Training Manual on Advanced Life Support

Non Communicable Disease Control Programme
Directorate General of Health Services
Ministry of Health & Family Welfare

Training Manual on Advanced Life Support (ALS)

Technical Assistance
Centre for Injury Prevention and Research, Bangladesh (CIPRB)

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Message

I am delighted to introduce the Training Manual on Advanced Life Support (ALS), a remarkable publication by the Non-Communicable Disease Control Program (NCDC), DGHS. This comprehensive manual is a significant milestone in our efforts to enhance healthcare delivery system in Bangladesh.

Bangladesh is now combating with growing burden of non-communicable diseases (NCDs) such as cardiovascular diseases, chronic respiratory illness etc. These conditions often lead to life-threatening situations that require immediate and specialized medical attention. Addressing the burden of NCDs requires a multi-faceted approach, involving prevention, early detection, and effective management.

In this context, the Training Manual on Advanced Life Support (ALS) will play a pivotal role in equipping healthcare professionals with the necessary skills and knowledge to provide optimal care for patients experiencing critical health emergencies. By focusing on advanced life support techniques, this manual empowers healthcare providers to respond swiftly and effectively, thereby increasing the chances of survival and reducing disability among patients.

I strongly believe that this manual will serve as an invaluable resource for healthcare professionals, trainers, and educators across the nation. I would like to express my heartfelt appreciation to the Non-Communicable Disease Control Programme for leading this initiative and bringing together a team of dedicated professionals committed to improving emergency care in our country. Finally, I encourage all healthcare professionals to utilize this manual as a reference guide and to actively participate in training programs that incorporate its principles.

Professor Dr. Abul Bashar Mohammed Khurshid Alam
Director General
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Mohakhali, Dhaka-1212.

Message

To our utmost pleasure, Training Manual on Advanced Life Support (ALS) has been published aiming to improve emergency healthcare service in Bangladesh. Cardiovascular diseases (CVDs) and related emergencies are on rise in Bangladesh. Here, patients suffering from CVDs top the list of people with non-communicable diseases. Doctors and associated health care providers working in emergency setting need to be prepared to manage these situations.

Advanced Life Support (ALS) techniques are specialized interventions that can significantly improve the chances of survival and positive outcomes for patients in critical condition. ALS encompasses a range of medical procedures and interventions, including airway management, cardiac resuscitation, administration of emergency medications, and other life-saving measures.

This manual is vital in ensuring that healthcare providers in Bangladesh are well-equipped to handle critical health emergencies and deliver optimal care to those in need. It is a testament to our commitment to improving healthcare outcomes and saving lives, and it represents a significant step forward in our collective efforts to address the burden of non-communicable diseases in the country.

This training manual reflects the collective efforts of numerous experts, medical professionals, and researchers who have dedicated their time and expertise to develop a standardized framework for advanced life support training. The content has been meticulously curated to incorporate the latest evidence-based practices, international guidelines, and contextualized approaches specific to the healthcare landscape of Bangladesh.

I extend my sincere gratitude to the dedicated team who have led this endeavour with unwavering commitment and professionalism. Their tireless efforts in compiling this manual will undoubtedly contribute to the development of a highly skilled healthcare workforce and improve the overall quality of emergency care in our country.

Professor Dr. Mohammad Robed Amin
Line Director
Non-Communicable Disease Control (NCDC)
Directorate General of Health Services (DGHS)

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List of abbreviations

ACLS	Advanced Cardiovascular Life Support
ACS	Acute Coronary Syndrome
AED	Automatic External Defibrillator
AF	Atrial fibrillation
AHA	American Heart Association
ALS	Advanced Life Support
AV Block	Atrioventricular block
BIRDEM	Bangladesh Institute of Research and Rehabilitation in Diabetes, Endocrine and Metabolic Disorders
BLS	Basic Life Support
BVM	Bag Valve Mask
CAG	Coronary Angiography
CCU	Coronary Care Unit
CK-MB	creatine kinase myocardial band
CMC	Chittagong medical College
CPR	Cardiopulmonary Resuscitation
CVD	Cardiovascular Diseases
DBP	Diastolic Blood Pressure
DGHS	Directorate General of Health Services
DMC	Dhaka Medical College
ECG	Electrocardiogram
EEG	Electroencephalogram
EMD	Electromechanical Dissociation
ERC	European Resuscitation Council
ET	Endotracheal Tube
FiO_2	Fraction of inspired oxygen
GO	Government Organization
GTN	Glyceryl Trinitrate
HCP	Health Care Provider
HDU	High Dependency Unit
I:E ratio	Inspiratory-to-expiratory ratio
ICU	Intensive Care Unit
IDH	Infectious Disease Hospital
ILMA	Intubating Laryngeal Mask Airway
INGO	International Non-governmental Organization
IO	Intra-osseus
IV	Intra-venous

LMA	Laryngeal Mask Airway
LT	Laryngeal Tube
MI	Myocardial Infarction
MV	Mechanical Ventilation
NCD	Non-Communicable Diseases
NCDC	Non-Communicable Disease Control
NCSE	Non-convulsive Status Epilepticus
NGO	Non Government Organization
NICVD	National Institute of Cardiovascular Diseases
NSTEMI	Non-ST-segment elevation myocardial infarction
PCI	Percutaneous Coronary Intervention
PEA	Pulseless Electrical Activity
pVT	Pulseless Ventricular Tachycardia
ROSC	Return of Spontaneous Circulation
RR	Respiratory rate
SBP	Systolic Blood Pressure
STEMI	ST-segment elevation myocardial infarction
SVT	Supraventricular Tachycardia
TTM	Targeted Temperature Management
UA	Unstable Angina
VAP	Ventilator Associated Pneumonia
VF	Ventricular fibrillation
VT	Ventricular tachycardia
V_T	Tidal volume

Background

Emergency medical service is an integrated part of healthcare delivery system which requires healthcare providers (HCPs) who are skilled in Basic Life Support (BLS) as well as Advanced Life Support (ALS). The knowledge of BLS and First Aid equips a person with primary medical skills to identify and manage a victim with life threatening conditions until they can receive full hospital care. BLS can be provided by healthcare providers of all tiers, even by the trained bystanders at community level. On the other hand, ALS can be provided at facility level only by the health care providers who have undergone more extensive training on emergency management, preferably by trained doctors and nurses in the context of Bangladesh.

Over the last few decades, the prevalence of noncommunicable chronic diseases and related mortality have increased significantly worldwide. Non-Communicable Diseases (NCDs) are the topmost causes of death in the world, accounting for 74% of all annual deaths. According to World Health Organization (WHO), in 2019, 17.9 million people died due to cardiovascular diseases (CVDs), making up 32% of total global death [(1)]. The scenario is no different in Bangladesh, where about 70% of all deaths were caused by NCDs in 2019, and 36 percent of them died from CVDs [(2)]. In Bangladesh, the leading cause of adult male death is found to be ischemic heart disease (25.9%), which contributes more than double the proportion of the other two leading causes- stroke and chronic respiratory illness (reported by verbal autopsy) [(3)]. Any emergency evoked by these conditions (e.g., sudden cardiac arrest) requires early intervention to increase the chance of survival.

Studies have shown that providing first aid at the right time and in the right manner effectively saves lives and reduces morbidity and disability. In addition, in-hospital provision of ALS to victim considerably increases the chance of survival [(4)]. Considering the above facts, NCDC of DGHS have taken initiatives to formulate national guideline on ALS in the context of Bangladesh.

This Training Manual on Advanced Life Support (ALS) consists of highly structured simulation-based training (SBT) including real-life scenarios to equip HCPs (doctors, and nurses working in selected areas) with the knowledge necessary for cardiovascular emergencies especially in Govt. health facilities of Bangladesh.

Methodology

Manual Development Methodology

To develop the training manual on **Advanced Life Support** the following methodology was adopted:

1. Advocacy with relevant stakeholders for the development of training manual on ALS	• Advocacy meeting of NCDC, DGHS with stakeholders from different institutes namely- DMC, CMC, BIRDEM, NICVD, IDH, WHO, MSF, and Goethe University, Germany to generate awareness and to develop the training manual on ALS. • Consultative workshop with experts from different GO, INGO, and NGO (5th September 2022): a) To be aware of the importance of developing a national manual for ALS for HCPs. b) To form the technical team to develop training manual for ALS following the WHO emergency care framework and literature review. c) To share all the existing manuals which are used for the ALS training in the country. d) To identify the training participants.
2. Manual development (Document review)	• Literature review – Relevant literature and scientific articles ✓ Thorough review of existing guidelines used in different post-graduate institutes of the country ✓ International guidelines on ALS (AHA, ERC etc.) ✓ GO, NGO and INGO websites
3. Manual development (Technical team workshops)	• Workshop with technical team ✓ 1st workshop to identify the training contents, duration, and trainers for ALS manual (6th September 22). ✓ Sharing the draft manual with the technical team and incorporating feedback. ✓ Sharing the content of the training manual with mid-senior level doctors from different Government organizations and incorporating feedback (24th November 2022). ✓ 2nd workshop to share the full draft of the training manual after incorporating feedback from the working group (2nd January 2023).
4. Field testing of the training manual	• Field testing of the manual in 1 Upazila health complex.
5. Reviewing and finalizing the training manual	• The manual was sent to review by National Review Committee on ALS, formed by NCDC, DGHS. Feedbacks were incorporated accordingly to finalize and get the approval of the training manual.

The training manual on **Advanced Life Support** is developed from a thorough review of existing manuals nationally and globally and consultation processes with relevant stakeholders from Government and non-government organizations. Two consultative workshops, several meetings, field-testing, and feedback by email were received before the finalization of the document. After initial completion of the draft, this training manual was piloted in one Upazila Health Complexes (UHC). After piloting in different health facilities, adjustments were done in different areas of the manual to finalize the manual.

Training objectives

- ☑ To equip the healthcare providers with the management skills of cardiopulmonary arrest or other cardiovascular emergencies.
- ☑ To enhance hospital management capabilities for various life-threatening illnesses.
- ☑ To improve the outcome (chance of survival) for the victims of cardiac arrest through early recognition and necessary interventions by the high-performance team.

Training participants

Target group for this training manual would be-

- ☑ Doctors (of all departments) working in UHC and DH
- ☑ Nurses working in ICU, CCU, HDU, Emergency room of medical college hospital and/or institutes, UHCs, and DHs

Training prerequisites for the participants

The participants should fulfil following criteria before attending this ALS course:

- ☑ Successful completion of Basic Life Support (BLS) training
- ☑ Electrocardiogram (ECG) rhythm interpretation for core ACLS rhythms

Duration of training

The full-time training is designed for three days.

Logistics required for the training

- ☑ CPR Manikin (Four)
- ☑ Intubating Manikin (Two)
- ☑ Airway adjuncts: Laryngoscope, BVM (Bag Valve Mask), Laryngeal Mask or Laryngeal Tube Mask, ET (endotracheal) tube, Supra-glottic with Laryngeal mask airways (LMA) etc.
- ☑ Syringe 10 cc, Adhesive tape, Infusion in plastic bag, IV drip set
- ☑ Power-point presentation slides
- ☑ Demonstrations by instructors

Training plan

- ☑ Participants Per Batch: 25-30
- ☑ Number of trainers / facilitators per batch: 3-5
- ☑ Practice station: 4/5 with simulated clinical scenarios
- ☑ Discussion and role-playing by the participants
- ☑ Participants should adopt effective high-performance team behaviours

There aren't many well-designed studies looking at healthcare providers' retention of knowledge and abilities related to adult ALS. According to the available data, ALS knowledge and skills deteriorate between six months and a year following training, with skills decaying more quickly than knowledge (5). So, the participants are recommended to have **refresher training in every 2 years** according to our country context.

Training Schedule

A three-day training program on Advanced Life Support (ALS)

Time	Topic	Responsible person
Day 1: Training on Advanced Life Support		
09.00 am	Registration	
Introductory session 09.30am - 10.00am	**Inauguration & training rules** ▪ Inauguration ▪ Introduction of participants ▪ Training rules ▪ Training schedule ▪ Pretest	Resource person/ Master trainer
Session 1 10.00am-11.00am	**Introduction to Advanced Life Support (ALS)** ▪ Concept of CPR ▪ Concept of ALS ▪ ALS team formation ▪ Systematic approach for providing ALS	Master trainer
11.00 am – 11.15 am	Tea break	
Session 2 11.15 am -1.00 pm	**Cardiac Arrest Rhythm Recognition and Management** ▪ Cardiac Arrhythmias ▪ Nonarrest rhythms (selected) ▪ AV Block ▪ Management of arrhythmia and ACS	Master trainer
Session 3 1.00 pm – 1.30 pm	**Defibrillation** ▪ Definition of Defibrillation ▪ Principle of operation of a Defibrillator ▪ Types of Defibrillators	Master trainer
Practice session 1.30 pm – 2.30 pm	**Group work and practice on manikin (with scenario)**	All of the participants
2.30 pm	Conclusion of Day 1 and Lunch	

Time	Topic	Responsible person
Day 2: Training on Advanced Life Support		
09.30am - 10.00am	Recap of the first day	Resource person/ Master trainer
Session 4 10.00am-11.00am	**Airway Management** ▪ Assessment of the airway ▪ Airway adjuncts ▪ Endo-tracheal intubation ▪ Surgical Airway	Master trainer
11.00 am – 11.15 am	Tea break	
11.15 am -12.30 pm	**Continuation of Session 4 (Airway Management)**	
Session 5 12.30 pm – 1.00 pm	**Drugs used in ALS.**	Master trainer
Practice session 1.00 pm - 2.30 pm	**Group work and practice on manikin (with scenario)**	All of the participants
2.30 pm	Conclusion of Day 1 and Lunch	
Day 3: Training on Advanced Life Support		
09.30 am - 10.00am	Recap of the first and second day	Master trainer and All of the participants
Session 6 9:30 am – 11:00 am	**Post cardiac arrest care.** ▪ Phases of Post Cardiac Arrest Care ▪ Post-resuscitation care guidelines (Additional points) ▪ Mechanical Ventilation	Master trainer
11.00 am - 11.15 am	Tea break	
Session 7 11.15 am - 12.15 pm	**Cardiac arrest / CPR in special situation** ▪ Cardiac arrest associated with Pregnancy ▪ Opioid overdose ▪ Anaphylaxis ▪ Accidental Hypothermia ▪ Drowning	Master trainer
12.15 pm-2.30 pm	• **Group work and practice on manikin (with scenario)** (Asystole, Airway management) • **Post test and assessment** • **Summary of the session**	All of the participants
2.30 pm	Conclusion of Training and Lunch	

Ground rule for training

- Arrive on time for each training session.
- Cell phones should be turned off at the beginning of the session and should remain off until the end except during breaks.
- Avoid side conversations – if anyone is unclear about the topic being discussed or the instructions, please ask the facilitator to clarify.
- Respect each other, yourselves, and the trainer. Do not speak when someone else is speaking.
- Participate actively in training and give everyone a chance to contribute and encourage others to do so.
- Don’t talk in chorus to express opinions and concerns.
- Try to keep the training room neat and clean.
- Don’t discuss any irrelevant topics during the session.

Chapter 1: Introduction to Advanced Life Support (ALS)

Learning objectives:

At the end of the session, participants will learn -

1. Brief introduction to ALS
2. Adult cardiac arrest algorithm
3. Importance of team formation with responsibilities in ALS
4. Systematic approach for ALS

1.1 Cardiopulmonary resuscitation (CPR)

CPR stands for Cardiopulmonary Resuscitation and is a technique to keep oxygenated blood flowing around the body by doing chest compressions and giving rescue breaths. In a small number of cases, this may restart the heart and keep brain activity normal.

Cardiopulmonary resuscitation (CPR) is a lifesaving procedure for a victim who has signs of cardiac arrest (i.e., unresponsive, no breathing or no normal breathing, and no pulse). When a patient develops cardiac arrest, a rescuer/health care provider initiates the steps of Basic Life Support (BLS) until the next level of care i.e., advanced life support (ALS) providers arrive. The aim of basic life support (including CPR) is to maintain a low level of circulation until more definitive treatment with advanced life support can be given by a multiple rescuer team/high performance team. High quality CPR improves a victim's chance of survival.

