

# Cardiovascular Disease

Lecture 9- Diseases of the Heart

Course Zool. 202  
Energetics and Homeostasis

## Cardiovascular Disease

- Cardiovascular disease generally refers to conditions that involve narrowed or blocked blood vessels that can lead to a heart attack, chest pain (angina) or stroke.
- Other heart conditions, such as those that affect heart's muscle, valves or rhythm, are considered forms of heart disease.
- Leading cause of death globally
  - 17.3 million deaths (31.5%) in 2013
  - Up from 12.3 million (25.8%) in 1990
- Most cardiovascular disease affects older adults

## Cardiomyopathy

- Cardiomyopathy (literally "heart muscle disease") is the measurable deterioration for any reason of the ability of the myocardium (the heart muscle) to contract, usually leading to heart failure.
- Common symptoms
  - Dyspnea (breathlessness)
  - Peripheral edema (swelling of the legs)
- Often at risk of-
  - Dangerous forms of irregular heart rate
  - Sudden cardiac death
- Cardiomyopathy and myocarditis resulted in 443,000 deaths in 2013, up from 294,000 in 1990

Although the term "cardiomyopathy" could theoretically apply to almost any disease affecting the heart, it is usually reserved for "severe myocardial disease leading to heart failure". Cardiomyopathy and myocarditis resulted in 443,000 deaths in 2013, up from 294,000 in 1990.

## Types of Cardiomyopathy

- American Heart Association divides cardiomyopathies into
  - Primary, which affect the heart alone
  - Secondary, which are the result of illness affecting other parts of the body.
- Primary/intrinsic cardiomyopathies
  - Defined as weakness of the heart muscle without an identifiable external cause
- Secondary/extrinsic cardiomyopathies
  - Where the primary pathology arose outside the myocardium itself. Some external factors are involved

## Primary/Intrinsic Cardiomyopathy

- Genetic
  - Hypertrophic cardiomyopathy
  - Arrhythmogenic right ventricular cardiomyopathy (ARVC)
  - LV non-compaction
  - Ion Channelopathies
  - Dilated cardiomyopathy (DCM)
  - Restrictive cardiomyopathy (RCM)
- Acquired
  - Stress Cardiomyopathy
  - Myocarditis
  - Ischemic cardiomyopathy

## Secondary/Extrinsic Cardiomyopathy

- Metabolic/storage
  - Fabry's disease
  - Hemochromatosis
- Endomyocardial
  - Endomyocardial fibrosis
  - Hypereosinophilic syndrome
- Endocrine
  - Diabetes mellitus
  - Hyperthyroidism
  - Acromegaly
- Cardiofacial
  - Noonan syndrome
- Neuromuscular
  - Muscular dystrophy
  - Friedreich's ataxia
- Other
  - Obesity-associated cardiomyopathy

## Common type of Cardiomyopathies

- Dilated cardiomyopathy
  - The pumping ability of the heart's main pumping chamber 'the left ventricle' becomes less forceful
- Hypertrophic cardiomyopathy
  - Abnormal thickening of the heart muscle, particularly affecting the muscle of the heart's main pumping chamber (left ventricle)
- Restrictive cardiomyopathy
  - Heart muscle becomes rigid and less elastic, meaning the heart can't properly expand and fill with blood between heartbeats
- Arrhythmogenic right ventricular dysplasia
  - The muscle in the lower right heart chamber (right ventricle) is replaced by scar tissue

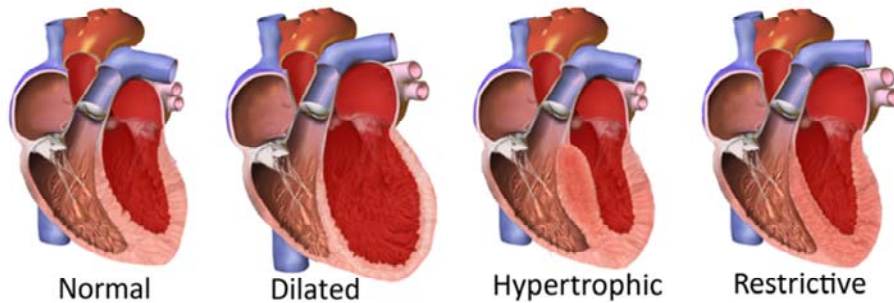
**Dilated cardiomyopathy:** This is the most common type of cardiomyopathy. In this disorder, the pumping ability of the heart's main pumping chamber 'the left ventricle' becomes less forceful. The left ventricle becomes enlarged (dilated) and can't effectively pump blood out of the heart.

