

Lecture 18

Cardiovascular Disease: Stroke and Heart Attack

3.20.08
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From Last Time

- Burden of cardiovascular disease (CVD)
- Cardiovascular system
- Measuring cardiovascular health
- Valve diseases
- Atherosclerosis/CAD and treatments
 - Stroke
 - Heart attack
- Heart failure and treatments

Muddiest Point/Clearest Point

- Clearest
 - Blood pressure
 - Measurement
 - Significance
- Muddiest
 - More circulatory system and heart anatomy
 - Guidant CD
 - Heart valves and valve diseases
 - Guidant CD

<http://japi.org/august2007/U-575.pdf>

Outline: Treatment of Heart Disease

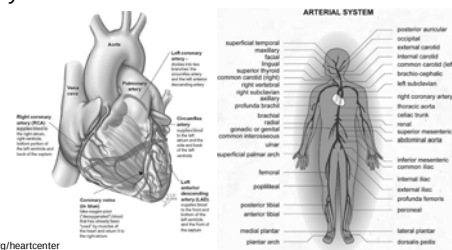
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- Cardiovascular system
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- Atherosclerosis/CAD and treatments
 - Stroke
 - Heart attack
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Atherosclerosis:

Stroke and Heart Attack

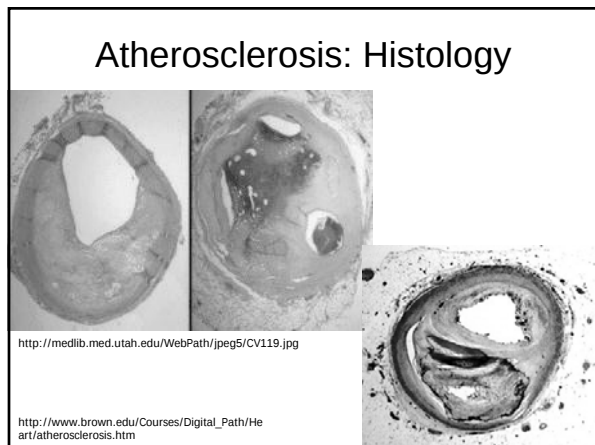
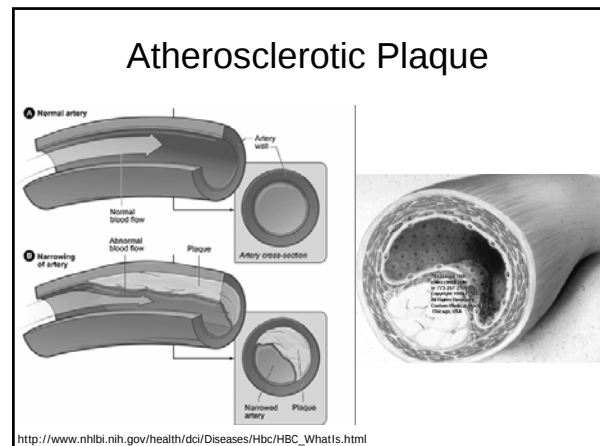
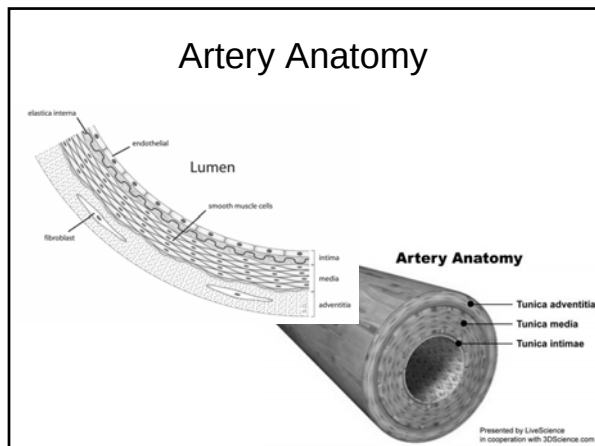
Arteries