1.2 Basics of ALS

Advanced Life Support (ALS), also referred to as Advanced Cardiac Life Support (ACLS), is a set of life-saving protocols and skills that extend beyond Basic Life Support (BLS).

The skill of Basic Life Support (BLS) is required to support victims experiencing life-threatening illnesses or injuries until they can be given full medical care at a hospital. BLS can be provided by a first responder, healthcare professionals, public safety professionals and/or qualified bystanders. On the other hand, ALS requires trained and authorized healthcare professionals to administer medications, perform injections, and conduct airway procedures on the patient at an advanced care facility and/or in a hospital environment.

ALS is used to provide urgent treatment to cardiac emergencies such as cardiac arrest, stroke, myocardial infarction, and other conditions. ALS is recognized as one of the key steps in the American Heart Association's (AHA) Chain of Survival [6].

Aim of ALS:

Advanced life support (ALS) aims to restore normal cardiac rhythm by defibrillation when the cause of cardiac arrest is due to a tachyarrhythmia, or to restore cardiac output by correcting other reversible causes of cardiac arrest. The following diagram (Figure 1) represents an overview of adult cardiac arrest algorithm-

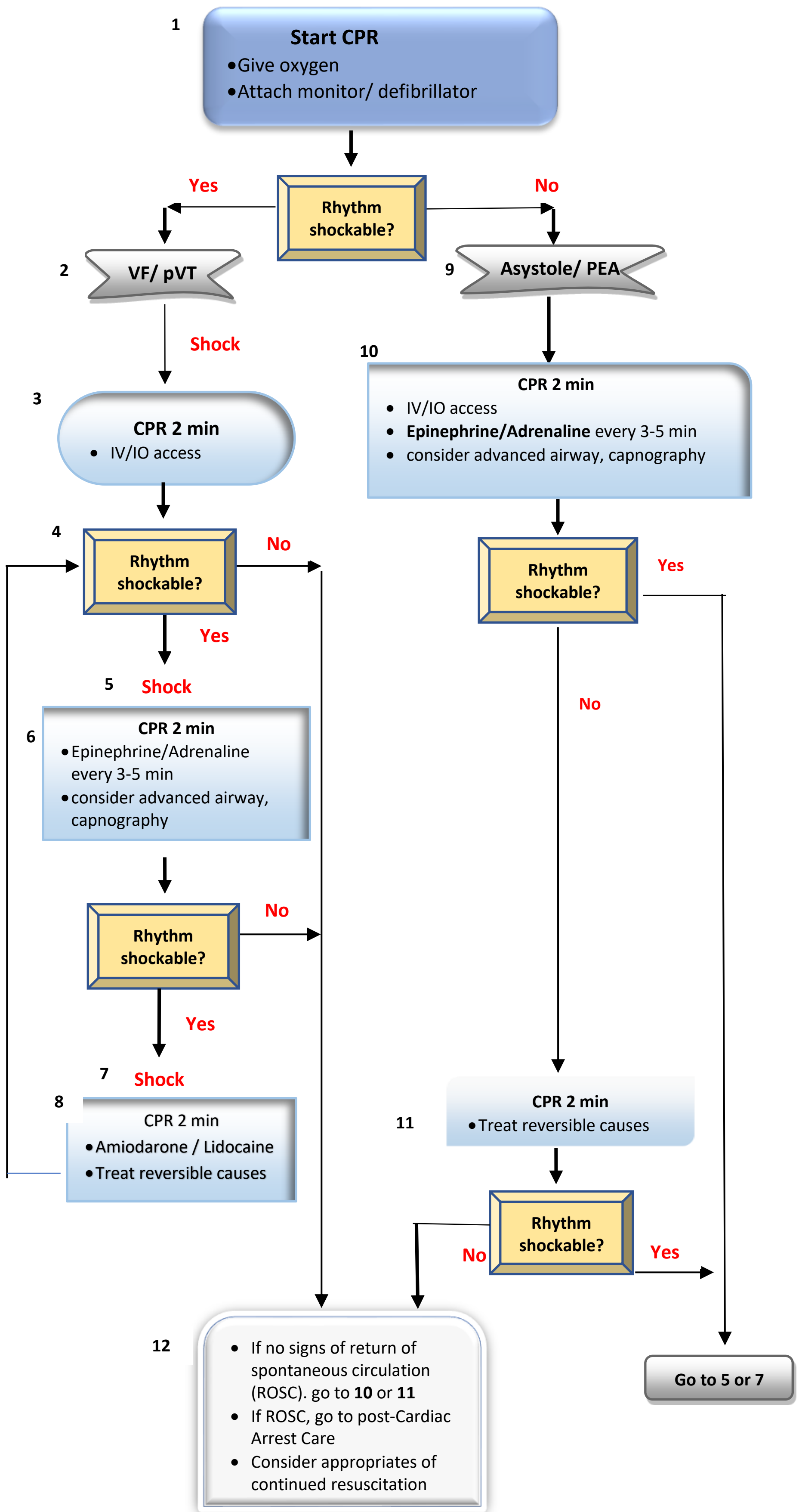


Figure 1. Adult Cardiac Arrest Algorithm [7]

**Adapted from AHA. (2020). In Highlights of the 2020 American Heart Association*

CPR Quality

- Push hard (at least 2 inches [5cm]) and fast (100-120/min) and allow complete chest recoil.
- Minimize interruptions in compressions.
- Avoid excessive ventilation.
- Change compressor every 2 min, or sooner if fatigued.
- If no advanced airway, 30:2 compression-ventilation ratio.

Shock energy for defibrillation

- **Biphasic**: Manufacturer recommendation 9eg, initial dose of 120-200J); if unknown, use maximum available. Second and subsequent doses should be equivalent, and higher doses may be considered.
- **Monophasic**: 360J

Drug Therapy

- **Epinephrine/Adrenaline:**
  IV/IO dose: 1 mg every 3-5 minutes
- **Amiodarone** IV/IO dose:
  First dose: 300mg bolus
  Second dose: 150mg
  Or
  Lidocaine IV/IO dose:
  First dose: 1-1.5mg/kg
  Second dose: 0.5-0.75mg/kg

Advanced Airway

- Endotracheal intubation or supraglottic advanced airway
- Waveform capnography or capnometry to confirm and monitor ET tube placement
- Once advanced airway in place, give one breath every 6 seconds (10 breaths/min) with continuous chest compressions.

Return of Spontaneous Circulation (ROSC)

- Pulse and blood pressure
- Abrupt sustained increase in PETCO2 (typically >40 mmHg)
- Spontaneous arterial pressure waves with intra-arterial monitoring

Reversible Causes (5H & 5T)

- **H**ypovolemia
- **H**ypoxia
- **H**ydrogen ion, H^+ (acidosis)
- **H**ypo/ hyperkalaemia
- **H**ypothermia
- **T**ension pneumothorax
- **T**amponade, cardiac
- **T**oxins
- **T**hrombosis, pulmonary
- **T**hrombosis, coronary

An intermediate goal of resuscitation is return of spontaneous circulation (ROSC). Return of spontaneous circulation (ROSC) is the resumption of a sustained heart rhythm that perfuses the body after cardiac arrest. Signs of return of spontaneous circulation include- breathing, coughing, or movement and a palpable pulse or a measurable blood pressure. “Sustained ROSC is deemed to have occurred when chest compressions are not required for 20 consecutive minutes and signs of circulation persist”. [7]

In summary, ALS Management of Cardiac Arrest includes: -

1. Ensure High quality CPR
2. Access for drugs
3. Monitoring of ROSC (Return of spontaneous circulation)
4. Identify rhythm & Shock energy
5. Drug therapy
6. Placement of Advanced Airway
7. Identify reversible causes and treat accordingly

For the treatment of cardiac arrest, ALS interventions build on the basic life support (BLS).

1.3 Responsibility of ALS team

For successful execution of ALS interventions, a number of health care providers need to work simultaneously and adopt various roles according to their expertise and situation. The team members should have effective communication skill and adapt to the team dynamics to execute timely intervention.

What ALS team or high-performance team will do?

1. After taking over from BLS rescuer, high performance team will continue high quality CPR and defibrillation.
2. The team will perform advanced interventions like obtaining vascular access, giving medication to support the circulation and endotracheal intubation to ventilate the lungs.
3. They will attach monitor to find out the type of arrest rhythm and treat accordingly.

Endotracheal intubation

Defibrillation

Obtaining vascular access

Attaching monitor to the patient and identify rhythm.

Figure 2: Different activities of ALS team members

ACLS is a teamwork. Every high-performance team needs a team leader to organize the efforts of the team. And the team leader has certain responsibilities as follows:

- Monitors individual performance of team members
- Backs up team members
- Models excellent team behaviour
- Trains and coaches
- Focuses on comprehensive patient care
- Temporarily designates another team member to take over as Team Leader if an advanced procedure is required

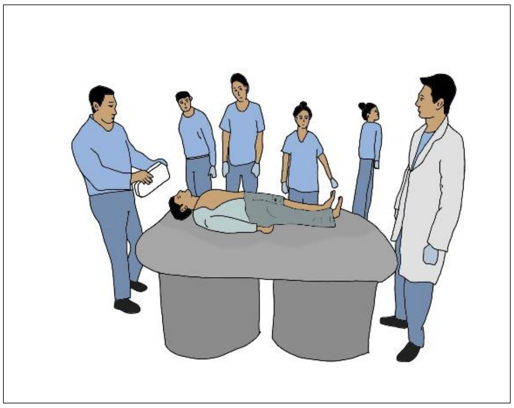


Figure 3: Teamwork of ALS

Every team member should know his or her roles and responsibilities. The following figure (Figure 4) represents a 6-member team formation for executing different roles at ALS [6]. However, if less than 6 member present, the team leader should prioritize and redistribute the tasks among the members available.

Figure 4: Positions for 6-Person High-Performance Teams [6]

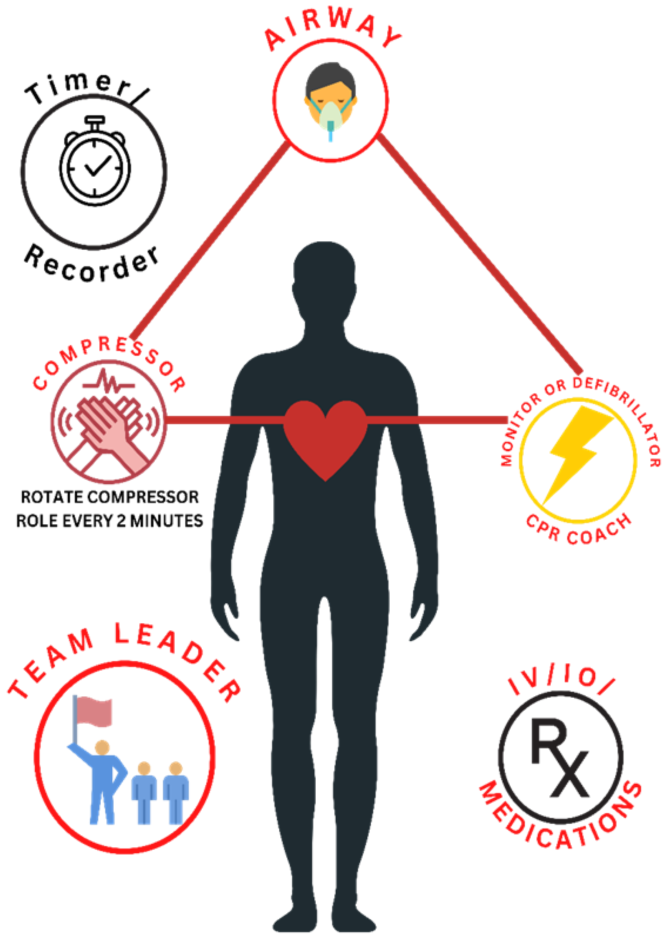
Resuscitation Triangle

Compressor
- Assesses the patient
- Performs compressions
- Rotates every 2 minutes or earlier if fatigued

Monitor/ Defibrillator/ CPR Coach
- Brings and operates the AED/ monitor/defibrillator and acts as the CPR Coach if designated
- If a monitor is present, places it in position where it can be seen by the Team Leader (and most of the team)

Airway
- Opens the airway
- Provides bag-mask ventilation
- Inserts airway adjuncts as appropriate

The team owns the code. No team member leaves the triangle except to rotate compressors or to protect his or her safety.



Leadership Roles

Team Leader
- Every resuscitation team must have a defined leader.
- Assigns roles to team member.
- Makes treatment decisions.
- Provides feedback to the rest of the team as needed.
- Assumes responsibility for roles not defined.

IV/IO/Medications
- An ALS provider role
- Initiates IV/IO access
- Administer medications

Timer/Recorder
- Records the time of interventions and medications (and announces when these are next due)
- Records the frequency and duration of interruptions in compressions
- Communicates these to the Team Leader (and the rest of the team)

**Adapted from AHA. (2020).*

1.4 Systematic approach for providing ALS

A systematic approach is suggested for health care providers to treat victims of cardiac arrest. After verifying scene safety, the systematic approach requires the provider to check for patient's level of consciousness and follow accordingly (Figure 5):

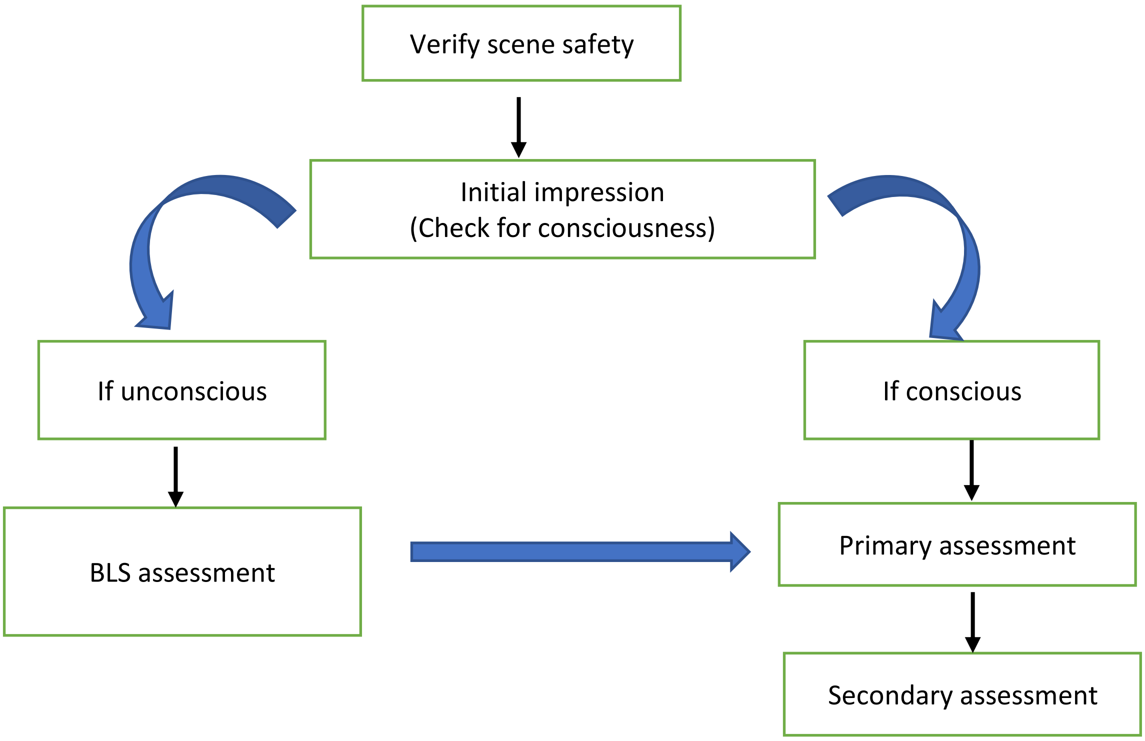


Figure 5: Systematic approach for providing ALS [6]

**Adapted from AHA. (2020)*

- **BLS assessment**: Steps of BLS algorithm to be followed (National manual on BLS).
- **Primary assessment**: Health care providers should do primary assessment after the BLS steps on an unconscious patient; or, on a conscious patient as he/she might require advance assessment. Primary assessment consists of **A, B, C, D, and E**.

