# Advanced Cardiac Life Support in Adults

## Introduction

<style type="text/css"> table.table-border-nula td {padding: 12px;!} table.table-border-nula i {font-size: 0.9em; color: grey;!} hr.lm {display:none;!} ul.obsah {border: 1px solid; border-color: rgba(200, 200, 200, .4); border-radius: 10px; background: rgba(255, 255, 255, .9); top: 40px; padding-left: 20px; padding-top: 10px; padding-bottom: 10px; margin-left: 0px; margin-bottom: 10px; margin-top: 20px;font-size: 0.8em; width: 160px; float: right;!} .obsah::before {content: "Table of contents:"} .obsah li {margin-top: 5px; padding-left: 0px;} .obsah li+li {margin-top: 0px; margin-bottom: 0px;} .obsah li:last-of-type {margin-bottom: 5px;} .vnoreny-obsah {padding-left: 0px; font-size: 0.9em; color: grey;!} .vnoreny-obsah a {color: grey;!} .obsah a:link {text-decoration: none} .obsah a:hover {text-decoration: underline} .video {float:right; margin-left: 15px; margin-bottom: 10px; text-align: right; border: 20px solid; border-color: rgba(255, 255, 255, .4); border-radius: 10px; background: rgba(255, 255, 255, .5);} .video span { color: grey; font-size: 0.9em; line-height: 0.9em; } .pageContent ol {padding-top:20px;padding-right:20px;padding-bottom:20px; background: #FFFFE0;border-radius: 10px;border: 1px solid; border-color: rgba(200, 200, 200, .4);} /*table.table-border-nula td {padding: 12px;!} table.table-border-nula i {font-size: 0.9em; color: grey;!} .obsah {font-size: 0.9em;!} .obsah li li a {font-size: 0.8em; color: grey;!}*/ </style>
**Actualisation according to ERC Guidelines 2021.**

The content is based mainly on The European Resuscitation Council Guidelines for Resuscitation 2021 ( https://cprguidelines.eu/ ) if not another source is quoted in the text.

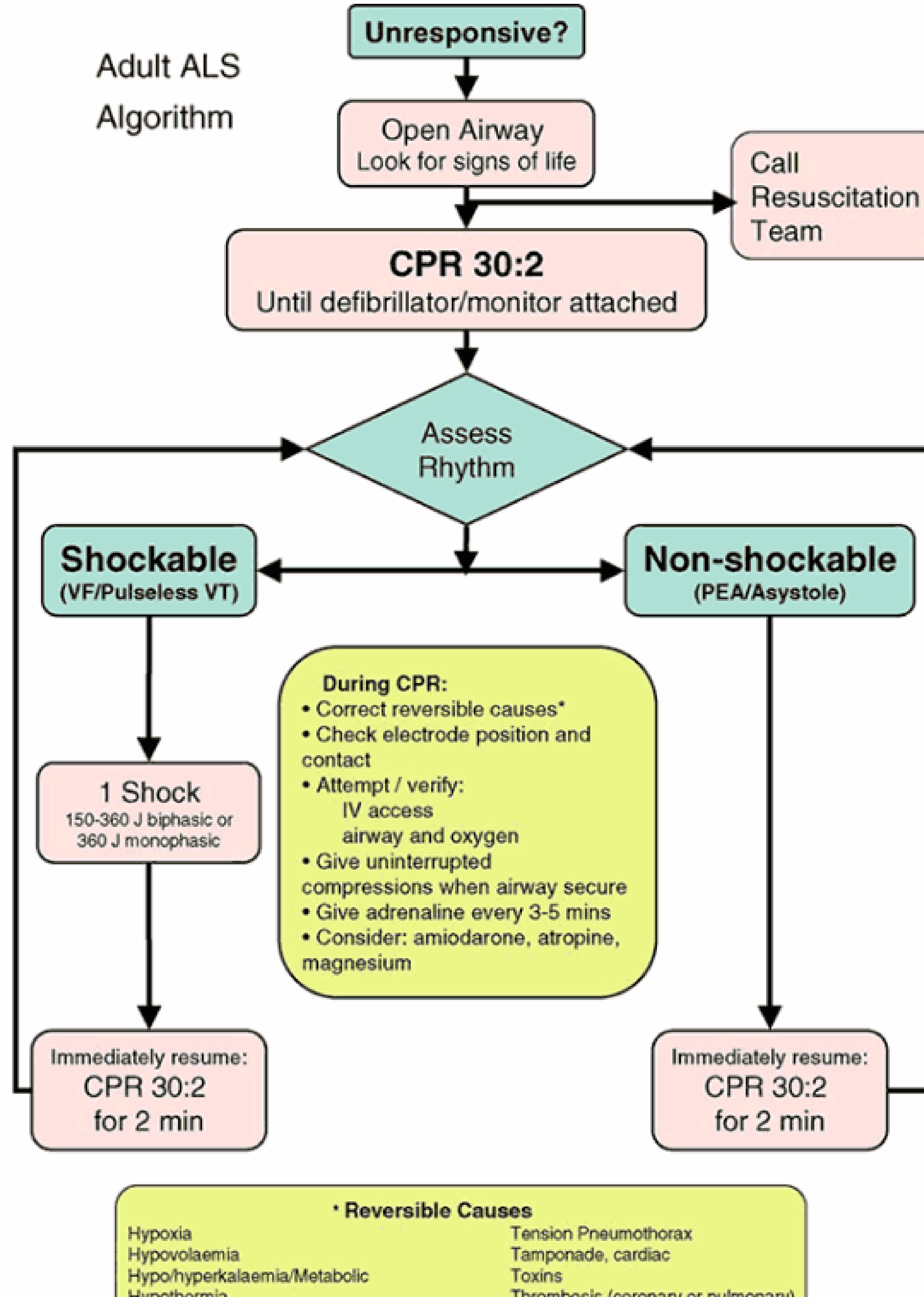
**Cardiopulmonary Resuscitation (CPR)** is the emergency substitution of heart and lung action to restore life to someone who appears dead. The goal of CPR is to prevent brain damage or death. The two main components of conventional cardiopulmonary resuscitation (CPR) are chest compression to make the heart pump and mouth-to-mouth ventilation to breath for the victim. Hands-only CPR is a form of resuscitation that involves continuous, rapid chest compressions only, and although effective, it is not as beneficial as conventional CPR in a patient who is not breathing. The following concept of the Chain of Survival summarises the vital steps needed for successful resuscitation. Most of these links are relevant for victims of both ventricular fibrillation (VF) and asphyxial arrest.

