

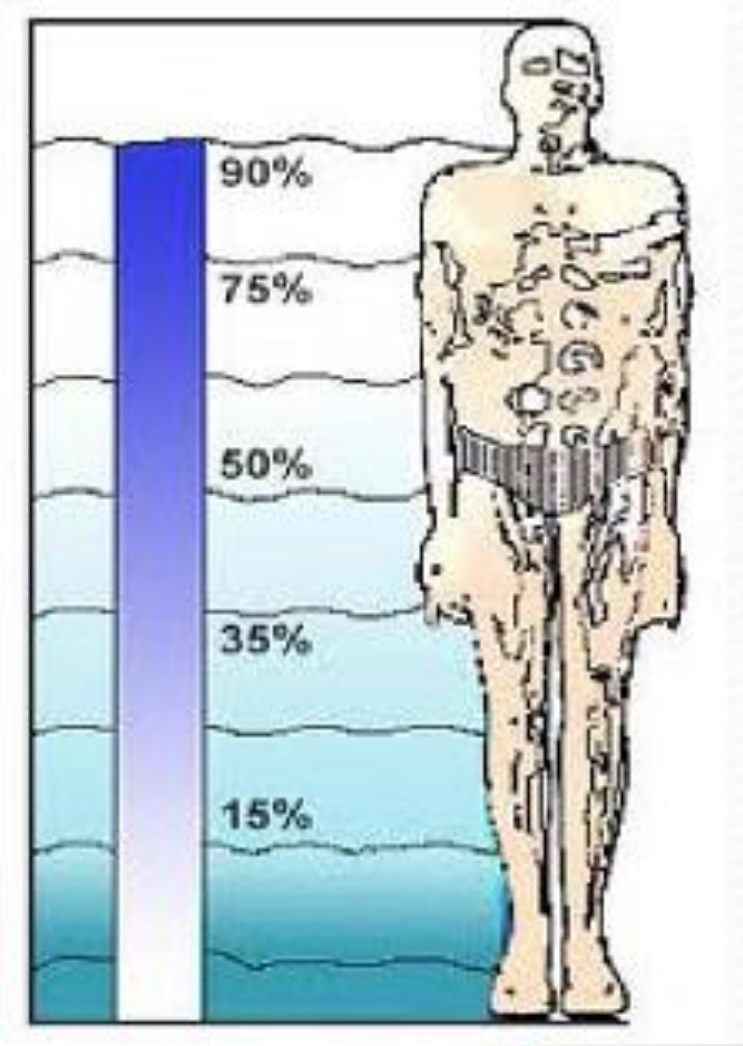
- **Clinical Significance:**
  - Creates resistance with all active movements
  - Increasing the surface area moving through water
  - increases resistance

Properties of water

- **Surface tension :**
  - the surface of fluid act as membrane under tension
  - It is measured as a force/unit length

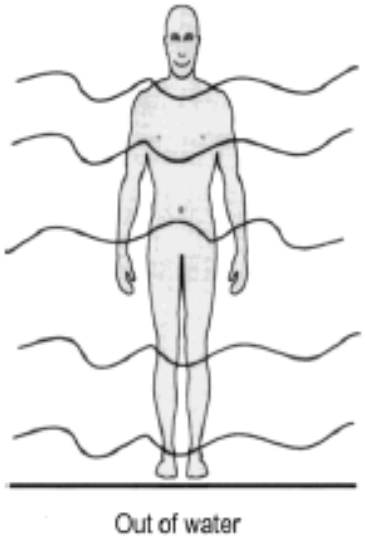
Percentage of weight bearing at various immersion depth:





Effect on Resting HR

Figure 1. Effects of Water Immersion Level on Resting Heart Rate

Heart Rate		Level of Immersion
↓ 15 ± 3 bpm		Neck
↓ 14 ± 3 bpm		Xiphoid Process
↓ 11 ± 3 bpm		Umbilical
↓ 1 ± 1 bpm		Knee
No change		Ankle

Adapted from Meyer and Bucking (2004).

