

# Eye Catching and Comprehensive Study on Cardiology: Heart Attack

Sakshi Arun Sarode and Dr. Vijay D. Tarde

Dr.N.J.Paulbudhe College of Pharmacy, Ahmednagar, India

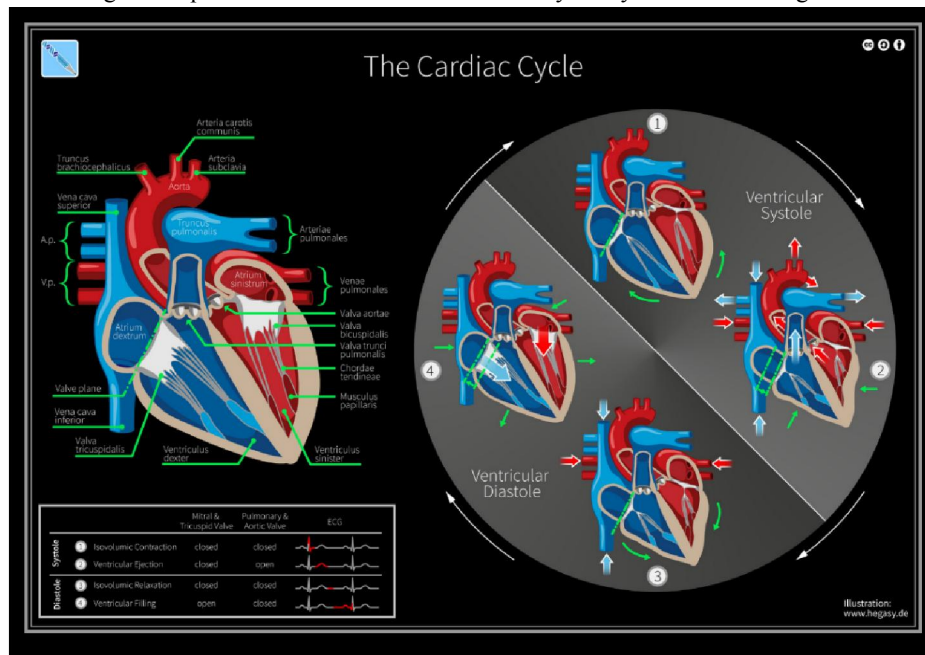
**Abstract:** A heart attack, or myocardial infarction, occurs when blood flow to a part of the heart muscle is blocked, often by a clot in a coronary artery. This interruption in blood flow deprives the heart muscle of oxygen, leading to tissue damage or death. Common symptoms include chest pain, shortness of breath, sweating, and nausea. Risk factors for heart attack include high blood pressure, high cholesterol, smoking, diabetes, and a family history of heart disease. Timely medical intervention, such as the administration of clot-dissolving medications or surgical procedures like angioplasty, is crucial to restoring blood flow and minimizing heart damage. Preventive measures include lifestyle modifications, such as a healthy diet, regular exercise, and stress management.

**Keywords:** heart attack

## I. INTRODUCTION

Cardiology:

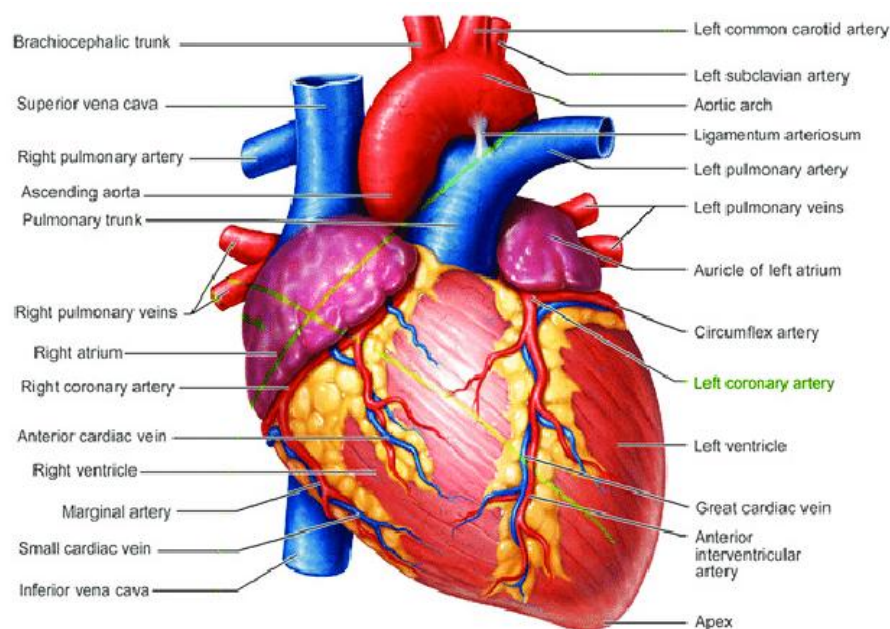
The term cardiology is derived from the Greek words “cardia,” which refers to the heart and “logy” meaning “study of.” Cardiology is a branch of medicine that concerns diseases and disorders of the heart, which may range from congenital defects through to acquired heart diseases such as coronary artery disease and congestive heart failure.



Cardiac cycle

Heart is the main organ in cardiovascular system. It's essential to life. Its components cooperate to circulate blood around our bodies in a synchronized fashion. Muscle and tissue make up the heart, a first-sized organ that circulates blood throughout the body. While the pumping blood transports carbon dioxide and other waste products from metabolism to the lungs, it also delivers oxygen and nutrients to the body.

Heart is located between the middle of chest, behind and slightly to the left of your breastbone (sternum). A double-layered membrane called the pericardium surrounds your heart like a sac. The outer layer of the pericardium surrounds the roots of your heart's major blood vessels and is attached by ligaments to spinal column, diaphragm, and other parts of body. The inner layer of the pericardium is attached to the heart muscle. A coating of fluid separates the two layers of membrane, letting the heart move as it beats. The heart weighs between 200 to 425 grams and is little larger than the size of fist.



Human Heart

Parts of heart:

- Walls
- Chambers
- Valves
- Blood vessels
- An electrical conduction system

**Heart wall:** The Heart consist of several layers of tough muscular wall, the myocardium. A thin layer of tissue, the pericardium, covers the outside, and another layer, the endocardium, lines the inside.

**Heart Chamber:** Heart has four separate chambers. The upper chambers are called the left and right atria, and the lower chamber are called the left and right ventricles.

**Heart Valves:** Four valves regulate blood flow through heart:

- The tricuspid valve regulates blood flow between the right atrium and right ventricle.
- The Pulmonary valve regulates blood flow from the right ventricle into the pulmonary arteries, which carry blood to lungs to pick up oxygen
- The mitral valve less oxygen rich blood from lungs pass from the left atrium into the left ventricle.
- The aortic valve opens the way for oxygen rich blood to pass from the left ventricle into the aorta, body's largest artery.

**Blood vessels:** heart pumps blood through three types of blood vessels:

Arteries carry oxygen rich blood from heart to body tissues.

Veins carry oxygen poor blood back to heart

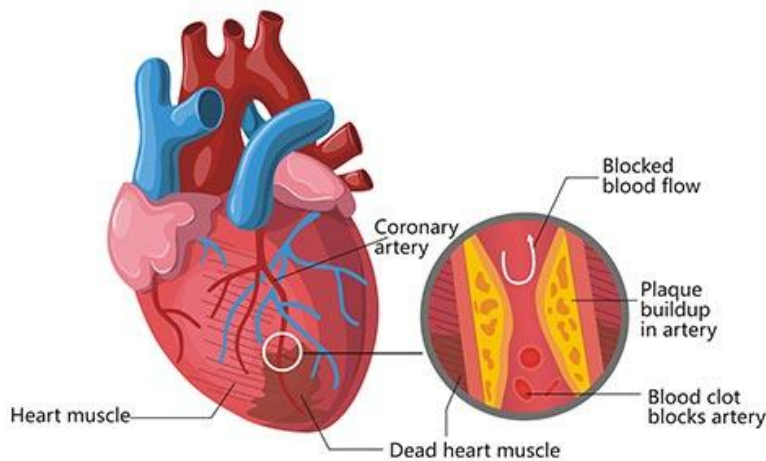
Capillaries are small blood vessels where body exchanges oxygen rich and oxygen poor blood

**Electrical conduction system:** Electrical impulses from heart muscle (the myocardium) cause heart to contract. This electrical signal begins in the sinoatrial (SA) node, located at the top of the right atrium. The SA node is sometimes called the heart's "natural pacemaker." An electrical impulse from this natural pacemaker travels through the muscle fibres of the atria and ventricles, causing them to contract. Although the SA node sends electrical impulses at a certain rate, your heart rate may still change depending on physical demands, stress, or hormonal factors.