- Early recognition of the emergency and calling for help: activate the emergency medical services (EMS) or local emergency response system, e.g. ,phone 155 in the Czech Republic. An early, effective response may prevent cardiac arrest.
- Early bystander CPR: immediate CPR can double or triple survival from sudden cardiac arrest.
- Early defibrillation: CPR plus defibrillation within 3-5 min of collapse can produce survival rates as high as 49-75%. Each minute of delay in defibrillation reduces the probability of survival to discharge by 10-15%.
- Early advanced life support and postresuscitation care: the quality of treatment during the post-resuscitation phase affects outcome.

**Warning signs of cardiac arrest** are chest pain, dyspnoea and other signs of hypoxia - restlessness, cyanosis, tachypnoea, sweating, exhaustion, fainting, blurred vision, sudden palpitation or irregular puls. Call emergency medical service immediately and be prepared for resuscitation.

**Vital functions** are consciousness, respiration and circulation. Failure of one vital function results sooner or later in cessation of the remaining two ones. For example, in sudden cardiac arrest unconsciousness follows in 10 – 15 sec. and cessation of breathing in 2 minutes.
**Basic Life Support** should be provided by all bystanders without special aids and equipment any time, when no clear signs of death (rigor mortis, livor mortis, apparently fatal injury accident,) are present. In medicine, terminal stage of untreatable illness and apparently futile attempts must be excluded. The rules differ in various countries. Basic life support consists of

- **A - A**ssess unconsciousness and open airways
- **B - B**reathing – control if normal breathing is present
- **C - C**ardiac massage + artificial ventilation


Adult ALS
Algorithm
Unresponsive?
Open Airway
Look for signs of life
Call
Resuscitation
Team
CPR 30:2
Until defibrillator/monitor attached
Assess
Rhythm
Shockable
(VF/Pulseless VT)
Non-shockable
(PEA/Asystole)
1 Shock
150-360 J biphasic or
360 J monophasic
During CPR:
• Correct reversible causes*
• Check electrode position and contact
• Attempt / verify:
IV access
airway and oxygen
• Give uninterrupted compressions when airway secure
• Give adrenaline every 3-5 mins
• Consider: amiodarone, atropine, magnesium
Immediately resume:
CPR 30:2
for 2 min
Immediately resume:
CPR 30:2
for 2 min
* Reversible Causes
Hypoxia
Hypovolaemia
Hypo/hyperkalaemia/Metabolic
Tension Pneumothorax
Tamponade, cardiac
Toxins

Compile

Rescuers begin CPR if the victim is unconscious or unresponsive and not breathing normally (ignoring occasional gasps). A single compression-ventilation (CV) ratio of 30:2 is used by the single rescuer of an adult and 15 : 2 of a child (excluding neonate). Guidelines 2000 introduced the concept of checking for ‘signs of a circulation’. This change was made because of the evidence that relying on a check of the carotid pulse to diagnose cardiac arrest is unreliable and time-consuming, mainly, but not exclusively, when attempted by non-healthcare professionals. Subsequent studies have shown that checking for breathing is also prone to error, particularly as agonal gasps are frequently misdiagnosed as normal breathing. In Guidelines 2015 the absence of breathing, in a non-responsive victim, continues to be the main sign of cardiac arrest. Also highlighted is the need to identify agonal gasps as another, positive, indication to start CPR. Finally, there is recognition that delivering chest compressions is tiring. It is now recommended that, where more than one rescuer is present, another should take over the compressions (with a minimum of delay) about every 2 min to prevent fatigue and maintain the quality of performance. There are other changes in the guidelines. In particular, allowance has been made for the rescuer who is unable or unwilling to perform rescue breathing. It is well recorded that reluctance to perform mouth-to-mouth ventilation, in spite of the lack of evidence of risk, inhibits many would-be rescuers from attempting any form of resuscitation. These guidelines encourage chest compression alone in such circumstances. Basic life support in detail is presented at https://www.lf3.cuni.cz/cpr .
<hr/>

