

Metabolic Disorders and Stress Testing



Metabolic Disorders

- Causes:
 - drugs can induce cellular changes, changes in respiratory or cardiac function resulting in acidosis or alkalosis
 - Changes in ventilation
 - hyper-v, alkalosis
 - hypo-v, acidosis
 - Metabolic diseases

Drugs

- Acidosis
 - Aspirin
 - tranquilizers
- Alkalosis
 - stimulants



Effects of ventilation

- Hyperventilation
 - Low PCO_2
 - alkalosis
 - coronary vasoconstriction (ischemia)
 - may occur during exercise
 - occurs with altitude
- Hypoventilation
 - high PCO_2
 - acidosis
 - vasodilation in the brain

Respiratory Acidosis

- May occur with chronic exercise
 - endurance athletes build up a tolerance against acidosis
 - reverses rapidly during recovery
- Cardiac effects (good and bad)
 - depresses cardiac function
 - suppresses arrhythmias
- EKG changes
 - lowering of T waves
 - prolongation of QT interval

Respiratory Alkalosis

- Chronic hyperventilation
 - emotionally labile women
 - chest pain
 - ST depression
 - pH 7.5
 - low serum potassium
 - untrained exercisers
 - altitude



Metabolic Diseases

- Thyroid
- Diabetes
- Obesity
- Renal Failure



Thyroid Hormone Disorders

- Hyperthyroidism
 - Increased appetite
 - Loss of weight
 - Trouble sleeping
 - ↑ HR, BP, ejection rate, coronary bf
 - ↓ TPR
 - arrhythmias
 - at maximal exercise, ↓ EF
 - Feel good
 - normal exercise capacity

Hypothyroidism

- Weight gain
- Tired, increased sleep
- ↓ cardiac output, myocardial contractility, HR
- T wave flattening, ST depression
- decreased exercise capacity

Metabolic Syndrome

- Can precede diabetes for many years
- Metabolic syndrome
 - hypertension, dyslipidemia, obesity
 - upper body fat patterning
- sedentary lifestyle is the major risk factor
- Prevention
 - Lifestyle
 - Lipid lowering drugs
 - Glucose lowering drugs

Diabetes, prevalence

- 6% of US population and 10% of those over 65
- 1/3 more are undiagnosed
- Increasing at a fast rate
 - 0.4% in 1935
 - 3.0% in 1994
 - 6% in 2000
 - 12% in 2015?



Diabetes, CV complications

- Damage to the vasculature (retina)
- Deposits of mucopolysaccharides in the myocardium
 - > incidence of congestive heart failure
- Metabolic dysfn, ↑ ammonium
 - acidosis, ↓ cardiac contractility
- Autonomic neuropathy
 - lower HRmax, higher BP
 - ST depression

Why do diabetics usually die from CV disease?

- Association with obesity, dyslipidemias, hypertension
- “fear” of exercise-induced glucose dysregulation-sedentary
- greater occurrence of CAD, congestive heart failure
- nerve damage masks ischemic pain

Responses to Exercise

- Improves insulin action
 - decreases blood glucose
- Insufficient insulin before exercise
 - impairs glucose transport
 - Hyperglycemia, ketosis, acidosis,
- Too much insulin before exercise
 - hypoglycemia
 - seizures and unconscious

ACSM recommendations before exercise

- Measure blood glucose before, during and after exercise
 - >300mg/dl or >240 mg/dl with ketosis don't exercise
- Avoid exercise at peak insulin times
- extra carbohydrates (20-30 g) 30 min before exercise
- reduce insulin (50-90%)
- have easily absorbed carbs handy
- know signs and symptoms



Stress Testing Diabetics

- Diabetics are high risk and should undergo stress testing before exercise
- Thompson criteria for exercise stress testing
 - type 2 > 10 yrs
 - all > 35 yrs
 - presence of microvascular disease
 - presence of autonomic neuropathy

Diabetics with autonomic neuropathy

- EXTRA EXERCISE PRECAUTIONS
- ANS dysfn can result in high resting HR and blunted exercise HR
- ventricular dysfunction
 - blunted cardiac output
 - reduced exercise capacity
- excessive increase in BP
- Post-exercise fainting

Possible adverse effects of exercise training

- Cardiovascular
 - arrhythmias, htn
- Microvascular
 - retinal hemorrhage, proteinuria, microvascular lesions
- Metabolic
 - hyperglycemia and acidosis, hypoglycemia
- Musculoskeletal
 - foot ulcers, orthopedic injury, degen joint disease

Recommended exercises for diabetics with neuropathy

- Swimming
- bicycling
- rowing
- chair exercises
- arm exercises
- other non-weight-bearing exercises

Famous Athletes with Diabetes

- **Type 1**
 - Jim “Catfish” Hunter, NY Yankee Hall of Famer
 - Gary Hall, Jr, 1996 Olympic Gold medalist
 - Sugar Ray Robinson, boxer
- **Type 2**
 - Arthur Ashe (tennis)
 - Air Steven Redgrave, rower- 5 Olympic gold medals



[Http://diabetes.about.com](http://diabetes.about.com)

Renal Disease

- **Causes of renal disease**
 - Hypertension and diabetes cause most cases
 - Polycystic kidney disease
 - Affects over 600,000 people in US

Renal Disease: detection

- Urine albumin
- Light exercise screening test
 - 2 watts/kg for 30 min
 - Reveals increased protein in urine early in the course of diabetes

Renal Disease: metabolic effects

- Inefficient excretion of waste products results in a build-up of urea and creatinine and acidosis
- Symptoms
 - Increased cardiac troponin and myocardial dysfunction
 - Weakness, hypertension, anorexia, fatigue

Renal Disease and exercise capacity

- Lower maximal HR and exercise capacity
 - 50-60% VO₂max of predicted
 - May be related to renal anemia
- Muscle weakness and fatigue
- Metabolic effects of acidosis
 - Glucose intolerance
 - Altered lipid metabolism
 - Increased protein breakdown

Kidney Transplants

- 9% of dialysis patients receive a kidney transplant
- Despite reversal of uremia, cardiovascular disease is a major cause of death in transplant patients
- Exercise is becoming a major therapy for patients on dialysis and after transplant
- Treatments include EPO, dialysis, and exercise therapy (aerobic and resistive)

Estrogens and ST changes

- Estrogens are associated with ST depression!
 - cause of false positives in young women?
 - women with ST depression reverted to a normal EKG after their ovaries were removed
 - patients with CAD had greater ST depression after 2 wks treatment with estrogen

Androgens

- Testosterone has been shown to improve ST depression!
 - surprising results for estrogens and androgens--opposite to what would be predicted from epidemiology mortality studies of gender differences
- Positive effects of androgens
 - increase cardiac muscle strength
 - increase hct and oxygen carrying capacity
 - ↓ angina

Carbon Monoxide

- Patients with CAD
 - extremely sensitive to CO
 - 2-4% CO levels in blood will cause ↓ exercise capacity, earlier ST depression and ischemia
 - these levels can occur with cigarette smoking or during a long ride on a crowded freeway



Metabolic Abnormalities Summary

- Clients with metabolic abnormalities may have altered exercise responses
 - T (tablets), psychological stress, exercise stress, metabolic diseases
- During exercise
 - arrhythmias, ST depression, reduced exercise capacity
- Diabetes is a common metabolic disease
 - extra precautions should be taken during stress testing