WHAT TECHNIQUES ATHLETES ARE USING TODAY

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Michael Kruger, MD
Objectives

- Review techniques/fads and scientific evidence for trends/techniques seen in athletic competition
The Orthopedic Triad: famous athlete, famous doctor, untested treatment

- Dr. John Bergfeld, an orthopedic sports medicine specialist at the Cleveland Clinic

Having an athlete report that a treatment worked “is almost like direct-to-consumer advertising,” said Dr. Fred Azar, a sports medicine orthopedist in Memphis.

Cupping

- Practiced in most cultures in one form or another throughout history
- Alternative medicine
  - Chinese
  - Egyptian
- Creates a vacuum
- Dry vs wet
Gaining publicity
  - Rio 2016

There is still no reliable scientific data clarifying the exact mechanism which can determine the therapeutic effect of cupping
  - Stagnant blood/lymph
  - Chi

Cupping

- Illustration from a medical textbook "Exercitationes practicae"
  - published in 1694

Wikipedia
Hope of improving exercise performance at sea level

Obtain the beneficial effects of altitude
- Cardiovascular, respiratory and metabolic adaptations

Avoiding
- The need for a decrease in training intensity
- The detrimental effects of chronic hypoxia
  - muscular mass loss, fatigue or deteriorated aerobic performance
  - 10% of athletes are susceptible to pulmonary hypertension and high-altitude pulmonary edema
- Known cardiovascular disease is associated with an increased risk for sudden cardiac death during mountaineering and downhill skiing
  - Healthy athletes who exercise at increased altitude are at low risk for ventricular arrhythmias

Live High Train Low

- Ambient air (21% O2)
- 15% O2 – 8,500 ft (2,591 m)
Physiologic Changes at Altitude

- **Hyperventilation**
  - the first change noted during hypoxic exposure at increased altitude

- **Hyperpnoea**
  - increased depth of breathing
  - occurs above 2500 m

- **Respiratory alkalosis**
  - created by hyperventilation
  - corrected within a few days by increased urinary excretion of bicarbonate

Physiologic Changes at Altitude

- Decreased arterial oxygen content
  - causes HR to increase to maintain cardiac output
- Hemoglobin
  - initially increases due to hemoconcentration
  - eventually increases due to increased erythropoietin
- Erythropoietin release
  - correlates with degree of hyperventilation elicited by hypoxia and degree of respiratory alkalosis
- Increase Hgb
  - Increase arterial oxygen content

Physiologic Changes at Altitude

- Decrease in plasma volume from loss of water due to
  - increased ventilation
  - increased perspiration
  - increased urine output
  - decreased oral intake by hypoxia-induced adipsia
    - the lack of thirst despite dehydration
- Decreased stroke volume in athletes at increased altitude has been attributed to a reduction in preload
- LVEF does not change with hypoxia and increased altitude

Live High Train Low

- Technical development of new devices
  - artificial altitude/normobaric hypoxia
    - nitrogen dilution
    - oxygen extraction
    - altitude tents/hypoxic sleeping units
    - decompression chambers
    - supplemental oxygen
- Additional training stimulus without traveling to the mountains
The Altitude Center
- Ireland
- Consumer/commercial

Several altitude training sites exist around the world
- Third Space Gym (London)
  - 15% O2/8500 ft

LHTH camps are mostly carried out two to three times a year.
Live High Train Low

- Sleep tents
- Hypoxia generators
- Individual equipment
Phases
- Acclimatization Phase
- Primary Training Phase
- Recovery and Preparation for Return to Sea Level
- Return to Sea Level

Optimal altitude for living high
- 2200–2500m to provide an optimal erythropoietic effect
- up to 3100m for non-haematological parameters

Optimal duration at altitude
- 4 weeks for inducing accelerated erythropoiesis
- <3 weeks (i.e. 18 days) are long enough for beneficial changes
  - economy, muscle buffering capacity, the hypoxic ventilatory response or Na+/K+-ATPase activity.

Daily dose of altitude.
- altitude of 2500m for 20–22 h/day
  - travelling down to the valley only for training
  - sufficient to increase erythropoiesis and improve sea-level performance.
- minimum daily dose
  - 12 h/day.