# Advanced Cardiac Life Support - ACLS

ACLS in the Czech Republic is provided by trained healthcare professionals. The team leader is a doctor. The aims of the team is to continue in CPS provided by bystanders using special equipment, aids and drugs to restore spontaneous circulation, stabilise vital functions and transport the patient to a hospital for further resuscitation care.
**ACLS consist of:**

- **D – Defibrillation**
- **E – ECG**
- **F – Fluids and drugs**

<div class=video> <iframe width="281" height="226" src="https://www.youtube.com/embed/yEH2Vxo8QQI?rel=0&showinfo=0" frameborder="0" gesture="media" allowfullscreen></iframe><br/> <span>ACLS in 2 rescuers</span> </div>
The Emergency Medical Team (EMT) must be skilled in providing tracheal intubation or any other way to secure clear airway and perform automated artificial ventilation, provide access to systemic circulation, pacing, chest drainage, etc. Providing external chest compressions is the priority that must not be interrupted for a longer period. Defibrillation, tracheal intubation etc. should be performed as quickly as possible. The algorithm and skills must be learned. ACLS in 2 rescuers is demonstrated in a model situation. See video .
After arrival, an ambulance physician takes over CPR from a bystander; a paramedic initiates ECG monitoring and prepares a defibrillator in the case of ventricular fibrillation. Once a defibrillator is attached, and if a shockable rhythm is confirmed, a single shock is delivered. Irrespective of the resulting rhythm, chest compressions and ventilations (two minutes with a compression/ventilation ratio of 30:2) are resumed immediately after the shock to minimise ‘no-flow’ time. External cardiac massage is further performed by a paramedic; an ambulance physician continues artificial ventilation and in the meantime prepares equipment for tracheal intubation and intubates the patient. Tracheal intubation should take no longer than 5 seconds. Use of an automatic ventilator enables the physician to perform other actions – mainly administration of drugs. The drug of choice is adrenaline which may be administered by an intra-osseous needle (see further), if intravenous access is not available. After 2 minutes of CPR an ECG is checked again and another defibrillation is delivered, if necessary. The physician takes over the external cardiac massage and a paramedic charges defibrillator and delivers the shock. After securing the paddles, a paramedic would continue with chest compressions, while the doctor secures intravenous access. Resuscitation continues, following an algorithm of continuous CPR, administration of drugs, and defibrillation until spontaneous circulation is restored or CPR is terminated because of failure.
These skills must be learned to be performed quickly and correctly. Regular checks of equipment is essential: laryngoscopes, tracheal tubes with attached syringe for cuff inflation, self-inflating bag, ventilator, drugs, full oxygen cylinder, defibrillator with charged batteries etc.

## Other definitions used in ACLS

- **Defibrillation time** – time elapsed from cardiac arrest to the first defibrillation
- **Restore of Spontaneous Circulation (ROSC)** – Restore of spontaneous circulation for longer than 1 min.
- **Primary successful CPR** – patient is resuscitated and transferred to a hospital
- **Successful CPR** – patient gains Glasgow Outcome Score (GOS) 4-5 anytime after CPR

## Glasgow Outcome Score

| **Score** | **Rating** | **Definition** |
|---|---|---|
| **5** | Good Recovery | Resumption of normal life despite minor deficits |
| **4** | Moderate Disability | Disabled but independent. Can work in sheltered setting |

| | | |
|---|---|---|
| **3** | Severe Disability | Conscious but disabled. Dependent for daily support |
| **2** | Persistent vegetative | Minimal responsiveness |
| **1** | Death | Non survival |

**Note:**
In trauma patients ABCD approach has different meaning. It is a systematic approach to the immediate assessment and treatment of critically ill or injured patients: Airway, Breathing, Circulation, Disability, Exposure/Examination. For more details see https://www.resus.org.uk/resuscitation-guidelines/abcde-approach/
<hr/>

# Defibrillation

<div class=video> <iframe width="281" height="226" src="https://www.youtube.com/embed/U2GdxMpV72g?rel=0&showinfo=0" frameborder="0" gesture="media" allowfullscreen></iframe><br/> <span>Defibrillation</span> </div>
Defibrillation is a process in which an electronic device gives an electric shock to the heart. This helps reestablish normal contraction rhythms in a heart having dangerous arrhythmia or in cardiac arrest. Defibrillation is the passage across the myocardium of an electrical current of sufficient magnitude to depolarise a critical mass of myocardium and enable restoration of coordinated electrical activity. Defibrillation is defined as the termination of fibrillation or, more precisely, the absence of ventricular fibrillation/ventricular tachycardia (VF/VT) at 5 s after shock delivery; however, the goal of attempted defibrillation is to restore spontaneous circulation. Defibrillation is a key link in the Chain of Survival and is one of the few interventions that have been shown to improve outcome from VF/VT cardiac arrest. Sudden cardiac arrest (SCA) is a leading cause of death in Europe, affecting about 700,000 individuals a year. At the time of the first heart rhythm analysis, about 40% of SCA victims have ventricular fibrillation (VF). It is likely that many more victims have VF or rapid ventricular tachycardia (VT) at the time of collapse but, by the time the first ECG is recorded, their rhythm has deteriorated to asystole - see video . VF is characterized by chaotic, rapid depolarisation and repolarisation. The heart loses its coordinated function and stops pumping blood effectively. Many victims of SCA can survive if bystanders act immediately while VF is still present, but successful resuscitation is unlikely once the rhythm has deteriorated to asystole. The optimum treatment for VF cardiac arrest is immediate bystander CPR (combined chest compression and rescue breathing) plus electrical defibrillation.
**Primary causes** of sudden cardiac arrest are heart attack, malignant arrhythmias, coronary artery diseases, injury caused by electric current,
**Secondary causes** of sudden cardiac arrest are trauma, drug overdose, drowning, and in many children asphyxia; rescue breaths are critical for resuscitation of these victims. Victims of cardiac arrest need immediate CPR. This provides a small but critical blood flow to the heart and brain. It also increases the likelihood that a defibrillatory shock will terminate VF and enable the heart to resume an effective rhythm and effective systemic perfusion. CPR provides temporary survival of CNS cells, but cannot reverse ventricular fibrillation to a normal sinus rhythm. The probability of successful defibrillation and subsequent survival to hospital discharge declines rapidly with time and the ability to deliver early defibrillation is one of the most important factors in determining survival from cardiac arrest. For every minute that passes following collapse and defibrillation, mortality increases 7%-10% in the absence of bystander CPR.