**Hypertrophic cardiomyopathy:** This type involves abnormal thickening of the heart muscle, particularly affecting the muscle of the heart's main pumping chamber (left ventricle). The thickened heart muscle can make it harder for the heart to pump blood.

**Restrictive cardiomyopathy:** The heart muscle in people with restrictive cardiomyopathy becomes rigid and less elastic, meaning the heart can't properly expand and fill with blood between heartbeats.

**Arrhythmogenic right ventricular dysplasia:** In this rare type of cardiomyopathy, the muscle in the lower right heart chamber (right ventricle) is replaced by scar tissue. This can lead to heart rhythm problems. This condition is often caused by genetic mutations.

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## Symptoms

- May not have any signs and symptoms in the early stages
- Signs and symptoms usually appear as the condition advances
- Symptoms may include:
  - Breathlessness with exertion or even at rest
  - Swelling of the legs, ankles and feet
  - Bloating of the abdomen due to fluid buildup
  - Cough while lying down
  - Fatigue
  - Irregular heartbeats that feel rapid, pounding or fluttering
  - Chest pain
  - Dizziness, lightheadedness and fainting

No matter what type of cardiomyopathy you have, signs and symptoms tend to get worse unless treated. In certain people, this worsening happens quickly, while in others, cardiomyopathy may not worsen for a long time.

## Causes

- Genetic conditions
- Long-term high blood pressure
- Heart tissue damage from a previous heart attack
- Chronic rapid heart rate
- Heart valve problems
- Metabolic disorders, such as obesity, thyroid disease or diabetes
- Nutritional deficiencies of essential vitamins or minerals, such as thiamin (vitamin B-1)
- Pregnancy complications
- Drinking too much alcohol over many years
- Use of cocaine, amphetamines or anabolic steroids
- Use of some chemotherapy drugs and radiation to treat cancer
- Certain infections, which may injure the heart and trigger cardiomyopathy
- Iron buildup in your heart muscle (hemochromatosis)
- A condition that causes inflammation and can cause lumps of cells to grow in the heart and other organs (sarcoidosis)
- A disorder that causes the buildup of abnormal proteins (amyloidosis)
- Connective tissue disorders

Often, the cause of the cardiomyopathy is unknown. In some people, however, doctors are able to identify some contributing factors. Possible causes of cardiomyopathy include:

## Risk Factors

- Family history
- High blood pressure
- Conditions that affect the heart
- Obesity and Diabetes
- Alcoholism and Illicit drug use
- Cancer treatments
- Thyroid disorders
- Hemochromatosis
- Diseases that affect the heart

## Tests and Diagnosis

- Chest X-ray
- Echocardiogram
- Electrocardiogram (ECG)
- Treadmill stress test
- Cardiac catheterization
- Coronary angiogram
- Cardiac magnetic resonance imaging (MRI)
- Cardiac computerized tomography (CT) scan
- Blood tests
- Genetic testing or screening

**Chest X-ray.** An image of the heart will show whether it's enlarged.

**Echocardiogram.** An echocardiogram uses sound waves to produce images of the heart.

**Electrocardiogram (ECG).** In this noninvasive test, electrode patches are attached to the skin to measure electrical impulses from the heart.

**Treadmill stress test.** Heart rhythm, blood pressure and breathing are monitored while walking on a treadmill.

**Cardiac catheterization.** In this procedure, a thin tube (catheter) is inserted in the groin and threaded through the blood vessels to your heart. Doctors may extract a small sample (biopsy) of the heart for analysis in the laboratory.

**Coronary angiogram.** Doctors may inject a dye into your blood vessels to help your blood vessels show up on X-rays.

**Cardiac magnetic resonance imaging (MRI).** Cardiac MRI is an imaging technique that uses magnetic fields and radio waves to create images of the heart.