  Steps of primary assessment:

  1. Airway =
     - Maintain airway patency in unconscious patient
     - Apply advance airway management if needed.
  2. Breathing =
     - Give supplementary oxygen when indicated
     - Monitor adequacy of ventilation and oxygenation.
  3. Circulation =
     - Monitor quality of CPR
     - Attach monitor and/or defibrillator for cardiac arrest rhythms
     - Obtain IV/IO access
     - Give IV/IO fluids and/or appropriate drugs

4. Disability =
   - Check for neurologic function
   - Assess for level of consciousness, and pupil dilatation
5. Exposure =
   - Remove clothing to perform physical examination, look for any definitive sign of trauma, bleeding, burns etc.

- **Secondary assessment:** Next step is the secondary assessment that is required for differential diagnosis of the patient's condition. Secondary assessment helps to quickly find out the possible diagnosis and definitive interventions for the patient. For convenience, secondary assessment can be recalled as SAMPLE, 5 H and 5 T's.
  1. SAMPLE includes
     - **S**igns and symptoms
     - **A**llergies
     - **M**edications (including the last dose taken)
     - **L**ast meal consumed (Food intake history)
     - **E**vents
  2. 5 H and 5 T's: Includes the most common causes of cardiac arrest (Mentioned in figure 1):
     - **H**ypovolemia
     - **H**ypoxia
     - **H**ydrogen ion, H+ (acidosis)
     - **H**ypo/ hyperkalaemia
     - **H**ypothermia
     - **T**ension pneumothorax
     - **T**amponade, cardiac
     - **T**oxins
     - **T**hrombosis, pulmonary
     - **T**hrombosis, coronary

Chapter 2: Cardiac Arrest Rhythm Recognition and Management

Learning objectives:

At the end of the session, participants are expected to-

- To recognize the arrest rhythms.
- To identify the common cardiac arrhythmias that may appear during or after cardiopulmonary resuscitation.

2.1 Cardiac Arrhythmias

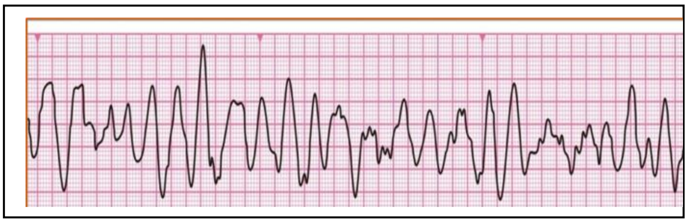
Cardiac arrhythmias may cause cardiac arrest or may appear during or after resuscitation of a cardiac arrest victim.

Arrest rhythms

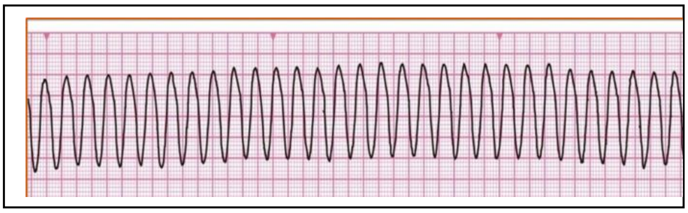
Cardiac arrhythmias causing cardiac arrest are the arrest rhythms.

There are 4 Cardiac Arrest rhythms:

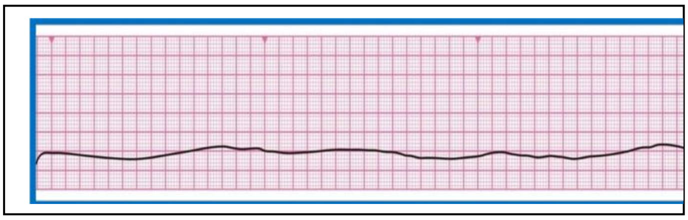
- **V**entricular fibrillation ⇨



- **P**ulseless ventricular tachycardia ⇨



- **A**systole ⇨



- **P**ulseless electrical activity (PEA)

or formerly called

electromechanical dissociation (EMD) ⇨

During cardiac arrest and peri-arrest period, the rhythms may toggle among them.

(2.1.A) Ventricular fibrillation (VF): VF is the commonest and potentially most treatable cause of cardiac arrest. In VF, the coordinated contraction of the ventricular myocardium is replaced by high-frequency, disorganized excitation, resulting in cardiac pump failure. Acute coronary syndrome is the commonest cause of VF.

ECG features:

- General description: Chaotic rhythm. May be coarse or fine. The fine VF may be difficult to differentiate from asystole.
- Regularity: Irregular
- Rate: High
- P wave: Absent
- PR interval: Absent
- QRS complex: Broad, bizarre

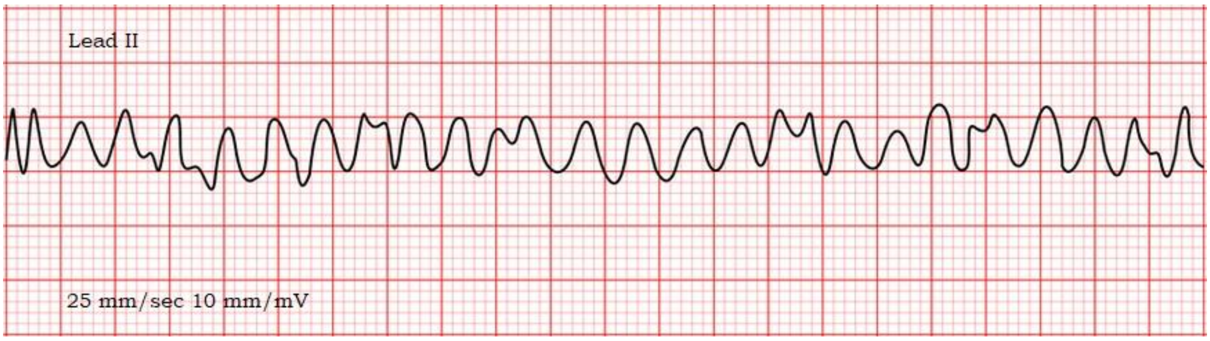


Figure 6: Coarse Ventricular Fibrillation

Coarse ventricular fibrillation: Note high amplitude QRS complexes of varying size and shape causing chaotic rhythm.

Figure 7: Fine Ventricular Fibrillation

Fine ventricular fibrillation: Note absence of QRS complexes but presence of baseline undulations.

Practical tips: Presents with cardiac arrest. VF is a shockable rhythm. Managed by defibrillation with or without drugs, including Adrenaline, amiodarone, procainamide, and lignocaine.

(2.1.B) Pulseless ventricular tachycardia (pVT): Clinically, behaves like VF. Very fast ventricular rate results in haemodynamic compromise.

ECG features:

- General description: Wide-complex tachycardia, regular or irregular. Irregular polymorphic VT may be difficult to differentiate from VF.
- Regularity: Regular or irregular
- Rate: High
- P wave: May be present occasionally
- PR interval: Not measured due to atrioventricular dissociation
- QRS complex: Broad. Morphology more or less uniform in case of monomorphic VT, but varies from complex to complex in case of polymorphic VT.

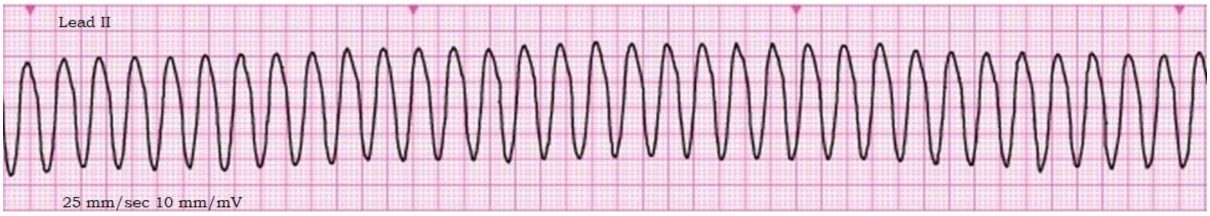


Figure 8: Pulseless VT

Pulseless ventricular tachycardia: Note regular wide-complex tachycardia with ventricular rate 250/min.

Practical tips: Pulseless VT is a shockable rhythm. Presents with cardiac arrest. Like VF, managed by defibrillation with or without drugs, including Adrenaline, amiodarone, procainamide, and lignocaine.

(2.1.C) Asystole:

Asystole is the absence of ventricular contractions in the context of a lethal arrhythmia. It is an unshockable rhythm.

ECG features:

- General description: ECG is characterized by **flat line with no QRS complexes**.
- Regularity: No QRS complexes, hence, regularity cannot be determined
- Rate: No QRS complexes, hence, ventricular rate cannot be counted
- P wave: May or may not be present
- PR interval: No QRS complexes, hence, PR interval cannot be determined
- QRS complex: Essentially absent.

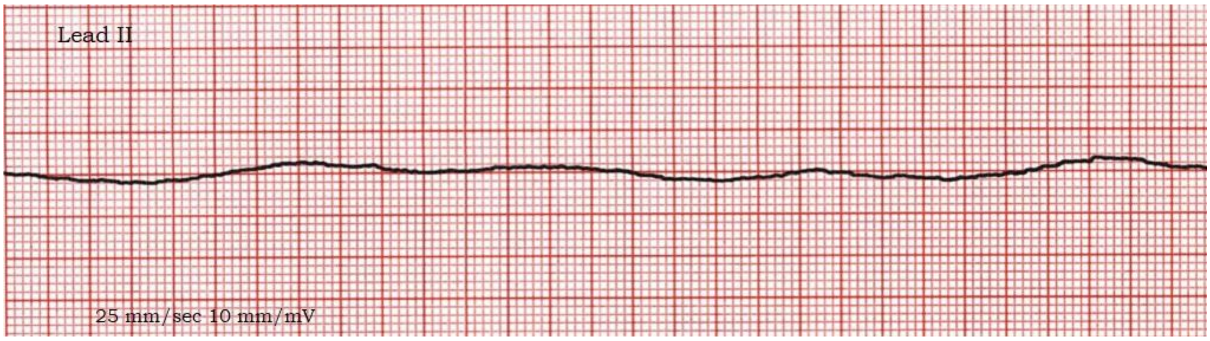


Figure 9 : Asystole

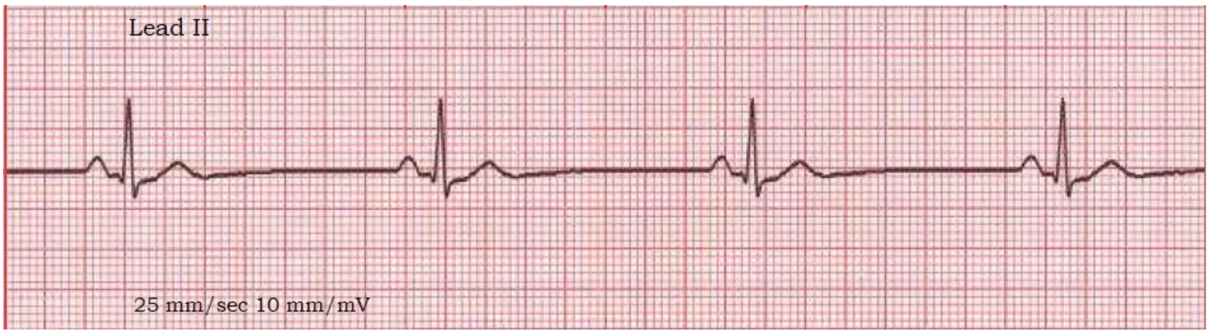
Asystole: Note absence of QRS complexes.

Practical tips: Asystole must be confirmed in at least another lead. It may be difficult to differentiate from fine VF. It is an unshockable rhythm. Presents with cardiac arrest. Managed by CPR and drugs, including Adrenaline.

(2.1.D) Pulseless electrical activity (PEA): PEA, formerly called electromechanical dissociation (EMD), is characterized by lack of a palpable pulse in the presence of organized cardiac electrical activity other than VF and pulseless VT. It is an unshockable rhythm. Hypovolemia and hypoxia are the commonest causes of PEA. The mnemonic suggested by the American Heart Association (AHA) for the causes of PEA are 5H & 5T.

ECG features:

- General description: ECG is characterized by organized rhythm, but usually not as organized as normal sinus rhythm.
- Regularity: Any rhythm, regular or irregular
- Rate: Fast or slow
- P wave: Present or absent
- PR interval: May or may not be detectable
- QRS complex: Narrow or wide.



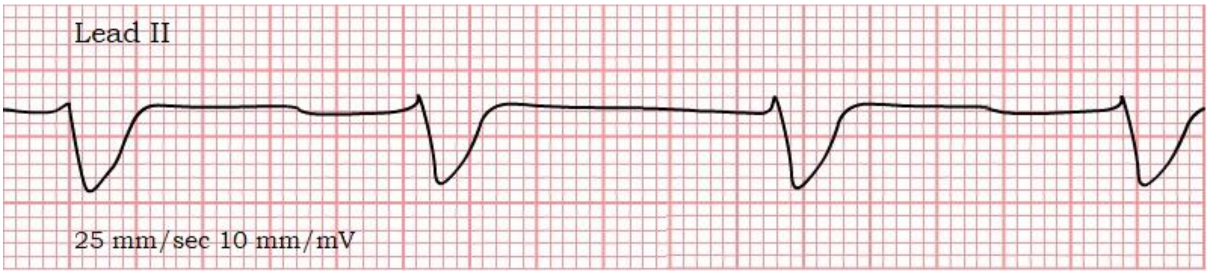


Figure 10: Pulseless electrical activity (PEA)

Pulseless electrical activity (PEA): In the above two examples, note presence of organized electrical activity characterized by definite QRS complexes (but there was no pulse in this case). In the upper ECG tracing, the QRS complexes are normal looking and are preceded by a P wave, but in the lower ECG tracing, the QRS complexes are broad, lack P wave and mimics idioventricular rhythm.

Practical tips: In PEA, narrow and fast rhythm is usually caused by noncardiac aetiology, whereas wide and slow rhythm is usually caused by cardiac causes. It is an unshockable rhythm. Presents with cardiac arrest. Managed by CPR and drugs, including Adrenaline. Reversible causes should be treated.

2.2 Nonarrest rhythms (selected)

Nonarrest rhythms do not cause cardiac arrest per se, but they may appear in the peri-arrest period. Some basic understanding of the common rhythms and arrhythmias are core to comprehensive management of cardiac arrest.

(2.2.A) Normal sinus rhythm: Not an arrhythmia.

ECG features:

- Regularity: Regular
- Rate: 60-100/min
- P wave: Present, normal looking, one P wave for every QRS complex
- PR interval: <120 ms
- QRS complex: Narrow.

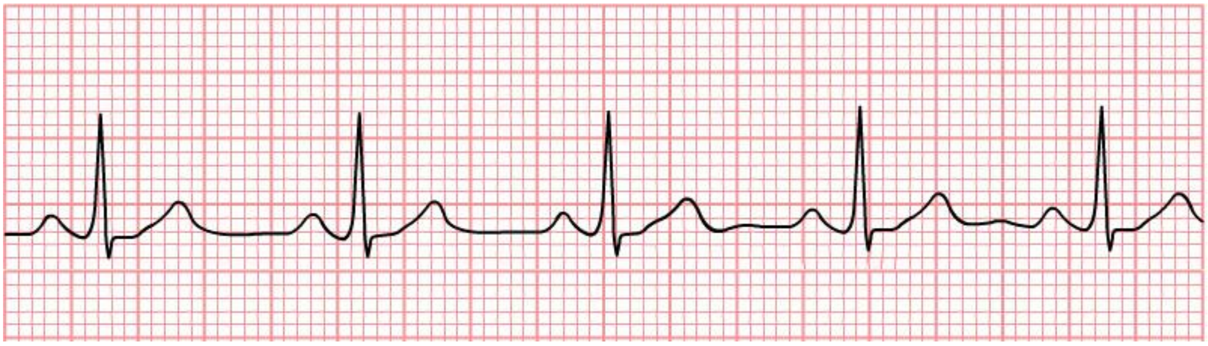


Figure 11: Normal sinus rhythm

Normal sinus rhythm: Note regular narrow-complex rhythm, each QRS complex is preceded by a P wave, ventricular rate 80/min.

Practical tips: In PEA, normal sinus rhythm may be associated with no pulse.