<hr/>

# History of defibrillation

*(modified from* http://en.wikipedia.org/wiki/Defibrillation *)*

Defibrillation was first demonstrated in 1899 by Prevost and Batelli, from Geneva, Switzerland. They discovered that small electric shocks could induce ventricular fibrillation in dogs, and that larger charges would reverse the condition.

The first use on a human was in 1947 by Claude Beck, professor of surgery at Case Western Reserve University. Beck's theory was that ventricular fibrillation often occurred in hearts which were fundamentally healthy, in his terms "Heart too good to die", and that there must be a way of saving them. Beck first used the technique successfully on a 14 year old boy who was being operated on for a congenital chest defect. The boy's chest was surgically opened, and manual cardiac massage was undertaken for 45 minutes until the arrival of the defibrillator. Beck used internal paddles on either side of the heart, along with procaine amide, a heart drug, and achieved return of normal cardiac rhythm. Until the early 1950s, defibrillation of the heart was possible only when the chest cavity was open during surgery. The closed-chest defibrillator device which applied an alternating current of greater than 1000 volts, conducted by means of externally applied electrodes through the chest cage to the heart, was pioneered by Dr V. Eskin with assistance by A. Klimov in Frunze, USSR in mid 1950s.

In 1959 an alternative technique was used which involved charging of a bank of capacitors delivering the charge through an inductance such as to produce a heavily damped sinusoidal wave of finite duration (~5ms) to the heart by way of 'paddle' electrodes. The monophasic waveform was the standard for defibrillation until the late 1980s when numerous studies showed that a biphasic truncated waveform (BTE) was equally efficacious while requiring the delivery of lower levels of energy to produce defibrillation. A side effect was a significant reduction in weight of the machine. The BTE waveform, combined with automatic measurement of transthoracic impedance is the basis for modern defibrillators.

A major breakthrough was the introduction of portable defibrillators in ambulances in early 1960. In the Czech Republic, the first portable defibrillator was introduced by Prof. Peleška, MD from the institute of Clinical and Experimental Medicine in Prague. Today portable defibrillators are one of the most important tools carried by ambulances. They are the only proven way to resuscitate a person who has had a cardiac arrest unwitnessed by EMT who is still in persistent ventricular fibrillation or ventricular tachycardia at the arrival of pre-hospital providers.

Gradual improvements in the design of defibrillators, and partly based on the work developing implanted versions (see below) have lead to the availability of Automated External Defibrillators, which can analyse the heart rhythm by themselves, diagnosing the shockable rhythms, and then charging to treat. This means that no clinical skill is required in their use, allowing lay people to respond to emergencies effectively.

Defibrillation history – for more detail see http://efimov.wustl.edu/defibrillation/history/defibrillation_history.htm

<hr/>

# Defibrillation – practical guide

## Defibrillators with paddles

1. **Apply gel to decrease impedance of the chest**
2. **Adjust the energy**. The optimal energy for defibrillation is that which achieves defibrillation while causing the minimum of myocardial damage. Monophasic defibrillators are no longer manufactured, although many remain in use. Monophasic defibrillators deliver current that is unipolar (i.e., one direction of current flow). Biphasic defibrillators, in contrast, deliver current that flows in a positive direction for a specified duration before reversing and flowing in a negative direction for the remaining milliseconds of the electrical discharge. Biphasic defibrillators compensate for the wide variations in transthoracic impedance by electronically adjusting the waveform magnitude and duration. First-shock efficacy for long-duration VF/VT is greater with biphasic than monophasic waveforms and therefore use of the former is recommended whenever possible. Optimal energy levels for both monophasic and biphasic waveforms are unknown The optimal current for defibrillation using a monophasic waveform is in the range of 30-40 A. Indirect evidence from measurements during cardioversion for atrial fibrillation suggest that the current during defibrillation using biphasic waveforms is in the range of 15-20 A.

   **First shock**

   First-shock efficacy for long-duration cardiac arrest using monophasic defibrillation has been reported as 54%-63% for a 200-J monophasic Because of the lower efficacy of this waveform, the recommended initial energy level for the first shock using a monophasic defibrillator is 360 J. Although higher energy levels risk a greater degree of myocardial injury, the benefits of earlier conversion to a perfusing rhythm are paramount. The initial biphasic shock should be at least 150 J.

