



JESSENIUS FACULTY
OF MEDICINE IN MARTIN
Comenius University
Bratislava



Medical Education Support Center

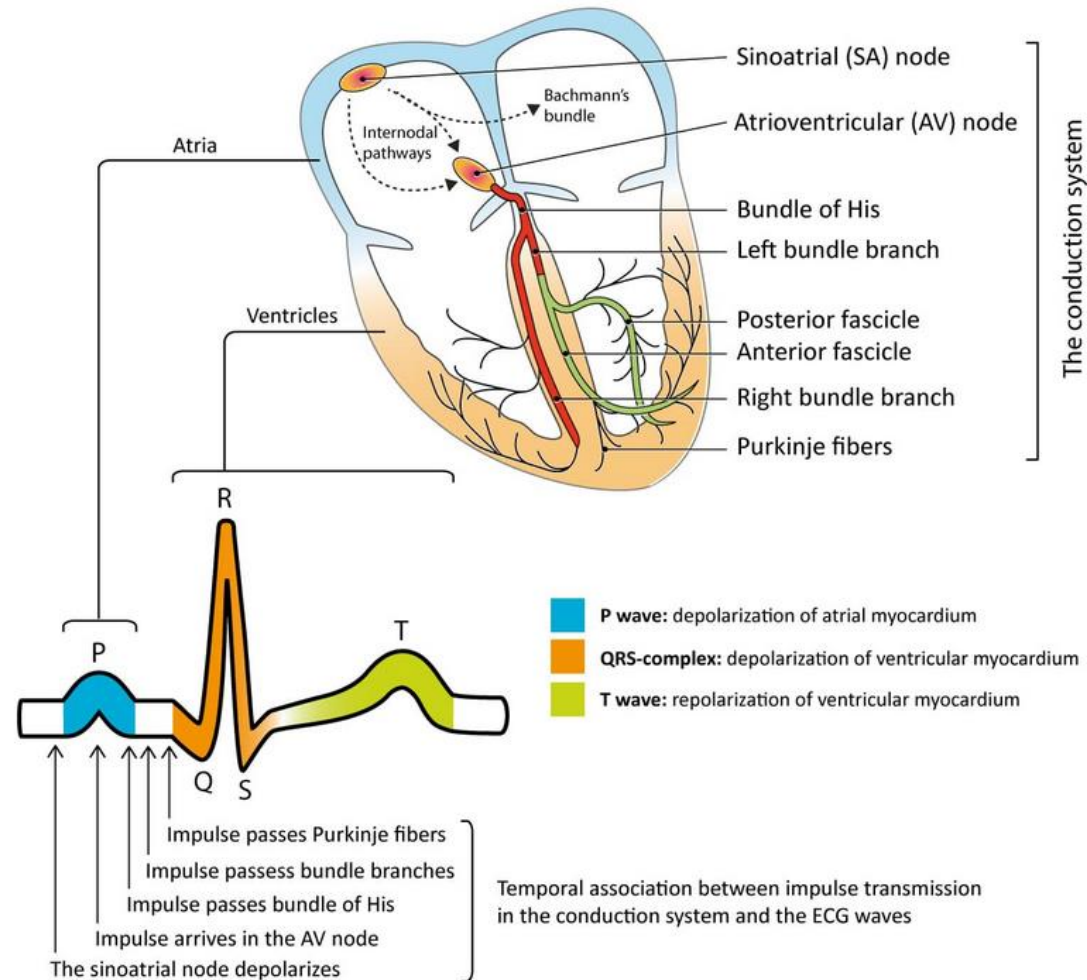
Pathophysiology of cardiac arrest

BLS – Basic Life Support

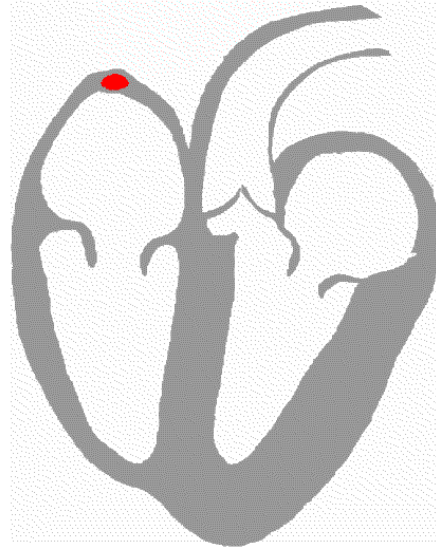
AED (Automated External Defibrillator)

prof. Jana Plevkova MD, PhD, 2025

Normal sinus rhythm



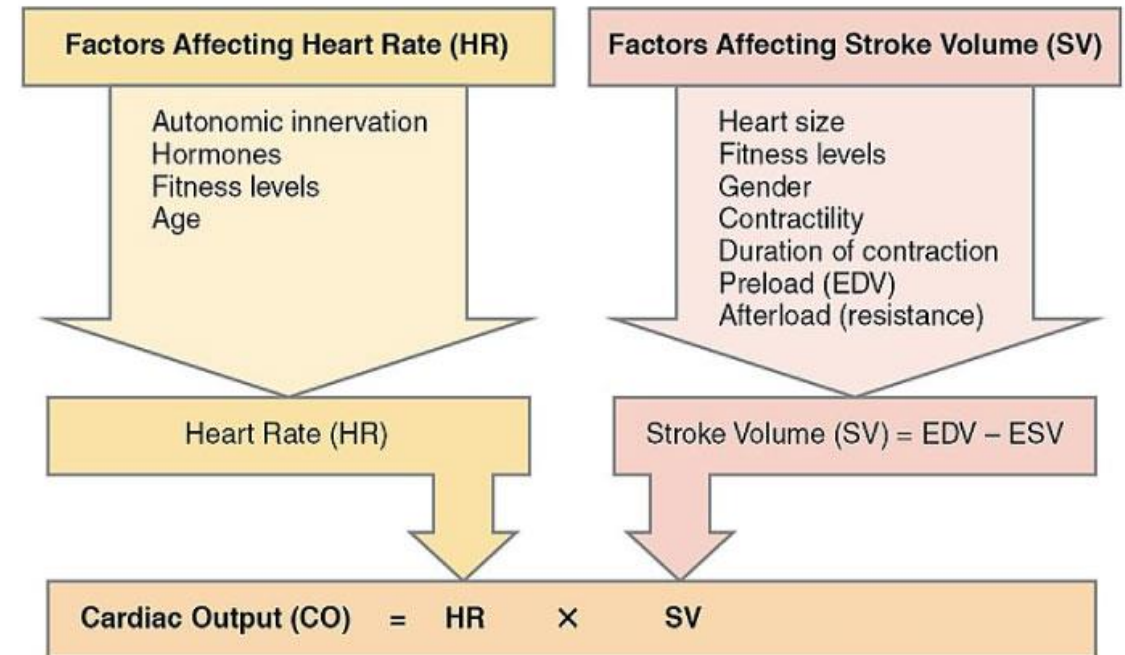
Normal sinus rhythm



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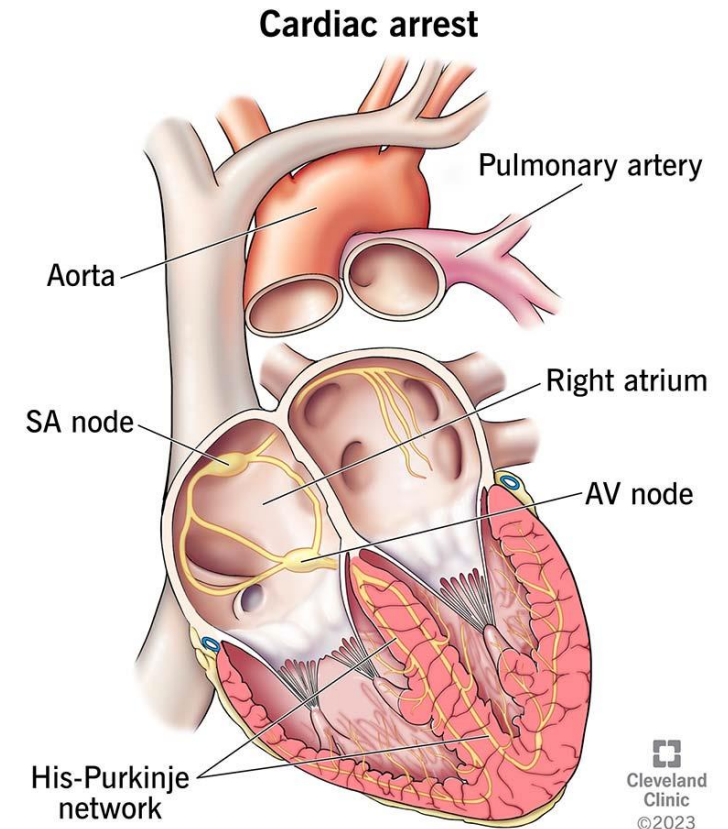
Cardiac output

- Cardiac output is the function of heart rate and stroke volume. The amount of blood pumped by the left ventricle in one compression is called the stroke volume.
- Cardiac Output is an excellent example to exhibit the efficiency of the human heart. It is related to the amount of blood the heart pumps per minute. A normal cardiac output would be about five liters of blood per minute in a healthy individual.