(2.2.B) Sinus tachycardia:

ECG features:

- Regularity: Regular
- Rate: >100/min, usually <150/min
- P wave: Present, normal looking, one P wave for every QRS complex
- PR interval: 120 to 200 ms
- QRS complex: Narrow, may be wide.

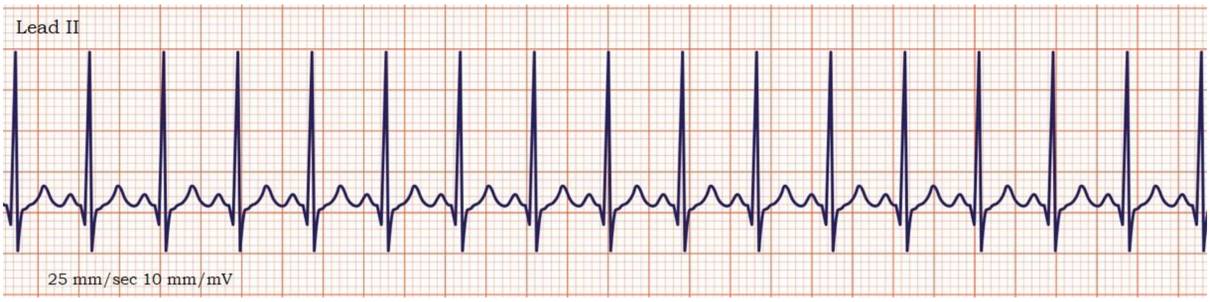


Figure 12 : Sinus tachycardia

Sinus tachycardia: Note sinus rhythm with ventricular rate 160/min.

Practical tips: Sinus tachycardia may be confused with supraventricular tachycardia. Sinus tachycardiac with pre-existing bundle branch block or pre-excitation may present with regular wide complex tachycardia.

(2.2.C) Supraventricular tachycardia (SVT)

ECG features:

- Regularity: Regular

- Rate: Usually 150 to 250/min
- P wave: Difficult to detect, often buried in preceding T waves
- PR interval: Usually not measurable
- QRS complex: Normal, but may be wide if abnormally conducted.

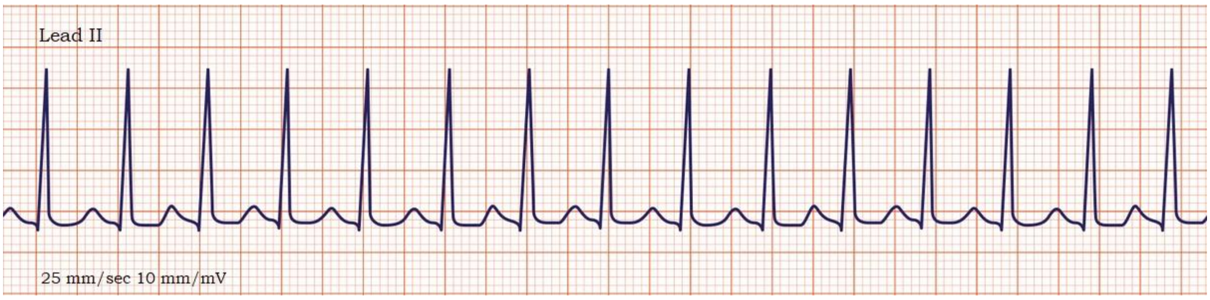


Figure 13: Supraventricular tachycardia

Supraventricular tachycardia: Note regular narrow-complex tachycardia with ventricular rate 170/min. P waves cannot be identified separately.

Practical tips: SVT may be confused with sinus tachycardia. Haemodynamically stable SVT is treated with carotid sinus massage with or without intravenous adenosine. On the other hand, haemodynamically unstable SVT is treated by DC cardioversion.

(2.2.D) Atrial fibrillation (AF):

ECG features:

- Regularity: Irregular
- Rate: Variable
- P wave: Absent, replaced by fibrillary waves
- PR interval: Cannot be measured
- QRS complex: Normal.

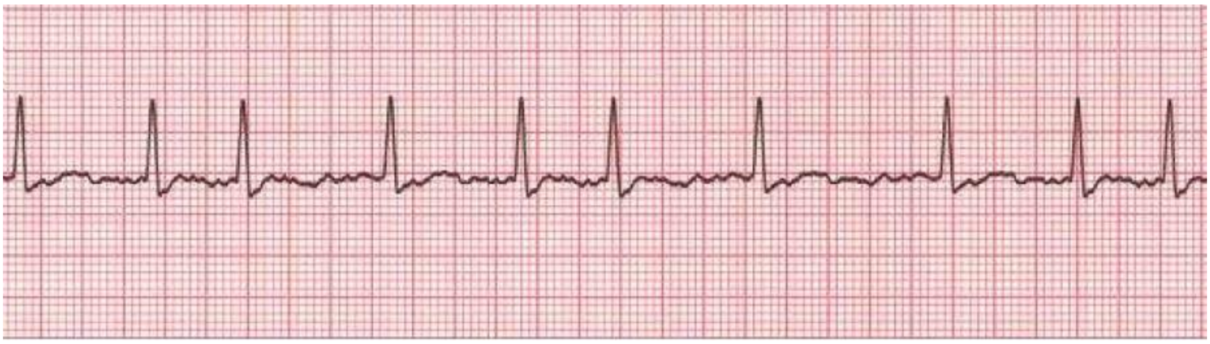


Figure 14: Atrial fibrillation

Atrial fibrillation: Note irregular narrow-complex tachycardia with baseline undulations indicating fibrillary waves.

Practical tips: Haemodynamically stable AF is treated with drugs whereas haemodynamically unstable AF is treated with DC cardioversion.

(2.2.E) Atrial flutter:

ECG features:

- Regularity: Regular or irregular
- Rate: Atrial 250–350/min, ventricular variable
- P wave: Replaced by flutter waves having saw-tooth appearance
- PR interval: Cannot be measured
- QRS complex: Normal.

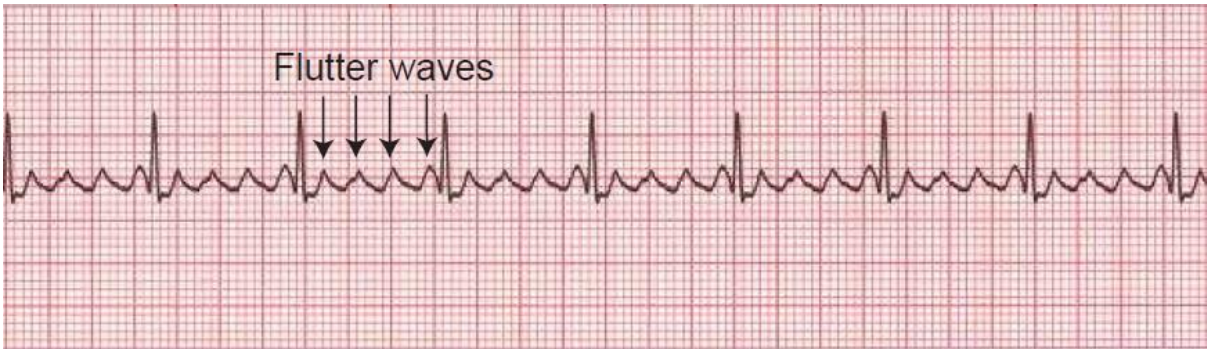


Figure 15: Atrial flutter

Atrial flutter: Note saw-tooth appearance of the baseline and normal QRS complexes.

Practical tips: Haemodynamically stable AF is treated with drugs whereas haemodynamically unstable AF is treated with DC cardioversion.

(2.2.F) Ventricular tachycardia (VT):

Ventricular tachycardia (VT) is defined as three or more consecutive ventricular extrasystoles occurring at a heart rate of greater than 120 beats/min.

May be monomorphic (having uniform shape) or polymorphic (having variable shape), non-sustained (lasting <30 sec) or sustained (lasting >30 sec).

***(2.2.F.1) Monomorphic ventricular tachycardia*:** QRS complexes have similar shape and amplitude.

ECG features:

- Regularity: Regular
- Rate: Typically, 120-250/min
- P wave: Present occasionally, but no relationship with QRS complex because of atrioventricular dissociation
- PR interval: Cannot be measured

- QRS complex: Wide and bizarre, corresponding T wave is of opposite polarity. Capture beat and fusion beat may be present.

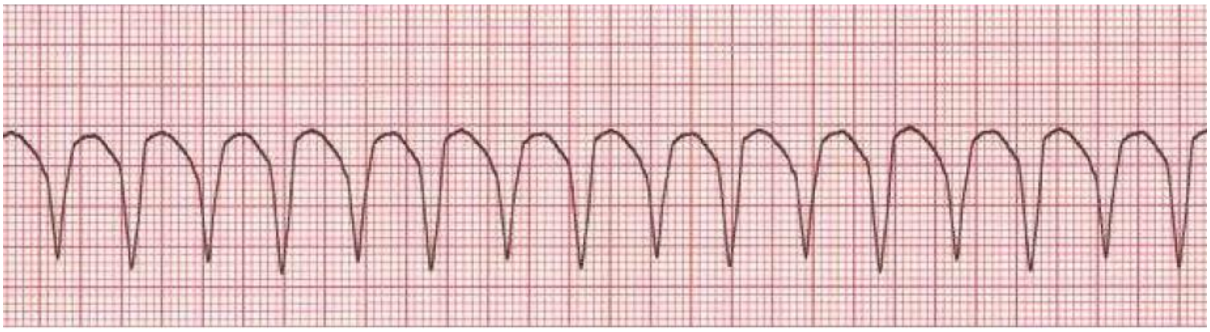


Figure 16: Ventricular tachycardia (monomorphic)

Ventricular tachycardia (monomorphic): Note regular wide-complex tachycardia.

Practical tips: In monomorphic VT, pulse may or may not present Haemodynamically stable VT is treated with drugs whereas haemodynamically unstable VT is treated with DC cardioversion.

(2.2.F.2) Polymorphic ventricular tachycardia:

QRS complexes have variable shape and amplitude.

ECG features:

- Regularity: Regular or irregular
- Rate: Typically, 120-250/min
- P wave: Present occasionally, but no relationship with QRS complex because of atrioventricular dissociation
- PR interval: Cannot be measured
- QRS complex: Wide and bizarre, morphology varies markedly, corresponding T wave is of opposite polarity. Capture beat and fusion beat may be present.

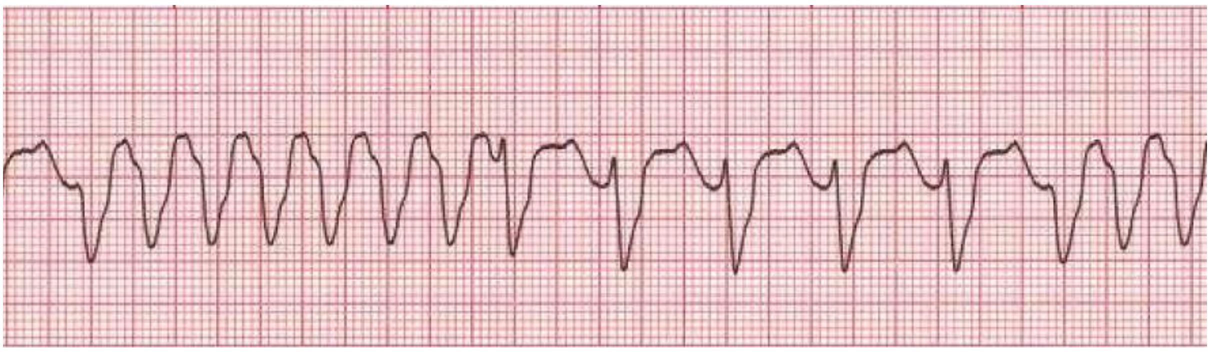


Figure 17: Ventricular tachycardia (polymorphic)

Ventricular tachycardia (polymorphic): Note irregular wide-complex tachycardia.

Practical tips: Often presents with haemodynamic instability. Rapidly degenerates into pulseless VT or VF. Haemodynamically stable VT is treated with drugs whereas haemodynamically unstable VT is treated with DC shock.

(2.2.G) Torsade de Pointes: A type of polymorphic VT.

ECG features:

- Regularity: Irregular
- Rate: 150-250/min
- P wave: Not discernible
- PR interval: Not discernible
- QRS complex: Wide and bizarre. The QRS complexes twist around the baseline.

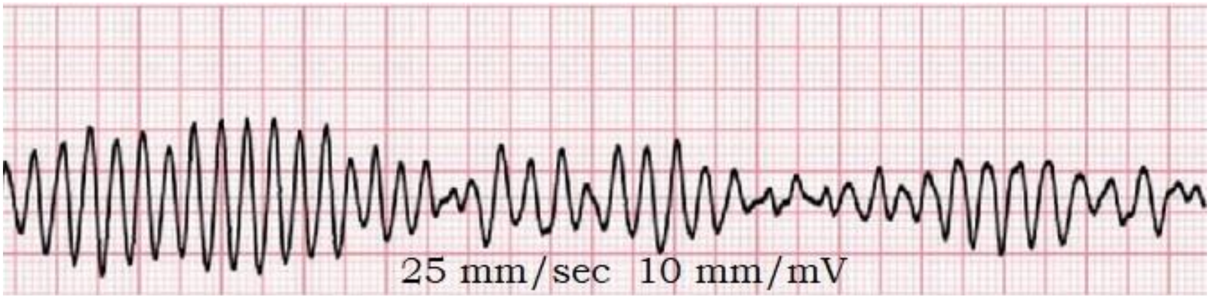


Figure 18: Torsade de Pointes

Torsade de Pointes: Note irregular wide-complex tachycardia with twisting of QRS axis around the baseline.

Practical tips: Often deteriorates to pulseless VT or VF. Drugs causing QT prolongation and electrolyte imbalance e.g., hypomagnesaemia are common cause of acquired torsade de pointes. Commonly treated with DC shock and intravenous magnesium.

(2.2.H) Sinus bradycardia:

ECG features:

- Regularity: Regular
- Rate: <60/min
- P wave: Present, normal looking, one P wave for every QRS complex
- PR interval: Normal, 120 to 200 ms
- QRS complex: Narrow.

Figure 19: Sinus bradycardia

Sinus bradycardia: Note sinus rhythm with ventricular rate 50/min.

Practical tips: Extreme sinus bradycardia may be confused with complete heart block or junctional bradycardia. Atropine is recommended medication here.

2.3 AV Block

(2.3.A) First degree atrioventricular block:

ECG features:

- Regularity: Regular
- Rate: Any, may be normal, bradycardia or tachycardia
- P wave: Present, normal looking, one P wave for every QRS complex
- PR interval: Prolonged, >200 ms, fixed
- QRS complex: Narrow.

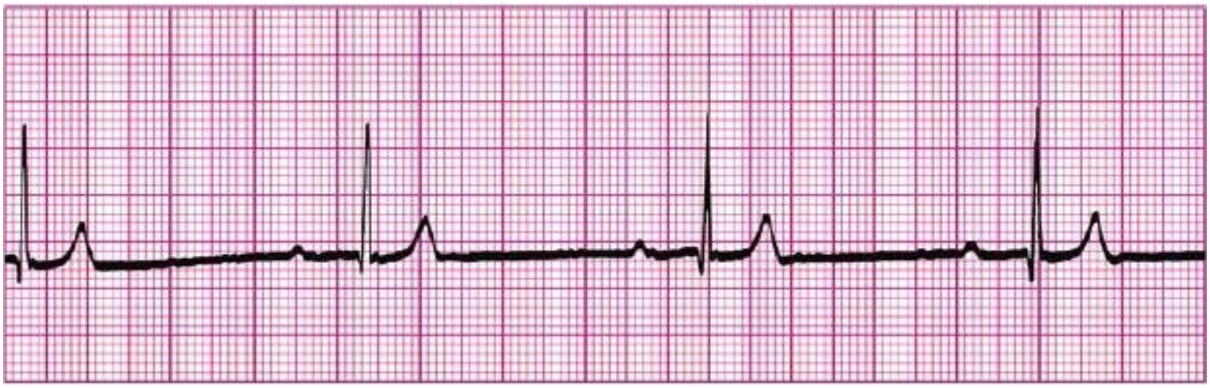


Figure 20: First degree AV block

First degree AV block: Note sinus rhythm with PR interval 360 ms.