- Muscular blood vessels that carry blood away from the heart
 - Veins carry blood to the heart
- Coronary arteries feed the heart itself



http://www.clevelandclinic.org/heartcenter/research/disease/cad/cad_arteries.htm

http://www.infvisual.info/03/060_en.html

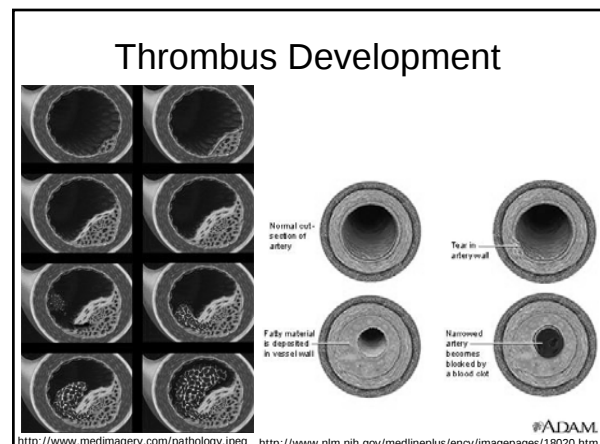


Atherosclerosis: Two Problems

- Occlusion (Stenosis)
 - Narrowed artery diameter
 - Less blood flow
- Thrombus
 - Formation of clots inside blood vessels
 - Can completely block blood flow

Atherosclerosis: Thrombus

- The thin layer or “cap” covering a plaque can rupture or burst
 - The inside of the plaque is then exposed to blood
 - This sends chemical signals to a host of blood cells
- Platelets aggregate to form a clot
 - Thrombus can block blood flow
 - Not enough oxygen delivered -- ischemia
 - Tissues can begin to die -- infarction



Atherosclerosis: Embolus

- Thrombus can be displaced from the origin and travel to another location
 - Vessels shrink in diameter away from the heart
 - Can then lodge in normally healthy vessels
 - Can cause blockage in distant location -- embolus
- If vessels in the neck or head are affected
 - Ischemia or infarction of the brain tissue
 - Stroke

Stroke (Cerebrovascular Event)

- A leading cause of death in older Americans
- # 1 cause of adult disability
- Caused by thrombus or embolus in vessels feeding brain
- Infarction results in brain damage
- Effects and long term damage depends on area of infarction
- Two-thirds of survivors have a disability
 - Limb weakness, speech impediment,

<http://www.stroke.org>

Stroke: Risk Factors

- High blood pressure
- High cholesterol levels
- Tobacco use
- Excessive alcohol consumption
- Diabetes
- Sedentary lifestyle
- Poor diet/nutrition



Stroke: Symptoms

- Stroke has a very rapid onset
- Sudden appearance of the following symptoms warrants medical attention
 - Numbness or weakness of face, arm or leg - especially on one side of the body
 - Confusion, trouble speaking or understanding
 - Trouble seeing in one or both eyes
 - Trouble walking, dizziness, loss of balance or coordination
 - Severe headache with no known cause



Stroke: "Act F.A.S.T"

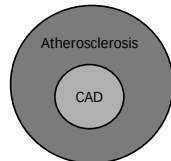
- Face
 - Ask the person to smile
 - Does one side of the face droop?
- Arms
 - Ask the person to raise both arms
 - Does one arm drift downward?
- Speech
 - Ask the person to repeat a simple sentence
 - Are word slurred? Can they repeat correctly?
- Time
 - Time is important!
 - Call 911 and/or seek medical help immediately



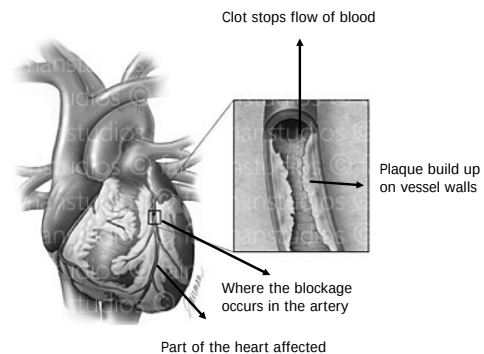
Heart Attack

Atherosclerosis vs. Coronary Artery Disease (CAD)

- Atherosclerosis
 - The build-up of plaques throughout vessel systems
 - Can have effects at distant sites
- CAD
 - Plaques in the coronary arteries
 - Specifically affects the heart muscle