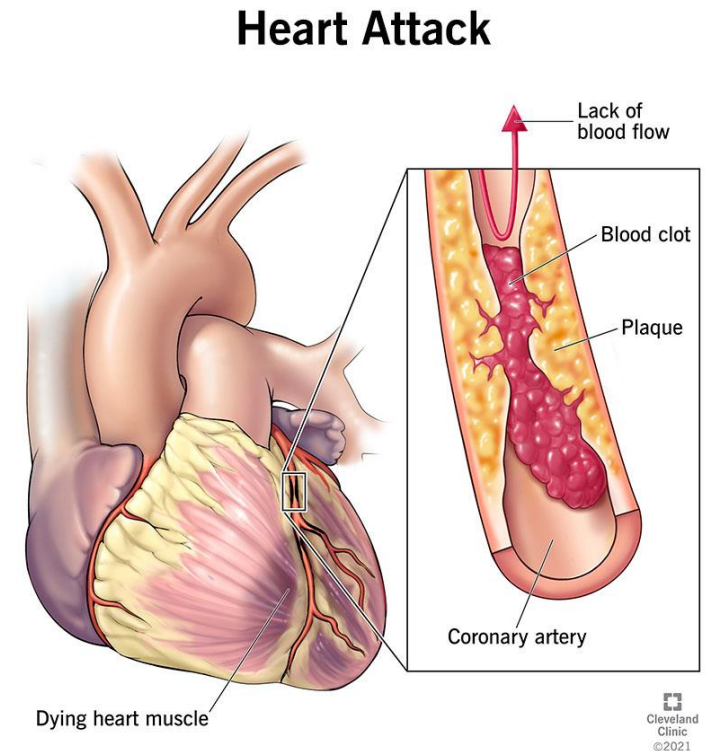
Cardiac arrest

- The heart stops beating or beats so fast that it stops pumping blood. During cardiac arrest, people typically collapse and become unresponsive. Symptoms start without warning - sudden cardiac arrest.
- This life-threatening condition can become fatal if you don't get immediate treatment.
- In cardiac arrest, the heart isn't pumping blood anymore. Within minutes, this puts organs and the whole body at risk of death because they must constantly receive oxygen.
- Emergency treatment includes CPR and defibrillation. CPR keeps enough oxygen in the lungs and gets it to your brain until an electric shock restores a normal heart rhythm. CPR and defibrillators may save lives.



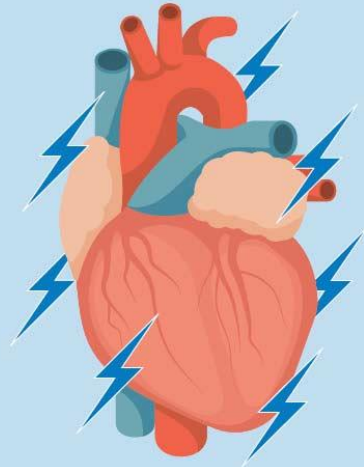
Heart attack

- Myocardial infarction is a hazardous condition due to not enough blood flow to the part of the cardiac muscle. This lack of blood flow occurs because of many factors but is usually related to a blockage in one or more coronary arteries.
- Without blood flow, the affected heart muscle will begin to die. If blood flow is not restored quickly, a heart attack can cause permanent heart damage and/or death.
- A heart attack is a life-threatening emergency. If you think you or someone you're with is having a heart attack, call 155 (local emergency services). Time is critical in treating a heart attack. A delay of even a few minutes can result in permanent heart damage or death.



Cardiac Arrest Vs. Heart Attack

How cardiac arrest and heart attack are different:



Cardiac arrest happens when rapid, abnormal impulses override your heart's natural rhythm.
It's an electrical issue.

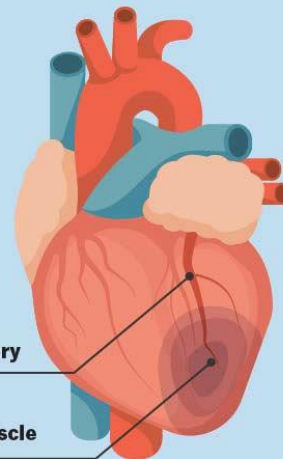
Heart attack occurs when a clogged artery disrupts blood flow to your heart.

A heart attack is a common cause of cardiac arrest.



Blocked Artery

Dying Muscle



Sudden cardiac arrest

- is the **third leading cause of death** in Europe
- Out-of-hospital cardiac arrest:
 - the incidence in Europe is 67-170 per 10. 000 inhabitants
 - resuscitation is attempted or continued by EMS personnel in about 50 – 60% of cases
 - the use of AEDs in Europe is still low – an average 28%
 - 80% of European countries provide dispatch-assisted CPR and 75% have an AED registry

Etiology of sudden cardiac arrest: **heart disease - 80% -90%**

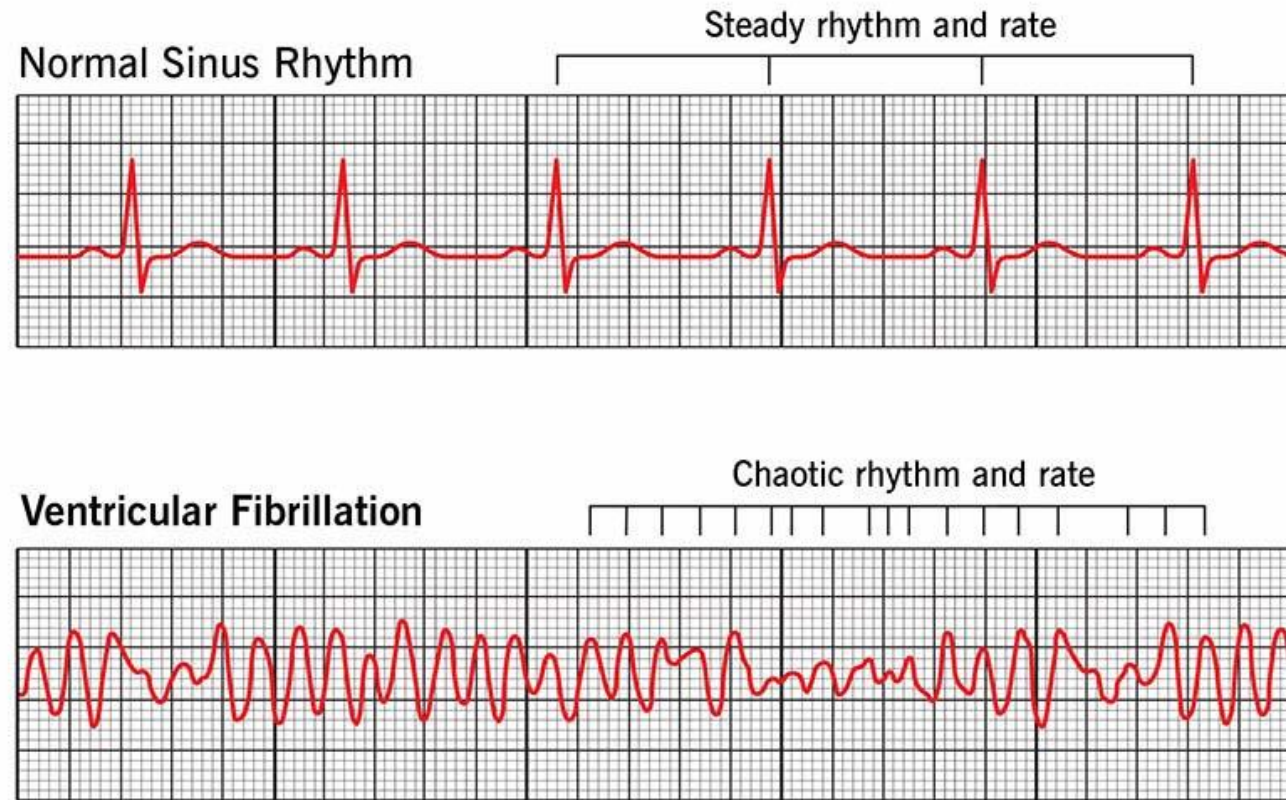
others - pulmonary disease, traumas...

Cardiac arrest - electrophysiology

Before cardiac arrest, abnormal, rapid impulses abruptly override the normal electrical impulses that start your heartbeat.

Abnormal heart rhythms (arrhythmias) cause most sudden cardiac arrests. The most common life-threatening arrhythmia is ventricular fibrillation (also called v-fib). This is an erratic, disorganized firing of impulses from your heart's ventricles (lower chambers). When this happens, your heart can't pump blood. When your heart isn't beating, there's no way to get oxygen-rich blood to the rest of your body. Without treatment, you can die within minutes.