**Cardiac computerized tomography (CT) scan.** In a cardiac CT scan, you lie on a table inside a doughnut-shaped machine. An X-ray tube inside the machine rotates around the body and collects images of the heart and chest.

**Blood tests.** Several blood tests may be done, including those to check your kidney, thyroid and liver function, and to measure your iron levels.

One blood test can measure B-type natriuretic peptide (BNP), a protein produced in your heart.

**Genetic testing or screening.** Cardiomyopathy can be hereditary. Discuss with your doctor whether genetic testing may be appropriate for you and your family.

## Treatment

- Suggestion of lifestyle changes to better manage the condition.
- Depends on the type of cardiomyopathy and condition of disease
  - Medication (conservative treatment)
  - Iatrogenic/implanted pacemakers for slow heart rates
  - Defibrillators for those prone to fatal heart rhythms
  - Ventricular assist devices (VADS) for severe heart failure
  - Ablation for recurring dysrhythmias
    - which cannot be eliminated by medication or mechanical cardioversion.
- The goal of treatment is often symptom relief, and some patients may eventually require a heart transplant.

Pacemakers: A battery-operated electrical device inserted into the body to deliver small regular shocks that stimulate the heart to beat in a normal rhythm

Defibrillator: A machine that administers a controlled electric shock to the chest or heart to correct a critically irregular heartbeat that cannot drive the circulation

Ablation is the removal of diseased or unwanted tissue from the body by surgical or other means.

## Hypertensive heart disease

- Includes a number of complications of high blood pressure that affect the heart
- Subcategories
  - Hypertensive heart disease with heart failure
  - Hypertensive heart disease without heart failure
- In 2013 hypertensive heart disease resulted in 1.07 million deaths up from 630,000 in 1990.

Hypertensive heart disease includes a number of complications of high blood pressure that affect the heart. While there are several definitions of hypertensive heart disease in the medical literature, the term is most widely used in the context of the International Classification of Diseases (ICD) coding categories.

## Signs and symptoms

- Fatigue- extreme tiredness or weariness resulting from physical or mental activity
- Irregular pulse or palpitations
- Swelling of feet and ankles
- Weight gain
- Nausea- the unsettling feeling in the stomach that accompanies the urge to vomit
- Shortness of breath
- Difficulty sleeping flat in bed (orthopnea)
- Bloating and abdominal pain
- Greater need to urinate at night
- An enlarged heart (cardiomegaly)

The symptoms and signs of hypertensive heart disease will depend on whether or not it is accompanied by heart failure. In the absence of heart failure, hypertension, with or without enlargement of the heart (left ventricular hypertrophy) is usually symptomless. Symptoms and signs of chronic heart failure can include

## Potential complications

- Left ventricular hypertrophy and left ventricular remodeling
- Diminished coronary flow reserve and silent myocardial ischemia
- Coronary heart disease and accelerated atherosclerosis
- Congestive heart failure, often termed diastolic heart failure
- Atrial fibrillation, other cardiac arrhythmias and sudden cardiac death

**Coronary-** Describes the arteries that supply blood to the muscle tissue of the heart, or the veins that take blood away from it.

**Ischemia-** An inadequate supply of blood to a part of the body, caused by partial or total blockage of an artery.

**Diastolic-** The rhythmic expansion of the chambers of the heart at each heartbeat, during which they fill with blood.

**Fibrillation-** A rapid chaotic beating of the heart muscles in which the affected part of the heart may stop pumping blood.

**Arrhythmia-** An irregularity in a rhythmic action such as a heartbeat or breathing.



## Diagnosis

| Category        | Systolic BP (mm Hg) | Diastolic BP (mm Hg) | Comments  |
|-----------------|---------------------|----------------------|---|
| Optimal         | < 120               | < 80                 | You are fit and full of life                                    |
| Prehypertension | 120-139             | 80-89                | Careful about your diet and life style                          |
| Stage I         | 140-159             | 90-99                | You have to take it seriously and change life style accordingly |
| Stage II        | >160                | >100                 | Start taking medications and follow a very disciplined life     |

## Differential Diagnosis

- Coronary artery disease or ischemic heart disease due to atherosclerosis
- Hypertrophic cardiomyopathy
- Left ventricular hypertrophy in athletes
- Congestive heart failure or heart failure with normal ejection fraction due to other causes
- Atrial fibrillation or other disorders of cardiac rhythm due to other causes
- Sleep apnea- a sleep disorder characterized by pauses in breathing or instances of shallow or infrequent breathing during sleep

Other conditions that can share features with hypertensive heart disease and need to be considered in the differential diagnosis.

