

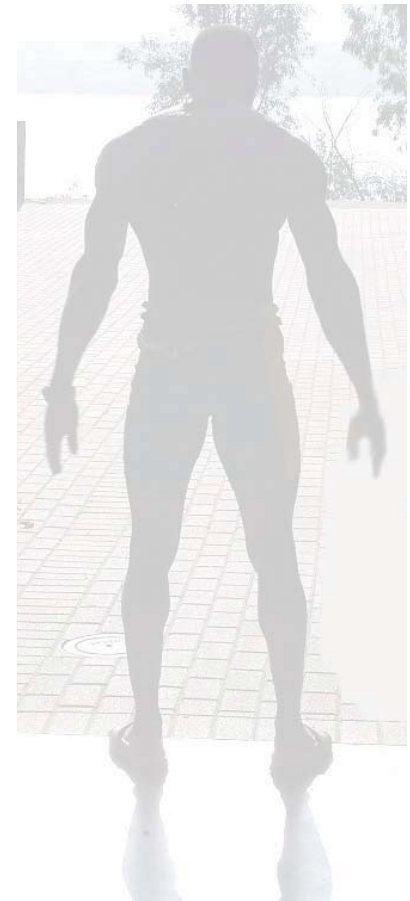
# Performance Enhancing Drugs: Dietary Supplements and Ergogenic Aids

The Sports Medicine Core Curriculum Lecture Series

Sponsored by an ACEP Section Grant

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# Athletic Performance

Genetic endowment

State of training

Nutrition

# Definitions

## Ergogenic

- Greek- work “generating”
- Performance-enhancing

## Doping

- Boer- stimulating liquor
- Old English- opium mix
- Use of foreign agents, or physiological substances in excess quantities, to gain an unfair advantage in competition

# Current Medicolegal Issues

Testing

“Natural” substances

Designer drugs

# Current Medicolegal Issues

## Role of the US Food and Drug Administration

How much power does it have to control availability of over-the-counter supplements?

# Current Medicolegal Issues

## 1994 Dietary Supplement Health and Education Act

- Shifted responsibility away from manufacturers
- Eliminated FDA regulation of herbal “food products”

# Current Regulation of Doping

Many national and international antidoping agencies

Individual regulating bodies often have differing provisions

In 1998 the IOC launched an initiative to standardize anti-doping regulation

World Anti-Doping Agency (WADA) is established in 1999

# World Anti-Doping Agency

## Anti-Doping Code

Variations on this code are used by many contemporary sporting organizations



# Supplements

Carbohydrates and Protein

Glutamine

Antioxidants

Creatine

Caffeine

Ginseng

Ephedrine Alkaloids

# Carbohydrate and Protein Supplementation

Increasing lean body mass requires adequate energy and building blocks

Supplementation of adequate diet with protein, carbohydrate, or protein-carbohydrate combination increases lean body mass in over-reaching athletes

Dietary sources are preferable

# Protein and Sports Drinks

Poor energy source; plays a role in recovery

Suggestion of adding protein to fluid and electrolyte recovery drinks

Attenuation of strength and power loss in overreaching resistance-trained athletes

# Branched-Chain Amino Acid Supplementation

Dietary supplementation of 5-10 g/d prolongs  
exercise with minimal side effects

## Theory:

Prolonged exercise depletes glycogen

Athlete metabolizes fat and (to some degree) protein

Consumption of branched-chain amino acids yields  
excess tryptophan

Tryptophan results in fatigue

# Protein Supplementation in General

Increases in dietary protein likely to meet needs of most athletes

Unused excess carbohydrate and amino acids converted to fat

# Glutamine Supplementation

Essential for lymphocyte proliferation

Used for repair of damaged myofibrils

Intense exercise depletes glutamine needed  
for lymphocytes

# Glutamine Supplementation

May account for association of exhaustive exercise and susceptibility to illness

Controlled trials show reduced incidence of opportunistic viral infection in endurance athletes with 500 to 1000 mg/d

# Antioxidant Supplementation

Mixed data

Vitamin C

Vitamin E

Glutathione

Beta-carotene

No evidence of performance improvement

At high doses, toxicity is a concern



# Creatine

Maximize stores of phosphocreatine  
(ATP-PC system)

Short term: increased muscle creatine levels,  
increased lean body mass, increased weight  
lifting performance, explosive sprint