Cardiac arrest - electrophysiology



Cardiac arrest - causes

Conditions and situations that can lead to these abnormal heart rhythms are the underlying causes of sudden cardiac arrest.

- Cardiomyopathy, Drugs for other medical conditions, Heart attack, Recreational drugs, Brugada syndrome.
- Long QT syndrome (LQTS), Severe illness or injury (trauma) with major blood loss.

Other cardiac arrest causes include:

- Coronary artery disease (CAD), Congenital heart conditions, Changes to heart's structure because of disease or infection, Extreme physical activity or blood loss, Infectious diseases, Respiratory conditions, Severe injury (trauma), Toxins

Some of these issues lower oxygen levels or reduce the volume of blood. This prevents the heart from functioning normally.

Hs and Ts is the name of mnemotechnic used to aid in remembering the possible treatable or reversible causes of cardiac arrest

- Hs
- Hypovolemia
- Hypoxia
- Hydrogen ions (acidosis)
- Hyperkalemia
- Hypokalemia
- Hypothermia
- Hypoglycaemia
- Hyperglycaemia

- Ts
- Tablets or toxins
- Tamponade
- Tension pneumothorax
- Thrombosis
- Thromboembolism
- Trauma

Manifestation

- Unresponsiveness
- No breathing
- No blood pressure
- Pupils begin dilating within 45 seconds
- Seizures may/may not occur
- Death-like appearance
- Lips and nail buds turn blue

Classification

Cardiac arrest is classified based upon the ECG rhythm into:

- Shockable (v-fib, and pulseless v-tach)
- Non-shockable (asystole and pulseless electrical activity)

Prognosis

- Out-of-hospital cardiac arrest has a worse survival rate (2-8% for discharge) than an in-hospital cardiac arrest (15% for discharge)
- Although mortality in the case of v-fib is high, rapid intervention with a defibrillator increases the survival rate
- Survival rates following an arrest induced by toxins are very much dependent on identifying the toxin and administering an appropriate antidote
- The overall survival following cardiac arrest is 6,8 %

Cardiopulmonary resuscitation (CPR)

- **lifesaving, emergency technique** consisting of chest compressions often combined with artificial ventilation to **restore spontaneous blood circulation and breathing** in a person who is in cardiac arrest

Basic vital functions:

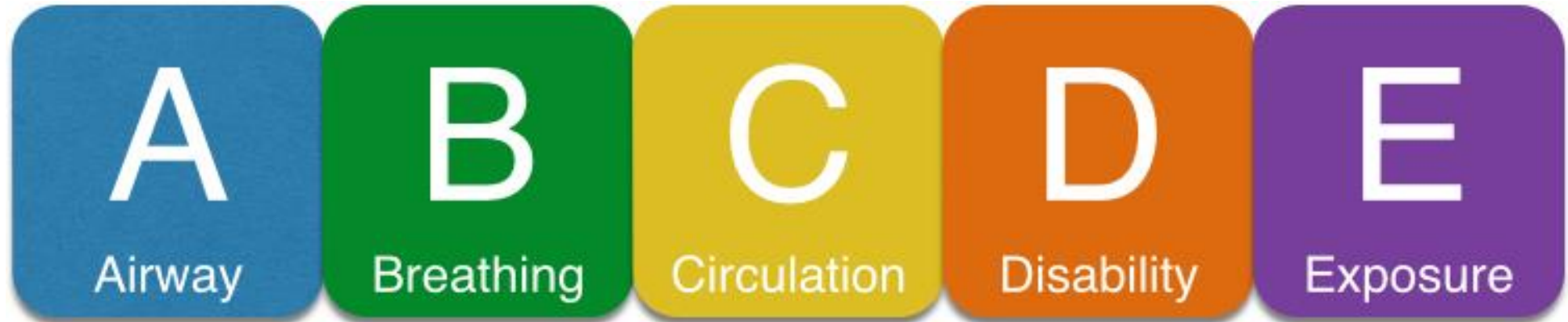
- **consciousness**
- **breathing**
- **blood circulation**
- **homeostasis**

... their failure can cause death of organism



ABCDE approach

Rapid assessment of vital functions



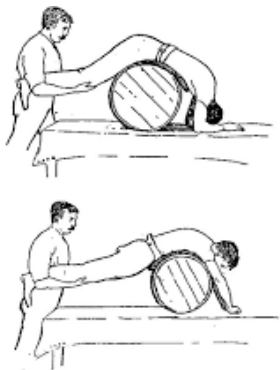
ABCDE chart

	EXAMINATION	INTERVENTION	GOAL
A 	• airway noises • position of head • foreign body • fluid, secretions • oedema	• open • suction • secure • O₂	Patent airway
B 	• look - listen - feel approach • respiratory rate and effort • breath and added sounds • subcutaneous emphysema • symmetry of chest movement • tracheal deviation • jugular vein distention • cyanosis SpO₂ - ETCO₂ - USG - X-ray - CT	• O₂ according to SpO₂ • pneumothorax therapy • inhalation therapy • ventilation	Sufficient oxygenation and ventilation
C 	• heart rate • blood pressure • capillary refill time • bleeding • skin colour • blood samples • diuresis ECG - USG - CT - X-ray	• I.V. / I.O. access • control of bleeding • massive haemorrhage protocol • fluids • drugs • transfusion	Stabilization of circulation
D 	• AVPU / GCS • reactivity and symmetry of pupils • blood glucose level • basic neurological examination • posture • toxicological examination	• glucose • antidotes	Evaluation of neurological state
E 	• head to toe examination • medical history • temperature • injuries • oedemas • scars • signs of drug abuse • skin changes • signs of infection/sepsis	• identified cause therapy • thermomanagement • trauma treatment • insertion of NGT, IUC	Revealing other symptoms and thermomanagement

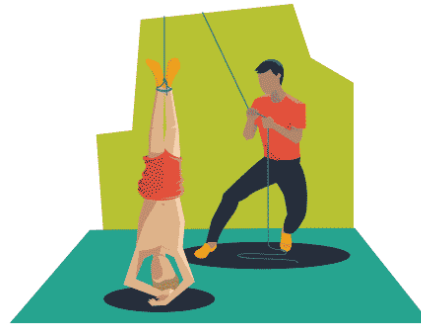
History of CPR

1767 - Society for the preservation of life from accidents in water, Amsterdam

- Recommendation:
- *warming up*
 - *removing water from the lungs and stomach* (head down position, induction of vomiting, applying manual pressure to the abdomen)
 - *support of vital functions* (tickling the victim's throat, rectal and oral fumigation with tobacco smoke)
 - *artificial ventilation* (releasing air into the victim's mouth, using a bellows or with a mouth-to-mouth method)
 - *bloodletting*



The "barrel" method.
Top: Expiratory phase.
Left: Commencement
of inspiratory phase.
Reproduced from
the Lancet, 1909.



History of CPR

1960- **Dr. Peter Safar** (1924 – 2003)

- cardiopulmonary resuscitation
- ABC approach



Dr. William B. Kouwenhoven (1886 – 1975)

- development of the closed-chest cardiac massage
- invention of the cardiac defibrillator



Keywords of CPR

- **CPR - cardiopulmonary resuscitation - effort to restore breathing and circulation**
- **BLS – Basic Life Support**
 - the first level of care for the person in cardiac arrest
 - providing by non-professionals
 - without specialized tools except of using AED

BLS is fundamental to all CPRs
- **ALS – Advanced Life Support**
 - set of life-saving protocols and skills that extend beyond BLS
 - ALS procedure includes invasive interventions (insertion of i.v. catheters, endotracheal intubations..), treatment procedures (manual defibrillation, cricothyrotomy...), and drug administration
 - providing by healthcare workers, specialized tools, monitoring

Keywords of CPR

- **Cardiac arrest** - cessation of cardiac mechanical activity resulting in the absence of circulating blood flow, the heart doesn't work as a pump and blood circulation is stopped
 - sudden cardiac arrest - **unexpected** cessation of circulation within a short period of symptom onset (often without warning)
- **Chest compressions** – „heart massage“
- **Rescue breath** – mouth-to-mouth breathing
- **Open airway**
- **Shockable / non-shockable rhythm**
- **Dispatch assisted CPR**

Chain of survival



- (1) **early access** - to activate the emergency medical services (EMS)
- (2) **early basic life support (BLS)** - to slow the rate of deterioration of the brain and heart, and buy time to enable defibrillation
- (3) **early defibrillation** - to restore a perfusing rhythm
- (4) **early advanced life support (ALS)** - to stabilize the patient

WHEN to start CPR?

- **Unresponsive person** (unconsciousness)
- **Absent or abnormal breathing** (agonal breathing- gasping - slow, labored breathing)
- **Unconsciousness with absent or abnormal breathing**
= cardiac arrest

Don't check pulse!