Function of Equipment

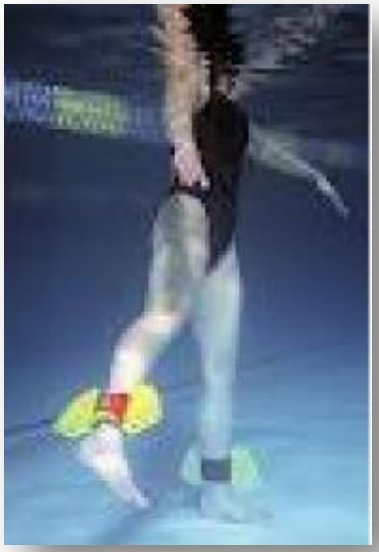
- Provide buoyant support
- Assist balance
- Generate resistance to the movement

Aquatic Exercise Equipment

- **Assistive**
  - Floats
    - Noodles
    - Vests
    - Belts
  - Dumbbells
  - Webbed gloves
  - Flippers
  - Kickboards

Aquatic Exercise Equipment(cont.)

- **Resistive**
  - Webbed gloves
  - Foam dumbbells
  - Paddles
  - Flippers
  - Jets



Aquatic Exercise Equipment (cont.)

- COLLARS, RINGS, BELTS
- SWIM BARS
- GLOVES, HAND PADDLES, HYDRO TONE BALLS
- FINS AND HYDRO TONE BOOTS
- KICKBOARDS

Components of Aquatic Exercise

- **Warm up**
  - 5-10 minutes
  - Gentle movements
  - Adapt to being in water
  - Walking

Components of Aquatic Exercise (cont.)

- **Stretching and ROM**
  - Can be used as part of the warm up
  - Range of Motion (ROM) should only be done within the normal range
  - Stretching should focus on any areas that are tight and should only be done within the normal ROM
  - Warm water will relax the muscles, enabling muscles to stretch easier

Components of Aquatic Exercise (cont.)

- **Strengthening/Toning**
  - Variables that impact strengthening/toning
    - Buoyancy
    - Resistance
    - Surface area
    - Turbulence
    - Lever arm length
    - Speed
    - Depth
    - Frequency
    - Repetitions

Components of Aquatic Exercise (cont.)

- **Aerobic/ exercise**
  - Walking
  - Swimming
  - Deep water bicycling
  - Deep water jogging
  - Treadmill walking/running
  - 10-20 minutes is the goal
    - May need to start at 2-3 minutes and gradually work up to longer time frame

Components of Aquatic Exercise (cont.)

- **Cool down**
  - 5 minutes of relaxing movement
    - Slow walking
    - Gentle swimming/floating