# Creatine

Increased fluid increases muscle bulk

Added bulk may impair endurance

Anecdotal reports of increased rates of injury

# Caffeine

Improves performance and endurance during prolonged exercise

Enhances short-term, high-intensity performance

Adenosine receptor antagonism; alters catecholamine release

Positive physiological and psychological effects

# Caffeine

Ergogenic at 5-10 mg/kg

No evidence of increased risk of heat injury or cardiovascular compromise (at these doses)

Insomnia, restlessness, anxiety

# Ginseng

Shrub whose root is used as an ergogenic aid

Many varieties, and available in many forms  
(with poor quality control)

Failure to consistently demonstrate improvement  
in aerobic exercise

American ginseng may help prevent or decrease  
severity of colds

# Ephedrine Alkaloids

May improve athletic performance (esp. when combined with caffeine)

In controlled studies, herbal ephedra ineffective on its own

# Ephedrine Alkaloids

Associated with numerous Adverse Effect Reports

AMI

CVA

Arrhythmia

Heat illness

2001

Ephedra products account for 1% of herbal supplement sales

Account for 64% AERs

# Ephedrine Alkaloids

FDA ban February 2004

May 14, 2007

US Supreme Court declines review of  
Nutraceutical Corp vs. von Eschenbach  
Upholds ban



# Ergogenic Aids

Anabolic steroids

Testosterone precursors

Peptide and Glycoprotein hormones

Human Growth Hormone

GHB

Erythropoietin and Synthetic Analogues

# Anabolic (Tissue Building) Steroids

## Mechanism of Action

Prevent muscle breakdown

Increase protein synthesis

Increase release of growth hormone

Psychological

Scientific data studying efficacy of steroids  
remains controversial

# Studies

Conflicting results

Limited population size

Different agents

Varying doses

Stacking/cycling

Differing skill levels of subjects: those who have reached plateau have greatest benefit

# Anabolic Steroids

## Do Increase:

Lean muscle mass  
Strength

## Do Not Increase:

Aerobic power  
Aerobic capacity  
Athleticism

# Prevalence

Recent surveys suggest decline in anabolic steroid use

NCAA: 4.9% (1989) -> 1.4% (2001)

High School: 6-11% (1988-89) -> 3-5.4% (2002)

# Prevalence

Initial use occurring earlier

>40% first use in high school

Increased use among non-athletic males and females (2.9%)

# Adverse Effects of Anabolic Steroids

Acne

Premature baldness

Gynecomastia

Altered cholesterol

Impaired glucose tolerance

Tendon strains and ruptures

Liver toxicity

Amenorrhea

Testicular atrophy/clitoral enlargement

# Testosterone Precursors

Androstenedione, androstenediol,  
dehydroepiandrosterone

Higher doses at short term do raise testosterone

Side effect profile similar to anabolic steroids



# Peptide and Glycoprotein Hormones

Human Growth Hormone (HGH)

Gamma Hydroxybutyric Acid (GHB)

Erythropoietin and Synthetic Analogues  
(EPO)

# Human Growth Hormone

Produced in pituitary gland

Increases lean muscle mass

Medically useful to treat dwarfism

# Human Growth Hormone

Produces skeletal muscle hypertrophy in mature adults

Potential ill effects

Fluid retention

Hyperlipidemia

Acromegaly

# Gamma Hydroxybutyric Acid (GHB)

Transiently stimulates release of growth hormone

Potent CNS depressant

Treatment of narcolepsy

Abuse as date-rape drug

# Erythropoietin (EPO) and Synthetic Analogues

Produced by kidneys

Stimulates production of RBCs

Used for treatment of severe anemia  
secondary to systemic disease

# Erythropoietin and Synthetic Analogues

Blood doping

Increased aerobic capacity for improved performance in endurance athletes

# EPO Adverse Effects

## Excessive RBC count

Dehydration may impair circulation

Risk of MI, CVA, CHF, arterial/venous thrombosis

# The Future...

Designer drugs

New “natural” supplements

Genetic manipulation



[www.usada.org](http://www.usada.org)

DRO- Drug Reference Online

Check if medication used is allowed by sport

# Take Home Points

Many supplements can be as harmful as helpful

Many supplements are unproven in scientific studies to provide the benefits that are advertised

Supplements are an unregulated industry

(no FDA oversight) and may contain substances that are not disclosed causing positive drug testing

Check ingredients to see if the substance is allowed in competition

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