

# BIOE 301

## Lecture Fifteen

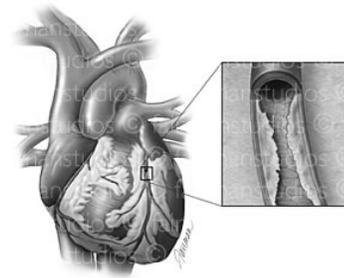


## Outline

- The burden of heart disease
- The cardiovascular system
- How do heart attacks happen?
- How do we treat atherosclerosis?
  - Open heart surgery
  - Angioplasty
  - Stents
- What is heart failure?
- How do we treat heart failure?
  - Heart transplant
  - Left ventricular assist devices
  - Artificial heart

## Early Warning Signs of Heart Attack

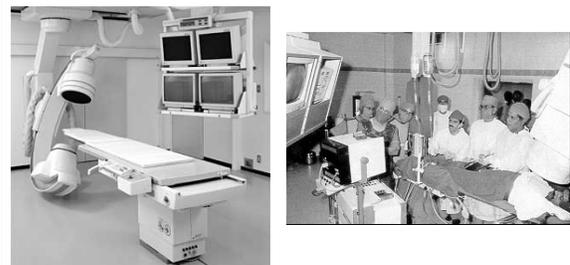
- Many heart attacks start slowly; symptoms may come and go
- Chest discomfort
  - Most heart attacks involve discomfort in the center of the chest that lasts for more than a few minutes, or goes away and comes back. The discomfort can feel like uncomfortable pressure, squeezing, fullness, or pain
- 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



## Heart Attacks

### Diagnosis of Atherosclerosis

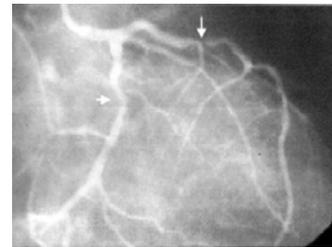
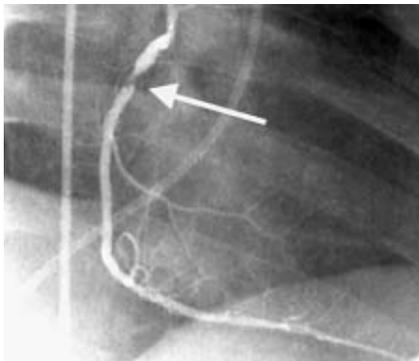
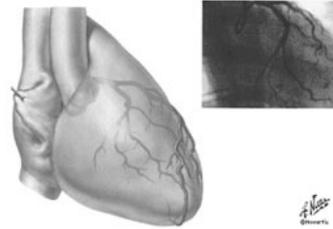
## Detection of Atherosclerosis



## Access to Cardiothoracic Surgery

- surgery cost and availability of trained individuals and centers are significant issues for cardiothoracic surgery worldwide.
- It is estimated that >10,000 cardiothoracic surgeons in >6,000 centers globally perform more than 2M open heart operations per year.
- 1,222 open heart operations per
  - 1 million population in North America
  - 18 per million in Africa
- translates into 1 center per
  - 120,000 people in the USA
  - 33 million people in Africa

Left Coronary Artery  
Arteriographic View 2

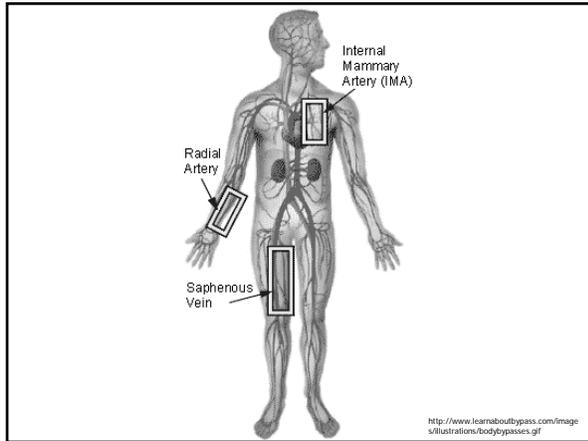
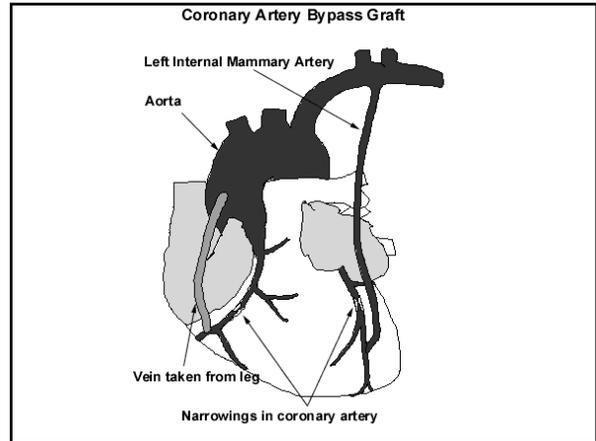
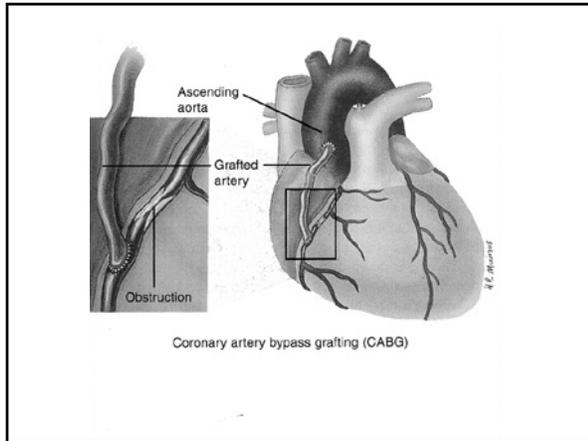