#### **Functions of Heart:**

- Heart's main function is to move blood throughout body.
- Blood brings oxygen and nutrients to cells.
- It also takes away carbon dioxide and other waste so other organs can dispose of them.
- Controls the rhythm and speed of Heart rate.
- Maintains blood pressure.
- Receiving deoxygenated blood.
- The heart generates electrical impulses that coordinate the contraction and relaxation of its chambers, maintaining a synchronised pumping action.

**HEART ATTACK:** Myocardial infraction (MI), also known as "heart attack", is caused by decreased or complete cessation of blood flow to a portion of the myocardium. Myocardial infraction may be "silent" and go undetected, or it could be a catastrophic event leading to hemodynamic deterioration and sudden death. Most myocardial infraction are due to underlying coronary artery disease, the leading cause of death in the United States. With coronary artery conclusion, the myocardium is deprived of oxygen. Prolonged deprivation of oxygen supply to the myocardium can lead to myocardial cell death and necrosis. Patients can present with chest discomfort or pressure that can radiate to the neck, jaw, shoulder, or arm. In addition to the history and physical exam, myocardial ischemia may be associated with ECG changes and elevated biochemical markers such as cardiac troponins.



Overview of Heart Attack

#### **Types of Heart Attack:**

Acute coronary syndrome (ACS) is when the arteries that carry blood, oxygen, and nutrients get blocked. Heart attacks are a form of ACS. They occur when heart doesn't get enough blood supply. A heart attack is also known as a myocardial infraction.

The three types of heart attacks are:

- ST segment elevation myocardial infraction (STEMI)
- Non-ST segment elevation myocardial infraction (NSTEMI)
- Coronary spasm, or unstable angina

“ST segment” refers to the pattern that appears on an electrocardiogram, which is display of heartbeat. Only a STEMI will show elevated segments. Both STEMI and NSTEMI heart attacks can cause enough damage to be considered major heart attacks.

#### **STEMI: The classic or major heart attack**

A STEMI heart attack is severe and requires immediate attention.

These occur when a coronary artery becomes completely blocked and a large portion of the muscle stops receiving blood. It's a serious heart attack that can cause significant damage.

#### **Symptoms and signs of a STEMI:**

A STEMI has the classic symptom of pain in the centre of the chest. This chest discomfort may be described as a pressure or tightness rather than a sharp pain. Some people who experience STEMI also describe feeling pain in one or both arms or their back, neck, or jaw.

Other symptoms that may accompany chest pain include:

- Nausea
- Shortness of breath
- Anxiety
- Light-headedness
- Breaking out in a cold sweat

Call for medical help immediately if you have symptoms of a heart attack. Most people who have a heart attack wait two or more hours for help. This delay can result in lasting heart damage or death.

#### **NSTEMI heart attacks**

These heart attack occur when the affected coronary artery is only partially blocked. A NSTEMI won't show any change in the ST segment on the electrocardiogram. While they are less dangerous than STEMI heart attacks, they can cause permanent damage.

A coronary angiography will show the degree to which the artery is blocked. A blood test will also show elevated troponin protein levels. While there may be less heart damage, as NSTEMI is still a serious condition.

#### **CAS, silent heart attack, or heart attack without blockage**

The coronary artery spasm is also known as a coronary spasm, unstable angina, or silent heart attack. The symptoms, which can be the same as a STEMI heart attack, may be mistaken for muscle pain, indigestion, and more. It occurs when the arteries connected to the heart contract, preventing or restricting blood flow to the heart. Only imaging and blood test results can tell if you've had a silent heart attack.

There is no permanent damage during a coronary artery spasm. while silent heart attack aren't as serious, they do increase risk of another heart attack or one that may be more serious.

#### **ETIOLOGY:**

The primary Etiology includes:

- Atherosclerosis: The most common cause, where fatty deposits build up in the coronary arteries, leading to narrowed or blocked arteries.
- Blood Clots: A clot can form at the site of atherosclerotic plaque, obstructing blood flow to heart muscle.
- Coronary artery spasm: Sudden, temporary tightening of the coronary arteries can restrict blood flow.

As stated above, myocardial infarction is closely associated with coronary artery disease. INTERHEART is an international multi-centre case-control study which delineated the following modifiable risk factors for coronary artery disease:

- Smoking
- Abnormal lipid profile / blood apolipoprotein
- Hypertension

- Diabetes mellitus
- Abdominal obesity (waist /hip ratio) (greater than 0.90 for males and greater than 0.85 for females)
- Psychosocial factors such as depression, loss of the locus of control, global stress, financial stress, and life events including marital separation, job loss, and family conflicts
- Lack of daily consumption of fruits or vegetables
- Lack of physical activity
- Alcohol consumption (weaker association, protective)

The INTERHEART study showed that all the above risk factors were significantly associated with acute myocardial infarction except for alcohol consumption, which showed a weaker association. Smoking and abnormal apolipoprotein ratio showed the strongest association with acute myocardial infarction. The increased risk with diabetes and hypertension were found to be higher in women, and the protective effect of exercise and alcohol was also found in women.

Other risk factors include a moderately high level of plasma homocysteine, which is an independent risk factor of MI. Elevated plasma homocysteine is potentially modifiable and can be treated with folic acid, vitamin B6, and vitamin B12.

Some non-modifiable risk factors for myocardial infarction include advanced age, male gender (males tend to have myocardial infarction earlier in life), genetics (there is an increased risk of MI if a first-degree relative has a history of cardiovascular events before the age of 50). The role of genetic loci that increase the risk for MI is under active investigation.

#### **Symptoms:**

Symptoms include:

- A feeling of pressure, tightness, pain, squeezing, or aching in the chest
- Pain that spreads to the arms, neck, jaw, or back
- A feeling crushing or heaviness in the chest
- A feeling similar to heartburn or indigestion
- Nausea and sometimes vomiting
- Feeling clammy and sweaty
- Shortness of breath
- Feeling lightheaded or dizzy
- In some cases, anxiety that can feel similar to a panic attack
- Coughing or wheezing, if fluid builds up in the lungs
- Fast or uneven heartbeat

Heart attack symptoms can be different from person to person or from one heart attack to another. Women and people assigned female at birth are more likely to have these heart attack symptoms:

- Unusual fatigue
- Shortness of breath
- Nausea or vomiting
- Dizziness or light-headedness
- Discomfort in gut(may feel like indigestion)
- Trouble sleeping

Heart attack symptoms can vary in their order and duration- they may start slowly or be intermittent over.

The following may also develop:

- Hypoxemia: This involves low oxygen in the blood.
- PulmonaryEdema: this involves fluid accumulating in and around the lungs.
- Cardiogenicshock: This involves blood pressure dropping suddenly because the heart cannot supply enough blood for the rest of the body to work adequately.



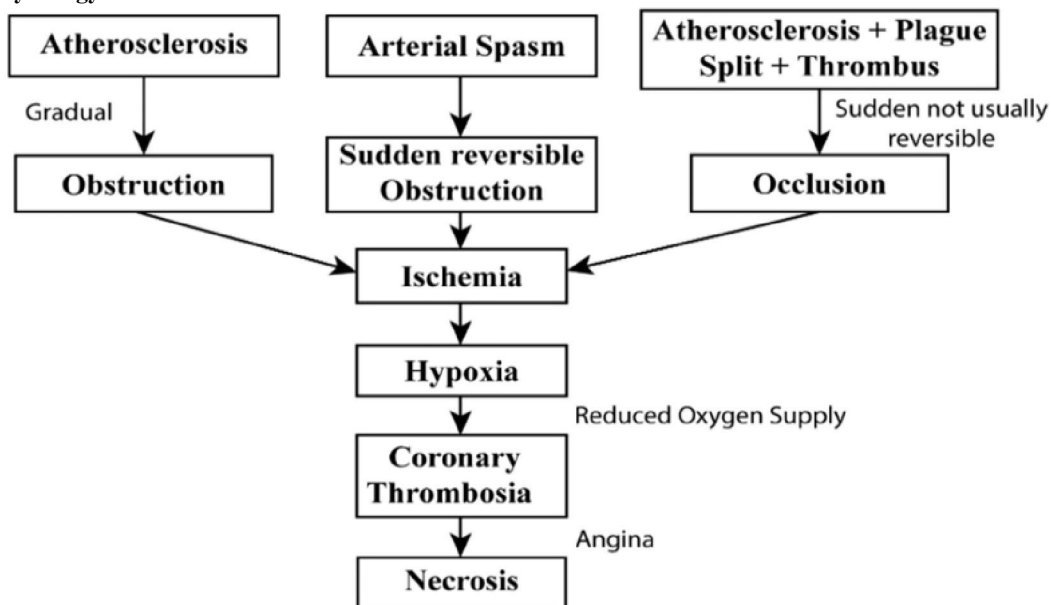
With some heart attacks, you won't notice any symptoms. This is more common in people who have diabetes.