Practical tips: Commonly caused by drugs like beta blockers, non-dihydropyridine calcium channel blockers and digoxin First degree atrioventricular block per se does not need any treatment.

(2.3.B) Second degree atrioventricular block: Some P waves are conducted while some are not.

Two types: Mobitz type 1 and Mobitz type 2.

***(2.3.B.1) Mobitz type 1 second degree atrioventricular block*:** Also known as Wenckebach phenomenon. The site of conduction block is usually in the AV node.

ECG features:

- Regularity: Irregular
- Rate: Any, may be normal, bradycardia or tachycardia
- P wave: Present, normal looking, some P waves are not followed by QRS complex
- PR interval: Progressive lengthening of PR interval followed by a drop beat, and regular repetition of the cycle.
- QRS complex: Narrow, some are not conducted at regular cycles.

Figure 21: Mobitz type 1 second degree AV block

Mobitz type 1 second degree AV block: Note progressive lengthening of PR interval followed by failure of conduction of every 4th P wave, and repetition of the cycle.

Practical tips: Commonly caused by drugs like beta blockers, non-dihydropyridine calcium channel blockers and digoxin, and also acute coronary syndrome. Usually benign, and may not need any treatment.

***(2.3.B.2) Mobitz type 2 second degree atrioventricular block*:** The site of conduction block is usually below the AV node.

ECG features:

- Regularity: Usually, irregular
- Rate: Any, may be normal, bradycardia or tachycardia
- P wave: Present, normal looking, some P waves are not followed by QRS complex
- PR interval: Fixed.
- QRS complex: Usually, narrow, some are not conducted.

.

Figure 22: Mobitz type 2 second degree AV block

Mobitz type 2 second degree AV block: Note every 3rd P wave is nor followed by QRS complex, but PR interval is fixed.

Practical tips: Commonly caused by acute coronary syndrome. Carries worse prognosis than the type 1 AV block and needs treatment. May herald development of complete atrioventricular block.

(2.3.C) Third degree atrioventricular block: Also known as complete atrioventricular block or complete heart block. The site of conduction block is usually below the AV node.

ECG features:

- Regularity: Regular
- Rate: Slow, lower than atrial rate. Atrial rate is commonly 60-100/min, ventricular rate 20-55/min.
- P wave: Present, normal looking, some P waves are not followed by QRS complex
- PR interval: Variable.
- QRS complex: Usually, wide, but may be narrow. No relationship between P and QRS complexes.

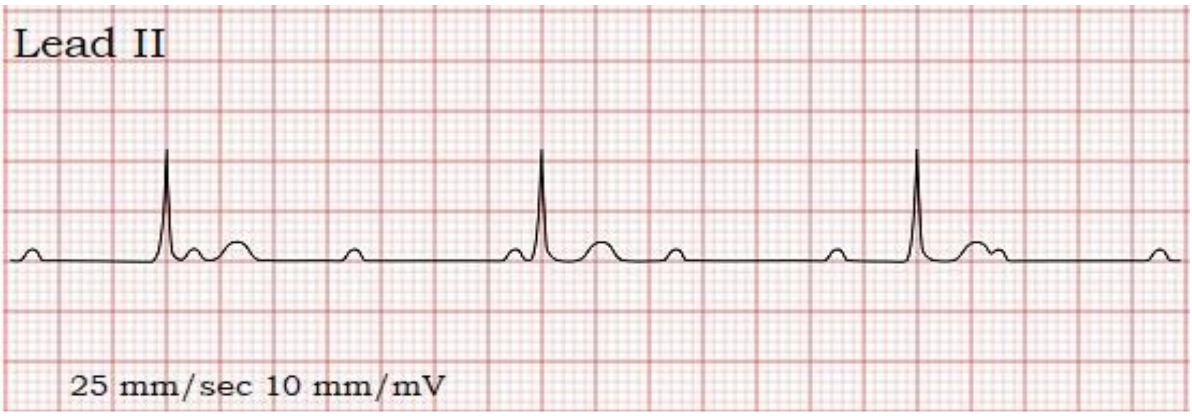


Figure 23: Third degree AV block

Third degree AV block: Note regular RR interval, regular PP interval and variable PR interval.

Practical tips: PP interval regular, RR interval regular and PR interval variable are the ECG hallmark for complete AV block. Commonly caused by acute coronary syndrome. May be degenerative or drug induced. Commonly treated with atropine and transcutaneous or temporary pacing.

2.4 Management of arrhythmia

Among the arrhythmias, arrest rhythms present with cardiac arrest, and are managed with BLS and ALS as per the established protocols. Other arrhythmias encountered during resuscitation or in post-cardiac arrest care are divided into tachyarrhythmia and bradyarrhythmia for management. Below are the management algorithms for tachyarrhythmia and bradyarrhythmia recommended by the American Heart Association Guidelines, 2020 for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care (Figure 24 and Figure 25).

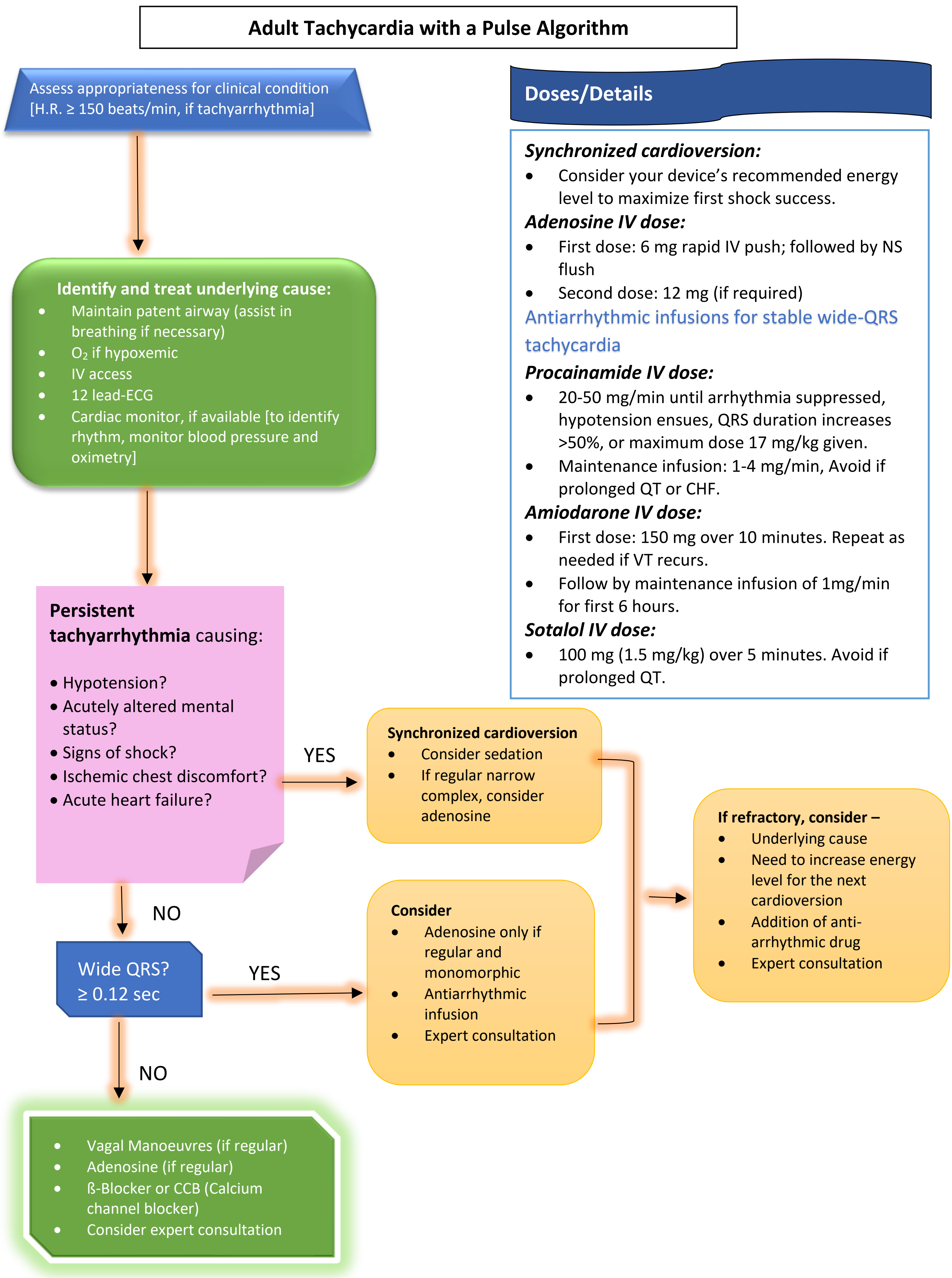


Figure 24: Adult Tachycardia with a Pulse Algorithm

**Adapted from AHA. (2020).*

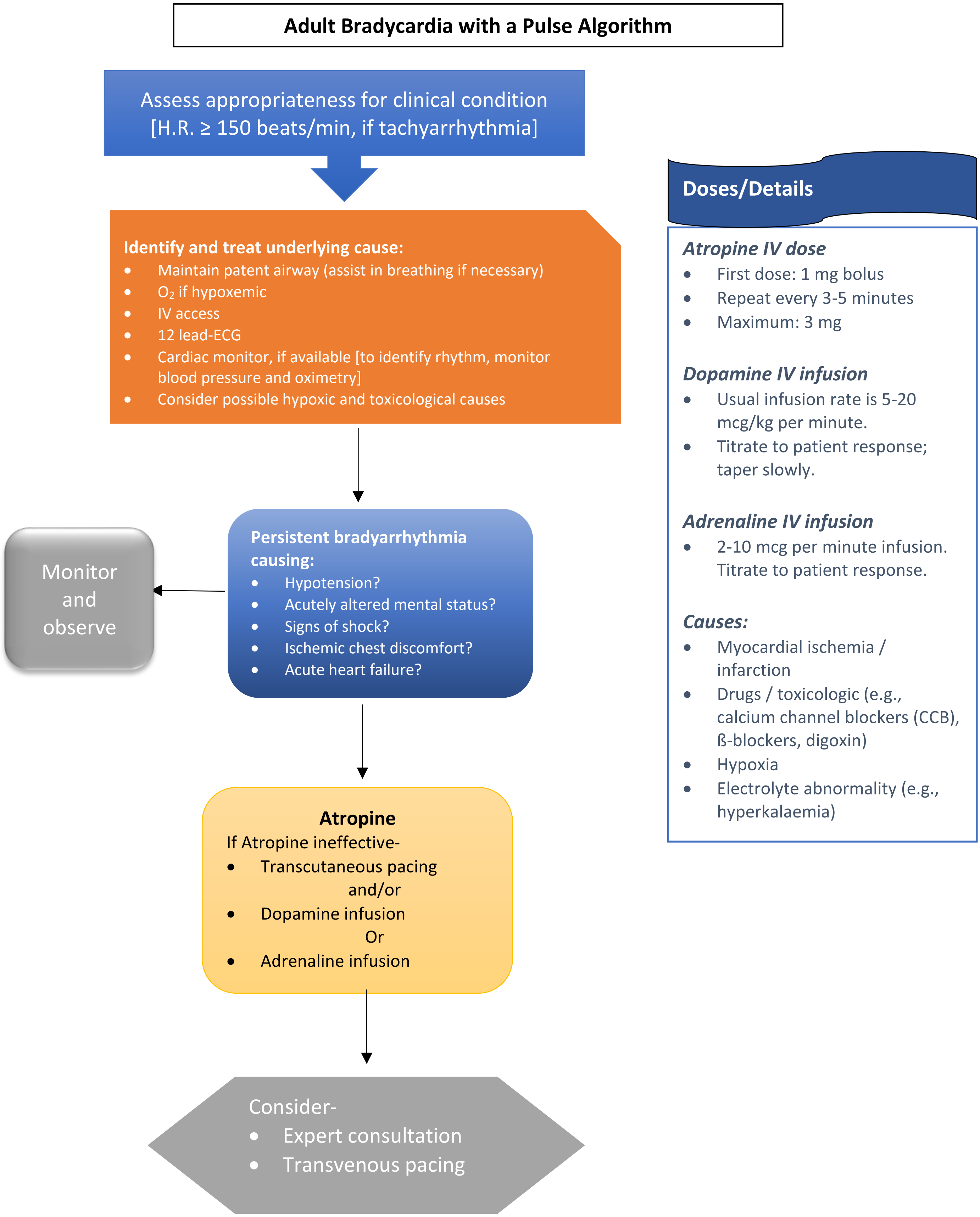


Figure 25: Adult Bradycardia with a Pulse Algorithm

**Adapted from AHA. (2020)*

2.5 Acute Coronary Syndrome (ACS)

Acute coronary syndrome (ACS) includes- unstable angina (UA), non-ST-segment elevation myocardial infarction (NSTEMI), and ST-segment elevation myocardial infarction (STEMI). This sub-chapter discusses in short about the clinical differentiation points and approach to a patient with suspected ACS, and subsequent management.

Table 1: Clinical differentiation and approach to chronic stable anginal and acute coronary syndrome.

Trait	Chronic stable angina	Acute coronary syndrome		
		Unstable angina	NSTEMI	STEMI
Chest pain	Yes	Yes	Yes	Yes
Mode of onset	Chronic, on and off	Acute	Acute	Acute
Precipitates by	Exertion	Spontaneous, at rest	Spontaneous, at rest	Spontaneous, at rest
Severity	Less	More	More	More
Relieved by rest	Yes	No	No	No
Relieved by nitrates e.g., GTN	Yes	No	No	No
ECG	Normal, or ST and T wave changes	Normal, or ST and T wave changes	ST and T wave changes	ST elevation, T inversion, Q waves
Troponin I	Normal/ negative	Normal/ negative	Elevated/ positive	Elevated/ positive
Treatment strategy	Medical management followed by CAG ± coronary revascularization	Medical management followed by CAG ± coronary revascularization	Medical management, including LMWH, followed by CAG ± coronary revascularization	Medical management + CAG + Primary PCI. Thrombolysis, if primary PCI not available

** NSTEMI= non-ST-segment elevation myocardial infarction, STEMI= ST-segment elevation myocardial infarction, GTN= glyceryl trinitrate, ECG= electrocardiogram, CAG= coronary angiography, PCI= percutaneous coronary intervention, LMWH= Low molecular weight heparin.*

Approach to a patient with suspected acute coronary syndrome

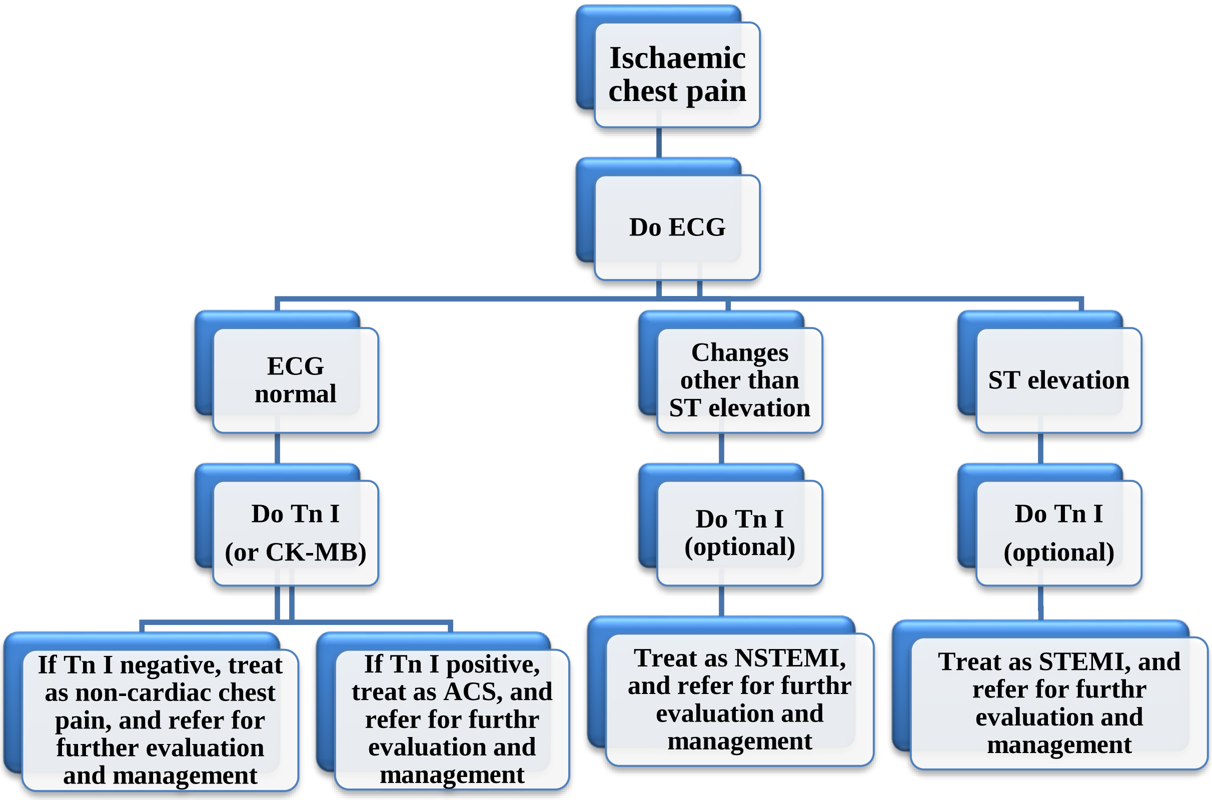


Figure 26: Approach to a patient with suspected acute coronary syndrome

**Tn I = troponin I, CK-MB = creatine kinase myocardial band*

Treatment of Acute Coronary Syndrome

ACS diagnosed

↓

Admit preferably in coronary care unit (CCU)

↓

For all ACS patients:

- Oxygen inhalation, especially if acute left ventricular failure
- Aspirin, 300 mg stat, followed by, aspirin, 75 mg daily
- Clopidogrel, 300 mg stat, followed by, clopidogrel, 75 mg daily
- Atorvastatin, 20-40 mg (or rosuvastatin 10-20 mg) stat, and daily
- Morphine, 3 mg iv stat, and repeated in small aliquot if required

  OR

  Pethidine, 50 – 100 mg iv, especially in right ventricular MI

  PLUS

  Prochlorperazine 25 mg (or, ondansetron 8 mg) iv stat with first dose of morphine or pethidine
- Metoprolol 25-50 mg stat and twice daily (or, equivalent dose of other beta blockers)
- Ramipril 1.25-5 mg daily (or, equivalent dose of ARB)
- Nitro-glycerine slow-release tablet, 2.6 mg twice daily
- Proton pump inhibitor and benzodiazepine if needed.