## Prevention

- Early diagnosis of high blood pressure can prevent
  - Heart disease
  - Stroke
  - Eye problems
  - Chronic kidney disease
- Cardiovascular disease and death can be reduced by lifestyle modifications
  - Dietary advice
  - Promotion of weight loss
  - Regular aerobic exercise
  - Moderation of alcohol intake
  - Stopping drug abuse
  - Cessation of smoking

Because there are no symptoms with high blood pressure, people can have the condition without knowing it. Diagnosing high blood pressure early can help prevent heart disease, stroke, eye problems, and chronic kidney disease.

## Treatment

- Treatment hypertensive heart disease falls under 2 categories
  - Treatment of the elevated BP with medications
  - Prevention of hypertensive heart disease with disciplined life style

# Heart Failure

- Sometimes known as
  - Congestive heart failure
  - Chronic heart failure
  - Congestive cardiac failure
- Occurs when the heart muscle doesn't pump blood as well as it should. Certain conditions gradually leave the heart too weak or stiff to fill and pump efficiently.
  - Coronary artery disease
  - High blood pressure
  - Atrial fibrillation
  - Valvular heart disease
  - Excess alcohol use
  - Infection, and Cardiomyopathy

Common causes of heart failure include coronary artery disease including a previous myocardial infarction (heart attack), high blood pressure, atrial fibrillation, valvular heart disease, excess alcohol use, infection, and cardiomyopathy of an unknown cause. These cause heart failure by changing either the structure or the functioning of the heart.

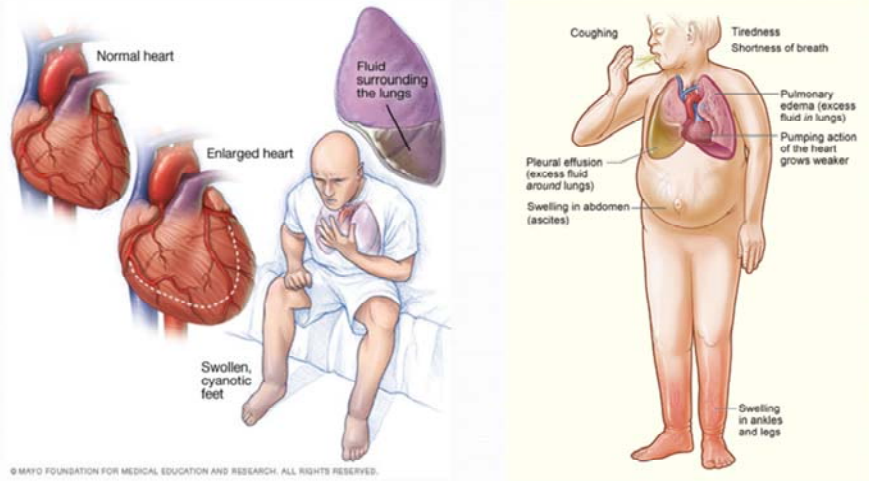
## Symptoms

- Shortness of breath (dyspnea) when the exert yourself or when you lie down
- Fatigue and weakness
- Swelling (edema) in the legs, ankles and feet
- Rapid or irregular heartbeat
- Reduced ability to exercise
- Persistent cough or wheezing with white or pink blood-tinged phlegm
- Increased need to urinate at night
- Swelling of the abdomen (ascites)
- Sudden weight gain from fluid retention
- Lack of appetite and nausea
- Difficulty concentrating or decreased alertness
- Sudden, severe shortness of breath and coughing up pink, foamy mucus
- Chest pain if the heart failure is caused by a heart attack

Heart failure can be ongoing (chronic), or your condition may start suddenly (acute).