   **Second and subsequent shocks**

   With monophasic defibrillators, if the initial shock has been unsuccessful at 360 J, second and subsequent shocks should all be delivered at 360 J. With biphasic defibrillators there is no evidence to support either a fixed or escalating energy protocol. Both strategies are acceptable; however, if the first shock is not successful and the defibrillator is capable of delivering shocks of higher energy, it is rational to increase the energy for subsequent shocks.
3. **Apply paddles firmly to the chest wall**. This reduces transthoracic impedance by improving electrical contact at the electrode-skin interface and reducing thoracic volume. The defibrillator operator should always press firmly on handheld electrode paddles, the optimal force being 8 kg in adults and 5 kg in children aged 1-8 years when using adult paddles; 8-kg force may be attainable only by the strongest members of the cardiac arrest team, and therefore it is recommended that these individuals apply the paddles during defibrillation. The right (sternal) electrode is placed

to the right of the sternum, below the clavicle. The apical paddle is placed in the midaxillary line, approximately level with the V6 ECG electrode or female breast. This position should be clear of any breast tissue. Continue in chest compression during placing paddles and charging defibrillator.
4. **Interrupt chest compression before applying an electric charge**, do not touch the patient.
5. **Continue CPR for 2 minutes** without assessing heart rhythm.

## Defibrillators with self-adhesive pads

The steps are similar, except of the first step.

## Automated external defibrillator (AED)

<div class=video> <iframe width="281" height="226" src="https://www.youtube.com/embed/evUoM1M1XG0?rel=0&showinfo=0" frameborder="0" gesture="media" allowfullscreen></iframe><br/> <span>Automated external defibrillator (AED)</span> </div>

Thanks to introduction of AED, defibrillation (point D) became a part of basic life support. These simple to use units are based on computer technology which is designed to analyze the heart rhythm itself, and then advise whether a shock is required. They are designed to be used by lay persons, who require little training. They are usually limited in their interventions to delivering high joule shocks for VF and VT (ventricular tachycardia) rhythms, making them generally limiting for use by healthcare professionals, who could diagnose and treat a wider range of problems with a manual or semi-automatic unit.

Automated external defibrillators are generally either held by trained personnel who will attend incidents, or are public access units. The locating of a public access AED should take in to account where large groups of people gather, and the risk category associated with these people, to ascertain whether the risk of a sudden cardiac arrest incident is high adults. Standard AEDs are suitable for use in children older than 8 years. For children between 1 and 8 years use paediatric pads or a paediatric mode if available; if these are not available, use the AED as it is. Use of AEDs is not recommended for children less than 1 year.