#### Risk Factors:

Lots of things can raise your chances of having a heart attack; some you can avoid and others you can't. They include:

- Lifestyle
- Sex and age
- Illness
- Family's health
- Overweight or obesity
- ethnicity
- Pregnancy
- Stress
- Being male
- High cholesterol levels
- High blood pressure
- Diet
- Low activity levels
- Genetic factors
- A high alcohol intake
- Smoking
- Often, heart attack results from combination of factors.

#### Pathophysiology:



Acute myocardial infarction (MI) is the term used to describe segmental (regional) myocardial necrosis that is usually endocardial in origin and results from an epicardial artery blockage. On the other hand, in cases of protracted cardiac arrest with resuscitation, global ischemia and reperfusion may cause concentric subendocardial necrosis. If thromboemboli from coronary thrombi obstruct smaller arteries, areas of myocardial infarction may be subepicardial. At angiography, obstructive coronary disease is present in most individuals.

The distribution of the occluded vessel is where the infarct occurs. While occlusion of the left anterior descending coronary artery results in necrosis restricted to the anterior wall, obstruction of the left main coronary artery typically generates a massive anterolateral infarct. Frequently, the front part of the ventricular septum is extended with proximal left coronary occlusion.

A posterior (inferior) infarct results from a right coronary artery obstruction in hearts with a right coronary dominance, where the right artery supplies the posterior descending branch. A proximal circumflex blockage will infarct the posterior wall in patients with a left coronary dominance (about 15% of the population); in patients with a right dominant pattern, a proximal obtuse marginal thrombus will only induce a lateral wall infarct, and the distal circumflex is a minor conduit.

The magnitude and location of necrosis are greatly influenced by anatomic variation brought on by microscopic collateral circulation, which is not visible at autopsy. Unexpected regions of infarct in relation to the blocked proximal segment may also arise from unusual patterns of supply to the posterior wall, such as wraparound left anterior descending or posterior descending arteries supplied by the obtuse marginal artery.

The so-called wavefront phenomenon is a typical distribution that begins at the sub endocardium and moves towards the epicardium when there is proximal blockage at the level of an epicardial artery. Consequently, if a region of necrosis or scarring is biggest at the endocardium and extends wedge-shaped to the epicardial surface, it is said to have a "ischemic pattern."

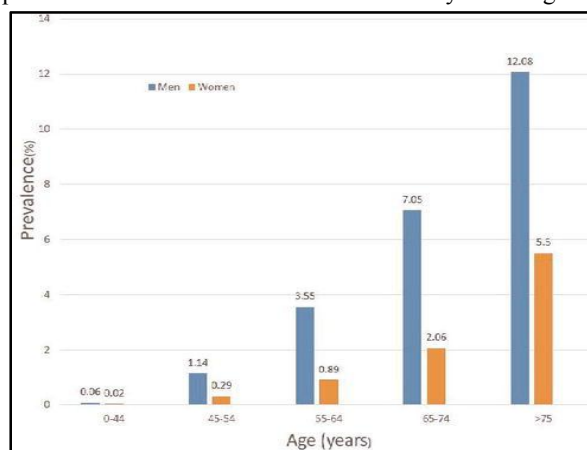
However, if the degree of coronary blockage is distant within the myocardium, ischemic damage may occur in the moderate myocardium or even the sub epicardium. Consequently, patchy infarction, which is frequently linked to apparent thrombi inside the cardiac arteries, may occur in situations of thromboemboli from epicardial thrombi (particularly plaque erosions).

### Epidemiology:

The most common form of CHD is the myocardial infarction (MI). In the following sections, prevalence and incidence of myocardial infarction are elaborated. Prevalence is defined as the number of diseased individuals present in the population at a specific time. The incidence rate is determined as the number of new cases of a disease that occur during a specific time. The estimates are reported from various data sources such as general practice registries and self-reported by the patient through the national survey. The reliability of data is based on the data source.

### Prevalence of myocardial infarction

According to 2014, based on the self-reported national survey of the UK, the prevalence of MI was reported as 640,000 in men and 275,000 in women; this represents about 915,000 people that have suffered an MI in the UK. As shown in figure, the prevalence of age-specific MI extends from 0.06% of men < 45 years of age to 2.46% of those >75 years old.



Prevalence of Myocardial Infarction

Figure

Age-specific prevalence of MI in the UK, 2014. Adapted from Clinical Practice Research Datalink (CPRD), 2014. Evaluations are based on records from a sample of general practices in each of the constituent nations of the UK.

In contrast to these developed countries, South Asian countries (India, Pakistan, Sri Lanka, Bangladesh, and Nepal) have the highest prevalence of MI seen in younger than 45 years of age compared to those older than 60 years.

### Incidence of myocardial infarction

First (acute) MI and MI in patients with a history of MI are reflected in the prevalence. Only the former is reflected in the incidence of MI. In industrialized nations like the United States and the United Kingdom, the incidence of MI has been decreasing.

According to AHA data, the incidence of MI in the USA is currently estimated to be around 525,000. Data comparing and contrasting the incidence of myocardial infarction in white men and women with that of black men and women were provided by the Mozaffarian research. Black men (12.9/100,000 males) in the 75–84 age range had a higher incidence of myocardial infarction than white men (9.1/100,000 males) and women (7.8/100,000 females), according to the study's findings.

Other age groups and their corresponding figs show similar patterns. Evaluating the success of public health initiatives to combat MI is crucial.

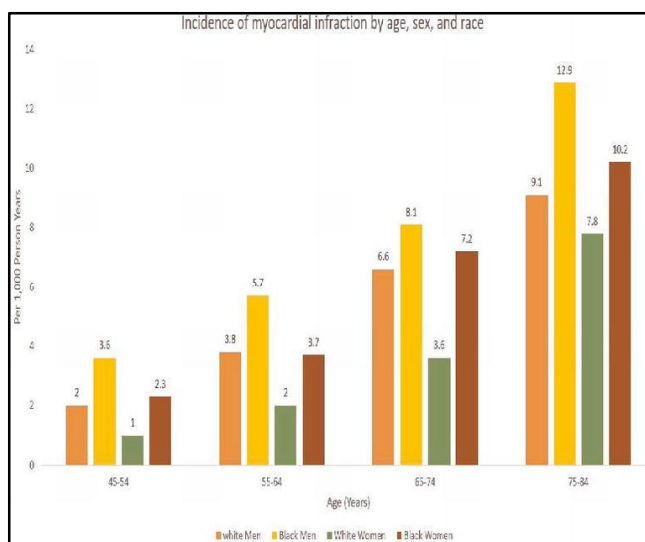


Figure incidence of myocardial infarction by age, sex, and race

Incidence of myocardial infarction by age, sex, and race in the USA, 2015. Adapted from Heart Disease and Stroke Statistics-2015 update: A report from the American Heart Association.

Regarding the clinical type of MI, it has been estimated that incidence rates (per 100,000) of STEMI decreased appreciably (121 to 77), whereas those incidence rates of NSTEMI declined slightly (126 to 132). In a landmark study, no variation was seen in all-cause mortality for both STEMI and NSTEMI between 6 months and 4 years of follow-up. but, STEMI patients have a worse long-term prognosis matched to NSTEMI patients. Other studies have shown a worse 7-year mortality rate for NSTEMI patients STEMI patients.

Risk factors

The INTERHEART study evaluated the prevalence of nine potentially modifiable risk factors in more than 15,000 cases with the first acute MI and matched with about 15,000 asymptomatic age-sex matched controls. Nine risk factors were strongly associated with acute MI in the 52 countries included in the trial. The modifiable risk factors represent over 90% of the risk for acute MI. Diabetes mellitus is a significant predictor of adverse cardiac outcomes, especially in women. It is considered to be a coronary heart disease equivalent (tables 1-4).