WHEN do not start CPR ?

- the rescuer is not safe
- conditions precluding the hope of survival (end stage of incurable disease)
- signs of irreversible death (cold to the touch, rigor mortis, lividity...) and injuries not compatible with life (decapitation...)

**If you have any doubts -
start CPR**

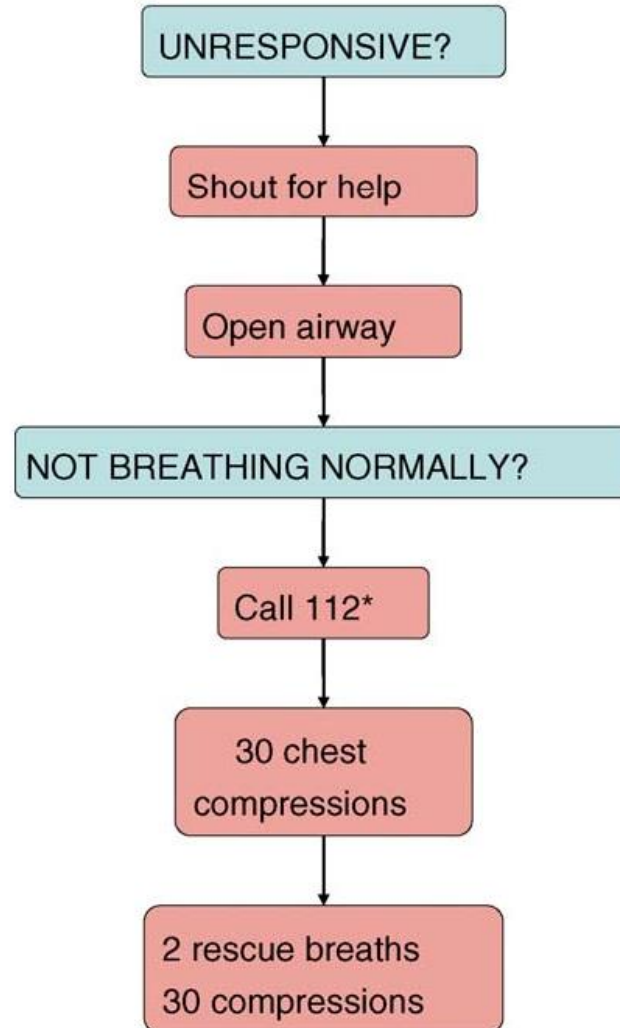
ALWAYS!!!



When should CPR be stopped ?

- presence of signs of life (normal breathing, opening eyes, movements...)
- handing over the affected person to a qualified resuscitation team/ staff of EMS
- you are too exhausted to continue

Adult basic life support



*or national emergency number

1. Make sure, that you - as a rescuer and all witnesses are in safety

2. Check for response

- ask loudly: Are you all right?
- **shake** the victim gently by shoulders
- **painful stimulus**

→ no response

→ call for help



- a short period of seizure-like movements can occur at the start of cardiac arrest, assess the person after the seizure has stopped

3. Open the airway

Tilt the head backward and lift the chin

Don't pull out the tongue !!!



Figure 2.4 Head tilt and chin lift. © 2005 European Resuscitation Council.

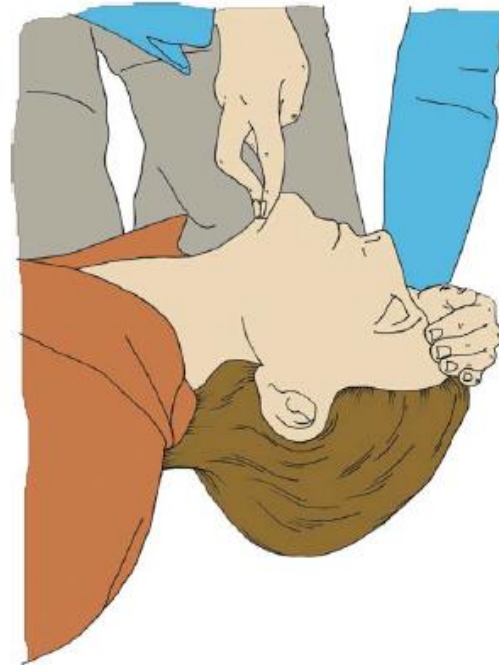


Figure 2.5 Head tilt and chin lift in detail. © 2005 European Resuscitation Council.

4. Check breathing

- LOOK
- LISTEN
- FEEL.....for breathing

Slow, infrequent, and noisy gasps or barely breathing person = abnormal breathing

**Unconsciousness + absent breathing/
abnormal breathing**

= cardiac arrest

Don't check the pulse!!!



Figure 2.6 Look listen and feel for normal breathing.
© 2005 European Resuscitation Council.

CALL 155/112

5. Chest compressions

- 30:2 (30 compressions, 2 rescue breaths)
- center of the chest
- depth of compression approx. 5.5 - 6 cm
- rate 100-120/min

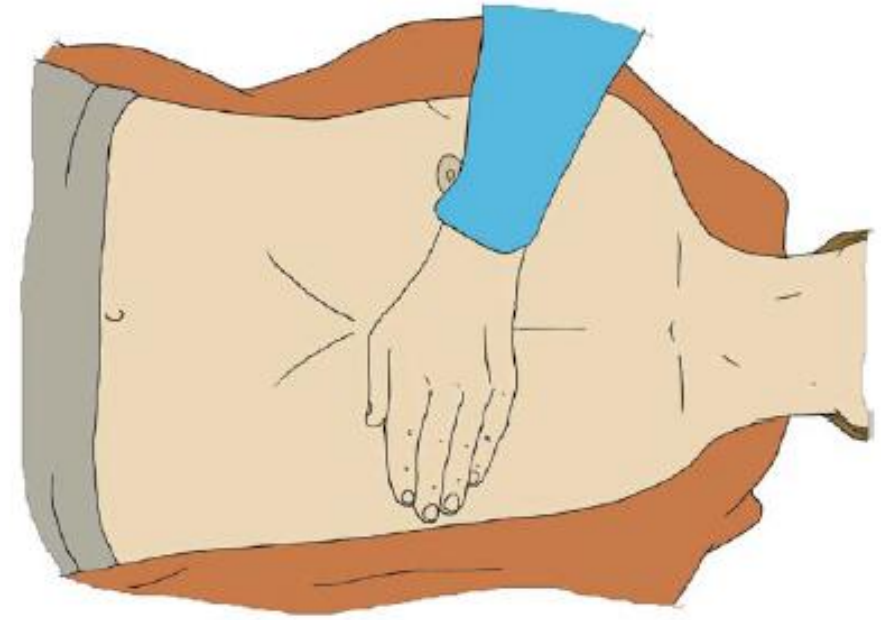
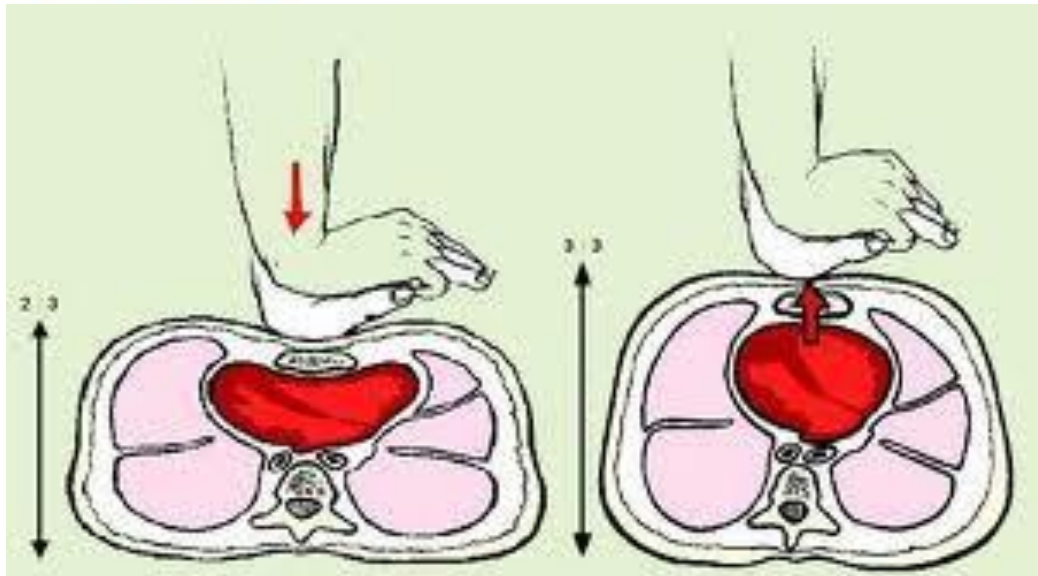
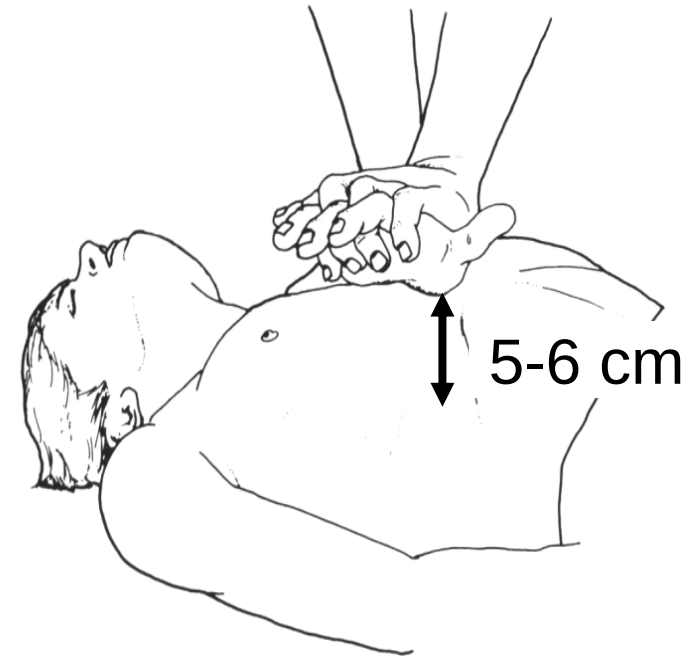
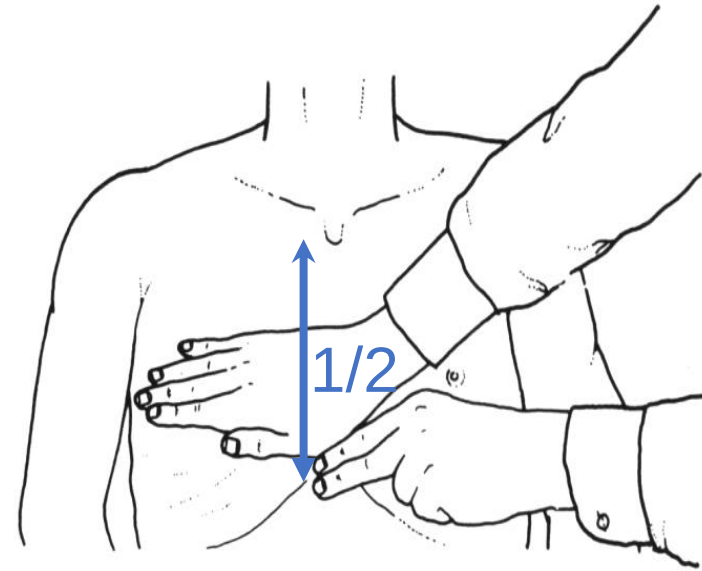