Leadville 100

- Low point, 9,200 feet; high point is Hope Pass, 12,600 feet. Majority is on forest trails with some mountain roads.
At moderate altitudes up to 4000 m
  - respiratory water loss may be increased
    - 1900 mL per day in men
    - 850 mL per day in women
  - urinary water loss
    - may increase up to 500 mL per day

Fluid intake
  - increased even up to 7 L per day to insure adequate hydration
    - Tour de France mountain stages of the race, several cyclists drank more than 10 L of fluid per day

Sports Nutrition Assessment

- Energy expenditure in athletes who train and live at high altitude
  - 2.5–3 times higher than at sea level
    - Tour de France, elite cyclists recorded a 3.6–5.3 higher energy expenditure than the resting metabolic rate

Carbohydrate consumption 40 min prior to acute hypoxia exposure increases ventilation and oxygen saturation, thereby oxygen delivery to the tissues.

60% CHO with one-third coming from liquid CHO due to reduced hunger at altitude.

Cyclists consume 12–13 g of CHO per kg of body mass per day.

Effective sports drinks have a carbohydrate concentration of 6 – 8 percent.

Precision Hydration

- How much you sweat
- What you sweat
- Salty sweater
  - 1700 mg/L sweat
- Average sweater
  - 200 mg/L sweat
Precision Hydration

- Sweat tests
- Electrolyte tablets
- Personalized electrolytes
- Advise you on when, what and how much to drink before, during and after training and

http://www.precisionhydration.com/pages/sweat-testing
Personalized Continuous Monitoring

- Biomed wearable tech
- Adhesive radio-frequency identification (RFID) sensor bandage (patch)

Adhesive RFID Sensor Patch for Monitoring of Sweat Electrolytes.
V02 Max (Aerobic Capacity)
- The highest VO2 (oxygen consumption) value recorded during maximal exercise
  - i.e. knowing what you are physiologically capable of
- College age males average VO2 max of 45ml/kg*min
- College age females average VO2 max of 35ml/kg*min.
- VO2 max can increase with training
  - An untrained individual may be able to increase VO2 max by as much as 15-20%.
- Well trained athletes increases in VO2 max may not be as great
- Velocity at VO2 Max is a better measure of fitness

http://www.ohio.edu/people/schwiria/Athlete%20&%20Coaches%20page/VO2max%20summary%20results%20Runners.htm
Controversial

When exercising at or below the LT, any lactate produced by the muscle is removed by the body without it building up.

Lactate Threshold Assessment

- Rationale for training Rx
- Evaluating endurance capacity

With regards to accuracy, no single portable analyser was perfect:
- low bias for BLa <15 mM
  - the Edge and Xpress
- low bias for high lactate concentrations
  - the Edge and Lactate Pro2
  - influential for training zone prescription

Body Composition

- Proposed to be a significant predictor of performance
  - Vertical jump
  - Sprint performance
  - Isometric force is directly related to the muscle mass of that individual

Use of B-Mode ultrasound as a body fat estimate in collegiate football players, Journal of Strength and Conditioning Research, V 30, N12, Dec 16
Body Composition

- 7-site US technique
  - Jackson and Pollock skinfold locations
- B mode US
Body Composition

- Similar results to caliper measurements
- Reduce degree of interrater error
- Easier to measure the full thickness of adipose tissue.

Use of B-Mode ultrasound as a body fat estimate in collegiate football players, Journal of Strength and Conditioning Research, V 30, N12, Dec 16
Gravity defying running

- Alter-G anti gravity treadmill
- Running or walking with partial body weight support
- Uses air pressure to support the lower body like an airbag attached to a treadmill
- Since 2009

Accuracy of unloading with the anti-gravity treadmill.
Findings suggest that there are significant differences between reported and measured BW support on the AlterG Anti-Gravity Treadmill.

- Largest differences (0.5%) found at 100% BW
- Greatest BW support (30 and 20% BW)
- Participants were young adults who were relatively light
- Axial knee forces
  - Increased with increasing treadmill speed
  - Decreased with increasing chamber pressure

Gravity defying running

- Peak knee forces did not change with treadmill incline
Gravity defying running

- Average normalized stride length increased with increasing treadmill speeds
Metabolic cost of running decreased with increased BWS

A blunted increase in metabolic cost with increasing velocity at higher levels of BWS

Gravity defying running

- Kobe Bryant
- Twitter post
- 2013
- ~ 4 months after Achilles surgery
Adjunct for postoperative rehabilitation

Clinical functional outcomes that are at least as good as traditional postoperative TKA rehabilitation

**Whole Body Cryotherapy**

- Therapy used to prevent or reduce muscle soreness after exercise and to enhance recovery.
- Single or repeated exposure(s) to extremely cold dry air (below -100 °C) in a specialized chamber or cabin for two to four minutes per exposure.
Whole Body Cryotherapy

- Popularized by celebrities and athletes
- Athletes treat like an ice bath
There is insufficient evidence to determine whether whole-body cryotherapy reduces self-reported muscle soreness, or improves subjective recovery, after exercise compared with passive rest or no WBC in physically active young adult males.