Table 1.: Risk factor for coronary heart disease (CHD)

DOI: 10.48175/568



CHD risk equivalents	Noncoronary atherosclerotic disease (e.g., carotid, peripheral, abdominal aortic aneurysm) Diabetes mellitus Chronic kidney disease
CHD-established risk factors	Dyslipidemia, smoking, psychosocial stressors, diabetes mellitus, hypertension, obesity, alcohol consumption, physical inactivity, and diet low in fruits and vegetables Age (especially >50 in men and postmenopausal women) Family history of CHD in first-degree relative age < 50 (men) and age < 60 (women)

Table 2.: Myocardial infarction location based on coronary artery involvement

Involved myocardium	Occluded vessel	ECG leads involved
Anterior MI	LAD	Some or all of leads V1–V6
Inferior MI	RCA or LCX	ST elevation in leads II, III, and aVF
Right ventricular MI (occurs in ½ of inferior MI)	RCA	ST elevation in leads V4–V6R
Posterior MI	LCX or RCA	ST depression in leads V1–V3 ST elevation in leads I and aVL (LCX) ST depression in leads I and aVL (RCA)
Lateral MI	LCX, diagonal	ST elevation in leads I, aVL, V5, and V6 ST depression in leads II, III, and aVF

Table 3.: Diagnostic tests

Test	Onset of abnormality	Duration of abnormality
ECG	Immediately at onset of chest pain	ST elevation progresses to Q-waves over several days to weeks
Myoglobin	1–4 hours	1–2 days
CK-MB	4–6 hours	1–2 days
Troponin	4–6 hours	1–2 weeks

Table 4.:Evaluation of chest pain in the acute setting

Mechanical complication of acute MI	Coronary artery typically involved	Time course	Clinical findings	Echocardiography
RV failure	RCA	Acute	Hypotension and clear lungs Kussmaul sign	Hypokinetic RV
Papillary muscle rupture	RCA	Acute and within 3–5 days	Acute severe pulmonary edema New holosystolic murmur	Severe mitral regurgitation with fail leaflet
Interventricular septal rupture/defect	LAD: Apical septal rupture RCA: Basal septal rupture	Acute and within 3–5 days	Shock and chest pain New holosystolic murmur Biventricular failure	Left-to-right shunt at the level of rupture Step-up oxygen level between the right atrium
Free wall rupture	LAD	Within first	Shock and chest pain	Pericardial effusion

Mechanical complication of acute MI	Coronary artery typically involved	Time course	Clinical findings	Echocardiography
		5 days to 2 weeks	Jugular venous distention Distant heart sounds	with tamponade

#### Diagnosis:

Diagnosis of heart attack includes checking blood pressure, pulse and temperature. Tests are done to see how heart is beating and to check overall heart health:

#### Tests:

Test to diagnose heart attack include:

Electrocardiogram (ECG OR EKG). This first test done to diagnose a heart attack records electrical signals as they travel through the heart and produce a graph of the voltages generated by heartbeats. Strictly patches (electrodes) are attached to the chest and sometimes the arms and legs. Commonly, 10 electrodes are attached to form 12 ECG leads. Each of the 12 leads reads a specific electrical impulse.

The impulses are broadly classified as:

- P wave (associated with the contraction of the heart atrium)
- QRS complex (associated with contraction of the heart ventricles)
- T wave (associated with the resting of the ventricles)

Changes in the normal ECG pattern can identify numerous cardiac abnormalities depending on which impulses (segments) are affected.

When diagnosing a heart attack, the healthcare provider will specifically look at the ST segment (the portion of the ECG reading that connects the QRS complex to the T wave).

The segment can not only help confirm the diagnosis but tell the practitioner which kind of heart attack you are having: ST-elevation myocardial infarction (STEMI) in which the blockage of a coronary artery is complete or non-ST-elevation myocardial infarction (NSTEMI), in which there is only a partial obstruction or narrowing of a coronary artery.

Blood Tests. Certain heart proteins slowly leak into the blood after heart damage from a heart attack. Blood tests can be done to check for test proteins (cardiac markers).

Chest X-ray. A chest x-ray shows the condition and size of the heart and lungs.

Echocardiogram. Sound waves (ultrasound) create images of the moving heart. This test can show how blood moves through the heart and heart valves. An echocardiogram can help identify whether an area of heart has been damaged.

Coronary Catheterization (angiogram). A long, thin tube (catheter) is inserted into an artery, usually in the leg, and guided to heart. Dye flows through the catheter to help the arteries show up more clearly on images made during the test.

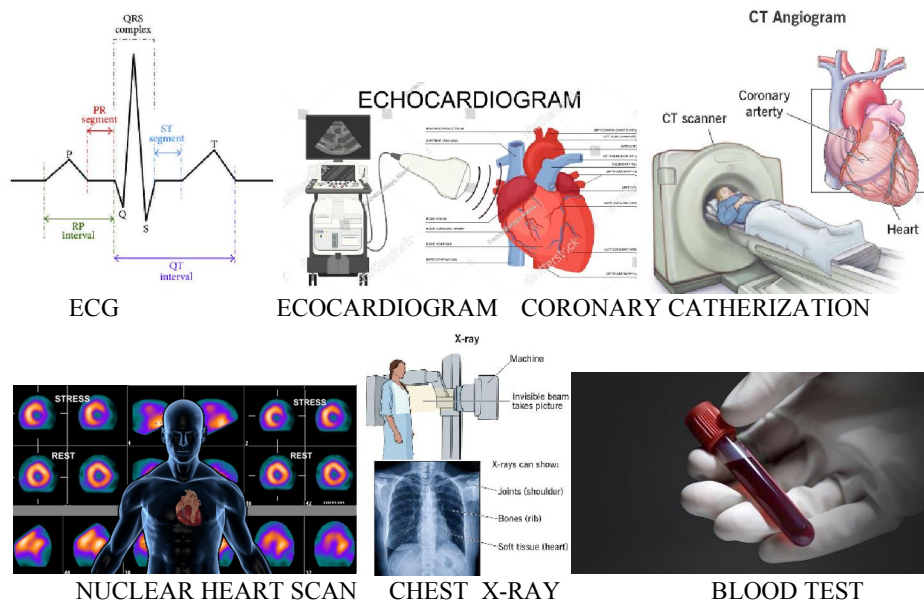
Cardiac computed tomography (CT) or Magnetic resonance imaging (MRI). These tests create images of the heart and chest. Cardiac CT scan uses X-rays. Cardiac MRI uses a magnetic field and radio waves to create images of heart. For both tests, usually lie on a table that slides inside a long tubelike machine. Each test can be used to diagnose heart problems. They can help show the severity of heart damage.

#### Nuclear heart scans.

These scans use a radioactive dye a provider injects into blood and computer-enhanced methods like computed tomography (CT) to find areas of your heart that aren't receiving as much blood are injured. These scans can be single-photon emission computed tomography (SPECT) scans or positron emission tomography (PET) scans.

Cardiac computed tomography (CT) or magnetic resonance imaging (MRI): These tests create images of the chest and heart. Cardiac CT scan uses X-rays. Cardiac MRI uses a magnetic field and radio waves to create images of your heart.

For both tests, usually lie on a table that slides inside a long tubelike machine. Each test can be used to diagnose heart problems. They can help show the severity of heart damage.



### Treatment:

A heart attack is life threatening and needs emergency attention. Each minute after heart attack, more heart tissue is damaged or dies.

Urgent treatment needed to fix blood flow and restore oxygen levels. Oxygen is given immediately. Specific heart attack treatment depends on whether there's a partial or complete blockage of blood flow.

Treatment will likely include several of the following methods.

Supplementary oxygen: people having trouble breathing or with low oxygen levels often receive supplementary oxygen along with other heart attack treatments. You can breathe the oxygen either through a tube that sits just below nose or a mask that fits over nose and mouth. This increases the amount of oxygen circulating in blood and reduces the strain on heart.

### Medications:

Medication to treat a heart attack include:

- Aspirin. Aspirin reduces blood clotting. It helps keep blood moving through a narrowed artery.
- Clot busters (thrombolytics or fibrinolytics). These drugs help break up any blood clots that are blocking blood flow to the heart. The earlier a Thrombolytic drug is given after a heart attack, the less the heart is damaged and the greater the chance of survival. Providers use these only within the first 12 hours after a heart attack.
- Other blood- thinning medicines. A medicine called heparin may be given by an intravenous (IV) injection. Heparin makes the blood less sticky and less likely to form clots.
- Nitro-glycerine. This medication widens the blood vessels. It helps improve blood flow to the heart. Nitro-glycerine is used to treat sudden chest pain (angina). It's given as a pill under the tongue, as a pill to swallow or as an injection.
- Morphine. This medication is given to relieve chest pain that doesn't go away with nitro-glycerine.
- Beta blockers. These medications slow the heartbeat and decrease blood pressure. Beta blockers can limit the amount of heart muscle damage and prevent future heart attacks. They are given to most people who are having a heart attack.

- Blood pressure medicines called angiotensin-converting enzyme (ACE) inhibitors. These drugs lower blood pressure and reduces stress on the heart.
- Statins. These drugs help lower unhealthy cholesterol levels. Too much bad (low-density lipoprotein, or LDL) cholesterol can clog arteries. These medications help in stabilize the plaque in heart's blood vessels so that they're less likely to rupture
- Anti-diabetic medication. To control blood sugar.
- Anti-arrhythmia medications. Heart attacks can often cause malfunctions in your heart's normal beating rhythm called arrhythmias, which can be life-threatening. Anti-arrhythmia medications can stop or prevent these malfunctions.