Figure 2.8 Place the heel of one hand in the centre of the victim's chest. © 2005 European Resuscitation Council.

30:2



6. Rescue breath

- open airway – head tilt and chin lift
- close the soft part of nose by the index finger and thumb
- take a normal breath and place your lips around the patient's mouth
- blow steadily into his/her mouth
- watching for his/her chest rising
- maintaining tilt head and lifted chin, take your mouth away from the victim, and watch for the chest to fall
- repeat other rescue breath
- **2 breaths**



Figure 2.13 Blow steadily into his mouth whilst watching for his chest to rise. © 2005 European Resuscitation Council.

Compression-Only CPR / Hands - Only CPR

- if you **don't know**, or you are **unable** or **unwilling** to provide rescue breaths
- chest compressions alone could circulate the remaining oxygen in the bloodstream of a victim of sudden cardiac arrest
- Concerns about infections: - recorded transmission during CPR - Mycobacterium tuberculosis, Helicobacter pylori, Herpes simplex, Meningococcus, Streptococcus, Salmonella ...
 - theoretically possible transmission - HIV, hepatitis B a C – not yet recorded, Covid ???
- Gastric regurgitation/ vomiting
- ILCOR suggests that bystanders who are trained, able, and willing to give rescue breaths and chest compressions do so for all adult patients in cardiac arrest (weak recommendation, very-low certainty evidence)

COVID-19 and Adult CPR

If an adult's heart stops and you're worried that they may have COVID-19, you can still help by performing Hands-Only CPR.



American
Heart
Association.

Step 1



Phone 9-1-1
and get an AED.

Step 2



Cover your own
mouth and nose
with a face mask
or cloth.



Cover the
person's mouth
and nose with
a face mask or
cloth.

Step 3



Perform
Hands-Only CPR.
Push hard and fast on
the center of the chest
at a rate of 100 to 120
compressions
per minute.

Step 4



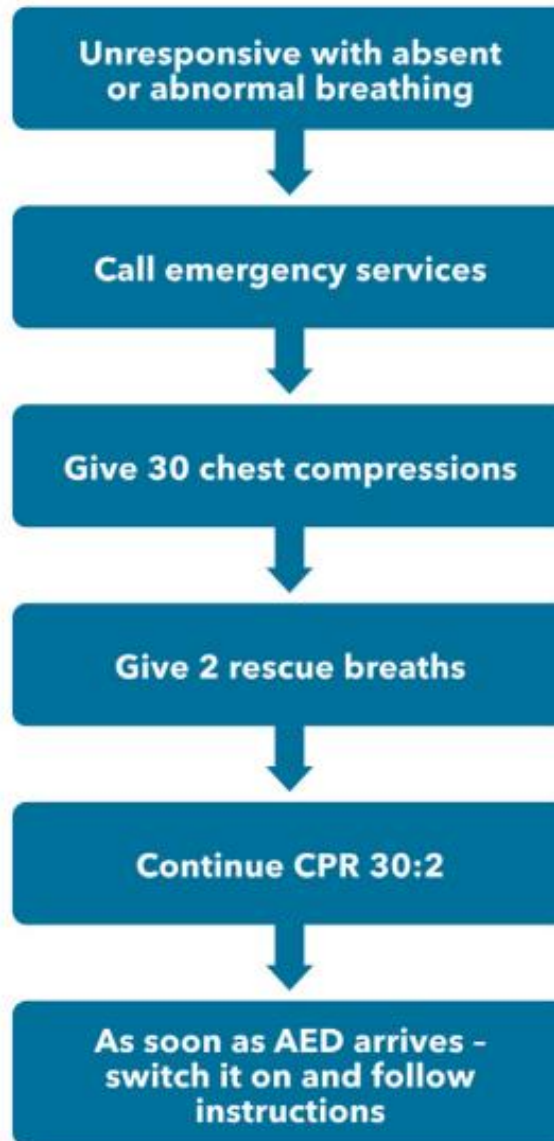
Use an AED as
soon as it is
available.