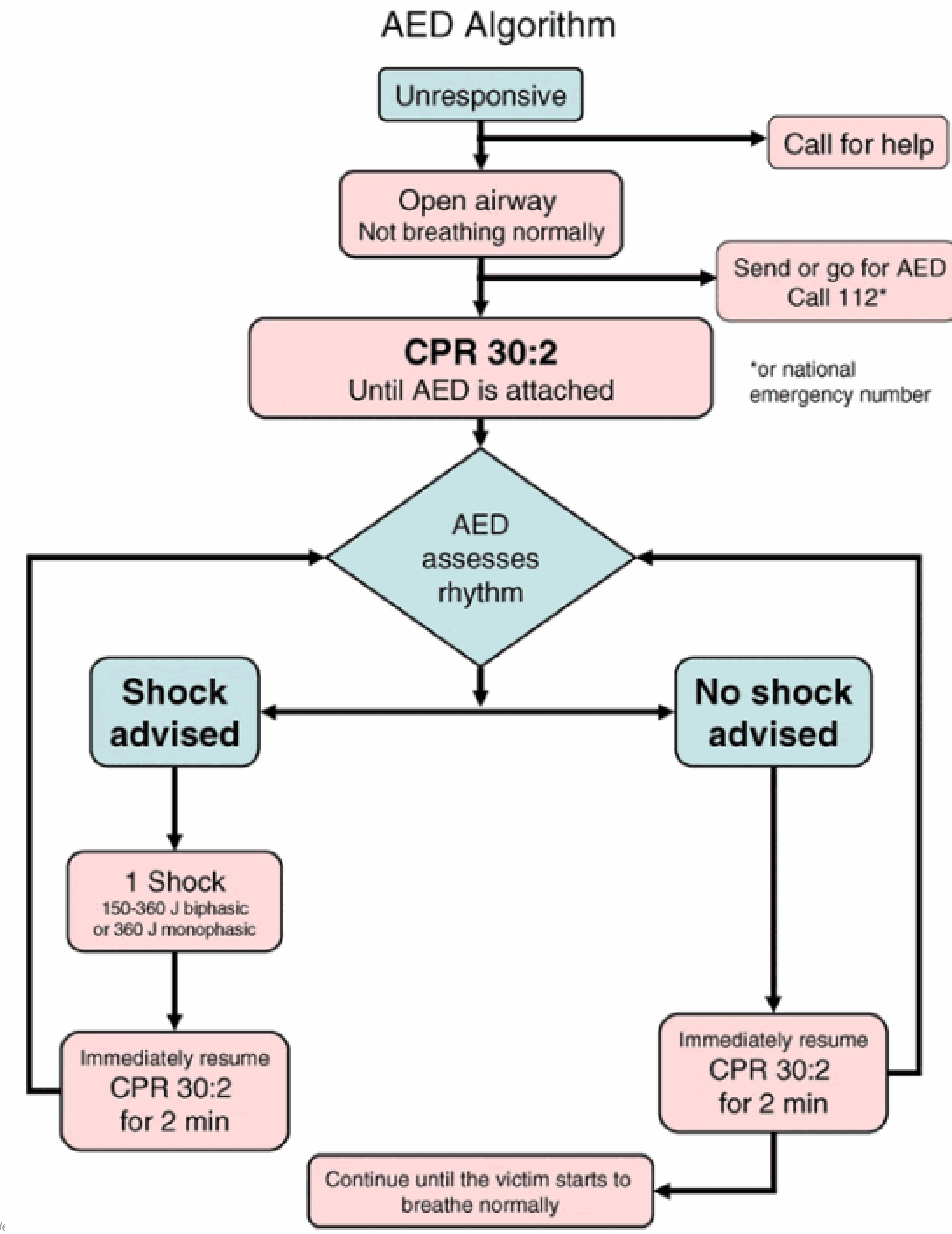
## Sequence for use of an AED

1. Make sure you, the victim, and any bystanders are safe.
2. If the victim is unresponsive and not breathing normally, send someone for the AED and to call for an ambulance.
3. Start CPR according to the guidelines for BLS.
4. As soon as the defibrillator arrives
   - switch on the defibrillator and attach the electrode pads. If more than one rescuer is present, CPR should be continued while this is carried out
   - follow the spoken/visual directions
   - ensure that nobody touches the victim while the AED is analysing the rhythm
5. a. If a shock is indicated
   - ensure that nobody touches the victim
   - push shock button as directed (fully automatic AEDs will deliver the shock automatically)
   - continue as directed by the voice/visual prompts

   b. If no shock indicated
   - immediately resume CPR, using a ratio of 30 compressions to 2 rescue breaths
   - continue as directed by the voice/visual prompts
6. Continue to follow the AED prompts until
   - qualified help arrives and takes over
   - the victim starts to breathe normally
   - you become exhausted

## CPR before defibrillation

Immediate defibrillation, as soon as an AED becomes available, has always been a key element in guidelines and teaching, and considered of paramount importance for survival from ventricular fibrillation. This concept has been challenged because evidence suggests that a period of chest compression before defibrillation may improve survival when the time between calling for the ambulance and its arrival exceeds 5 min.


AED Algorithm
Unresponsive
Call for help
Open airway
Not breathing normally
Send or go for AED
Call 112*
CPR 30:2
Until AED is attached
*or national emergency number
AED assesses rhythm
Shock advised
No shock advised
1 Shock
150-360 J biphasic
or 360 J monophasic
Immediately resume
CPR 30:2
for 2 min
Immediately resume
CPR 30:2
for 2 min
Continue until the victim starts to breathe normally

Compile

<hr/>

# Securing the airways and artificial lungs ventilation

Advanced life support includes several steps. One of them is using face mask and bag ventilation and securing the airway.

## Face mask and bag ventilation

<div class=video> <iframe width="281" height="226" src="https://www.youtube.com/embed/nlBlWpJ_9dg?rel=0&showinfo=0" frameborder="0" gesture="media" allowfullscreen></iframe><br/> <span>Face mask and bag ventilation </span> </div>

Bag-valve-mask (BVM) ventilation is an essential emergency skill which allows for oxygenation and ventilation of patients until a more definitive airway can be established. The rescuer should be positioned at the patient's head. In case of a single rescuer so called over-the- head resuscitation is performed (see ACLS in 2 rescuers ) . During cardiopulmonary resuscitation (CPR), 2 breaths after each series of 30 chest compressions are performed lasting no longer than 5 seconds. A good face seal must be achieved.

A one-person technique involves the "C seal" in which the first and second digits form a "C" over the mask pressing it down and third through fifth digits apply pressure to the mandible to hold the mask tight and tilt the head backward in a “head-tilt chin lift” maneuvre to open the airway.

The two-hand technique is preferred to the one-hand technique and should be used whenever possible. The rescuer performing chest compressions squeezes after each 30 compressions twice a bag using just one hand. The second rescuer holds the mask with both hands. Both thumbs are placed opposing the mask connector, using the thenar eminences to hold the mask on the patient's face, remaining fingers are free to lift up the mandible. This effectively seals the mask to the face and maintains a patent airway.

Proper head position and firm pressure on the face mask are essential for success. The compressions of a self-inflating bag present for a rescuer usually no problem. Adding 100 % oxygen 10 l/min to the reservoir of the bag can increase the oxygen content in lung of a victim significantly. Provide a volume of 6-7 mL/kg per breath (approximately 500 mL for an average adult). After return of spontaneous circulation ventilate at a rate of 10-12 breaths per minute.

Assess the adequacy of ventilation. Note the following:

- Observe for chest rise, improving color, and oxygen saturation.
- Monitor for air leak.
- Be cognizant of increasing gastric distention.