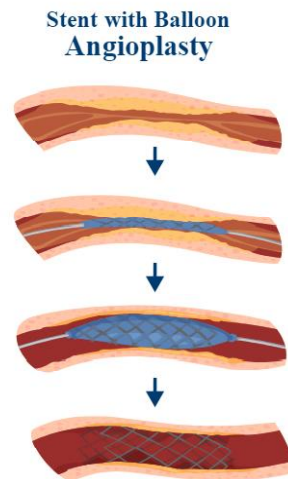
### **Surgical and other procedures**

If you've had a heart attack, a surgery or procedure may be done to open a blocked artery. Surgeries and procedures to treat a heart attack include:

#### **Coronary angioplasty and stenting.**

This procedure is done to open clogged heart articles. It may also be called percutaneous coronary interventions (PCI). If you've had a heart attack, this procedure is often done during a procedure to find blockages (cardiac catheterization). During angioplasty, a heart doctor (cardiologist) guides a thin, flexible tube (catheter) to the narrowed part of the heart artery. A thin balloon is inflated to help widen the blocked artery and improve blood flow.

A small wire mesh tube (stent) may be inserted un the artery during angioplasty. The stent helps keep the artery open. It lowers the risk of the artery narrowing again. Some stents are coated with a medication that keeps the arteries open.



Coronary artery bypass grafting (CABG). This is open-heart surgery. A surgeon. A surgeon takes a healthy blood vessel from another part of the body to create a new path for blood in the heart. The blood then goes around to create the blocked or narrowed coronary artery. It may be done as an emergency surgery at the time of heart attack. Sometimes it's done a few days later, after the heart has recovered a bit.

#### **Cardiac rehabilitation.**

cardiac rehabilitation is a personalized exercise and education program that teaches ways to improve heart health after heart surgery. It focuses on exercise, a heart-healthy diet, stress management and a gradual return to usual activities. Most hospitals offer cardiac rehabilitation starting in the hospital. The program typically continues for a few weeks or months after you return home.

People who attend cardiac rehab after a heart attack generally live longer and are less likely to have another heart attack or complications from the heart attack. If cardiac rehab is not recommended during hospital stay, ask provider about it.

**Prevention:****Lifestyle changes to prevent heart attacks**

Lifestyle changes are your first line of defence against heart attacks. Most major risk factor for heart disease are related in some way to your lifestyle, including obesity, blood pressure and cholesterol levels.

You can take the following steps to lower heart attack risk:

**Quit smoking:**

Smoking puts harmful chemicals in bloodstream and is a major risk factor for coronary artery disease (CAD), in which fatty deposits build up in arteries.

Even if you already have heart disease, you're more likely to have a heart attack- and to die from it -if you smoke than if you don't.

If you have CAD and you smoke, you can sharply reduce risk of a recurrent heart attack and death from cardiovascular causes by quitting, according to the CDC, with the risk to heart falling within just one to two years of quitting.

Talk to doctor about getting help to quit smoking if you're unsure how to go about it successfully.

**Increase physical activity:**

Exercise is a cornerstone of a heart-healthy lifestyle, which involves both aerobic and strength-building activities.

According to the physical activity guidelines for Americans from the U.S. department of Health and Human Services, you should aim for 150 min of moderate-intensity aerobic exercise each week, with activities such as taking a brisk walk.

As an alternative, you can perform 75 minutes of vigorous aerobic exercise, such as running.

In addition, you should do muscle-strengthening exercises at least twice a week. These exercises should work all major muscle groups- your legs, arms, chest, shoulders, abdomen, hips, and back.

Try to get at least 150 minute of physical activity a week for optimum heart health

**Diet:**

What and how much you eat can play a huge role in your heart attack risk. Take the following steps to achieve a heart-healthy diet:

**1. Eat lots of fruits and vegetables**

Aim for at least five servings of fruits and vegetables every day.

It's a good idea to include a wide variety of fruit and vegetable types and colours.

**2. Eat Fiber-Rich Grains and Legumes**

Good grains-based choices include oatmeal, brown rice, and whole -grain wraps and breads.

Legumes include dried beans chickpeas, lentils, and black-eyed peas.

**3. Choose Lean Meats and Fatty Fish**

Healthier meat and poultry choices include 95 percent lean ground beef, pork tenderloin, and skinless fresh chicken or turkey.

Fatty fish varieties are rich in omega-3 fatty acids, and include salmon, tuna, and trout.

**4. Get Healthy Fat from Nuts, Seeds, and Oils**

Consuming healthy monounsaturated and polyunsaturated fats can reduce risk of heart disease.

Good sources of these fats include tree nuts (most nut varieties), peanuts, seeds (such as sesame, pumpkin, and sunflower), and avocados, as well as canola, olive, safflower, and sunflower oils.

**5. Limit Salt and Sodium**

The AHA recommends that most Americans consume no more than 1,500 milligrams of sodium each day for optimal heart health.

The biggest source of sodium in most people's diet is processed foods. Canned soups, Sauces, deli meats, frozen dinners, packaged snacks, and bread are often very high in salt.

**6. Cut Unhealthy Fat**

Saturated and trans fats should be limited in diet.



Sources of saturated fat include fatty meat and poultry, high-fat dairy products, and coconut and palm oils. Foods that contain trans fats are made with partially hydrogenated oils, which should be avoided whenever possible. This ingredient is often found in packaged desserts and baked goods, microwave popcorn, frozen pizza, stick margarine, and coffee creamers.

#### **7. Limit Added Sugars**

Added sugars take many forms, including brown sugar, regular or high-fructose corn syrup, sucrose, fructose, glucose, honey, and maple syrup.

Sweetened drinks and packaged snacks, pastries, and candies are the main sources of added sugars in the United States.

#### **Limit Alcohol:**

If you drink, limit yourself to two drinks per day (if assigned male at birth) or one (if assigned female at birth). Make sure you know how much alcohol counts as a drink.

Drinking too much alcohol can lead to heart and blood vessel problems, including:

- Atrial fibrillation.
- Heart failure.
- High blood pressure.
- Stroke.

#### **Weight:**

Being overweight forces your heart to work harder to pump blood around your body, which can raise blood pressure. Use the BMI healthy weight calculator to find out if you are a healthy weight for height.

If you do need to lose weight, remember that losing just a few kilos will make positive difference to you blood pressure and health.

A healthy body mass index (BMI) is typically between 20 to 25

Get regular checks of cholesterol, blood pressure, and blood sugar(glucose) levels:

If you have diabetes, make sure it's controlled. Keeping a check on these numbers can help you be more aware of the changes you need to make to keep these levels within normal limits.

#### **Modern Treatment Methods for Heart Attack**

During a heart attack, clot forms in an artery that supplies blood to the heart and blocks blood flow to the area of heart muscle supplied by that artery. The portion of the heart muscle deprived of blood carrying the need oxygen begins to become damaged. This is called a "myocardial infraction," more commonly known as a heart attack.

##### **Fast Action Saves Lives**

Calling 9-1-1 is the fastest way to get lifesaving treatment. If you or someone you are with has any symptoms of a heart attack, call 9-1-1 immediately! If you have a history of chest pain for which your doctor has prescribed nitro-glycerine, then take ONE dose right away. If your symptoms are not better 5 minutes after taking one dose, then you should call 9-1-1 immediately. In the past, you may have been told to take up to 3 doses of nitro-glycerine before calling 9-1-1. However, the medical guidelines for the use of nitro-glycerine have changed to help people who may having a heart attack get to a hospital more quickly.

By calling 9-1-1 and taking an ambulance, you will be seen in the hospital and treated more quickly. Sometimes vehicle, but the ambulance will take you directly to the hospital. Emergency personnel can begin treatment even before you arrive at the hospital. For example, emergency personnel may place electrodes (adhesive patches to which wires are attached) on your chest to obtain an electrocardiogram (an ECG or EKG). An ECG records the electrical activity of the heart and will show abnormal patterns of electrical activity in the areas of the heart that are damaged or deprived of oxygen if heart attack is happening.

#### **Treatment**

At the hospital, the type of treatment you are given depends on the type of heart attack you are having and how quickly can be treated. Only certain hospitals are equipped to perform 24-hour emergency PCI. If you are located too far away from one of these hospitals, clot-dissolving drugs may be the best choice for treatment to reopen clogged arteries. Clot-

dissolving medicine may not be recommended for some patients depending on their medical history. The doctor who treats you will ask you or your family if you have a history of a major trauma or have had major surgery in the past 6 weeks; vomiting blood or bleeding from the rectum in the past 6 weeks; or any bleeding or neurological disorders; and whether you are (or might currently be) pregnant.