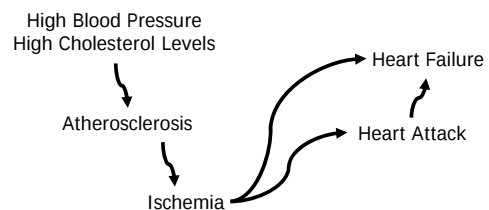
Coronary Atherosclerotic Plaque



Early Warning Signs: Angina

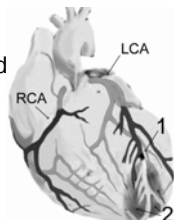
- Plenty of people with CAD have no symptoms
- Most prevalent symptom is angina
 - Chest pain
- Two types of angina: stable and unstable
 - Stable is brought on by stress or exercise
 - Unstable may be sudden or more variable
- Angina is typically the result of ischemia
 - Heart needs more oxygen

Progression of Heart Disease



CAD and Heart Attacks

- Myocardial infarction (MI or AMI)
 - Myocardium: heart muscle
 - Infarction: tissue death due to lack of blood (oxygen)
- Pathophysiology
 - Functional changes associated with or resulting from MI
- Diagnosis
- Treatment



Guidant Heart Attack

MI Pathophysiology: Case Study

- Three months following his first visit to your office, Mr. Solomon presents to the ER in the early morning, with chest pain of one hour duration.
- Mr. Solomon describes the pain as being severe and "like someone was sitting on his chest." The pain, located "in the lower part of my breast bone," awakened him from his sleep. Although he tried to relieve the pain by changing positions in bed, sitting up and drinking water, it remained unchanged.
- He did not sleep well because "I had an upset stomach an acid-burning feeling." He attributed these symptoms to over eating and drinking at a Christmas party.
- He has no pain or discomfort in his arms but says he has an "achiness" in his left jaw which he attributes to "bad teeth."
- Physical examination reveals the patient to be anxious, pale, diaphoretic and in obvious discomfort. He is unshaven and accompanied by his wife. He tries to relieve his pain by belching. He coughs occasionally. Mr. Solomon says "the flu has been going around the office, and I've had a little cough and fever all week."

Warning Signs of Heart Attack

- Many heart attacks start slowly; symptoms may come and go
- Chest discomfort
 - Most heart attacks involve discomfort in the center of the chest that lasts for more than a few minutes, or goes away and comes back. The discomfort can feel like uncomfortable pressure, squeezing, fullness, or pain
- Discomfort in other areas of the upper body
 - Can include pain or discomfort in one or both arms, the back, neck, jaw, or stomach
- Shortness of breath
 - Often comes along with chest discomfort. But it also can occur before chest discomfort
- Other symptoms
 - May include breaking out in a cold sweat, nausea, or light-headedness

<http://www.archive.org/details/gov.hhs.nih.56-042n>

Take Home Points

- Everyone is different
 - Symptoms will vary
- You don't have to be "old" to have a heart attack
- Women and men are equally susceptible
- The speed with which you receive treatment can make the difference
- Importance of prevention!

US Burden of Heart Attack

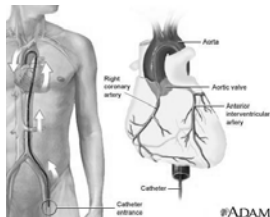
- 1.1 million/year
- 460,000 of those heart attacks are fatal
 - ~ 40%
- Half of those deaths occur within 1 hour of symptom onset, before person reaches hospital
 - High mortality highlights the importance of prevention
 - And diagnosis if you have angina or other symptoms

Heart Attack: Diagnosis of Atherosclerosis

- Blood tests
- Electrocardiograms (ECG)
- Ultrasound (echocardiogram)
- Stress tests
- Coronary angiography
- Computer tomography (CT)

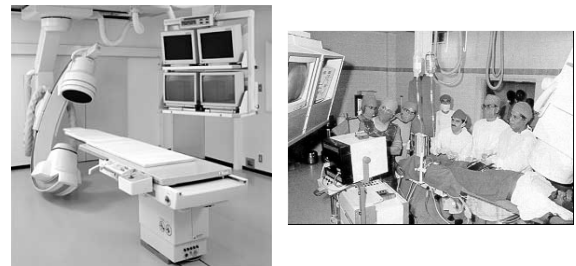
Atherosclerosis Diagnosis: Angiography

- Catheter threaded up to heart
- Contrast agent is injected near problem area
 - Blood looks same as tissues to X-rays
- Use standard X-ray or CT to take pictures and image occlusions