Protective equipment for CPR



bag mask – ambu bag



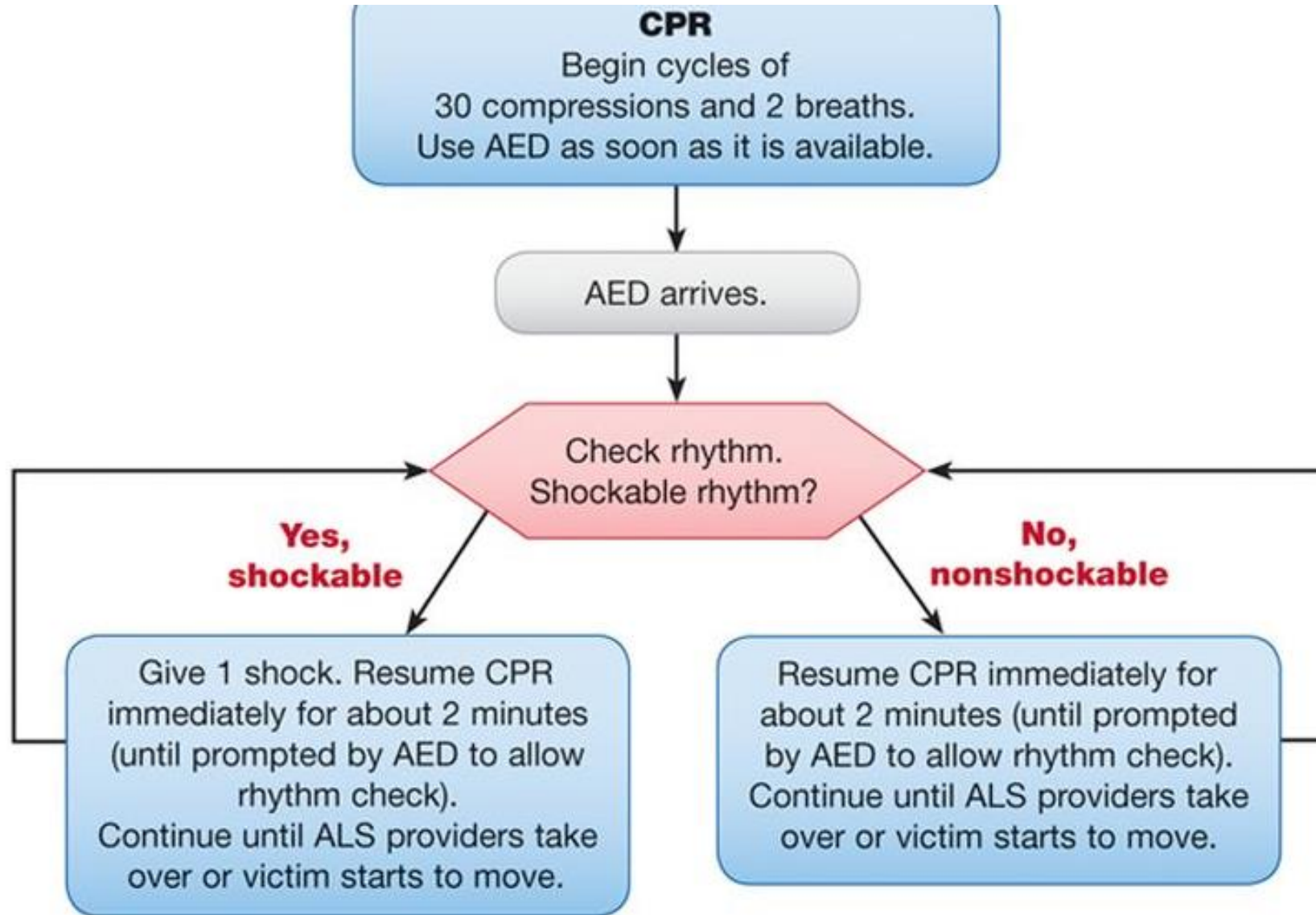


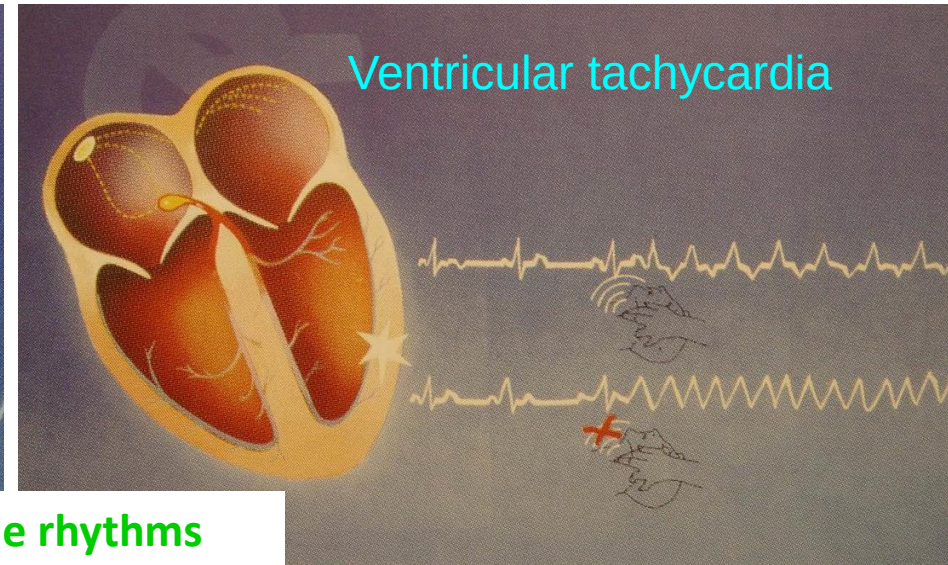
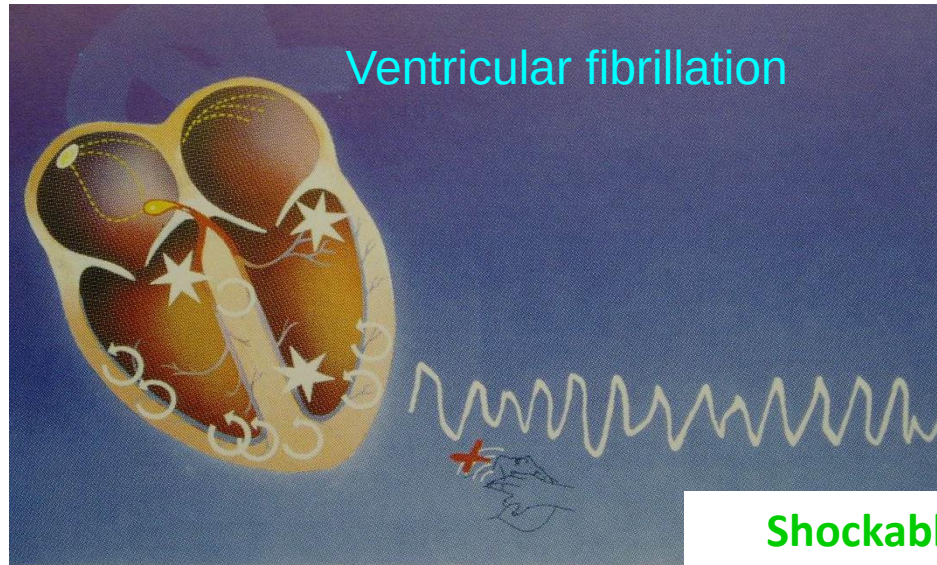
AUTOMATED EXTERNAL DEFIBRILLATOR (AED)

- AED - an electronic device:
 - to automatically **diagnose** the life-threatening cardiac arrhythmia
 - to **treat** life-threatening cardiac arrhythmia through defibrillation - the application of electricity which stops the arrhythmia
 - for non-professionals

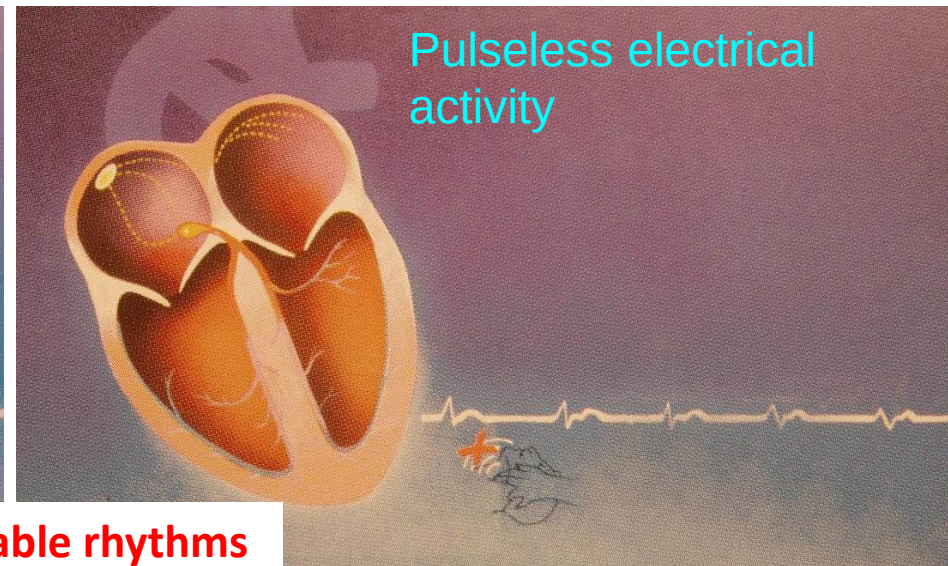
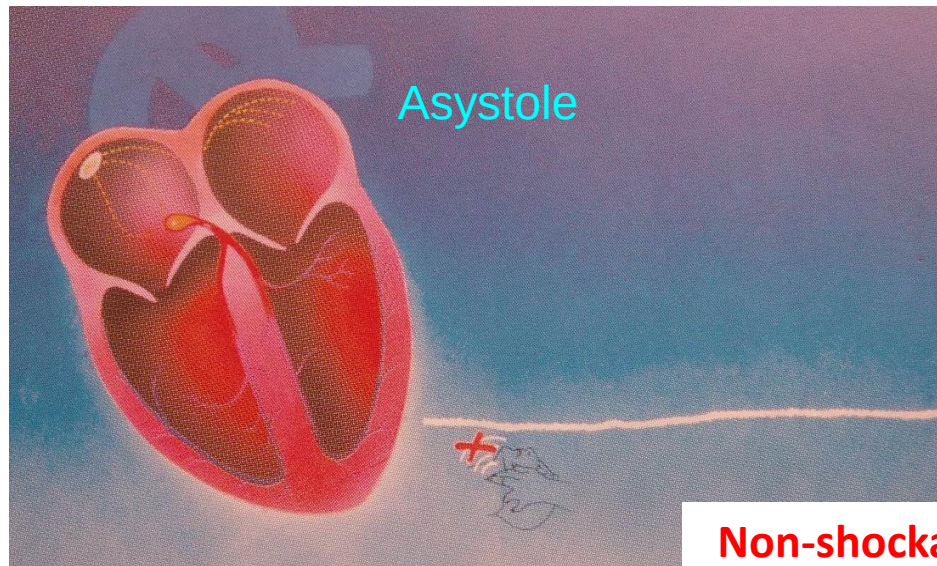