Phlegm- the thick mucus secreted by the walls of the respiratory passages, especially during a cold

# Symptoms



## Types of Heart Failure

| Type of heart failure  | Description   |
|--|---|
| Left-sided heart failure   | Fluid may back up in your lungs, causing shortness of breath.               |
| Right-sided heart failure  | Fluid may back up into your abdomen, legs and feet, causing swelling.       |
| Systolic heart failure   | The left ventricle can't contract vigorously, indicating a pumping problem. |
| Diastolic heart failure (also called heart failure with preserved ejection fraction) | The left ventricle can't relax or fill fully, indicating a filling problem. |



## Major Causes of Heart Failure

- Coronary artery disease and heart attack
- High blood pressure (hypertension)
- Faulty heart valves
- Damage to the heart muscle (cardiomyopathy)
- Myocarditis- inflammation of the heart muscle
- Heart defects you're born with (congenital heart defects)
- Abnormal heart rhythms (heart arrhythmias)
- Other diseases- diabetes, HIV, hyperthyroidism, hypothyroidism, or a buildup of iron (hemochromatosis) or protein (amyloidosis)

Any of the following conditions can damage or weaken your heart and can cause heart failure. Some of these can be present without your knowing it:

**Coronary artery disease and heart attack.** Coronary artery disease is the most common form of heart disease and the most common cause of heart failure.

**High blood pressure (hypertension).** Blood pressure is the force of blood pumped by your heart through your arteries.

**Faulty heart valves.** The valves of your heart keep blood flowing in the proper direction through the heart.

**Damage to the heart muscle (cardiomyopathy).** Heart muscle damage (cardiomyopathy) can have many causes, including several diseases, infections, alcohol abuse and the toxic effect of drugs, such as cocaine or some drugs used for chemotherapy.

**Myocarditis.** Myocarditis is an inflammation of the heart muscle. It's most commonly caused by a virus and can lead to left-sided heart failure.

**Heart defects you're born with (congenital heart defects).** If your heart and its chambers or valves haven't formed correctly, the healthy parts of your heart have to work harder to pump blood through your heart, which, in turn, may lead to heart failure.

**Abnormal heart rhythms (heart arrhythmias).** Abnormal heart rhythms may cause your heart to beat too fast, which creates extra work for your heart.

**Other diseases.** Chronic diseases — such as diabetes, HIV, hyperthyroidism, hypothyroidism, or a buildup of iron (hemochromatosis) or protein (amyloidosis) — also may contribute to heart failure.

## Risk Factors

- High blood pressure
- Coronary artery disease
- Heart attack
- Diabetes
- Some diabetes medications
- Sleep apnea
- Congenital heart defects
- Valvular heart disease
- Viruses
- Alcohol use
- Tobacco use
- Obesity
- Irregular heartbeats

| Possible Complications   |                       |
|--------------------------|-----------------------|
| Kidney damage or failure | Heart rhythm problems |
| Heart valve problems     | Liver damage          |

A single risk factor may be enough to cause heart failure, but a combination of factors also increases your risk.

**High blood pressure.** Your heart works harder than it has to if your blood pressure is high.

**Coronary artery disease.** Narrowed arteries may limit your heart's supply of oxygen-rich blood, resulting in weakened heart muscle.

**Heart attack.** Damage to your heart muscle from a heart attack may mean your heart can no longer pump as well as it should.

**Diabetes.** Having diabetes increases your risk of high blood pressure and coronary artery disease.

**Some diabetes medications.** The diabetes drugs rosiglitazone (Avandia) and pioglitazone (Actos) have been found to increase the risk of heart failure in some people. Don't stop taking these medications on your own, though. If you're taking them, discuss with your doctor whether you need to make any changes.

**Sleep apnea.** The inability to breathe properly while you sleep at night results in low blood oxygen levels and increased risk of abnormal heart rhythms. Both of these problems can weaken the heart.

**Congenital heart defects.** Some people who develop heart failure were born with structural heart defects.

**Valvular heart disease.** People with valvular heart disease have a higher risk of heart failure.

**Viruses.** A viral infection may have damaged your heart muscle.

**Alcohol use.** Drinking too much alcohol can weaken heart muscle and lead to heart failure.

**Tobacco use.** Using tobacco can increase your risk of heart failure.

**Obesity.** People who are obese have a higher risk of developing heart failure.

**Irregular heartbeats.** These abnormal rhythms, especially if they are very frequent and fast, can weaken the heart muscle and cause heart failure.