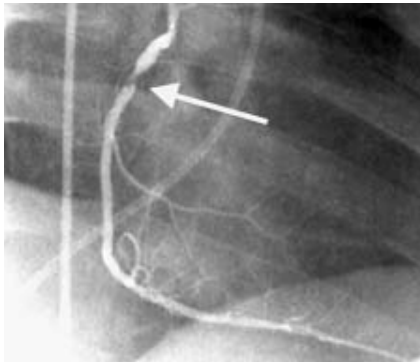


<http://www.nlm.nih.gov/medlineplus/ency/imagepages/18129.htm>

Angiography: Hardware



Angiography: Images

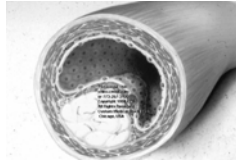


Atherosclerosis and Heart Attacks

Treatment of Acute Occlusion

Treatment of Coronary Occlusions

- Introduced in Lecture 4
- Thrombolytic drugs
- Angioplasty
- Stents
 - Often in combination with angioplasty
- Coronary artery bypass graft (CABG)



- Which one would you choose?

Thrombolytic Drugs

- Tissue plasminogen activator (tPA):
 - Protease that dissolves blood clots
 - Approved for use in certain heart attack or stroke patients
- Clinical Studies:
 - tPA and other clot-dissolving agents can reduce the amount of damage to the heart muscle and save lives
 - To be effective, they must be given within a few hours after symptoms begin
 - Few MI patients qualify
 - Administered through an intravenous (IV) line in the arm by hospital personnel
 - Patients treated within 90 min after onset of chest pain are 1/7 as likely to die compared to patients who receive therapy later

Thrombolytic Drugs

- Risks of thrombolytics:
 - Intra-cranial hemorrhage
 - Increased risk in those > age 70
 - Instead of ischemic stroke this can lead to hemorrhagic stroke
 - Patients may require further intervention
- Costs of thrombolytics:
 - tPA = \$2300
 - Streptokinase = \$320

Effectiveness of Thrombolytics

- Clinical Trial:
 - In 15 countries and 1081 hospitals
 - 41,021 patients with evolving myocardial infarction
 - Randomly assigned to 4 different strategies:
 - Streptokinase and subcutaneous heparin
 - Streptokinase and IV heparin
 - Accelerated tissue plasminogen activator (t-PA) and IV heparin
 - Combo of streptokinase plus t-PA with IV heparin
 - Primary end point was 30-day mortality
- Result:
 - Streptokinase & subcutaneous heparin: 7.2% (stroke 0.49%)
 - Streptokinase & IV heparin: 7.4% (stroke 0.54%)
 - Accelerated t-PA & IV heparin: 6.3% (stroke 0.72%)
 - Combo of both with IV heparin: 7.0% (stroke 0.94%)

Cost-Effectiveness of Thrombolytics

<i>Therapy</i>	<i>Patient Group</i>	<i>\$ per yr life saved</i>
tPA	Post MI, high risk	\$3,600
tPA	Acute MI, large infarct, treatment started >2 hours post	\$24,200
Counseling	Smoking cessation	\$1,300-\$3,900
CABG	Two vessel disease, severe angina	\$9,200-\$42,500