## Oropharyngeal and nasopharyngeal airways

Oropharyngeal airways are available in sizes suitable for the newborn to large adults. An estimate of the size required is obtained by selecting an airway with a length corresponding to the vertical distance between the patient's incisors and the angle of the jaw. If the glossopharyngeal and laryngeal reflexes are present, insertion of an oropharyngeal may cause vomiting or laryngospasm; thus, insertion should be attempted only in comatose patients. In patients who are not deeply unconscious, a nasopharyngeal airway is tolerated better than an oropharyngeal airway, but the resistance during ventilation is higher and bleeding from nasopharynx can be produced during insertion.

## Tracheal intubation

<div class=video> <iframe width="281" height="226" src="https://www.youtube.com/embed/cayDanM2X2U?rel=0&showinfo=0" frameborder="0" gesture="media" allowfullscreen></iframe><br/> <span>Tracheal intubation</span> </div>

Tracheal intubation is supposed to be a gold standard for ACLS. Tracheal intubation provides the most reliable airway, but should be attempted only if the healthcare provider is properly trained.

## Laryngeal Mask Airway (LMA)

<div class=video> <iframe width="281" height="226" src="https://www.youtube.com/embed/lOMeXRO_ej4?rel=0&showinfo=0" frameborder="0" gesture="media" allowfullscreen></iframe><br/> <span>Laryngeal Mask Airway (LMA)</span> </div>

The laryngeal mask airway comprises a wide-bore tube with an elliptical inflated cuff designed to seal around the laryngeal opening. It is easier to insert than a tracheal tube. The LMA has been studied during CPR, but none of these studies has compared it directly with the tracheal tube. During CPR, successful ventilation is achieved with the LMA in 72-98% of cases. Apart from LMA many other types of supraglottic devices have been introduced, like I-gel with non-inflatable cuff formed from a special polymer and others.

## Laryngeal tube

<div class=video> <iframe width="281" height="226" src="https://www.youtube.com/embed/4LAvUEq9Nus?rel=0&showinfo=0" frameborder="0" gesture="media" allowfullscreen></iframe><br/> <span>Laryngeal tube</span> </div>

The **laryngeal tube** is an airway management device designed as an alternative to other airway management techniques such as mask ventilation , laryngeal mask airway, and tracheal intubation. This device can be inserted blindly through the oropharynx into the hypopharynx to create an airway during anaesthesia and cardiopulmonary resuscitation so as to enable mechanical ventilation of the lungs. There are two apertures, located between two cuffs (large oropharyngeal cuff and a smaller oesophageal cuff), through which ventilation takes place. Both cuffs are inflated through a single small lumen line and pilot balloon. In emergency it is an ideal adjunct to secure the airway during difficult airway management as an alternative technique to mask ventilation and tracheal intubation.

<hr/>

# Venous access

Venous access is necessary for administration of drugs.

## Peripheral venous cannulation

<div class=video> <iframe width="281" height="226" src="https://www.youtube.com/embed/jSxLKnBCAN0?rel=0&showinfo=0" frameborder="0" gesture="media" allowfullscreen></iframe><br/> <span>Peripheral venous cannulation</span> </div>

Peripheral venous cannulation video is the standard procedure to administer drugs during ALS. A tourniquet is used to selectively compress veins, allowing venous engorgement, to facilitate the puncture. Dorsal side of the hand or cubita are most frequently used. Finger tapping makes veins more prominent. An antiseptic solution is applied, skin is fixed and the tip of cannula inserted. The sharp metal introducer is slightly withdrawn and just plastic part pushed further to minimise trauma to the vessel wall. After fixation, the drugs may be administered. . It is recommended to flush each bolus by 20 ML of normal saline to facilitate distribution. The most common complication of venous cannulation is haematoma, and – more seriously - necrosis caused by paravenous administration of some drugs may occur.

If intravenous access cannot be established, alternative route must be used:

## Intraosseous route

<div class=video> <iframe width="281" height="226" src="https://www.youtube.com/embed/p5X4z9tfr1M?rel=0&showinfo=0" frameborder="0" gesture="media" allowfullscreen></iframe><br/> <span>Intraosseous route</span> </div>

If intravenous access cannot be established, intraosseous delivery of resuscitation drugs will achieve adequate plasma concentrations. Several studies indicate that intraosseous access is safe and effective for fluid resuscitation, drug delivery and laboratory evaluation. Traditionally, the intraosseous route is used mainly for children, but it is also effective in adults.

<hr/>

# Drugs used during ACLS

The main drugs used during ACLS include:

- Adrenaline
- Amiodarone
- Lidocaine
- Atropine

## ADRENALINE

Its primary efficacy is due to its alpha-adrenergic, vasoconstrictive effects causing systemic vasoconstriction, which increases coronary and cerebral perfusion pressures. The beta-adrenergic actions of adrenaline (inotropic, chronotropic) may increase coronary and cerebral blood flow.

**Indications**

- Adrenaline is the first drug used in cardiac arrest of any aetiology: it is included in the ALS algorithm for use every 3-5 min of CPR.
- Adrenaline is preferred in the treatment of anaphylaxis.

- Adrenaline is second-line treatment for cardiogenic shock.

