LECTURE

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USA SWIMMING

“Physiological Profile of Swimming”

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Physical/Physiological Profile of Swimming

Keenan Robinson
USA Swimming

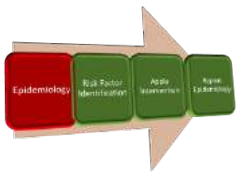
Health Training History

Use as correlation, not causation

Training load

Refer out to specialist if needed

Injury Prevention Model (Van Mechelen 1992)



PPE, Screen, Assessment, Needs Analysis

- Trends amongst Training Program Group
- -Trends against treatment interventions
- -Trends amongst academic majors(lifestyle compensations)
- -Are you intervening or covering up

PPE Standard Exams

Sports Specific Screen

Can the bodies joints get into the position to absorb and adapt to stress

Can strength/dryland interventions return those joints to baseline sport specific measurements

Does training shut the body down from a soft tissue standpoint or is it motor control/ neurological

Total Body Assessment for Weightroom intervention

Where in the chain is the weakness

Is it musculoskeletal weakness or joint fatigue somewhere else

Checklist

Shoulder IR and ER

Shoulder Supine Flexion(Latissmus length)

Scapular Dyskenisis (Yes/ No)

Distance of AC Joint from Wall

Shoulder Handheld Dynometere

Hip IR and ER

Ankle Plantar Flexion

Beighton Score

Individuality of Training

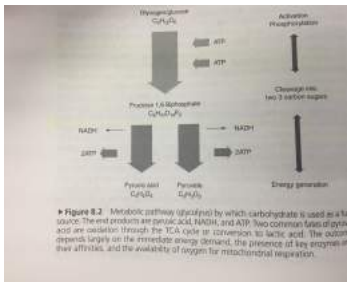
- Tremendous diversity- training plans push the adaptation
- Genetic Traits
- Mind- set to train
- Opportunity

Metabolism

- A myriad of chemical reactions involved in maintaining the health of the human body
  - Catabolic- breakdown of molecules and substrates for energy
  - Anabolic- the synthesis of new structures and compounds
  - Oxidation- chemical reaction in which an organic substance combines with oxygen(O2)

Glycolysis

- Breakdown of sugars(glucose) to form ATP useful physiological energy
- Two ATP molecules and Two NADH molecules
  - Aerobic Glycolysis- converted to acetyl- CoA low energy demands (pyruvate)
  - Anaerobic Glycolysis- converted to lactate to allow continued energy recycling



Aerobic Metabolism

- Oxygen is present
- Acetyl- CoA enters Krebs Cycle and Electron Transport Chain
- 32 ATP molecules are produced

Acidosis and Fatigue

- Hydrogen ions from lactate lower muscle pH causing fatigue
  - Acidity in intracellular fluids increases pain receptor sensitivity
  - ATP recycling decreases-> decreases muscle contraction-> can no longer produce lactic acid-> rest of the swim is done aerobically
  - Reduced calcium availability
  - Anaerobic metabolism is reduced because of enzyme inhibition

Energy Metabolism and Swimming

- Role of Lactic Acid and Muscle pH
  - Lack of O2, anaerobic metabolism causes lactic acid to accumulate in the muscles
  - Splits into lactate and hydrogen ions in the muscle
  - The accumulation of Hydrogen cause muscle pH to drop and decrease muscle force and speed

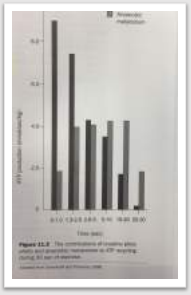
Not a bad thing…….Allows the body to perform at speeds higher than it could during aerobic metabolism

Training to Delay Acidosis

- Reduce rate of lactic acid production
  - Increase O2 delivery to muscles
  - Increase O2 usage by muscles
- Removing lactic acid from working muscle fibers
  - VO2 max training
- Buffering lactic acid
  - Sprint training

Anaerobic Metabolism

- Supplies half the energy for ATP-CP recycling during the first 5-6 seconds
- Thereafter, increases exponentially within 10-15 seconds
- Training quantity and activity of these enzymes has greater impact on sprint training.
- The end product of anaerobic metabolism is pyruvate(which when combined with hydrogen ions forms lactic acid)



Anaerobic Energy Pathways and Swimming Performance

- Amount of muscular work creates energy demand that exceeds aerobic production ability
- Onset of blood lactate accumulation(OBLA)
  - Production exceeds metabolism
  - A marker of aerobic conditioning throughout the season
  - Swimming at a faster speed with lower cost
- Active cool down can facilitate metabolism
  - Must be done aerobically
  - The shorter the race, the longer the cool down
  - At least 10 minutes(Olbrecht, The Science of Winning)