There is no evidence on the use of this intervention in females or elite athletes.

The lack of evidence on adverse events is important given that the exposure to extreme temperature presents a potential hazard.

Further high-quality, well-reported research in this area is required and must provide detailed reporting of adverse events.

Whole-body cryotherapy (extreme cold air exposure) for preventing and treating muscle soreness after exercise in adults. Costello JT, Baker PR, Minett GM, Bieuzen F, Stewart IB, Bleakley C. Cochrane Database Syst Rev. 2015 Sep 18;(9)
Whole Body Cryotherapy

- The FDA has not cleared or approved any of these devices for medical treatment of any specific medical conditions.
- Potential hazards
  - Loss of consciousness/Asphyxiation
    - When liquid nitrogen is used for cooling, the addition of nitrogen vapors to a closed room lowers the amount of oxygen in the room and can result in hypoxia, or oxygen deficiency.
  - Frostbite
  - Burns
  - Eye injury

http://www.fda.gov/ForConsumers/ConsumerUpdates/ucm508739.htm
In 2015, Chelsea Ake-Salvacion, who worked at a Nevada spa that offered cryotherapy, decided to hop into one of the chambers at the end of the day to relieve sore muscles. The 24-year-old was found dead the next day, "rock-hard solid," according to CNN.

3D Gait Analysis
Foot strike

 FOREFOOT STRIKING

Significantly higher calf force
(3.12 vs 2.54 Nm/kg)

Significantly higher Achilles tendon force
(6.3 vs 5.1 x body weight)

 REARFOOT STRIKING

Significantly higher patellofemoral contact force
(5.1 vs 4.3 x body weight)

Higher quads force
(3.54 vs 3.13 Nm/kg)

[adapted from Kuimala et al. (2013)]
Gait Retraining

- There has a higher tendency to non-rearfoot strike in both interventions, but more acute changes in the minimalist footwear.

ASICS

Analyses your foot using laser and micro cameras

“Find the shoes that match your feet best”

Measurements made by the system
- foot length, forefoot width, ball girth, arch height and heel tilt
Shoe-fitting fluoroscope

Dr. Scholl's will be in our store
Monday, February 15th

They bring with them the complete line of Dr. Scholl's Shoes (622 fittings)... every size, width and style— ... for every type foot. X-ray fitting—as well as other Dr. Scholl shoe fitting devices. Now you can obtain the shoe that will give you perfect satisfaction—and if you have foot troubles you will be shown how to obtain relief, quickly and inexpensively. Be sure to attend this great DISPLAY and DEMONSTRATION... first of its kind in this city.

GEO. S. MERCHANT
Winter Garden, Fla.
Minimal Footwear
Foot Strike and Shoe Choice

- Footwear alters the load rates during running, even with similar foot strike patterns.
  - ILR = instantaneous loading rate

Custom footwear
Glycogen Stores

- It is absolutely clear that low pre-exercise muscle glycogen stores result in reduced exercise intensity

Glycogen Stores

- Endurance athletes experience glycogen debt/depletion after long periods of exertion
- “Hitting the wall”
Present methods for measuring glycogen involve the intrusive process of biopsy into the muscle tissue:

- pain, soreness and repair process may degrade performance
Glycogen Stores

- a) Overview electron microscopy image (magnification \( \times 3200 \)) of a human skeletal muscle fiber.
- (b) (magnification \( \times 40,000 \)) of the subsarcolemmal region. Gray circle indicates the location of the subsarcolemmal glycogen particles (black dots) often found close to mitochondria.
- (c) (magnification \( \times 40,000 \)) of the myofibrillar region showing the intermyofibrillar (white circle) and intramyofibrillar (black circle) glycogen particles.

Muscle glycogen and cell function – Location, location, location; Scandinavian Journal of Medicine and Science in Sports, Volume 25, Issue Supplement S4, December 2015 Pages 34–40
Glycogen Stores

- Analysis of a biopsy to determine glycogen store
  - time consuming process
  - gauge of the glycogen levels at a past time
2011

- Working with professional cyclists
- Discovered that they could see glycogen through the use of everyday ultrasound

Validation study

Direct glycogen quantification from pre and post-exercise muscle biopsy samples was compared with glycogen content estimates made through a portable, diagnostic high-frequency ultrasound and cloud-based software system.

Pre-exercise muscle with high glycogen stores display darker pixel intensities. Post-exercise muscle with lower glycogen stores display brighter pixel intensities.
Validation of Musculoskeletal Ultrasound to Assess Muscle Glycogen Content. A Novel Approach – Colorado University School of Medicine
Glycogen store 502 within scan 500 is conceptually shown to be high by the use of large dots 504 providing a substantially dark appearance to the scanned portion of the target muscle tissue 206.