## Tests and Diagnosis

- Blood tests
- Chest X-ray
- Electrocardiogram (ECG)
- Echocardiogram
- Stress test
- Cardiac computerized tomography (CT) scan
- Magnetic resonance imaging (MRI)
- Coronary angiogram
- Myocardial biopsy

To diagnose heart failure, doctor will take a careful medical history, review the symptoms and perform a physical examination. A doctor will also check for the presence of risk factors, such as high blood pressure, coronary artery disease or diabetes. After the physical exam, the doctor may also order some of the following tests.

## Treatments

- Medications
  - Angiotensin-converting enzyme (ACE) inhibitors
  - Angiotensin II receptor blockers
  - Beta blockers
  - Diuretics
  - Aldosterone antagonists
  - Inotropes
  - Digoxin (Lanoxin)

Doctors usually treat heart failure with a combination of medications. Depending on your symptoms, you might take one or more medications. In some cases, doctors recommend surgery to treat the underlying problem that led to heart failure.

## Treatments

- Surgery and medical devices
  - Coronary bypass surgery
  - Heart valve repair or replacement
  - Implantable cardioverter-defibrillators (ICDs)
  - Cardiac resynchronization therapy (CRT), or biventricular pacing
  - Heart pumps
  - Heart transplant

## Life Style and Home Remedies

- Stop smoking
- Discuss weight monitoring with the doctor
- Check the legs, ankles and feet for swelling daily
- Eat a healthy diet
- Restrict salt in the diet
- Maintain a healthy weight
- Consider getting vaccinations
- Limit fats and cholesterol
- Limit alcohol and fluids
- Be active
- Reduce stress
- Sleep easy

Making lifestyle changes can often help relieve signs and symptoms of heart failure and prevent the disease from worsening. These changes may be among the most important and beneficial you can make.

## Pulmonary Heart Disease

- Also known as *Cor pulmonale*
- The enlargement and failure of the right ventricle of the heart as a response to increased vascular resistance or high blood pressure in the lungs (pulmonary hypertension).
- Chronic pulmonary heart disease
  - Usually results in right ventricular hypertrophy (RVH)
  - Individual muscle cells grow larger (in thickness)
  - Increased contractile force required to move the blood against greater resistance
- Acute pulmonary heart disease
  - Usually results in dilatation
  - Stretching (in length) of the ventricle in response to acute increased pressure

Hypertrophy is an adaptive response to a long-term increase in pressure. Individual muscle cells grow larger (in thickness) and change to drive the increased contractile force required to move the blood against greater resistance.

Dilatation is a stretching (in length) of the ventricle in response to acute increased pressure, such as when caused by a pulmonary embolism or ARDS (acute respiratory distress syndrome).

The heart has two pumping chambers. The left ventricle pumps blood throughout the body. The right ventricle pumps blood to the lungs where it is oxygenated and returned to the left heart for distribution. In normal circumstances, the right heart pumps blood into the lungs without any resistance. The lungs usually have minimal pressure, and the right heart easily pumps blood through to them.[2] However with certain lung diseases chronically present, like emphysema and chronic bronchitis, each of which is found in the pathology of chronic obstructive pulmonary disease (COPD), and also pulmonary hypertension, the blood vessels of the lungs are significantly reduced in number (due to lung tissue destruction) and/or chronically constricted (due to poor alveolar ventilation in the case of COPD). The right ventricle is no longer able to push blood into the lungs effectively, and the chronic overload eventually causes it to fail.

## Signs and Symptoms

- Shortness of breath which occurs on exertion but when severe can occur at rest
- Wheezing
- Chronic wet cough
- Swelling of the abdomen with fluid (ascites)
- Swelling of the ankles and feet (pedal edema)
- Enlargement or prominent neck and facial veins
- Raised jugular venous pressure (JVP)
- Enlargement of the liver
- Bluish discoloration of the skin (cyanosis)
- Presence of abnormal heart sounds

The symptoms of pulmonary heart disease depend on the stage of the disorder. In the early stages, one may have no symptoms but as pulmonary heart disease progresses, most individuals will develop the symptoms





## Causes