For acute STEMI patients (if primary PCI not feasible), within 12 hours of onset of chest pain:

- Streptokinase, 1.5 million units intravenously over 1 hour. (1 vial of 1.5 million units to be mixed with 100 ml of normal saline).

For acute NSTEMI and unstable angina patients (if early PCI not feasible):

- Enoxaparin, 1 mg/kg twice daily deep subcutaneously for 7-10 days.

Subsequent management of ACS patients

- Discharged after 2-5 days in uncomplicated cases
- Rest at home for 2 weeks, followed by resumption of usual activities over 4-6 weeks.

↓

- **Refer the patient with acute STEMI for primary PCI, and NSTEMI for early PCI in high-risk patients, if feasible.**
  Otherwise, after initial management, refer all ACS patients for coronary angiography and revascularization to appropriate centre.
- **Tenecteplase is a better choice than streptokinase as thrombolytic, if available.**

Figure 27: Treatment of Acute Coronary Syndrome

Chapter 3: Defibrillation

Learning objectives:

At the end of the session, participants are expected to-

- To learn principles of defibrillation
- To have a brief overview of the cardiac defibrillation procedure on a patient who is experiencing sudden cardiac arrest due to ventricular dysrhythmias.

3.1 Definition of Defibrillation

Defibrillation is a process in which an electronic device sends an electric shock to the heart to stop an extremely rapid, irregular heartbeat, and restore the normal heart rhythm.

The instrument for administering the shock is called a **DEFIBRILLATOR.**

Purpose of Defibrillation [6]

Defibrillation is a common treatment for life threatening cardiac dysrhythmias, e.g., ventricular fibrillation, and pulseless ventricular tachycardia, which could result in cardiac arrest. It should be performed immediately after identifying that the patient is experiencing a cardiac emergency, has no pulse, and is unresponsive.

Mechanism of defibrillation in cardiac dysrhythmias

- Fibrillations cause the heart to stop pumping blood, leading to brain damage.
- Ventricular fibrillation is a serious cardiac emergency resulting from asynchronous contraction of the heart muscles.
- Due to ventricular fibrillation, there is an irregular rapid heart rhythm.

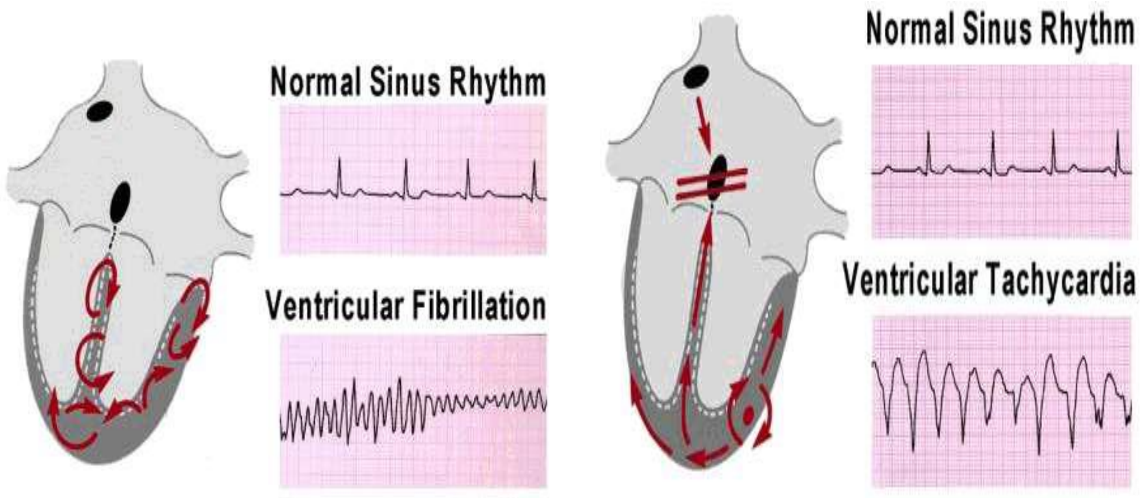


Figure 28: Shockable Rhythms (VF, VT)

- Defibrillators deliver a brief electric shock to the heart, which enables the heart's natural pacemaker to regain control and establish a normal heart rhythm.
- Ventricular fibrillation can be converted into a more efficient rhythm by applying a high energy shock to the heart.
- This sudden surge across the heart causes all muscle fibres to contract simultaneously.
- Possibly, the fibres may then respond to normal physiological pace making pulses.

3.2 Principle of operation of a Defibrillator [8]

- Energy storage capacitor is charged at relatively slow rate from AC line.
- Energy stored in capacitor is then delivered at a **relatively rapid rate** to chest of the patient.
- Simple arrangement involves the discharge of capacitor energy through the patient's own resistance.

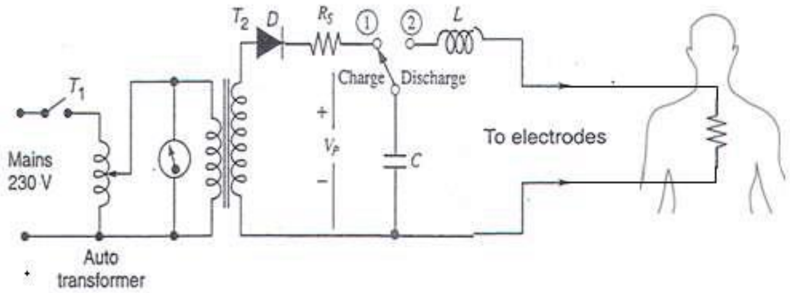


Figure 29: Schematic diagram of a defibrillator

- The discharge resistance which the patient represents as purely ohmic resistance of 50 to 100Ω approximately for a typical electrode size of $80cm^2$.
- This particular waveform Fig is called "Lown wave" form.
- The pulse width of this waveform is generally 10 ms.

Power requirement for Defibrillation

- Higher voltages are required for external defibrillation than for internal defibrillation.
- A corrective shock of 750-800 volts is applied within a tenth of a second. That is the same voltage as 500-533 no of AA batteries.

3.3 Types of Defibrillators

There are two Types of Defibrillators: (a) Internal and (b) External

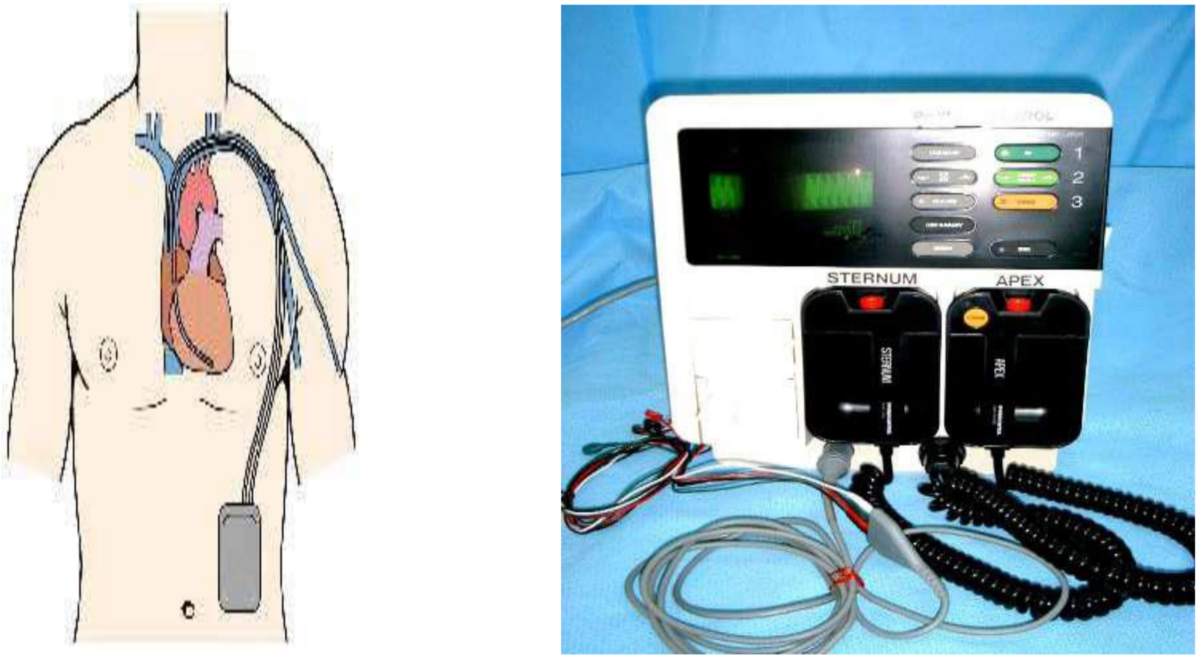


Figure 30: Types of Defibrillators

a) Internal defibrillator

- Electrodes placed directly to the heart e.g. -Pacemaker

b) External defibrillator

- Electrodes placed directly on the chest **e**.g. -AED

Automated External Defibrillator (AED)

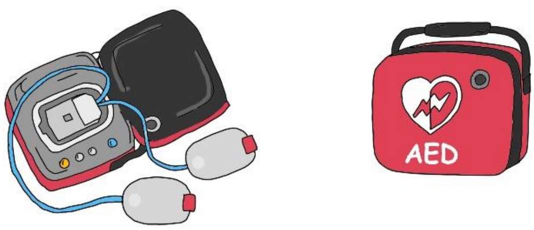


Figure 31: Automatic External Defibrillator

The automated external defibrillator (AED) is a device that recognizes ventricular fibrillation and other dysrhythmias and delivers an electric shock at the right time [7].

In cardiac emergencies, AED can be very helpful, wherever available. It is a lightweight, portable, easy-to-use tool that is found now-a-days in specialized hospitals, and advised to make available in all hospitals, and public places (e.g., airports, schools, government buildings etc).

- 'Automatic' refers to the ability to autonomously analyse the patient's condition.
- AEDs require self-adhesive electrodes instead of hand-held paddles.
- The AED uses voice prompts, lights, and text messages to tell the rescuer what steps have to take next.

Brief description of operating an AED

- Turned on or opened AED.
- AED will instruct the user to: -
    - Connect the electrodes (pads) to the patient.
    - Avoid touching the patient to avoid false readings by the unit.
- Place both pads on victim's bare chest.
    - One pad directly below the right clavicle, another pad on the side of the left nipple, where the top margin of the pad will stay 7 to 8 cm below the left armpit (anterolateral placement).
- The AED examine the electrical output from the heart and determine the patient is in a shockable rhythm or not. Stand clear of the victim (no one is touching the victim) when the AED is analysing rhythm.
- When device determined that shock is warranted, it will charge its internal capacitor in preparation to deliver the shock.
- When charged, the device instructs the user to ensure no one is touching the victim and then to press a red button to deliver the shock.
- Many AED units have an 'event memory' which store the ECG of the patient along with details of the time the unit was activated, and the number and strength of any shocks delivered.
- **Do not delay high-quality CPR after AED use.** Immediately resume CPR cycle.

Precautions while operating AED

- Always place pads directly on the skin and avoid contact with clothing and medication patches.
- The pads used in the procedure should not be placed: -
    - on a woman's breasts
    - directly over an implanted device / pacemaker patient.
- Before the pad is used, a gel must be applied to the patient's skin.

Risks involved in Defibrillation procedure

- Skin burns from the defibrillator paddles are the most common complication of defibrillation.
- Other risks include- injury to the heart muscle, abnormal heart rhythms, and blood clots.

Troubleshooting of AED

- Attach the external and internal paddles if the monitor reads, "No paddles."
- Check to ensure that the leads are securely attached if the monitor reads (No lead).
- Connect the unit to AC power if the message reads, "Low battery."
- Verify that the Energy Select control settings are correct if the defibrillator does not charge.
- Change the electrodes and make sure that the electrodes adapter cable is properly connected if you receive a message of "PACER FAILURE." Restart the pacer.
- Close the recorder door and the paper roll if the monitor message reads, "Check recorder".

Chapter 4: Airway Management

Learning objectives:

At the end of the session, participants are expected to learn -

- Management of the airway of a critically ill patient.
- Identify the airway adjuncts and their applications.

4.1 Introduction

Airway describes the anatomical structures that join the nose and mouth to the lungs. A patent airway is essential to life. One of the primary goals of airway management is to provide adequate oxygenation and ventilation to avoid or halt the progression to cardiopulmonary arrest. Effective and timely airway management is also an essential component of successful cardiopulmonary resuscitation.

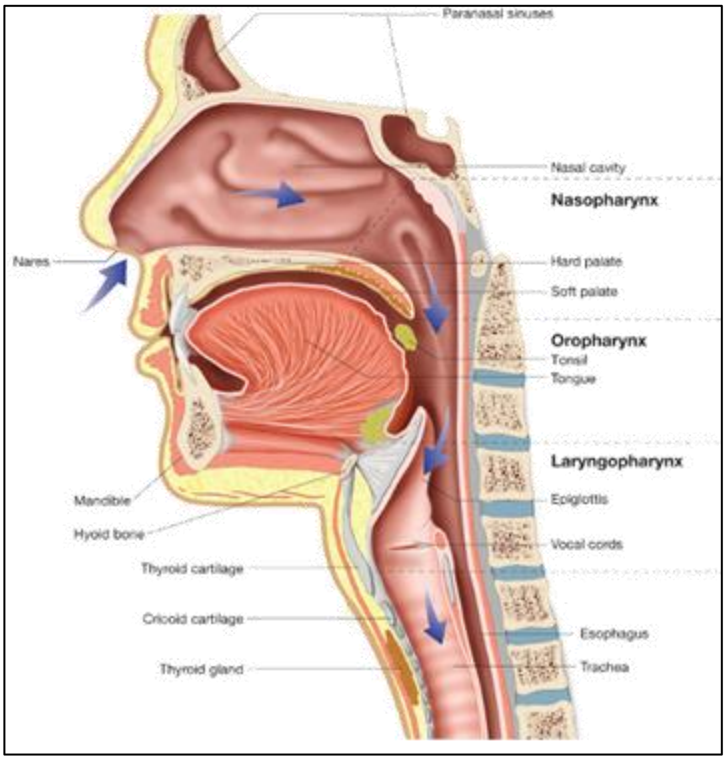


Figure 32: Median section of the head neck showing airway

4.1.A Indications of airway management

- Failure to oxygenate
- Failure to ventilate
- Failure to maintain a patent airway

4.1.B Airway obstruction

Types of Airway obstruction

Partial obstruction	Complete obstruction
• Flow of air to the lungs is reduced. • Abnormal sounds such as snoring, gurgling or wheezing. • The patient may become hypoxic if there is inadequate air flow to the lungs.	• No air reaches the alveoli. • Chest is silent, breath sounds are absent. • Profound hypoxia occurs rapidly. • Without intervention, the person will die within few minutes.