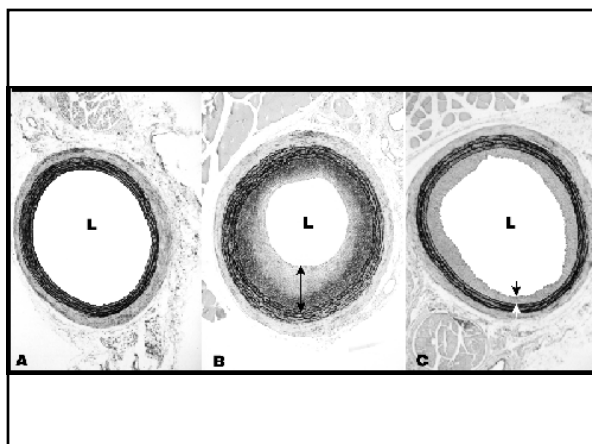
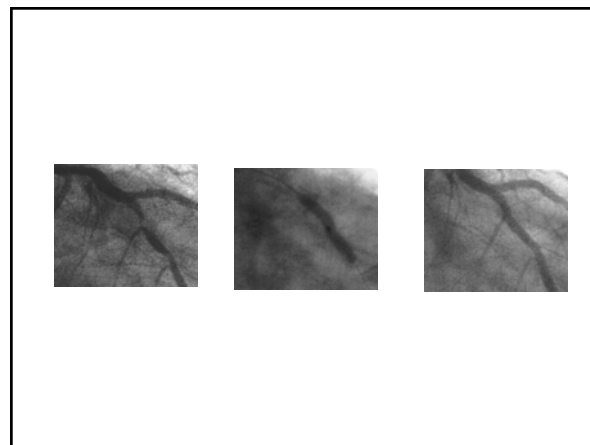
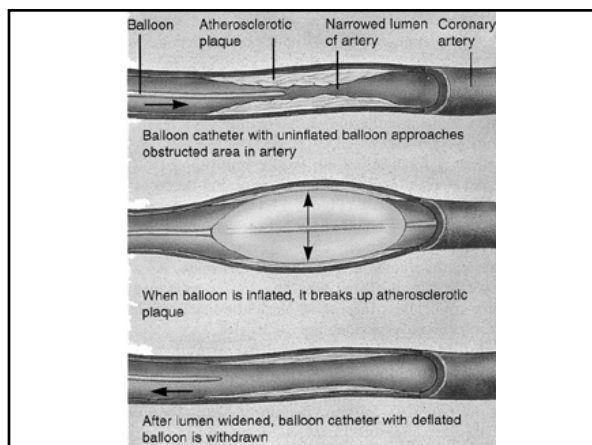
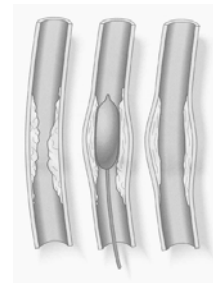
http://www.sciencedirect.com/science?_ob=ArticleURL&_asset=B-WA-A-A-MsSAYZA-UJA-AUYWDCBYZYAUUBBVZZYBWAUBWEUBAU&_rdoc=1&_fmt=full&_uid=B6T1048NJK25&_coverDate=5%2F22%2F2003&_cdi=4875&_orig=search&_src=13&_sort=ddview=&_acct=C000004378&_version=1&_urlVersion=0&_userid=10&22&md5=51493caa5165762c23c0d90eaa8b92d

Treatment of Atherosclerosis

- Percutaneous Transluminal Angioplasty (PCTA)

– Balloon Angioplasty

BALLOON ANGIOPLASTY

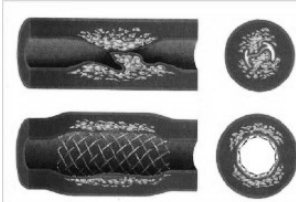


PCTA: Effectiveness

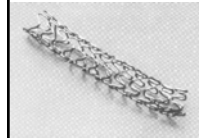
- Cannot always successfully perform procedure
 - Diffuse disease
 - Total occlusion
 - Calcified disease
 - Hardening of the arterial walls
- Restenosis
 - Occurs in 25-54% of patients
 - Usually occurs within 6 months

Treatment of Atherosclerosis: Stents

- A wire (typically) cage is inserted along with a balloon
 - Incorporates angioplasty
- Inflate the balloon
- Place the stent
- Retract balloon
- Stent remains



Stents



How is a Coronary Stent Implanted?

A stent is mounted on a balloon catheter.

The balloon is inflated and the stent is expanded.

The balloon is removed and the stent is implanted in the vessel.

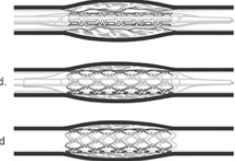
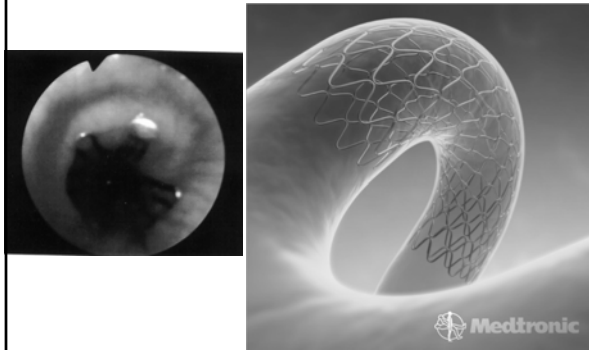


Image provided courtesy of Cordis Corporation.

