The Aging Circulatory System: Optimizing a Performance Engine
Kevin J. Makati MD FACC FHRS
Co Director Electrophysiology Laboratory
SJH/SJH North

Outline
• A. Basic principles of the circulatory system
• B. The circulatory system as it ages over time
• C. Current literature regarding expected performance curves of the aging master athlete
• D. Common cardiovascular disease states that affect the master athlete
• E. Methods for maintaining optimal cardiovascular health while exercising

PART 1
BASIC CARDIOVASCULAR PHYSIOLOGY
Basic Cardiopulmonary Physiology

- The cardiovascular system is composed of a highway which sends and returns blood flow from the heart
- **Blood** has red blood cells which serve to exchange oxygen and carbon dioxide from muscles and tissue
- **Performance** is therefore a function of the ability to transport blood effectively (heart function), deliver oxygen (blood capacity), and utilize nutrients effectively (muscle efficiency)

Cardiovascular Physiology

Life Expectancy
Causes of Death: Then and Now

The Mechanism of Aging

- Why we age is poorly understood. The maximum age a human has been recorded to live is 122 years of age.
- Aging is influenced by intrinsic (genes) and extrinsic (environmental) factors.
- Intrinsic factors can be further divided to the lack of circulating proteins to prevent aging and a reparative process gone awry.

Circulating factors

- Premature human aging called Progeria has provided insight as to why humans age.
- Mice with mutated genes (klotho) show premature aging.
- Cells which reproduce are known to have shorter telomeres.
Sam Berns dies at 17 from Progeria

The Telomere Hypothesis

PART 2
THE AGING HEART
The Aging Circulatory System: Problem #1: Elasticity

- Blood vessels have decreased ability to stretch
- This results in increased blood pressure
- This results in increased work and long term deterioration

The Aging Circulatory System: Problem #2: Dropout and Stiffness

- Total muscle fibers of the heart decrease with age
- This results in increased wall thickness
- This results in decreased heart efficiency

The Aging Circulatory System: Problem #3: Electrical issues

- 50-75% of electrical cells in the heart die by the age of 50
- The body’s natural pacemaker ages and is therefore less responsive
- Increased susceptibility to electrical malfunction
PART 3

PERFORMANCE OF THE AGING HEART

VO2 Max as a Function of Aging

Response to Upright Exercise
The Bottom Line

- Elderly hearts compensate the inability to increase heart rate by increasing the volume of blood ejected with each beat of the heart.
- Elderly hearts are less responsive to natural adrenaline.
- Elderly hearts are more dependent on the upper chambers of the heart called atria.
- The amount of blood that can be ejected by the heart decreases by 8cc/year.

1. Am J Geriatr Cardiol. 2003;12(1)
2. Age-Related Differences in Left Ventricular Structure and Function, the Multiethnic Study of Atherosclerosis

Age Related Decline in Triathletes

Age Related Performance Loss

- VO2 max decreases with age 10%/decade beyond age 25 and steeply after 60.
- Muscle area decreases by 40% between 20-80 years of age.
- Fast twitch muscle fibers decrease to a greater degree then slow twitch.
- Older adults utilize less fat during endurance exercise then younger athletes.
Cardiovascular Risks to the Master Athlete

- The most common cause of sudden cardiac death in athletes > 35 is coronary artery disease
- Less common causes include
  - Hypertrophic cardiomyopathy
  - Valvular disease
  - Myocarditis or infection of the heart
  - Electrical abnormalities

Heart Related Disease by Age

Effect of Exercise by Amount

Cardiovascular Risk


Sudden Cardiac Arrest During Sports Activity in Middle Age Circulation.2015; 131: 1384-1391
Risk of Death by Amount of Exercise

Effect of Weight Training on BP

Weight lifting and rupture of silent aortic aneurysms
- Anecdotal reports have shown rupture of the initial segment of the aorta while weight lifting
- The diameter of the aortas were not great enough to explain spontaneous rupture
- The authors conclude limiting weight lifting in patients with family histories, predisposing disease, high blood pressure or known aneurysm
Cardiovascular Risks to the Master Athlete

• Prehypertension (120–139/80–89 mm Hg)
• Stage 1 hypertension (140–159/90–99 mm Hg)
• Stage 2 hypertension (160/100 mm Hg)

Athletes who have stage 2 high blood pressure should be restricted from static high resistance and high intensity sports.

Iron Nun Madonna Bruder at 84
The Good News

- Muscle mass is directly related to peak strength but not necessarily performance
- Muscle power is lost at a greater rate than endurance capacity
- Resistance training modifies age related changes
- Age related decline in strength can be delayed or diminished by resistance training more effectively than aerobic

The Joel Friel Method

- Workout Intensity
- Strength Training
- Sleep
- Nutrition

Workout Intensity

- 3 modifiable elements
  - Workout duration, intensity, and frequency
  - Consider maintaining intensity while maintaining muscular endurance instead of long and slow
  - Consider a medical evaluation before engaging in intense activity
Strength Training

- Aging results in decreased muscle mass
- Consider increasing mass with weight training
- Beneficial “side effects” of weight training include weight loss and increase in bone density

Sleep

- Lack of sleep has deleterious effects on the cardiopulmonary system
- Lack of sleep affects interrupts reparative processes
- Snoring or obstructive sleep apnea has been shown to increase the risk of cardiac arrhythmia, and high blood pressure

Nutrition

- Micronutrients (vitamin and minerals acquired through diet)
- Caution with vitamin supplementation as observation trials have shown a higher risk of cancer and death
- Macronutrients before and after exercise to promote muscle mass
Caution with Extreme Sports

- Sustained elevated heart rates have been shown to cause electrical disorders of the heart
- Extreme sports have been shown to cause heart muscle damage mimicking heart attacks
- Escalation of blood flow has been theorized to promote atherosclerosis

Endurance Sports and AF

Testosterone and Cardiovascular Risk

- Highly controversial and currently off label
- FDA now requires a label change to include the risk of cardiovascular disease and stroke
- Supplementation now requires the addition of an associated medical condition
- HIGHLY CONTROVERSIAL
Summary Statements

• Aging is an irreversible process with associated changes of the cardiovascular system
• The leading cause of death in the masters athlete is also the leading cause of death in America; heart disease
• Varying levels of exercise do increase the risk of sudden death however the benefits out weigh the risk.
• Masters athletes can improve performance when training is within limits and heart disease has been excluded