ATP- CP System

- Only chemical stored in muscles that can provide energy
- Can provide energy more rapidly than any other phase of metabolism, but only for 4-6 seconds
- Training this system has minimum effect on swim performance

Muscular System

- Type I- slow twitch, slow oxidative, red fibers
  - Endurance/ Aerobic because…
    - Contain more mitochondria- protein where metabolism occurs
    - Contain more myoglobin- what transports oxygen across a muscle cell
- Type II- fast twitch, white fibers
  - Produce more lactic acid
  - Use Glycogen faster

Effects of Training on ST and FT Muscle Fibers

- Endurance training will increase the aerobic capacity of slow twitch and fast twitch fibers
- Strength and Sprint training will increase the size and contractile speed of fast twitch and slow twitch muscle fibers, as well as potential for rapid energy release
  - Fast twitch has higher propensity for such increases

Fiber Type and Swimming

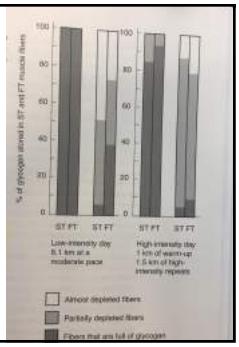
- Most human muscle contains equal amounts of both fast twitch and slow twitch muscle fibers
- Research has not produced any high relationship between the percentage of either fiber type in the muscles of swimmers and their performance over certain races
- Shortest race 17.99- 25 sec(Track 60 yard dash 5-6 seconds)
- Longest race 14-16 minutes(Track several hours)
  - *10k race

Fiber Type and Recruitment during Work

- Contract according to force needed, not speed of movement
- Slow twitch contracted first and perform most of the work when the resistance is light
- Motor Unit recruitment follows the "Ramp Effect"

Glycogen Depletion

- Efforts >70% maximum effort, fast- twitch depleted first
- Slow swims, slow twitch muscle fibers lose their glycogen first
- Both types are recruited during training speeds in excess of 50% VO2max



Fiber type conversion

- The percentage of fast-twitch and slow- twitch cannot be converted with training
- Sprint training CAN improve contraction speed and power of slow twitch
- Endurance training CAN improve aerobic capacity of fast twitch
- FTb are the fibers that are impacted greatest, too much aerobic training decreases contraction speed, too little and their enzymatic/ metabolic improvement is decreased

Role of Hormones in Training

- Regulated by the autonomic nervous system
  - Sympathetic- regulates energy mobilization "fight or flight"
  - Parasympathetic- regulates governs replacement during recovery
- Examples in training:
  - Training reduces rate of insulin secretion-higher glucose levels for longer period of time
  - Catecholamines- increase need for O2 and glucose after exercise(overtraining)
  - Cortisol- increased release, decreases amino acids from muscle, but free fatty acids from adipose tissue

Rate of Accumulation is the Issue

- Faster speeds, require more muscle fiber contraction
- Improved O2 consumption, leads to Hydrogen and Pyruvate becoming oxidized.. Less lactate produced
- Slow Twitch fibers metabolize lactic acid more efficiently
  - Some lactate from FT can be transported across cell membranes
  - Some will be transported to blood stream to be metabolized in the liver

In the end training improves efficiency of this energy substrate/ waste

Purpose of Swim Training

- Increase rate of energy release during races
- Delay fatigue
- Training that benefits one system or one phase of metabolism may be detrimental to others

Practice Example

Anaerobic glycolysis in Action

Weekly Training Cycle

Overtraining

- Excessive overload in training stress and inadequate recovery, which leads to acute feelings of fatigue and decreases in performance
  - Functional- alarm and supercompensation
  - Non- Functional- performance worsens for weeks to months and even recovery doesn't return to previous performance levels
  - Overtraining- long term decrement in performance in accordance to psychological symptoms

Strength Training for Swimming

- "The value of land resistance training for swimmers is controversial because they do not need a great deal of muscular power to swim their events." – Maglischo 2003 Swimming Fastest
- "A dryland exercise program, when properly designed and followed, can build strength and flexibility faster than these traits can be built by training with swimming alone."- Counsilman 1968 The Science of Swimming
- "Although more strength is not necessarily better, swimmers may need to achieve at least a baseline level of strength to achieve peak performances at any level." – Riewald 2015 Science of Swimming Faster

Now the Conference can Begin!