Stents



Stents

- Are stents more effective than angioplasty?
- The cage does provide support for the vessel
- Restenosis is still a major concern
- Endothelial cells proliferate and grow over and around the stent

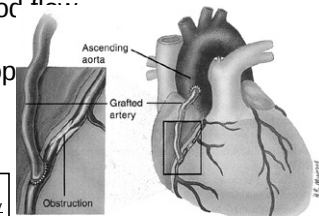
Drug-Eluting Stents

- Slowly releases drugs
 - Hinder cell proliferation around and over the stent
 - Slow restenosis
 - May increase thrombosis
- FDA approved for new lesions in small vessels
- More expensive (3-4 times)
- Very popular with public
 - NPR story from October 2003
- Long-term effectiveness
 - Restenosis is pronounced in small vessels
- The verdict is still out

<http://www.npr.org/features/feature.php?wfId=1452217>

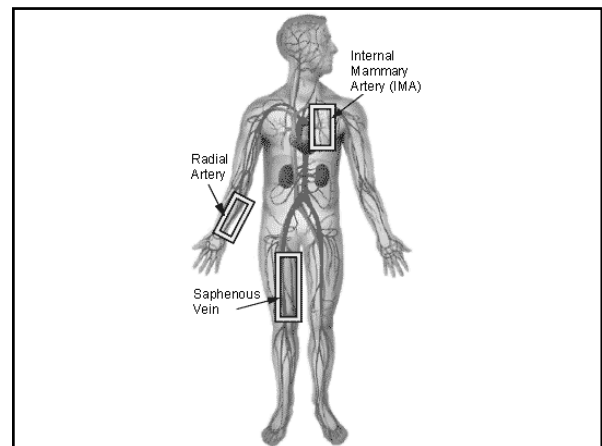
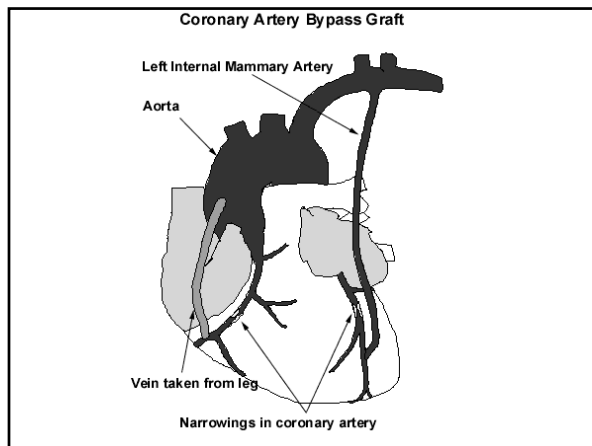
Treatment of Atherosclerosis

- Coronary artery bypass graft (CABG)
- A graft vessel from another area of the body is used to circumvent the occlusion and return blood flow
- To do this we have to stop the heart from beating



Coronary artery bypass grafting (CABG)

<http://www.nlm.nih.gov/medlineplus/tutorials/coronaryarterybypassgraft/htm/index.htm>



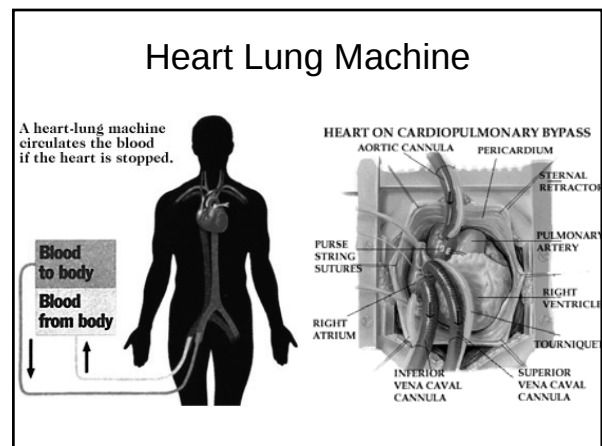
CABG Procedure

1. Patient is prepped, general anesthesia
2. Chest access is gained, through sternum
3. Graft vessel is retrieved
4. Expose heart through pericardium
5. Divert blood through heart lung machine
6. Stop heart
7. Insert graft
8. Return circulation to heart
9. Close incision