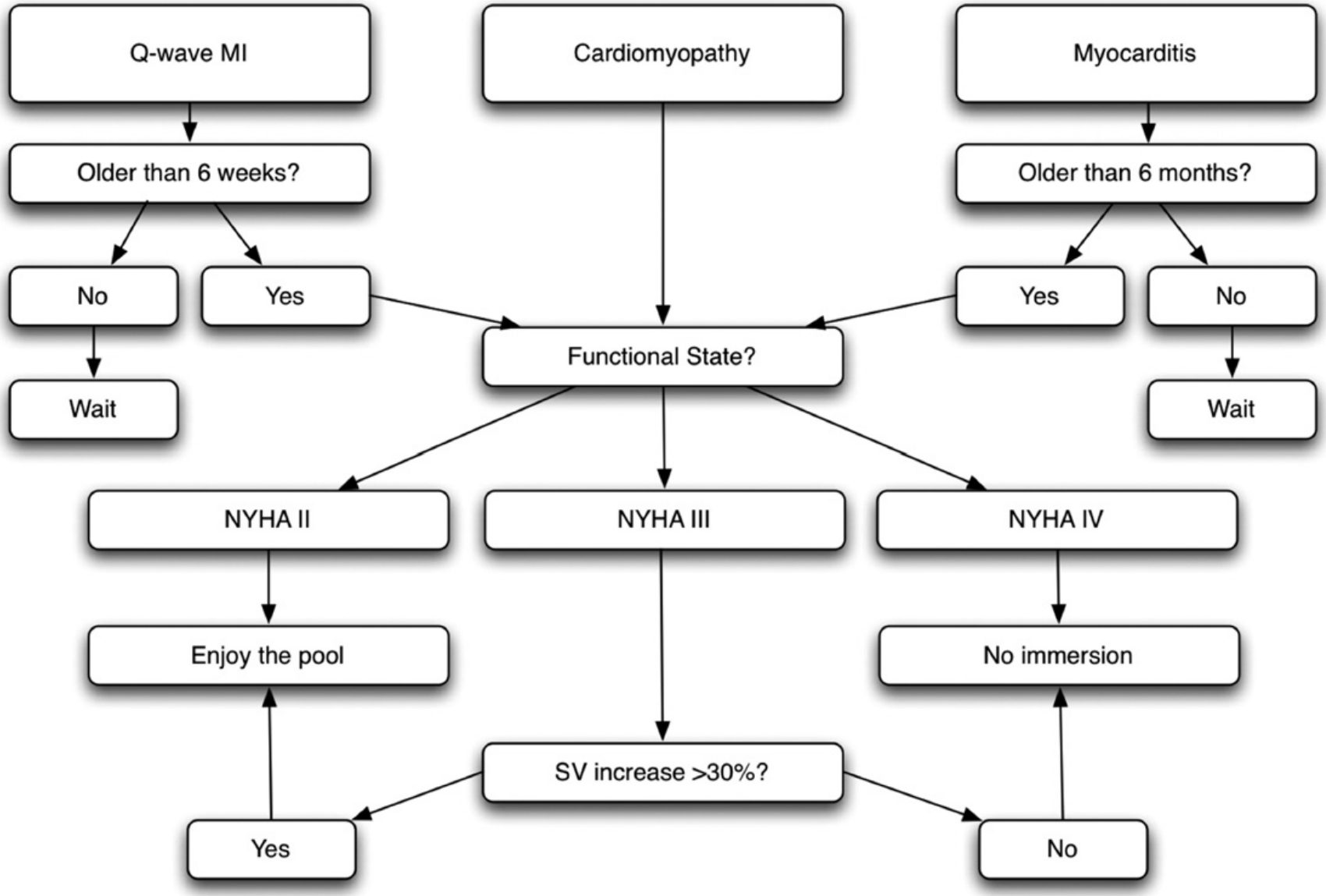
Additional Components of Aquatic Exercise

- **Balance** -floats assist, turbulence challenges
- **Trunk control/Strength** -turbulence will challenge
- **Proprioception** –
  - Ankle weights assist
  - Buoyancy will challenge
  - Water takes away visual accuracy -improves prop
- **Coordination**
  - More challenging with resistance of water

Immersion Temperatures For Rehabitative Issues

	Aquatic Temperatures				
Suitable activities	Cold (10°-15° C)	Cool (26°-29.5° C)	Neutral (33.5°-35.5° C)	Warm (36°-38.5° C)	Hot (37.5°-41°)
Post-exertional recovery	✔				
Contrast baths	✔			✔	✔
Vigorous exercise		✔			
Arthritis exercise			✔		
Typical Aquatic Therapy			✔		
Cardiac Rehab			✔		
Multiple Sclerosis exercise		✔			
SCI programs			✔		
Parkinson's programming			✔		
Relaxation				✔	✔

A Clinical Algorithm for Aquatic Activity Decision-Making



Adapted from Meyer & Leblanc, Clin Invest Med, Vol 31:2, April 2008

Effect on hemodynamic

- Central venous pressure rises with immersion to the xiphoid and increases until the body is completely immersed
- There is an increase in pulse pressure as a result of the increased cardiac filling and decreased heart rate during thermoneutral or cooler immersion
- Central blood volume increases by 0.7 L during immersion to the neck, a 60% increase in central volume, with one-third of this volume taken up by the heart and the remainder by the great vessels of the lungs
- Cardiac volume increases 27%–30% with immersion to the neck

Arborelius M, Jr., Balldin UI, Lilja B, Lundgren CE. Hemodynamic changes in man during immersion with the head above water. Aerosp Med 1972;43:592-598.
Gabrielsen A, Johansen LB, Norsk P. Central cardiovascular pressures during graded water immersion in humans. J Appl Physiol 1993;75: 581-585.
Gabrielsen A, Warberg J, Christensen NJ, et al. Arterial pulse pressure and vasopressin release during graded water immersion in humans.
Am J Physiol Regul Integr Comp Physiol 2000;278:R1583-R1588.
Risch WD, Koubenec HJ, Gauer OH, Lange S. Time course of cardiac distension with rapid immersion in a thermo- neutral bath. Pflugers Arch 1978;374:119-120.