**Dose**
During cardiac arrest in adults, the initial intravenous dose of adrenaline is 1 mg by intravenous or intra-osseous access. There is no evidence supporting the use of higher doses of adrenaline for patients in refractory cardiac arrest. In some cases, an adrenaline infusion is required in the post-resuscitation period. Following return of spontaneous circulation, excessive (?1 mg) doses of adrenaline may induce tachycardia, myocardial ischaemia, VT and VF. Once a perfusing rhythm is established, if further adrenaline is deemed necessary, titrate the dose carefully to achieve an appropriate blood pressure. Intravenous doses of 50-100 mcg are usually sufficient for most hypotensive patients. Use adrenaline cautiously in patients with cardiac arrest associated with cocaine or other sympathomimetic drugs.
**Practical guidelines**
In an asystolic patient, administer adrenaline as soon as intravenous, or intra – osseous route is established. In case of ventricular fibrillation, give adrenaline after the third unsuccessful defibrillation attempt, then give adrenaline during ACLS 1mg every 3-5 min until ROSC is achieved; this will be once every two loops of the algorithm. If signs of life return during CPR (movement, normal breathing, or coughing), check the monitor: if an organised rhythm is present, check for a pulse. If a pulse is palpable, continue post-resuscitation care and/or treatment of peri-arrest arrhythmia. If no pulse is present, continue CPR. Providing CPR with a CV ratio of 30:2 is tiring; change the individual undertaking compressions every 2 min.

# AMIODARONE

Amiodarone is a membrane stabilising anti-arrhythmic drug that increases the duration of the action potential and refractory period in atrial and ventricular myocardium. Atrioventricular conduction is slowed, and a similar effect is seen with accessory pathways. Amiodarone has a mild negative inotropic action and causes peripheral vasodilation through non-competitive alpha-blocking effects. Following three initial shocks, amiodarone in shock-refractory VF improves the short-term outcome of survival to hospital admission compared with placebo or lignocaine. Amiodarone also appears to improve the response to defibrillation when given to humans or animals with VF or haemodynamically unstable ventricular tachycardia. Amiodarone 300 mg is recommended if VF/VT persists after three shocks.

**Indications**
Amiodarone is indicated in
- refractory VF/VT
- haemodynamically stable ventricular tachycardia (VT) and other resistant tachyarrhythmias

**Dose**
Consider an initial intravenous dose of 300 mg amiodarone, diluted in 5% dextrose to a volume of 20 ml (or from a pre-filled syringe), if VF/VT persists after the third shock. Second dose 150 mg is given after the fifth shock.

**Clinical aspects of use**
Amiodarone may paradoxically be arrhythmogenic, especially if given concurrently with drugs that prolong the QT interval. However, it has a lower incidence of pro-arrhythmic effects than other anti-arrhythmic drugs under similar circumstances. The major acute adverse effects from amiodarone are hypotension and bradycardia, which can be prevented by slowing the rate of drug infusion, or can be treated with fluids and/or inotropic drugs. The side effects associated with prolonged oral use (abnormalities of thyroid function, corneal microdeposits, periphera

# LIDOCAINE

Until the publication of the 2000 ILCOR guidelines, lidocaine was the antiarrhythmic drug of choice. Comparative studies with amiodarone have displaced it from this position, and lidocaine is now recommended only when amiodarone is unavailable. Lidocaine is a membrane-stabilising antiarrhythmic drug that acts by increasing the myocyte refractory period. It decreases ventricular automaticity, and its local anaesthetic action suppresses ventricular ectopic activity. Lidocaine suppresses activity of depolarised, arrhythmogenic tissues while interfering minimally with the electrical activity of normal tissues. Therefore, it is effective in suppressing arrhythmias associated with depolarisation (e.g. ischaemia, digitalis toxicity) but is relatively ineffective against arrhythmias occurring in normally polarised cells (e.g., atrial fibrillation/flutter). Lidocaine raises the threshold for ventricular fibrillation.
**Indications**
Lidocaine is indicated in refractory VF/VT (when amiodarone is unavailable).
**Dose**
When amiodarone is unavailable, consider an initial dose of 100 mg (1-1.5 mg kg-1) of lidocaine for VF/pulseless VT refractory to three shocks. Give an additional bolus of 50 mg if necessary. The total dose should not exceed 3mg kg-1 during the first hour.

# ATROPINE

Atropine antagonises the action of the parasympathetic neurotransmitter acetylcholine at muscarinic receptors. Therefore, it blocks the effect of the vagus nerve on both the sinoatrial (SA) node and the atrioventricular (AV) node, increasing sinus automaticity and facilitating AV node conduction.

**Indications**

sinus, atrial, or nodal bradycardia when the haemodynamic condition of the patient is unstable

**Dose**
In adults the dose for treatment of bradycardia is 0.5 mg, may be repeated to a maximum 3.0 mg.

<hr/>

*Production of this textbook was supported by project FRVŠ No. 1201/2008, 208/2010 and internal grant of the 3FM CU*
*Authors: J. Málek, A. Dvořák, J. Knor, M. Jantač, A. Kurzová*

*Video production: TM Studio, executive manager M. Jantač*
*English translalation: J. Malek, M. Sukhanenko, WP. Kirk, A. Whitley*


***Acknowledgement***
*The authors would like to acknowledge following corporations and firms for their help and access to film documents.*
- *Cook Medical*
- *Cheirón, a.s.*
- *Chemelek spol s r.o.*
- *Czech Airlines*
- *Emergency Medical Service, Central Bohemia Region*
- *Emergency Medical Service, Prague*
- *Kendall*
- *MSM spol. s r.o.*
- *OMS – ZOLL s.r.o.*