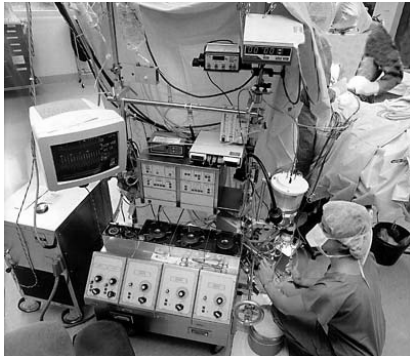


Heart-Lung (Bypass) Machine

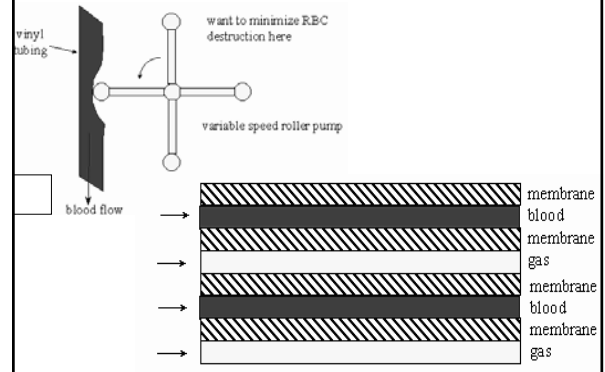
- Connected to patient by a series of tubes that the surgical team places
- Consists of a chamber that receives the blood from the body
- Blood is pumped by machine through an oxygenator
- Oxygenator removes CO_2 and adds oxygen
- Pump then pumps this newly oxygenated blood back to the body



Heart Lung Machine



Heart Lung Machine



CABG Effectiveness

- 2001: 516,000 CABG procedures performed
- Procedure takes 4-6 hours, 5-7 day hospital stay
- Grafts remain open & functioning for 10-15 yrs
 - Little restenosis
- Risks:
 - Heart attack (5%)
 - Stroke (5%) (risk greatest in those over 70 years old)
 - Death (1-2%)
 - Sternal wound infection (1-4%)
 - "Post-pericardiotomy syndrome" (30%)
 - Occurs few days to 6 months after surgery
 - Symptoms are fever and chest pain
 - Some people report memory loss and loss of mental clarity or "fuzzy thinking" following CABG

Innovations

- Off-pump CABG:
<http://www.surgery.usc.edu/divisions/ct/videos-mpeg-offpumpcoronaryarterybypassgrafting.html>
- Closed chest CABG:
[http://www.hsforum.com/stories/storyReader\\$1537](http://www.hsforum.com/stories/storyReader$1537)

The Heart Surgery Forum #2000-0380
4/11/2000 5/20/2001

Online address: www.hsforum.com/stories/storyReader\$1537

Closed Chest Coronary Artery Bypass on the Beating Heart

(#2000-0380) ... June 8, 2000

Utz Kappert, MD,¹ Romsdahl Cichon, MD,¹ Vassilios Guelleson, MD,²
Jens Schneider, MD,¹ Ina Schramm, MD,¹ Joachim Nicolai, MD,²
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Dr. Kappert

Comparison of Treatment Methods

- Hospital Stay:
 - CABG: 4-7 days
 - PCTA: 1-2 days
 - Stent: 1-2 days
- Restenosis:
 - CABG: 5-6%, usually after 5 years
 - PCTA : 25-45%, usually within 6 months
 - Stent: 15-20%, usually within 6 months

Comparison of RX Methods

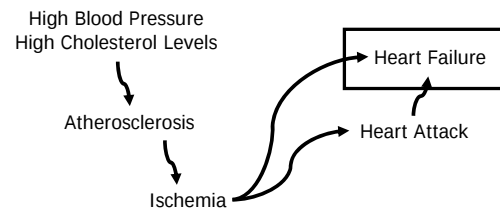
- Cost
 - CABG: \$35,000
 - PCTA : \$17,000
 - Stent: \$19,000
 - With drug-eluting stent: \$30,000
- Cost-effectiveness
 - Additive procedures:
 - Within 5 years, 20-40% of patients have second PCTA, 25% have CABG
 - Additive costs:
 - 0 years: per patient costs of PCTA 30-50% those of CABG
 - 1 year: 50-60%
 - 3 years: 60-80%
 - >3 years: >80%

Prevention versus Treatment?

- Which is more cost effective in terms of both money and resources?
 - For the patient?
 - For medical community?
 - For society?

<http://www.nytimes.com/2004/03/21/health/21HEAR.html>

Progression of Heart Disease



Assignments Due Next Tuesday

- Project Task 5
- Muddiest Point/Clearest Point