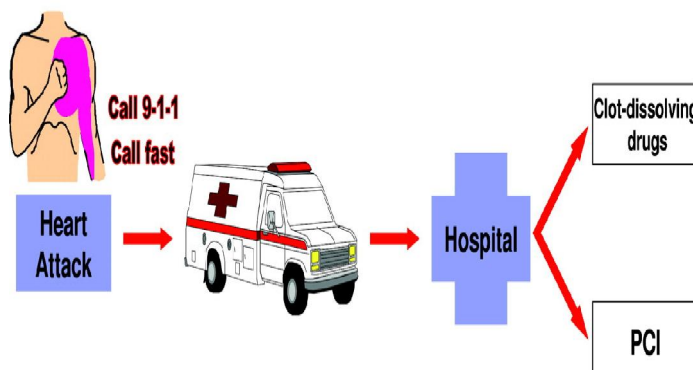
If the answer to any of these questions is yes, it will be factored into the decision of which heart attack treatment is best. Emergency PCI is performed only at certain hospitals that are equipped with special x-rays rooms called Cath labs where the procedures are performed. Some hospitals have Cath labs that are staffed only during daytime hours. The ambulance may not bring you to the closest community hospital with a Cath lab unless the hospital is able to perform cardiac catheterization procedures 24 hours a day on an emergency basis. If you or a loved one is considered at high risk for a heart attack, it is good to know which hospitals perform 24-hour angioplasty in your city or state. This way you will know in advance the hospitals where you or your loved ones may be taken in the event of a heart attack.



Cath Lab

Many hospitals and health centres offer cardiac rehabilitation for patients who have suffered a heart attack. Cardiac rehabilitation can help you to develop a safe exercise plan, healthy eating habits, a weight loss plan, and a plan for quitting smoking or reducing alcohol intake.

Make a plan now for what you would do if a heart attack should happen. Doing so will save time and could help prevent extensive injury to your heart muscle. Getting early (“modern”) treatment for a heart attack, as shown in figure, will help to keep your heart muscle strong and will mean a longer and fuller life for you.



Modern treatment for heart attack

### Heart Attacks Striking Younger Women

A recent study highlights a troubling trend: heart attacks are becoming more common among younger women. While heart attack rates have declined in older adults, they have increased significantly in individuals aged 35-54, particularly among women. The Atherosclerosis Risk in Communities (ARIC) study, which analyzed over 28,000 hospitalizations for heart attacks across four U.S. cities, discovered this concerning rise in younger women. However, the study doesn't explain why this shift is happening, though experts suspect that more people, especially younger women, are developing risk factors for heart disease at younger ages.

#### Risk Factors for Heart Disease in Women

There are several key factors that increase the likelihood of developing heart disease in women. Nearly 50% of Americans have at least one of the major risk factors for heart disease, including:

- High Blood Pressure: Women, particularly those over the age of 65, are more likely than men to develop high blood pressure. It can also result from using birth control pills or occur during pregnancy.
- High Cholesterol: Estrogen helps protect women against unhealthy cholesterol levels. However, after menopause, estrogen levels drop, which increases the likelihood of developing high cholesterol.
- Smoking: Although men are still more likely to smoke, the gender gap in smoking has narrowed. Women also tend to find it harder to quit smoking compared to men.

Additional risk factors include:

- Diabetes
- Obesity
- Family history of heart disease
- Age (risk increases with age)
- Unhealthy diet
- Lack of physical activity
- Excessive alcohol consumption

#### The Role of Hormones in Heart Disease Risk

Hormones can influence a woman's risk for heart disease, especially in relation to birth control and hormone replacement therapy (HRT).

- Birth control pills: These medications can increase the risk of blood clots, both in the heart and legs, and can also raise blood pressure. If you have a history of high blood pressure or clotting problems, alternative contraceptive options might be better. However, for most young women, birth control pills are generally considered safe.
- Hormone replacement therapy (HRT): For women over 65, it's recommended to avoid estrogen and progesterone treatments due to their link to increased heart disease and breast cancer risks. If a postmenopausal woman has a low risk of heart disease and needs relief from hot flashes or other symptoms, HRT may be considered, but it's used cautiously in women over 65.

#### Recognizing Heart Attack Symptoms in Women

Heart disease is the leading cause of death for both men and women, making it essential for women to recognize the signs of a heart attack and seek immediate medical care. While chest pain is the most common symptom of a heart attack for both men and women, women are more likely to experience less obvious symptoms, such as:

- Discomfort or pain in areas other than the chest, like the back, neck, jaw, arms, or stomach
- Shortness of breath
- Lightheadedness
- Cold sweats
- Unusual fatigue
- Nausea and vomiting

#### How to Prevent Heart Disease and Heart Attacks

Though some risk factors, like family history, are out of your control, there are many lifestyle changes you can make to protect your heart health. It is estimated that up to 80% of heart disease, including heart attacks and strokes, can be prevented through lifestyle changes. Key strategies include:

Maintaining a healthy weight: Being overweight or obese increases your risk of heart disease, so maintaining a healthy weight is crucial.

Eating a heart-healthy diet: Focus on eating a balanced diet rich in whole foods, including fruits, vegetables, whole grains, and lean proteins. Reduce your intake of processed meals, added sweets, and bad fats.

Exercising regularly: Aim for at least 150 minutes of moderate physical activity per week. Exercise helps keep the heart healthy and improves circulation.

Limiting alcohol: Women should consume no more than one alcoholic drink per day to minimize their risk of heart disease.

Staying active throughout the day: In addition to structured exercise, try to stay active by avoiding long periods of sitting. increase the amount of movement you do each day.

Managing stress: Chronic stress can increase heart disease risk. Practice stress-management techniques such as meditation, yoga, or deep breathing to improve heart health.

Getting regular check-ups: Regular medical check-ups are crucial for catching early signs of heart disease, such as high blood pressure or high cholesterol. An annual exam helps you stay on top of your risk factors and manage related conditions like diabetes or hypertension.

#### **COVID-19 Surges Linked to Spike in Heart Attacks**

New data analysis from the Smidt Heart Institute at Cedars-Sinai found that deaths from heart attacks rose significantly during pandemic surges, including the COVID-19 Omicron surges, overall reversing a heart-healthier pre-pandemic trend.

Prior to the COVID-19 pandemic, heart attacks were the leading cause of death worldwide but were steadily on the decline. However, the new study-recently shows that heart attack death rates took a sharp turn and increased for all age groups during the pandemic.

The spikes in heart attack deaths have tracked with surges of COVID-19 infection-even during the presumed less-severe Omicron phase of the pandemic. Furthermore, the data showed the increase was most significant among individuals ages 25-44, who are not usually considered at high risk for heart attack.

“The dramatic rise in heart attacks during the pandemic has reversed what was a prior decadelong steady improvement in cardiac deaths.”

Using data from the Centers for Disease Control and Prevention’s National Vital Statistics System, the Cedars-Sinai researchers identified 1,522,699 deaths from heart attacks-medically called acute myocardial infarctions-between April 1, 2012, and March 31, 2022.

Investigators then compared age-related mortality rates between pre-pandemic and pandemic periods, as well as demographic groups and regions.

Key finding from the study include:

In the year before the pandemic, there were 143,787 heart attack deaths; within the first year of the pandemic, this number had increased by 14% to 164,096.

The excess in acute myocardial infarction-associated mortality has persisted throughout the pandemic, even during the most recent period marked by a surge of the presumed less-virulent Omicron variant.

Researchers found that although acute myocardial infarction deaths during the pandemic increased across all age groups, the relative rise was most significant for the youngest group, ages 25 to 44.

By the second year of the pandemic, the “observed” compared to “predicted” rates of heart attack death had increased by 29.9% for adults ages 25-44, by 19.6% for adults ages 45-64, and 13.7% for adults age 65 and older.

“There are several potential explanations for the rapid rise in cardiac deaths in patients with COVID-19, yet still many unanswered questions,” said Yeo. “importantly, our results highlight disparities in mortality that have emerged from the COVID-19 pandemic and that are persisting even through the Omicron era.”

The possible explanations, Yeo said, include that COVID-19 may trigger or accelerate the presentation of preexisting coronary artery disease, even in younger adults.

Reasons for the spike in heart-related conditions could also be related to psychological and social challenges associated with the pandemic, including job loss and other financial pressures that can cause acute or chronic stress leading to cardiac disease.



The research team members say they have long known that infections such as the flu can increase risk for heart disease and heart attack, but the sharp rise in heart attack deaths is like nothing seen before.