## Heart Attacks

Treatment of Atherosclerosis

## How Do We Treat Atherosclerosis?

CABG



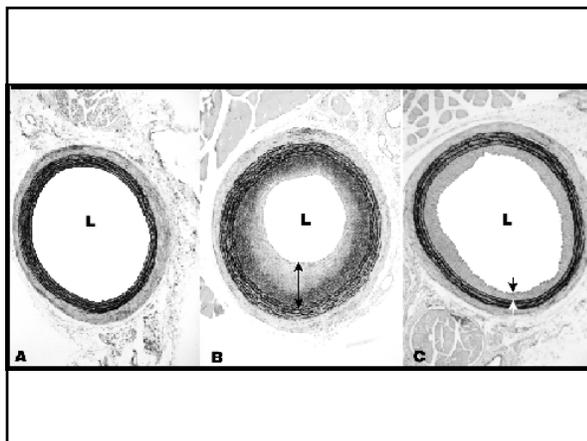
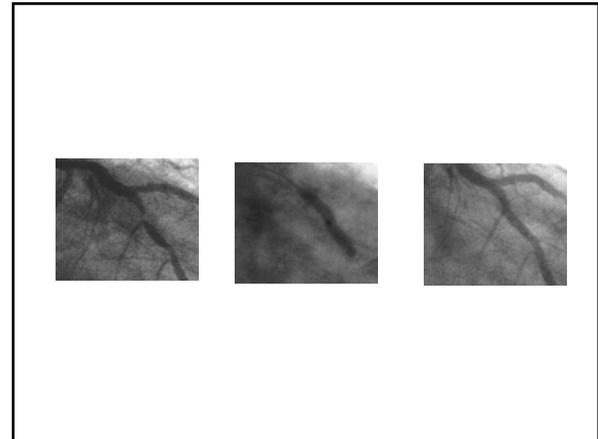
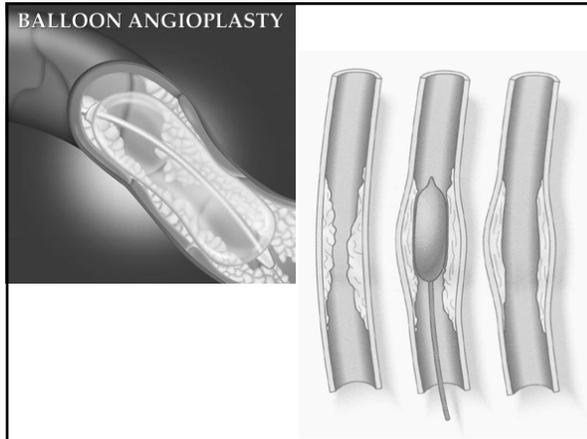
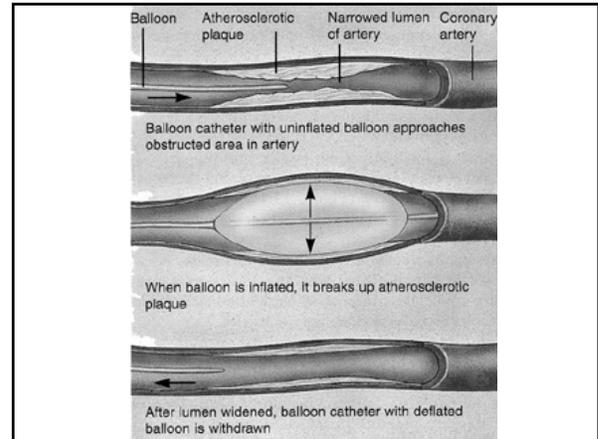
- ### CABG Procedure
- Patient is prepped, general anesthesia
  - Chest access is gained, through sternum
  - Graft vessel is retrieved
  - Expose heart through pericardium
  - Divert blood through heart lung machine
  - Stop heart
  - Insert graft
  - Return circulation to heart
  - Close incision