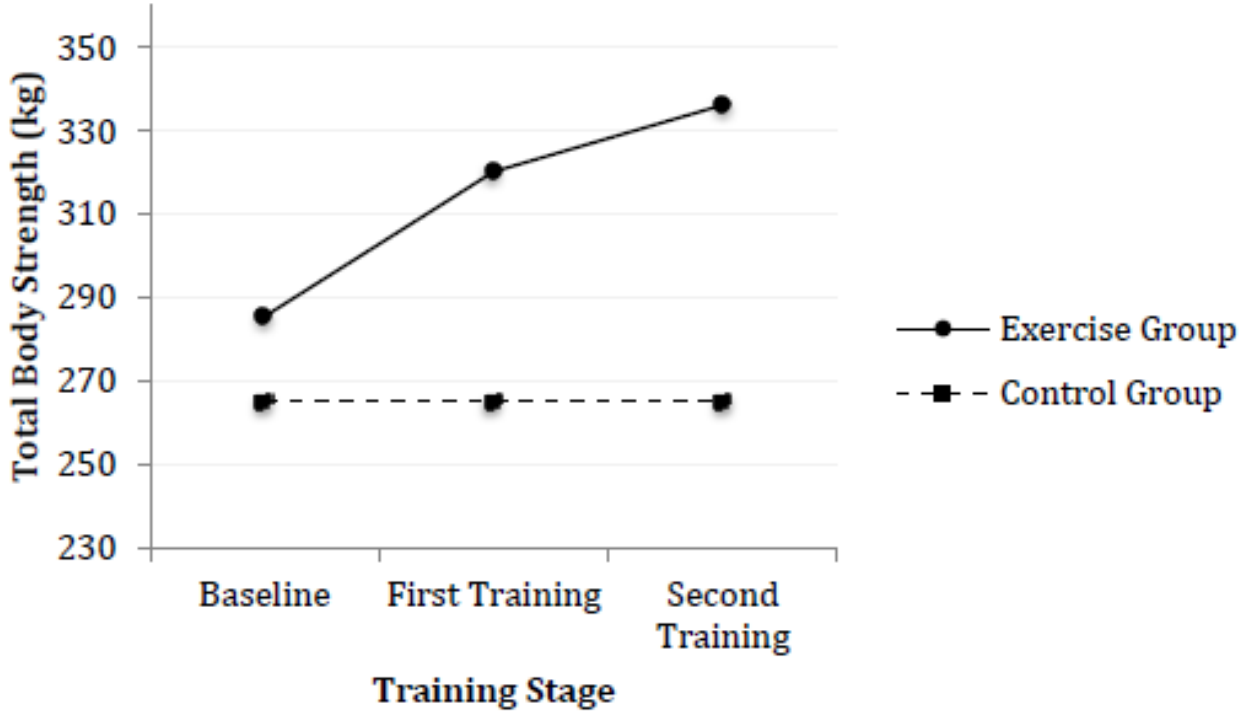
Changes in Resting Heart Rate and Blood Pressure After a 10-Week Swimming Program in Hypertensive Adults

Variables	Before Training	After Training
Resting HR (bpm)	80.8 ± 3.8	70.7 ± 3.2*
Seated Blood Pressure (mmHg)	Systolic: 150 ± 5 Diastolic: 96 ± 4	Systolic: 144 ± 4* Diastolic: 94 ± 3
Supine Blood Pressure (mmHg)	Systolic: 141 ± 5 Diastolic: 90 ± 4	Systolic: 135 ± 5* Diastolic: 85 ± 3

Tanaka, H., Bassett Jr, D. R., Howley, E. T., Thompson, D. L., Ashraf, M., & Rawson, F. L. (1997). Swimming training lowers the resting blood pressure in individuals with hypertension. Journal of Hypertension, 15 (6), 651-657.

Effects on body strength

Figure 2. Effects of Water Exercise on Total Body Strength After Two Sessions of Water Training in Patients With CAD



Adapted from Tokmakidis, Spassis, and Volaklis (2007).