Common causes of airway obstruction

• **Obtundation of consciousness:** In low level of consciousness, obstruction is due to tongue fall back into the posterior pharynx due to loss of muscle tone. • **Intraluminal contents:** Pooled secretions, blood, vomitus and foreign bodies (e.g., broken tooth in trauma)	• Oedema due to burns, inflammation or anaphylaxis • **Laryngospasm /Bronchospasm** • **External compression of the airway (tumour, haematoma, trauma)** • **Blocked tracheostomy tube** • Airway **trauma** • Regurgitation of stomach contents

4.2 Assessment of the airway

4.2.A Assessment of the airway: points to remember

- A person who can talk in sentences, with no abnormal airway sounds, is likely to have a patent airway.
- Talking to the patient and eliciting a response is a good initial assessment in the conscious patient.
- For individuals who are not fully conscious, or when there is doubt about the patency of the airway, a ***look-listen-feel*** approach is recommended.

- **Look** for chest movement and evaluate the work of breathing-
    - Normal breathing: Chest and abdomen rise together
    - Obstructed airway: Work of breathing is increased, and the use of accessory muscles are evident.
    - Paradoxical breathing: Airway is completely occluded.

- **Listen** for breath sounds at the mouth and nose.
    - Normal breath sounds: Quiet and unlaboured.
    - Partial airway obstruction: Noisy breathing, and especially snoring and gurgling
    - Complete airway obstruction: No breath sounds

- **Feel** for breath on cheek.

4.2.B Opening the airway using basic techniques

When airway obstruction is detected, immediate measures must be taken to maintain a clear airway. There are some manoeuvres (Figure 33) which are used to improve an airway obstructed by the tongue or other upper airway structures in an unconscious patient. These are:

1. **Head tilt & chin lift** : Hand is placed on victim's forehead and gently tilt his head back, avoid pressing deeply into the soft tissue under the chin during this manoeuvre because this might block the airway.
2. **Jaw thrust** : Performed in patients where there is suspicion of an injury to the cervical spine.

Manoeuvre of jaw thrust

- At first identify the angle of the jaw.
- With the index and other fingers placed behind the angle of the mandible, apply steady upwards and forward pressure to lift the jaw.
- Using the thumbs, slightly open the mouth by downward displacement of the chin.

(** After each manoeuvre, check for success using the *look, listen and feel* sequence described above.)

- If a clear airway cannot be achieved, other causes of airway obstruction must be sought.
- A solid foreign body in the mouth should be removed using a finger sweep.

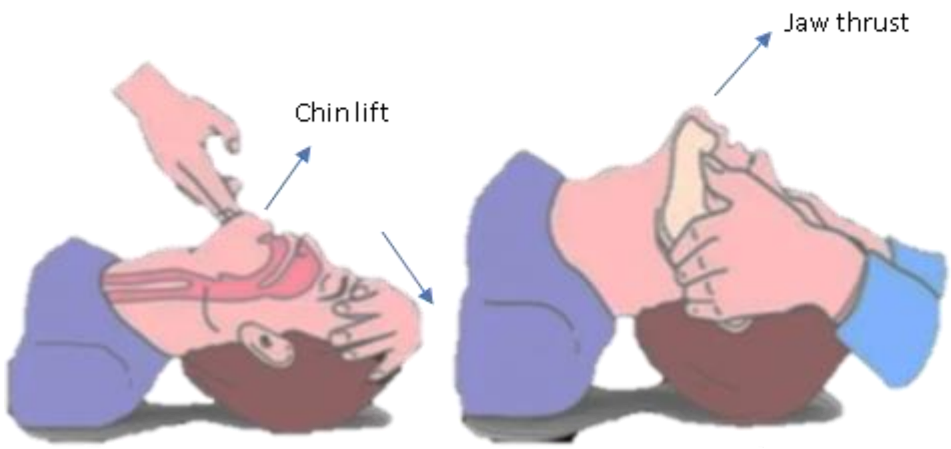


Figure 33: Head Tilt-Chin Lift and Jaw Thrust Manoeuvres

4.3 Airway adjuncts

Airway adjuncts are used to relieve or bypass an upper airway obstruction during airway management. However, upper airway obstruction may be present for several reasons, and airway adjuncts may not be able to relieve or bypass all types of obstruction. Airway adjuncts are:

• Oropharyngeal airway	• Endotracheal tube
• Nasopharyngeal airway	• Front of the neck airway

• Supraglottic airway ➢ LMA ➢ LTA ➢ I- gel	➢ Needle cricothyrotomy ➢ Tracheostomy tube

4.3.A Oropharyngeal airway (OPA)

Different sizes of oropharyngeal airway

Appropriate size of oropharyngeal airway

Figure 34: Different sizes of oropharyngeal airway

The oropharyngeal airway is a curved hollow tube that is used to create an open conduit through the mouth and posterior pharynx. It should be used **only in the unresponsive patient with no cough or gag reflex**. If the patient has a cough or gag reflex, the oropharyngeal airway may stimulate vomiting & laryngospasm.

Indication of OPA

- To maintain or open the airway by preventing fall down the tongue.

Contraindications of OPA

- Conscious patient with an intact gag reflex.
- Foreign body that causes airway obstruction.
- Nasal fractures or an actively bleeding nose.

Complications of OPA

- It may induce vomiting which may lead to aspiration.
- It may cause or worsen airway obstruction if an inappropriately sized airway is used (i.e., too small).
- An inappropriately sized airway can also cause laryngospasm (i.e., too big).
- Damage to the oral structures or dentition can also result from oropharyngeal airway insertion.

The procedure for oropharyngeal airway

• At first select the proper size of airway (extending from the incisor teeth to mandibular angle).
• Open the patient's mouth with the crossed finger (scissors) technique.
• Insert a tongue blade on top of the patient's tongue and far enough back to depress the tongue adequately. Be careful not to cause the patient to gag.
• Insert the airway posteriorly, gently sliding the airway over the curvature of the tongue until the device's flange rests on top of the patient's lips. The device must not push the tongue backward and block the airway.
** Alternate technique for insertion (Rotation method) : Insert the OPA upside down so its tip is facing the roof of the patient's mouth. As the airway is inserted, it is rotated 180^0 until the flange comes to rest on the patient's lips and/or teeth. This manoeuvre should not be used in children.

- Remove the tongue blade.
- Reassess the patient to ensure that the airway is now patent.

4.3.B Nasopharyngeal airway (NPA / Nasal trumpet / Nose hose)

It is a type of airway adjunct, a tube that is designed to be inserted through the nasal passage down into the posterior pharynx to secure an open airway. These are made from soft malleable plastic, bevelled at one end and with a flange at the other. Unlike oropharyngeal airways, nasopharyngeal airways can be used in conscious, semiconscious, or unconscious patients (intact cough or gag reflex). ***It may be lifesaving in patients with clenched jaws, trismus, or maxillofacial injuries.***

Different sizes of nasopharyngeal airway

Insertion technique of nasopharyngeal airway

Figure 35: Different sizes of nasopharyngeal airway and insertion techniques

Technique of nasopharyngeal airway insertion

- Assess any visible obstruction of the nasal passage.

- Select the proper size airway which will easily pass the selected nostril (*Measure from the tip of the patient's earlobe to the tip of the patient's nose*).
- Lubricate the nasopharyngeal airway using lidocaine jelly.
- Insert the tip of the airway into the nostril and direct it posteriorly and toward the ear of that side.
- Gently insert the nasopharyngeal airway through the nostril into the hypopharynx with a slight rotating motion until the flange rests against the nostril.

4.3.C Laryngeal mask airways (LMA)

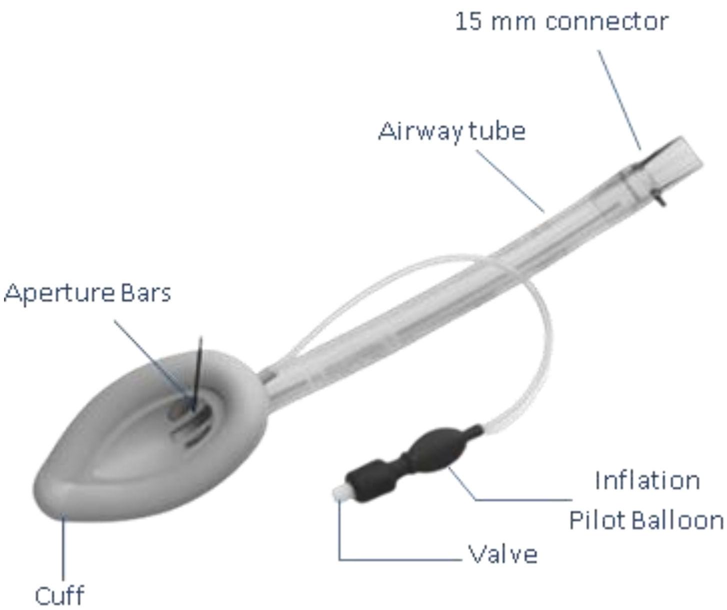
Laryngeal mask airways (IMA) are single-use or reusable supraglottic airway devices which can be used as a temporary method to maintain an open airway. (*During the administration of anaesthesia or as an immediate life-saving measure in a difficult or failed airway*).
Supraglottic devices (e.g., LMA) are designed to be inserted blindly through the mouth and into the hypopharynx to seal around the glottic opening allowing for ventilation. LMAs are excellent alternatives to the use of bag masks to reduce the risk of gastric inflation thus decreasing the risk of aspiration. While it may decrease the risk of aspiration, it is far less protective than an endotracheal tube. LMA's may stimulate the gag reflex, and, therefore, should not be used in a conscious or awake patient.

Appropriate size of LMA (For adults)

Weight (Kg)	Size	Cuff inflation (ml air)
Adults 30 to 50 kg	3	20
50 to 70 kg	4	30
Over 70 kg	5	40

Steps of laryngeal mask airway insertion

- Prior to insertion, the device should be placed on a flat surface.
- The cuff should be inflated and then completely deflated to ensure the cuff is not folded, pressing firmly on the flat surface.
- Lubricate both sides of the device with a water-soluble lubricant.
- Neck is extended in a sniffing position (when there is no risk of neck damage). Otherwise, a jaw thrust may be performed to facilitate passage.
- Hold the LMA with the dominant hand as you would a pen, with the index finger placed at the junction of the cuff and the shaft.
- The LMA is introduced behind the tongue with backward pressure using the index finger, pressing the device against the hard palate until it is completely inserted.
- Then use the other hand to push the LMA until some resistance is felt and it can go no further.



Different parts of LMA

LMA insertion technique

Figure 36: Different parts of LMA and insertion techniques

- The cuff should then be inflated with correct volume of air (Indicated on the shaft of the LMA).
- Check the placement of LMA by applying bag mask ventilation.
- Visually observe chest expansion and assess breath sounds.

Hazards of the LMA

- In patients with deep unconsciousness, they may react to the insertion of the LMA by coughing, straining, or developing laryngeal spasm. In patients with cardiorespiratory arrest, it will not occur.
- A good airway is not achieved if LMA is incorrectly placed.

4.3.D I gel

I-gel is a second generation of supraglottic airway device. It is made of a soft, gel-like thermoplastic elastomer that makes up the non-inflatable cuff. The I-gel's non inflatable cuff makes a nontraumatic tight seal over the laryngeal, pharyngeal and parapharyngeal structures.

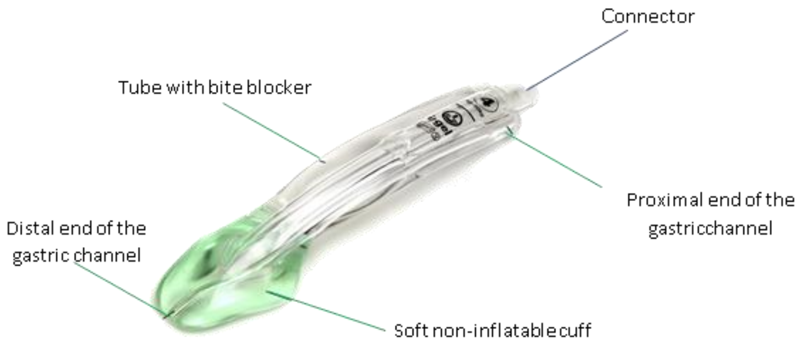


Figure 37: Different parts of I-gel

Advantages of I-gel

- Easier insertion, Simple design
- Minimal risk of tissue compression and stability after insertion (i.e., no position change with cuff inflation).
- Not necessary to insert fingers into the mouth of the patient for full insertion.
- Requires less technical skill than previous methods and requires little training, both initially and ongoing.

Figure 38: Techniques of I-gel insertion

4.4 Endo-tracheal intubation

Intubation is a process where a tube is inserted through a person's mouth or nose, then down into their trachea. The tube keeps the trachea open so that air can get through. The tube can connect to a machine that delivers air or oxygen. Intubation is necessary when airway is blocked or damaged or patient can't breathe spontaneously.

Indications of intubation

1. Airway obstruction
2. Cardiac arrest
3. Injury or trauma to neck, abdomen or chest that affects the airway
4. Loss of consciousness or a low level of consciousness
5. Need for surgery that make a patient unable to breathe on his own
6. Guillain-Barré syndrome (GBS), myasthenia gravis
7. Risk for aspiration (breathing in an object or substance such as food, vomit or blood)

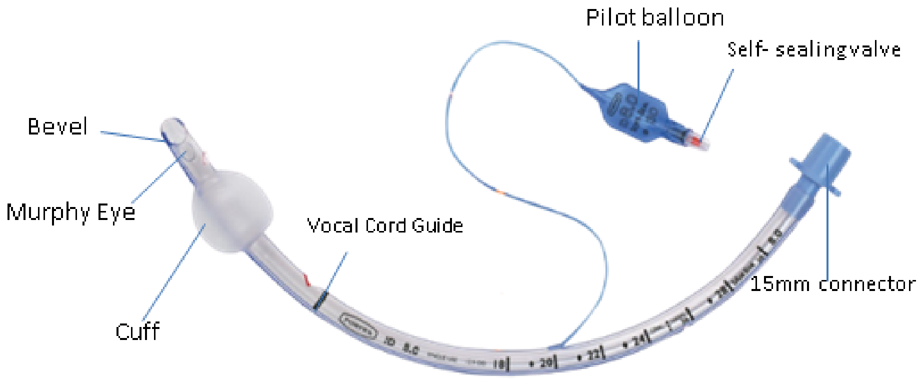


Figure 39: Different parts of Endotracheal tube

Essential equipment for intubation

1. Appropriate size of laryngoscope (curved Macintosh blade). The bulb and battery must be checked regularly to ensure working order, and spares must be immediately available.
2. Appropriate size of tracheal tubes (cuffed).
   Adult male 8.0-9.0mm internal diameter
   Female 7.0-8.0mm internal diameter
3. Syringe for cuff inflation.
4. Others:
   - Lubricating jelly such as water-soluble KY jelly, Magill's forceps
   - Introducers: either gum-elastic bougie or semi-rigid stylet which may be useful to aid intubation (see below)
   - Tape or bandage to secure tubes into position
   - Stethoscope for confirming correct position of the tube.
   - Suction apparatus with a wide bore rigid suction end (Yankauer) and a range of smaller flexible catheters.