Shockable rhythms



Non-shockable rhythms

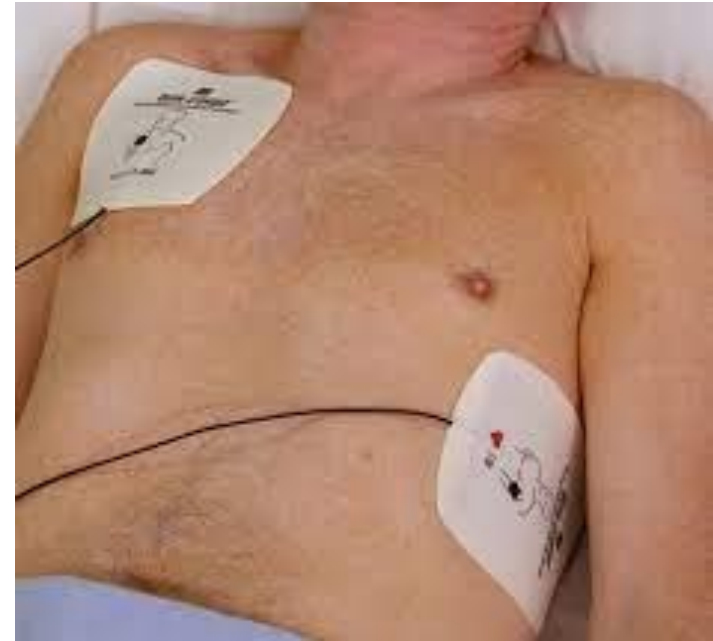
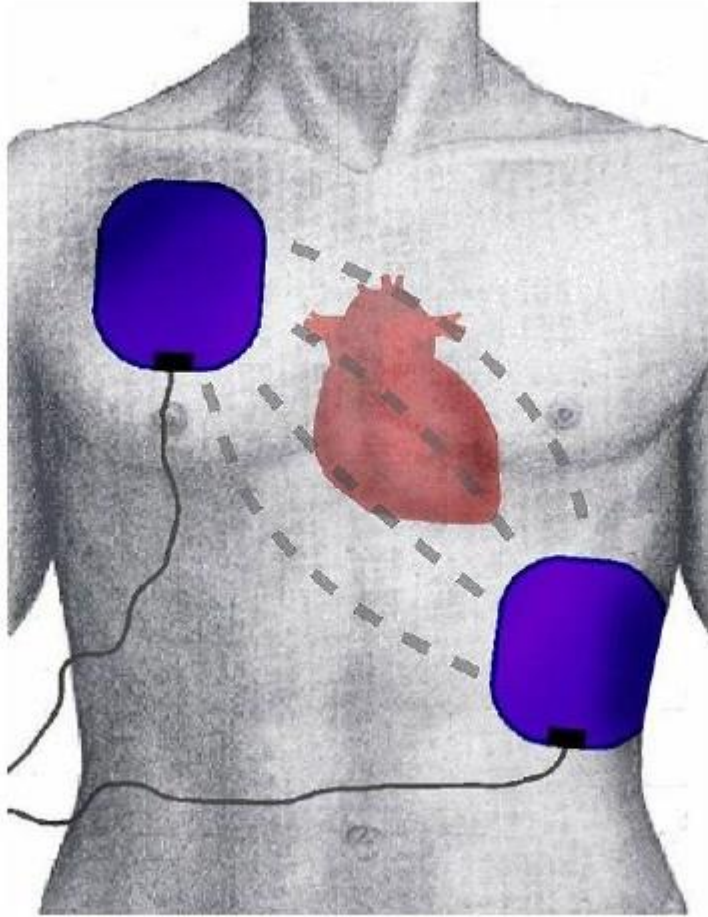
AED

- activate AED by opening cover
- follow sound instructions
- attach pads

- don't stop CPR (chest compression) during attaching AED pads !!!



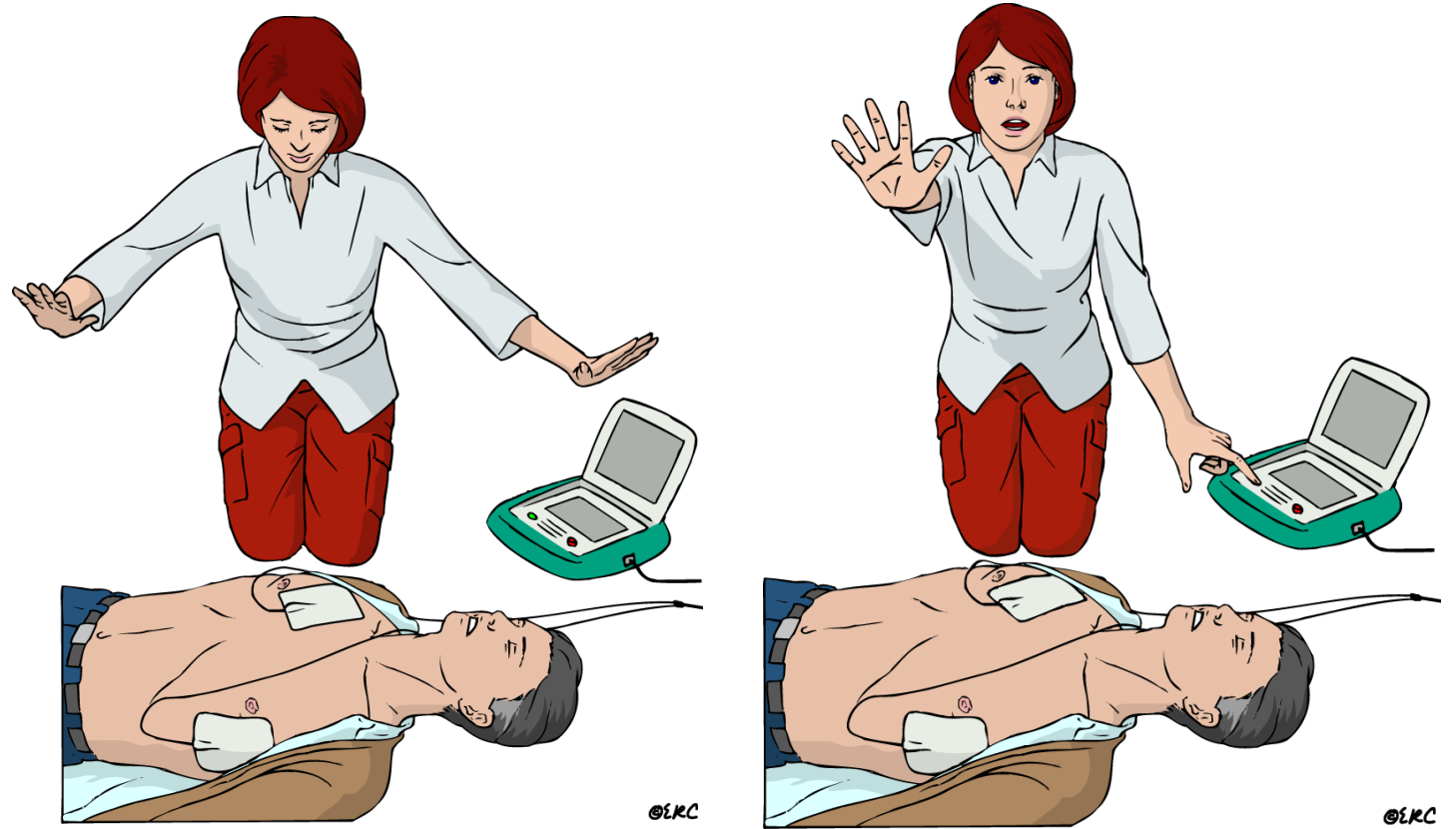
AED pads placement



AED

Stop CPR: rhythm analysis

Shock is **advised** → don't touch the patient → press button **SHOCK**
→ **SHOCK** → immediately restart CPR 30:2 -2 min.