“There is something very different about how this virus affects the cardiac risks,” said Susan Cheng. “The difference is likely due to a combination of stress and inflammation, arising from predisposing factors and the way this virus biologically interacts with the cardiovascular system.”

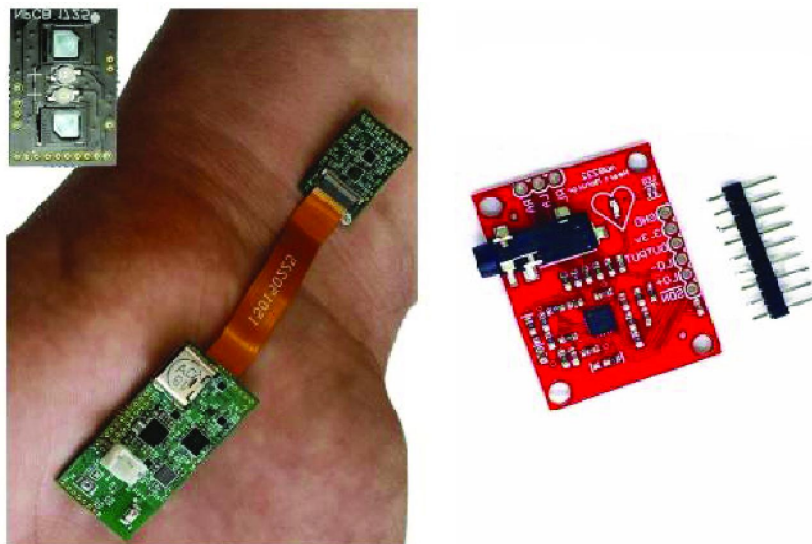
### **Smart Watch for early heart attack detection and emergency assistance using IoT**

#### **Introduction:**

The Internet of Things (IoT) has emerged as a key player in modern technological advancements, bridging the gap between the digital and physical worlds. IoT is built on a vast network of interconnected devices, systems, and services that seamlessly collect, share, and act on data. These devices range from everyday objects to complex machinery, all equipped with sensors, actuators, and communication capabilities. The rapid growth of IoT is driven by advances in miniaturization, connectivity, and computing power, which enable intelligence to be embedded in common items. IoT devices communicate through various networks such as Wi-Fi, Bluetooth, and cellular connections allowing them to interact with one another and centralized systems. This interconnectedness makes real-time monitoring, analysis, and control of processes possible, ultimately leading to smarter, more efficient systems. At the core of IoT is data vast amounts of information collected from sensors tracking everything from temperature to motion. Cloud computing platforms help harness this data, providing storage, processing power, and analytical capabilities that support predictive maintenance, smarter decision-making, and personalized user experiences.

In healthcare, IoT devices can continuously monitor patient vitals, track medication adherence, and enable remote patient care, all of which improve patient outcomes. However, this explosion of IoT devices also brings challenges, particularly around security and privacy concerns. With billions of devices collecting sensitive information, the need for robust security measures such as encryption and authentication is greater than ever. Standardization and interoperability are also vital to ensuring these devices can seamlessly work together. By adhering to common protocols, IoT technology can transform industries and improve lives in countless ways. However, this transformation must prioritize security, privacy, and standardization to unlock the full potential of IoT in the future.

Integrating IoT technology into smartwatches for heart health monitoring offers several advantages. These devices can continuously track heart rate and other vital signs, allowing for early detection of irregularities such as arrhythmias or signs of a heart attack. The ability to transmit this data to healthcare providers in real-time enables timely interventions and personalized care. IoT-enabled smartwatches enhance not only heart health management but also general wellness by facilitating remote consultations and integration with health and fitness apps. With continuous monitoring and data sharing, these smartwatches have the potential to revolutionize personal health management.





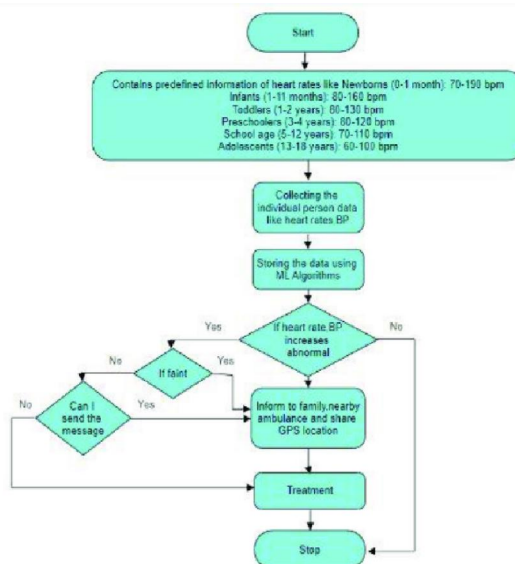
### PPG and ECG Sensors

Normally, Heartbeat rate for Newborns (0-1 month): 70-190 bpm, Infants (1-11 months): 80-160 bpm, Toddlers (1-2 years): 80-130 bpm, Preschoolers (3-4 years): 80-120 bpm, School age (5-12 years): 70-110 bpm, Adolescents (13-18 years): 60-100 bpm.

IoT enables machines to complete tedious tasks without human intervention. We can connect two devices without the need of human intelligence, but it is already programmed to do those tasks. Smart devices rely on the IoT to connect to sensors. These sensors are attached to objects or other network- connected devices and gather data from their surroundings. Smart devices can then store this data, share it with other smart devices and conduct data analyses to provide insights to users.

### Method

The proposed system aims to significantly reduce the response time during critical cardiac events, potentially saving lives and minimizing long-term health consequences. User privacy and data security are paramount, and the system is designed to comply with stringent privacy regulations and encryption standards. This research contributes to the advancement of wearable health technologies, demonstrating the potential of smart watches not only as fitness trackers but also as a life-saving devices. The integration of real-time monitoring, machine learning algorithms, and seamless communication mechanisms positions the smart watch as a valuable tool in the early detection and management of cardiovascular emergencies.



Flow chart of smart watch heart attack detection

### Flow chart explanation

From above flow diagram, we can understand the working flow of the smart watch. It contains predefined information of heart rate based on the age of the individual which can be identified by the normal observations like heart rate, blood pressure, number of steps, etc. the collected information's are stored using machine algorithms. If the heart rate increased or decreased abnormally, it will move to the next procedure for emergency assistance. It will use a sensor like accelerometer and gyroscope to check the user is faint if so, it automatically informs to the family members and call to the ambulance by sharing GPS locations. If the user is suffering from severe pain, it will send a display message to confirm the emergency by touching the screen then inform to the family and ambulance services.

### Sensors included:

Optical Heart Rate Sensor: Continuously measures heart rate.

Accelerometer and Gyroscope: Detects sudden movements or falls.

ECG Sensor: Provides detailed analysis of heart rhythm.

### Data Collection and Processing

The system continuously gathers data from the sensors, which is then analyzed in real-time by onboard algorithms to detect irregularities such as abnormal heart rhythms or sudden movement changes. The system uses machine learning models that have been trained on a variety of heart attack and non-emergency cases to improve the accuracy of predictions. If any irregularities are detected, the smartwatch will notify the user and initiate emergency alerts.

### Real-Time Monitoring and Alerts

The system is designed to monitor vital signs continuously, setting thresholds for heart rate, heart rhythm, and sudden movements. When these thresholds are exceeded, an alert system is triggered, notifying the user of potential health risks. Alerts may include vibration, sound, or visual notifications, depending on the severity of the detected condition. The alert system prioritizes emergencies, ensuring that the most critical issues are addressed first.

### Emergency Assistance Integration

The smartwatch is integrated with emergency response systems, allowing users to call for help directly from the device. In case of an emergency, the device automatically sends a notification with the user's location and vital signs to emergency contacts or local medical facilities. This feature ensures timely intervention and effective care during a cardiovascular emergency.

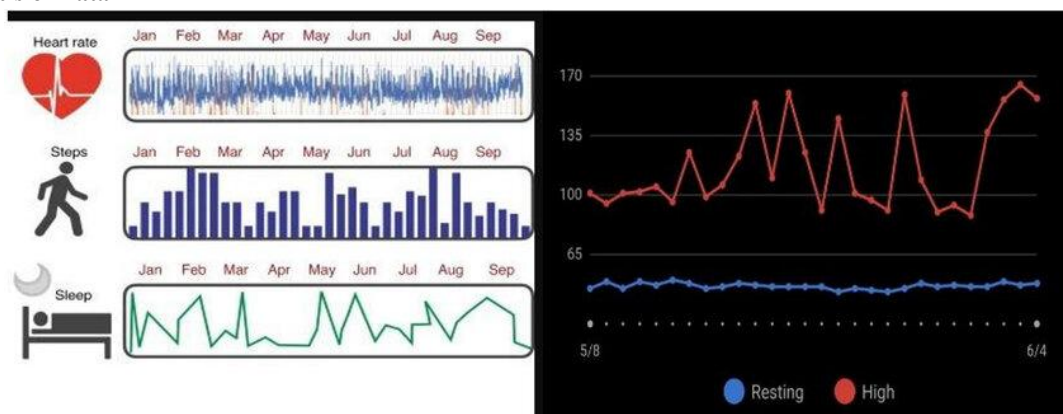
### User Interface

The user interface is designed for ease of use, displaying vital signs, alerts, and emergency options in a clear, intuitive manner. The system provides users with step-by-step instructions on how to respond to emergency alerts, making it accessible to people with varying levels of technical expertise. Additionally, the system regularly updates algorithms and software to ensure improved accuracy and reliability.