Effects on Exercise Capacity and Endurance

Measure	Participant Group	Before	After
Exercise Capacity (W)	Training	84 ± 23	91 ± 24
	Control	74 ± 25	70 ± 22
VO_2 (ml/kg·min)	Training	14.3 ± 2.7	15.3 ± 3.2
	Control	14.3 ± 3.0	12.5 ± 2.7
6-Minute Walk (m)	Training	421 ±115	450 ± 94
	Control	329 ± 98	335 ± 95

Adapted from Cider, Schaufelberger, Sunnerhagen and Anderson (2003).

Effects on Ventricular Function

Variables	Baseline	After Water Exercise
Cardiac Output (L/min)	3.1 ± 0.8	4.2 ± 0.9
Stroke Volume (mL)	43.9 ± 13.6	64.4 ± 16.5
LVEF (%)	31 ± 9	35 ± 8
DFV (cm/sec)	8.3 ± 1.8	9.5 ± 1.8

Adapted from Svealv et al. (2009); LVEF – left ventricular ejection fraction; DFV – diastolic filling velocity; L/min – liters per minute; cm/s – centimeters per second.

Water Exercise Recommendations for Instructors and Patients

Instructors	Patients
Allow breaks for patients throughout water exercise; every 10 minutes if possible	Take breaks during exercise about every 10 minutes if possible
Set pool to the correct temperature for each exercise	Be able to check HR properly either manually or with underwater HR monitor
Choose appropriate water immersion levels for each exercise session	Be careful with temperature, water immersion, and intensity during exercise for safety
Make sure to have medical personnel and/or hospital close by in case of emergency with patients	Check with instructor about medical personnel and/or hospital nearby in case of emergency

Clinical implications for patients with LVD and/or CHF

- Immersion up to the neck could produce abnormal hemodynamic responses temporarily
- Decompensated HF is an **absolute contraindication** for water therapy
- Feeling good in water is no guarantee that the LV tolerates the increased volume loading caused by immersion
- Patients with previous severe myocardial infarctions and/or CHF who can sleep supine may bathe in a half sitting position (e.g. balneotherapeutic baths), but immersed no deeper than the xiphoid process
- Therapeutic water exercises in a pool, e.g. for orthopaedic reasons, can be allowed for patients with Q-wave MI older than 6 weeks, and/or moderate CHF, provided that patients are in an upright position and immersed no deeper than the xiphoid process

Meyer & Leblanc. Aqua therapy in left ventricular dysfunction and heart failure; Clin Invest Med • Vol 31, no 2, April 2008

Example of Water Exercise for CAD

- Warm up- 5 min
  - Water walking at chest height
  - Floating on back with supports at neck/pelvis
- Stretching
  - Only areas of tension working within normal range of motion
- Strengthening
  - Upper Extremity (UE) exercises
    - No resistance, slow movements, use of buoyancy to support/assist
  - Lower Extremity (LE) exercises
    - No resistance, decreased speed
    - May use buoyancy to support/assist if needed

Example of Water Exercise for CAD (cont..)

- Aerobic Exercise
  - Treading water
    - Begin with 10-30” trials x 3
    - Progress to 1-2 min. trials x 2-3
  - Walking in chest-waist deep water
    - Begin with 2-3 min. trials x 3
    - Progress to 5-10 min. trials x 2-3
    - Progress to 20-30 min. x 1
  - Aqua jogging (use Flotation Belt)
  - Supine back glides using Bilateral Arms and legs
  - Supine/prone swimming using kickboard to support UE while LE kicks slowly or as tolerates
- Cool down -5 min
  - Gentle supine float with flotation device with gentle movement
  - Water walking at chest height

CRP Activities in Serdang Hospital

Conclusion

- Aquatic exercise is highly promoted and increase popularity in CR
- CVD patients who feel uncomfortable on land cardio exercise can feel more comfortable in water
- Aquatic aerobic and strength training are safe for stable CHF and CAD patients
- ENJOYMENT in exercise and physical activities prescription are keys for sustainable and compliance to CR

"the symptoms of debility of the heart are often removable by a regulated course of gymnastics, or by pedestrian exercise"

1804-1878

.....In the body, there is a piece of flesh, if it is sound, the whole body is sound, if it is corrupt, the whole body is corrupt, and behold, it is the HEART.

Terima Kasih

Stokes W. *The diseases of the heart and the aorta*. Dublin: Hodges & Smith, 1854.