A pre-established glycogen concentration scale 506 is also shown.

The pre-establishment of the glycogen concentration scale 506 aids in the effective identification of attributes that are correlated to the glycogen store, e.g., color, contrast, darkness, luminance and or combinations thereof.
Glycogen Stores

- Identify a balance point
- Eat proactively if stores are low
- Avoid eating to avoid diverting blood flow for digestion
Platelet Rich Plasma

- Concentration of platelets from whole blood
- Platelets are filled with growth factors
  - Platelet-derived growth factor (PDGF)
  - Transforming growth factor (TGF-B)
  - Insulin-like growth factor (IGF)
  - Epidermal growth factor (EGF)
  - Vascular endothelial growth factor (VEGF)
  - Fibroblast growth factor (FGF)
## Platelet Rich Plasma Isolation Devices

<table>
<thead>
<tr>
<th>Device Name</th>
<th>Device Image</th>
<th>Technology Summary</th>
<th>Total Process Time</th>
<th>Disposable Compatibility</th>
<th>Disposable List Price (1 kit)</th>
<th>Hardware List Price</th>
<th>Increase Above Baseline</th>
<th>% Platelet Recovery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biomet GPS™</td>
<td><img src="image1.png" alt="Biomet GPS™ Image" /></td>
<td>Floating Buoy</td>
<td>27 min</td>
<td>Druker 755 VES Centrifuge</td>
<td>$700</td>
<td>$16,000</td>
<td>3.2 x</td>
<td>70%</td>
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<tr>
<td>Biomet</td>
<td><img src="image2.png" alt="Biomet Image" /></td>
<td>Standard Centrifugation</td>
<td>20 min</td>
<td>Machine Specific</td>
<td>$75-175</td>
<td>$10,000</td>
<td>4-6x</td>
<td>75%</td>
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<tr>
<td>Cell Saver Based Systems</td>
<td><img src="image3.png" alt="Cell Saver Image" /></td>
<td>Computer Aided System</td>
<td>25 min</td>
<td>Sorin Centrifuge</td>
<td>$495</td>
<td>$10,950</td>
<td>4.3x</td>
<td>76%</td>
</tr>
<tr>
<td>Haemonetics</td>
<td><img src="image4.png" alt="Haemonetics Image" /></td>
<td>Standard Centrifugation</td>
<td>1-2 min</td>
<td>Cytomedix Centrifuge</td>
<td>$325</td>
<td>$5000</td>
<td>1x</td>
<td>78%</td>
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<tr>
<td>Sorin Angel</td>
<td><img src="image5.png" alt="Sorin Angel Image" /></td>
<td>Standard Centrifugation</td>
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<tr>
<td>Sorin</td>
<td><img src="image6.png" alt="Sorin Image" /></td>
<td>Standard Centrifugation</td>
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<td>AutoloGel System</td>
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<td>Standard Centrifugation</td>
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<tr>
<td>Cytomedix</td>
<td><img src="image8.png" alt="Cytomedix Image" /></td>
<td>Standard Centrifugation</td>
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</tr>
</tbody>
</table>
Platelet Rich Plasma

- Biomet – GPS
- Harvest
- Arteriocyte
- Cytomedix/Angel

Leukocyte rich
Buffy coat based

- Cascade
- Arthrex/ACP
- RegenKit

Leukocyte poor
Plasma based
PRP - Leukocyte Poor

Plasma + platelets
WBCs

RBCs + WBCs
PRP – Leukocyte Rich
PRP – Activated

Glass beads
PRP

- Platelet concentration
  - 1.5-9x baseline
  - ? Optimal concentration
Platelet Concentration

- Different uses may require different concentrations of platelets
- Optimal concentration in human tendon, muscle, joint is unknown
- Most commercial preparation kits produce PRP in the range of 500,000 µ to 1,500,000 µ
- Variability in platelet concentration is also highly dependent on variability in patient platelet count
PRP

- Leucocytes
  - In acute muscle injuries leukocyte poor product may be better
  - Because neutrophils are larger cells their concentration could be expected to be decreased compared to other fractions of WBCs in buffy coat products
  - Leukocyte rich may be helpful in a chronic injury because of phagocytic properties
The studies of intra-articular cellular therapy injections for osteoarthritis and focal cartilage defects in the human knee suggested positive results with respect to clinical improvement and safety.

However, the improvement was modest and a placebo effect cannot be disregarded.

Questions?