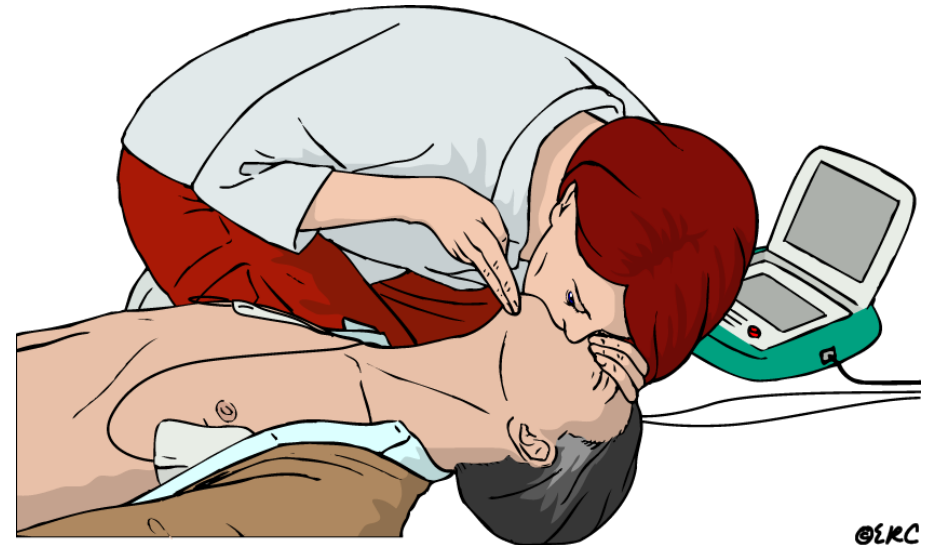
SHOCK → CPR 30:2, 2 min → rhythm analysis



©ERC

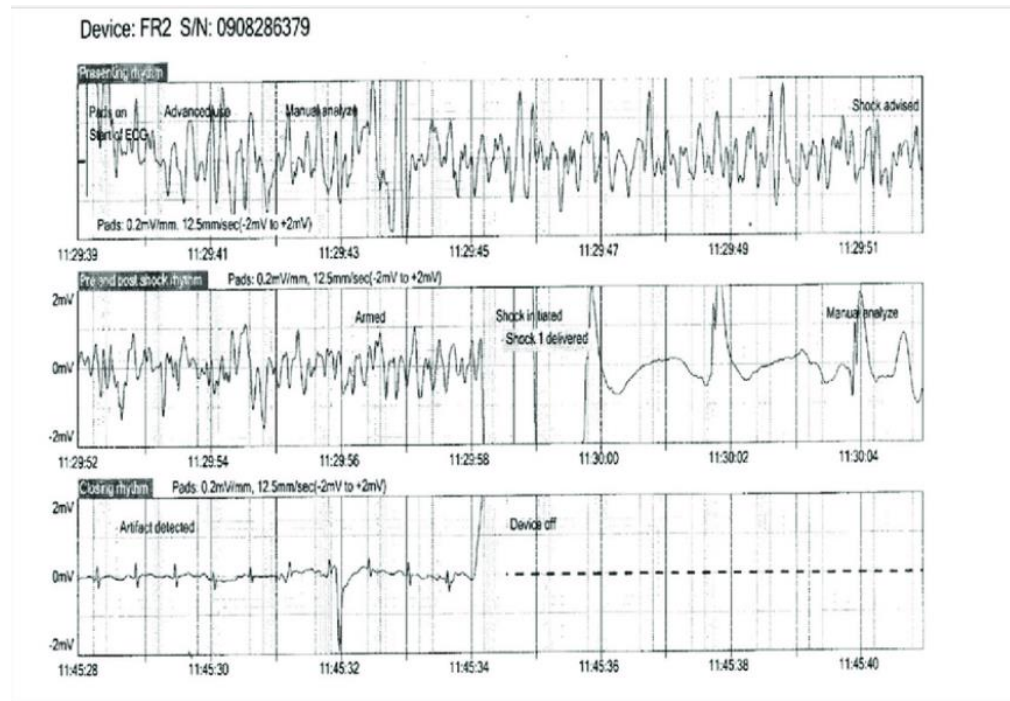


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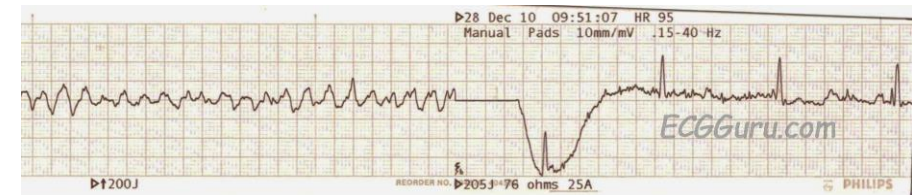


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Defibrillation



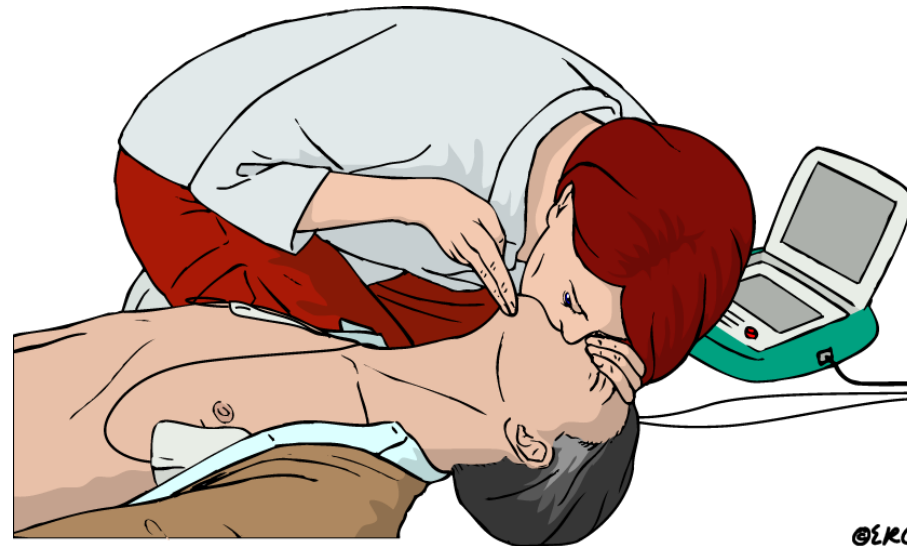
Automated external defibrillator record showing ventricular fibrillation converted to sinus rhythm by defibrillation.



AED

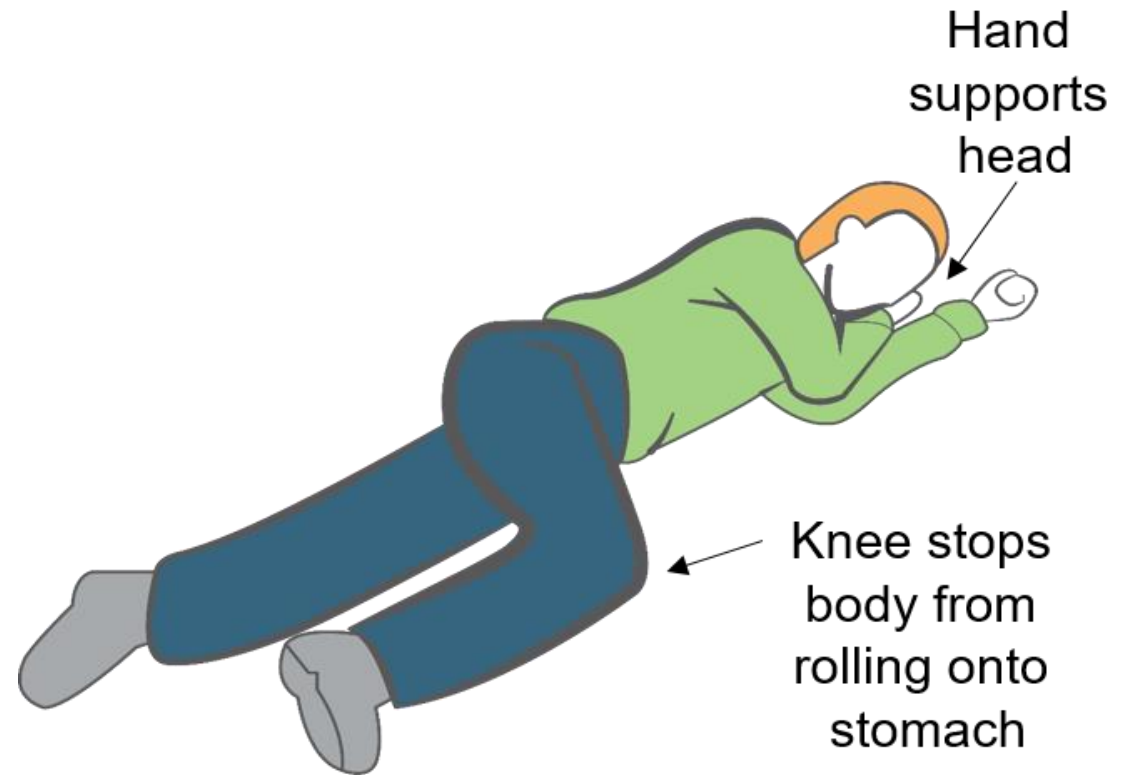
Stop CPR: **rhythm analysis**

Shock is not advised → immediately restart CPR 30:2 -2 min.



Recovery position

- unresponsive, normally breathing patient
- prevention of airway obstruction
- using for more than 100 years



POST-CPR RECOVERY POSITION

1. Bend one arm and keep legs straight.



2. Place back of victim's hand against cheek and hold there.



3. Hold victim's hand against cheek to support head.



4. Hand supports head.
Bent knee prevents rolling
Bent arm gives stability

Front view of recovery position





**The worst thing you
can do is nothing.**