# How Do We Treat Atherosclerosis?

## Angioplasty



## PTCA: Effectiveness

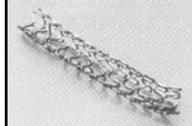
- Cannot always successfully perform procedure
  - Diffuse disease
  - Total occlusion
  - Calcified disease
- Restenosis
  - Occurs in 25-54% of patients
  - Usually occurs within 6 months

# How Do We Treat Atherosclerosis?

## Stent

## Stents

<http://www2.cajun.net/~wpharo/stent.jpg>



<http://www.vbamc.amedd.army.mil/images/newsphotos/stent%20implantation.jpg>

### How is a Coronary Stent Implanted?

A stent is mounted on a balloon catheter.



The balloon is inflated and the stent is expanded.



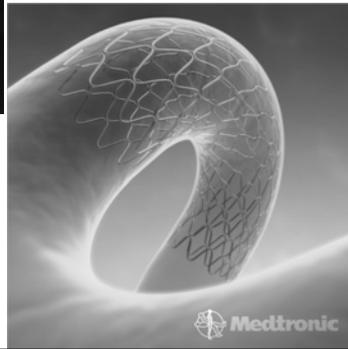
The balloon is removed and the stent is implanted in the vessel.



Image provided courtesy of Cordis Corporation.



## Stents



<http://www.priority.com/cmst/stent3.jpg>

[http://www.hybridmedicalanimation.com/media/mdtmc\\_stent.jpg](http://www.hybridmedicalanimation.com/media/mdtmc_stent.jpg)

Medtronic

## Drug Eluting Stents

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

## Comparison of RX Methods

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

## Comparison of RX Methods

- Cost
  - CABG \$35,000
  - Angioplasty \$17,000
  - Stent \$19,000
- Cost-effectiveness
  - Additive procedures:
    - Within 5 years, 20-40% of patients have second PTCA, 25% have CABG
  - Additive costs:
    - 0 years: per patient costs of PTCA 30-50% those of CABG
    - 1 year: 50-60%
    - 3 years: 60-80%
    - >3 years: >80%
- Moving Target Problem

## What Would You Do?

- Angioplasty
  - Stent
  - CABG
- A 28% decrease in coronary artery bypass operations between 1997 and 2005, and a 121% increase in stent procedures over the same period.

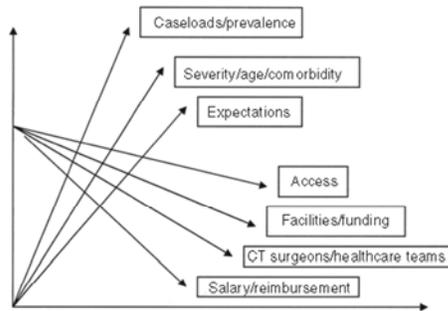
## The challenges for cardiothoracic (CT) surgery in the USA and developed countries



Pezzella A. T.; Asian Cardiovasc Thorac Ann 2010;18:299-310  
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Asian Cardiovascular & Thoracic Annals

## The challenges for cardiothoracic (CT) surgery in developing countries



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## Cost-Effectiveness

Therapy	Patient Group	\$ per yr life saved
tPA	Post MI high risk	\$3,600
tPA	Acute MI, large infarct, treatment started >2 hours post	\$24,200
Counseling	Smoking cessation	\$1300-\$3900
CABG	Two vessel disease, severe angina	\$9,200-\$42,500

[http://www.sciencedirect.com/science?\\_ob=ArticleURL&\\_ast=B-WA-A-A-McSAYZA-UUA-AUYWDCBYZYALYUBBVZZYBWAUBWEURAU&\\_rdoc=1&\\_fmt=full&\\_udi=B6T1048NXX25&\\_coverDate=5%2F22%2F2003&\\_cdi=4876&\\_orig=search&\\_sl=13&\\_sort=&view=c&\\_acct=C000004378&\\_version=1&\\_urlVersion=0&\\_userid=108429&md5=5f493ca5565762c23c0d90a8a892d](http://www.sciencedirect.com/science?_ob=ArticleURL&_ast=B-WA-A-A-McSAYZA-UUA-AUYWDCBYZYALYUBBVZZYBWAUBWEURAU&_rdoc=1&_fmt=full&_udi=B6T1048NXX25&_coverDate=5%2F22%2F2003&_cdi=4876&_orig=search&_sl=13&_sort=&view=c&_acct=C000004378&_version=1&_urlVersion=0&_userid=108429&md5=5f493ca5565762c23c0d90a8a892d)

## Prevention or Treatment?

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

## Progression of Heart Disease