### Privacy and Security

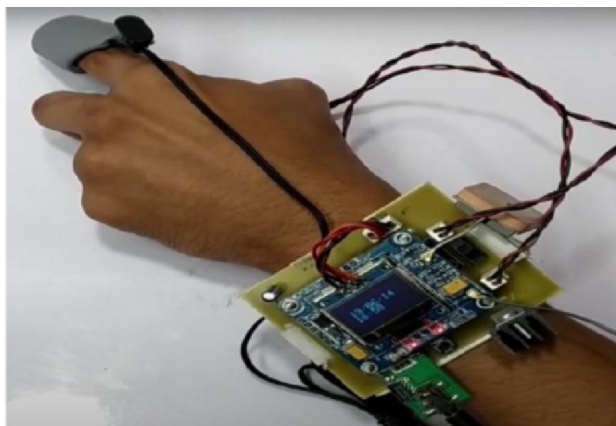
Given the sensitivity of health data, the system implements strict privacy measures. It ensures compliance with medical device regulations and allows users to control their data-sharing preferences. Robust encryption techniques safeguard the user's sensitive health information, ensuring that the system is both secure and trustworthy.

### Analysis of Data



data of the heart rate, number of Graph of heart rate detection with accuracy steps and sleep timing

## II. RESULT AND DISCUSSION



Working model of smart watch

the heart rate of the human if it is normal, it just stores the data if it is high, it sends the message to the hospital ambulance service and the family member how send to another member.



Heart rate

## III. CONCLUSION

Cardiology is the study of diseases and disorders of the heart, a vital organ in the cardiovascular system that pumps blood throughout the body. The heart has different parts like walls, chambers, valves, blood vessels, and an electrical conduction system that work together to keep the body functioning. Heart attacks, or myocardial infarctions, are caused by blockages in the heart's blood vessels depriving the heart muscle of oxygen. Modern treatment methods for heart attacks include aspirin, clot busters, and surgeries like coronary angioplasty or bypass grafting. Lifestyle changes like quitting smoking, being physically active, and eating a heart-healthy diet can prevent heart attacks. Recent data also suggests that heart attacks have increased during the COVID-19 pandemic, especially among younger individuals.

The integration of IoT technology into smartwatches for early heart attack detection and emergency assistance represents a significant advancement in healthcare. By enabling continuous monitoring of vital signs, these devices empower users to take proactive control over their cardiovascular health, facilitating early detection of irregularities that could indicate a potential heart attack. Therefore, the investment in and adoption of IoT-enabled smartwatches should be prioritized not just for their convenience, but for their profound ability to enhance health outcomes and improve quality of life

## REFERENCES

- [1]. Ojha, N., & Dhamoon, A. S. (2023, August 8). Myocardial Infarction. StatPearls-NCBI Bookshelf. <https://www.ncbi.nlm.nih.gov/books/NBK537076>

- [2]. Newman, T. (2024, February 9). How to spot and treat a heart attack. <https://www.medicalnewstoday.com/articles/151444>
- [3]. The Texas Heart Institute. (2022, March 31). Heart Anatomy| The Texas Heart Institute. <https://www.texasheart.org/heart-health/heart-information-center/topics/heart-anatomy/>
- [4]. The Editors of Encyclopaedia Britannica. (2024, October 31). Heart| Structure, Function, Diagram, Anatomy, & Facts. Encyclopedia Britannica. <https://www.britannica.com/science/heart>
- [5]. Reimer KA, Jennings RB, Tatum AH. Pathobiology of acute myocardial ischemia: metabolic, functional and ultrastructural studies. *Am J Cardiol.* 1983 Jul 20;52(2):72A-81A.
- [6]. Apple FS, Sandoval Y, Jaffe AS, Ordóñez-Llanos J., IFCC Task Force on Clinical Applications of Cardiac Bio-Markers. Cardiac Troponin Assays: Guide to Understanding Analytical Characteristics and Their Impact on Clinical Care. *Clin Chem.* 2017 Jan;63(1):73-81
- [7]. Anand SS, Islam S, Rosengren A, Franzosi MG, Steyn K, Yusufali AH, Keltai M, Diaz R, Rangarajan S, Yusuf S., INTERHEART Investigators. Risk factors for myocardial infarction in women and men: insights from the INTERHEART study. *Eur Heart J.* 2008 Apr;29(7):932-40
- [8]. Professional, C. C. M. (2024, May 1). Heart, Cleveland Clinic. <https://my.clevelandclinic.org/health/body/21704-heart>
- [9]. Zilpah Shaikh M.D. (2023, September 21). Heart attack. WebMD. <https://www.webmd.com/heart-disease/heart-disease-heart-attacks>.
- [10]. Aaron Kandola. (2023, July 10). Types of heart attack: What you need to know. <https://www.medicalnewstoday.com/articles/321699>
- [11]. Malik MA, Alam Khan S, Safdar S, Taseer IU. Chest Pain as a presenting complaint in patients with acute myocardial infarction (AMI). *Pak J Med Sci.* 2013 Apr;29(2):565-8.
- [12]. Roffi M, Patrono C, Collet JP, Mueller C, Valgimigli M, Andreotti F, Bax JJ, Borger MA, Brotons C, Chew DP, Gencer B, Hasenfuss G, Kjeldsen K, Lancellotti P, Landmesser U, Mehilli J, Mukherjee D, Storey RF, Windecker S., ESC Scientific Document Group. 2015 ESC Guidelines for the management of acute coronary syndromes in patients presenting without persistent ST-segment elevation: Task Force for the Management of Acute Coronary Syndromes in Patients Presenting without Persistent ST-Segment Elevation of the European Society of Cardiology (ESC). *Eur Heart J.* 2016 Jan 14;37(3):267-315.
- [13]. Heart attack- Diagnosis & treatment- Mayo Clinic. (2023, October 9). Mayo Clinic. <https://www.mayoclinic.org/diseases-conditions/heart-attack/diagnosis-treatment/drc-20373112>
- [14]. Heart attack: symptoms, causes & treatment. (n.d.). Cleveland Clinic. <https://my.clevelandclinic.org/health/diseases/16818-heart-attack-myocardial-infarction>
- [15]. Roland, J. (2020, February 18). Types of heart attacks: what you should know. Healthline. <https://www.healthline.com/health/heart-disease/types-of-heart-attacks>
- [16]. Marple, A. F., Antman, E.M., & Hand, M. M. (2006). Modern treatment for heart attacks. *CIRCULATION* 114(20). <https://doi.org/10.1161/circulationaha.106.648279>
- [17]. Heart attacks striking younger women. (2022, October 2). Johns Hopkins medicine. <https://www.hopkinsmedicine.org/health/conditions-and-disease/heart-attack/heart-attacks-striking-younger-women>
- [18]. Kinman, T. (2022, February 15). Heart attack symptoms, causes, and treatment. Healthline. <https://www.healthline.com/health/heart-attack>
- [19]. Konkel, L. (2024, November 1). How to prevent a heart attack. EverydayHealth.com. <https://www.everydayhealth.com/heart-attack/guide/prevention/>
- [20]. Burke, A. P., MD. (n.d.). pathology of Acute myocardial infarction; overview, pathophysiology, etiology. <https://emedicine.medscape.com/article/1960472-overview?.form>
- [21]. Jayaraj, J.C., Davatyan, K., Subramanian, S., & Priya, J. (2019). Epidemiology of myocardial infarction. In *IntechOpen eBooks*. <https://doi.org/10.5772/intechopen.74768>
- [22]. News-Medical. (2023, June 15). What is Cardiology? <https://www.news-medical.net/health/Cardiology-What-is-Cardiology.aspx>

- [23]. S. MuthuSundari, M. Priyadharshii, V. Preethi, K. Priya, K. Priyadharcini., Smart Watch for early heart attack detection and emergency assistance using IoT, LatIA. 2024; 2:109.  
<https://doi.org/10.62486/Latia2024109>