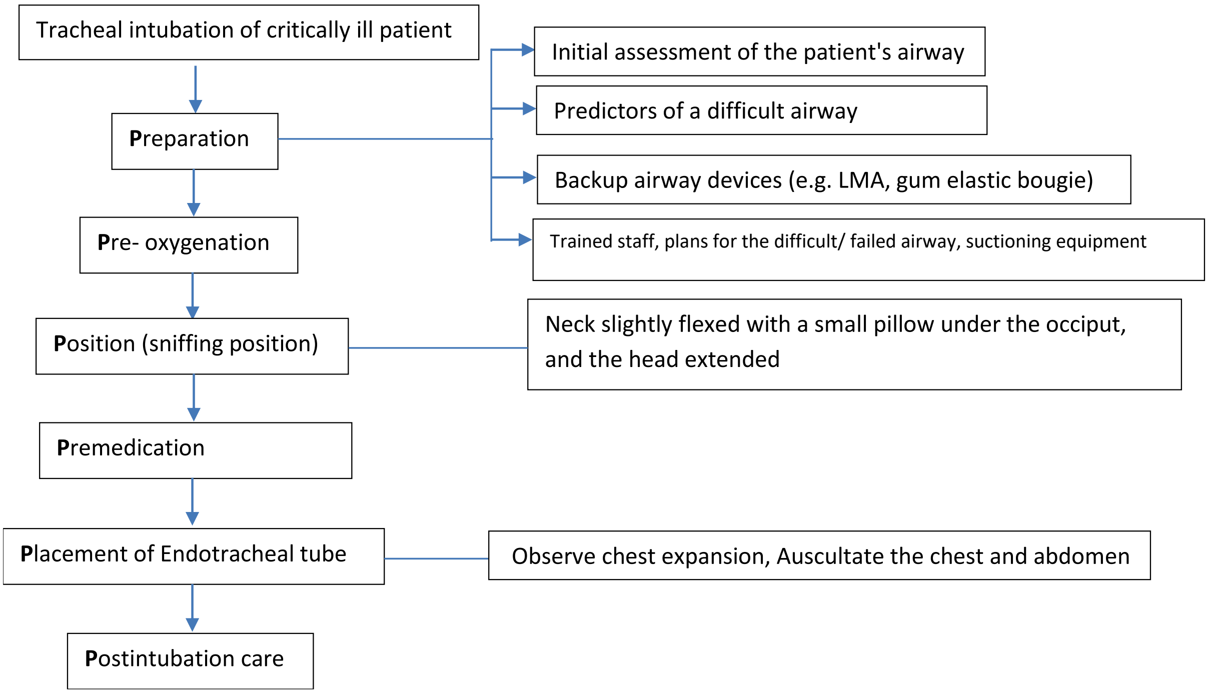


Figure 40: Flow chart for endo-tracheal intubation

Figure 41: Sniffing position

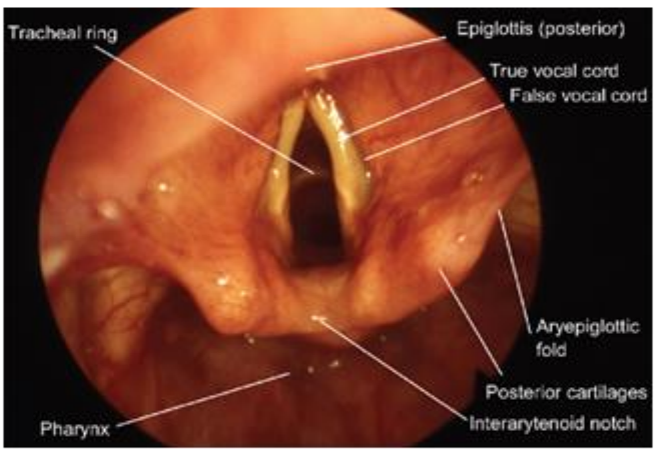


Figure 42: Laryngoscopic view (tracheal intubation)

Steps of endotracheal intubation

Patient Positioning

- Patient should be supine.
- Extension at atlanto-occipital joint & flexion at cervical spine (sniffing positioning) (Figure 41).
- This position is achieved by putting an about 10 cm thick pillow under the occiput.

Laryngoscopy & Intubation

- Laryngoscope blade should be inserted from right side of the mouth and advanced slowly displacing the tongue to the left until epiglottis is visualized.
- Once epiglottis is visualized, it is lifted anteriorly to visualize the glottis.
- Once the glottis is seen, ETT is passed between the vocal cords.
- Cuff is inflated with 4-8 ml of air and the cuff should be well below the vocal cords.
- Position of ETT is verified by capnography and auscultation over the chest for equal air entry into both lungs.
- ETT should be well secured at angle of mouth with adhesive tape or bandage.

LEMON criteria: Predicts difficult intubation.

Table 2: Airway assessment using LEMON score

L	Look externally: • Obese, short neck • Facial trauma, large incisors, and large tongue)
E	Evaluate the 3-3-2 rule: • Incisor distance <3 finger breadths • Hyo-mental distance <3 finger breadths • Thyro-Hyoid distance <2 finger breadths)
M	Mallampati* (Mallampati score ≥3)
O	Obstruction (presence of any condition that could cause an obstructed airway)
N	Neck mobility (limited neck mobility)

***Brief description of Mallampati score**

The Mallampati Score is a grading system based on the visualisation of the pharyngeal structures during laryngoscopy.

Grade 1: Faucial pillars, soft palate and uvula could be visualized.

Grade 2: Faucial pillars and soft palate could be visualized, but uvula was masked by the base of the tongue.

Grade 3: Only soft palate could be visualized.

Tracheal intubation during cardiac resuscitation

Intubation during cardiac resuscitation is often challenging because of the circumstances surrounding the intubation. Excitement and apprehension accompany this life saving effort. If you don't intubate often, you're likely to be nervous. Even experienced intubators get excited in emergency situations, but we need to control our excitement and let the adrenaline work for us, rather than against us.

- **Step one**, therefore, is to remain in control of your own sense of alarm. The leaders, which includes the person in control of the airway, must stay calm. If you appear panicked, the rest of your team will follow your lead.
- **Step two**, is to quickly assess the situation. Is the patient being ventilated? Ventilation takes priority over intubation. Is there suction available? Without suction you may not be able to see the glottis, and you won't be able to manage emesis. What help do you have? The intubator almost always needs some assistance in having someone hand equipment, or assist with cricoid pressure, among other tasks. Intubation is a team sport.
- **Finally,** you need to assess what position the patient is in, and how can you optimize that position. The patient is often in a less than optimal position while chest compressions are in progress. You usually find the patient in one of two awkward positions: on the ground or in a bed.

(A) Intubation On the Ground [9]

When the patient lies on the ground, you must get down to the patient's level. One technique is to kneel down. Mechanical advantage is more difficult from this position. You must rely more heavily on your arm strength to lift the head rather than your upper back and shoulder muscles. The natural tendency to lean forward and bend your arm, will make it hard for you to balance. The weight of the patient pulls you forward when you try to lift (Figure 43).

Awkward positioning

Position your center of gravity over the patient's head.

Figure 43: Intubation on the ground

Kneeling behind the cardiac arrest victim during intubation allows the intubator to ergonomically lift the patient's head with the strength of the back and shoulders, not just the arm. It provides the distance needed to use binocular vision to see the larynx.

Instead, keep your left arm and your back as straight as you can, leaning backward. Tense your lower back and thigh muscles to form a firm base of support. Lift upward (Figure 43). Position your head and shoulders over the patient's head to improve your center of gravity. Straddling the head with your knees allows you to steady the head, steady yourself, and improve your angle or approach. A folded sheet under the head can lift it into the sniffing position.

You can also sit to the patient's right side, facing the feet. Your hips should be at level with the back of your patient's head. Bend your knees slightly to allow you to maintain balance while shifting your weight to optimize the position of your outstretched left arm doing the laryngoscopy. This position gives you good leverage without pressing on the upper teeth. You will need to twist your back to pass the endotracheal tube with your right hand (Figure 44).

Figure 44: Sitting on the right of the patient.

Sitting to the right of a cardiac arrest victim during intubation allows the intubator to ergonomically lift the patient's head and see the glottis. You can lean backward to counterbalance the weight of the head.

(B) Intubation in The Bed

Unfortunately, having the patient lie in the typical hospital bed is also awkward. Look at the contrasting approaches in the suboptimal (Figure 45-A), and the more optimal (Figure 45-B). Most hospital beds have a fairly high headboard that prevents easy access to the patient's head (Figure 45-A).

Have someone remove the headboard while you prepare your equipment (Figure 45-B).

If you can't easily reach the patient, pull him toward you. Small individuals like myself will have more effective control because you don't have to lean forward.

You'll often find the patient on a soft hospital mattress with the hard cardiac arrest board under his back. Because the backboard allows effective CPR, we take this position for granted. We often fail to notice that the patient's head now hangs fully extended off the back of the board, forcing you to lift the patient's head much higher to straighten the airway.

45-A: Problems with intubation in the bed

45-B: Optimize your position for intubation during CPR

Figure 45: Optimal vs suboptimal positioning of a patient in a bed for intubation during cardiac arrest

(C) Head Position

CPR often places the patient's head in hyperextension as the head falls backward behind the CPR backboard under the patient. If you don't correct this, your view will be extremely anterior, making it difficult to see the glottis and to pass the tube.

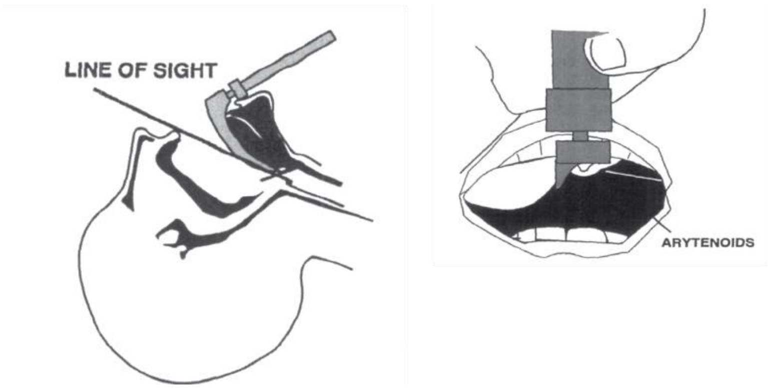


Figure 46: Difficulty due to head hyperextension

Head hyperextension impedes intubation because it makes the larynx appear very anterior. You can compensate by lifting the head into a sniffing position.

You must get the head into a sniffing position. Lifting a heavy head high during CPR is difficult. Use pillows to put the head in the sniffing position and decrease the lift needed.

Use your helpers. Don't hesitate to ask for help in lifting while you place the tube. Your helper must not move the head during laryngoscopy, or else tooth damage could occur. Cricoid pressure to push the larynx down can also help, as can pulling back the cheek.

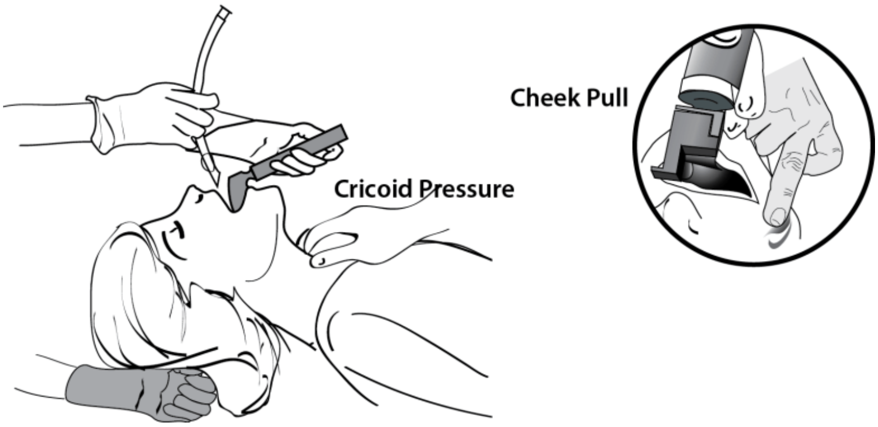


Figure 47: optimizing head position during resuscitation

Optimizing head position during resuscitation may entail having a helper assist you in holding the head up. Your help must not move the head in order to avoid tooth damage.

Special Note 1: Chest Compressions Hinder Intubation

CPR means that someone is rhythmically and forcefully pushing on the patient's chest. The patient and bed are both moving up and down. Moving targets are hard to hit at the best of times.

In emergency situations, you can choose a Macintosh curved blade. Its broader flange is more forgiving of less than perfect placement, awkward positioning, and moving target: conditions common in the emergency intubation. It also makes balancing the patient's head easier in those circumstances.

You get in position, visualize the larynx, and try to pass the tube. If movement prevents intubation, you say the command **"stop CPR".** Pass the tube. Then say the command **"begin CPR"**. This attempt should take no longer than 15 to 20 seconds, usually less. If you have any difficulty passing the tube have your associates begin CPR again.

Special Note 2: Video Laryngoscopy

Video laryngoscopy is another technique that can help in awkward positions. Video laryngoscopy makes difficult intubations faster, and reliably easier during cardiac arrest situations. It also makes intubation easier and less stimulating during emergency intubations for respiratory distress in the fragile patient.

It’s important for your helpers to clear a space for the video laryngoscopy monitor. Remind them that you must be able to see it during the key moments of the intubation — helpers have a tendency to step to the side of the bed to help, pushing it out of the way at inopportune moments.

Special Note 3: Don’t Delay Compressions but Do Provide Ventilation

Never delay CPR for an extended period because of an intubation attempt. If you have any difficulty passing the tube have your associates begin CPR again. Remove your blade, and ventilate the patient. Ventilation is the priority. If you have to place a device such as a laryngeal mask airway to ensure ventilation until you are in a better position to intubate, don’t hesitate to do so. This is far from ideal as cardiac arrest victims are at high risk of potentially massive emesis, but ventilation is key.

Following intubation, suction the tube and trachea carefully to remove any possible secretions and blood aspirated during the resuscitation.

4.5 Surgical Airway

Surgical airway is defined as obtaining access to ventilation by creating opening in trachea which can be achieved by either cricothyroidotomy or tracheostomy.

4.5.A Cricothyroidotomy

Needle cricothyroidotomy

In patients with extensive facial trauma, or when there is mechanical laryngeal obstruction, it is unfeasible to ventilate an apnoeic patient with a bag-valve-mask, or to pass a tracheal tube or another advanced airway device. Then it will be necessary to create a surgical airway below the level of the obstruction. However, it can only be a temporary measure until a definitive surgical airway can be created.

Advantages of needle cricothyroidotomy

- Immediate technique of choice in difficult airway.
- Less hazardous.
- Can be done rapidly.
- Requires only simple equipment.

Procedure

- Position: Supine with the head slightly extended.
- Palpate the cricothyroid membrane (between the thyroid cartilage (Adam's apple) and the cricoid cartridge).
- A large bore (≥ 14 gauge) intravenous cannula is attached to a 5 ml syringe and the membrane is punctured. Aspiration of air confirms the correct position. The trachea is situated just deep to the subcutaneous tissue and should be encountered at a very shallow depth.

- Direct the cannula a 45^0 angle caudally, while applying negative pressure to the syringe.
- Carefully insert the cannula through the lower half of the cricothyroid membrane, aspirating as the needle is advanced. The addition of 2-3 cc of saline to the syringe will aid in detecting air. Aspiration of air, which signifies entry into the tracheal lumen.
- Syringe is removed and the needle is withdrawn, while gently advancing the cannula downward into position taking care not to perforate the posterior wall of the trachea.
- Attach the jet insufflation equipment to the cannula or attach the oxygen tubing or 2mL Syringe (7.5) endotracheal tube connector combination over the catheter needle hub and secure the catheter to the patient's neck.
- Apply intermittent ventilation either by using the jet insufflation equipment or using thumb to cover the open hole cut into the oxygen tubing or inflating with an Ambu bag. Deliver oxygen for 1 second and allow passive expiration for 4 seconds.
- Observe check chest expansion and auscultate the chest for adequate ventilation.

** Adequate PaO_2 can be maintained for only around 30 to 45 minutes, and CO2 accumulation can occur more rapidly.

4.5.B Tracheostomy

Tracheostomy tracheal tubes

These are curved plastic tubes usually inserted through the 2nd ,3rd & 4th tracheal cartilage rings.

Figure 48: Different parts of tracheostomy tracheal tube

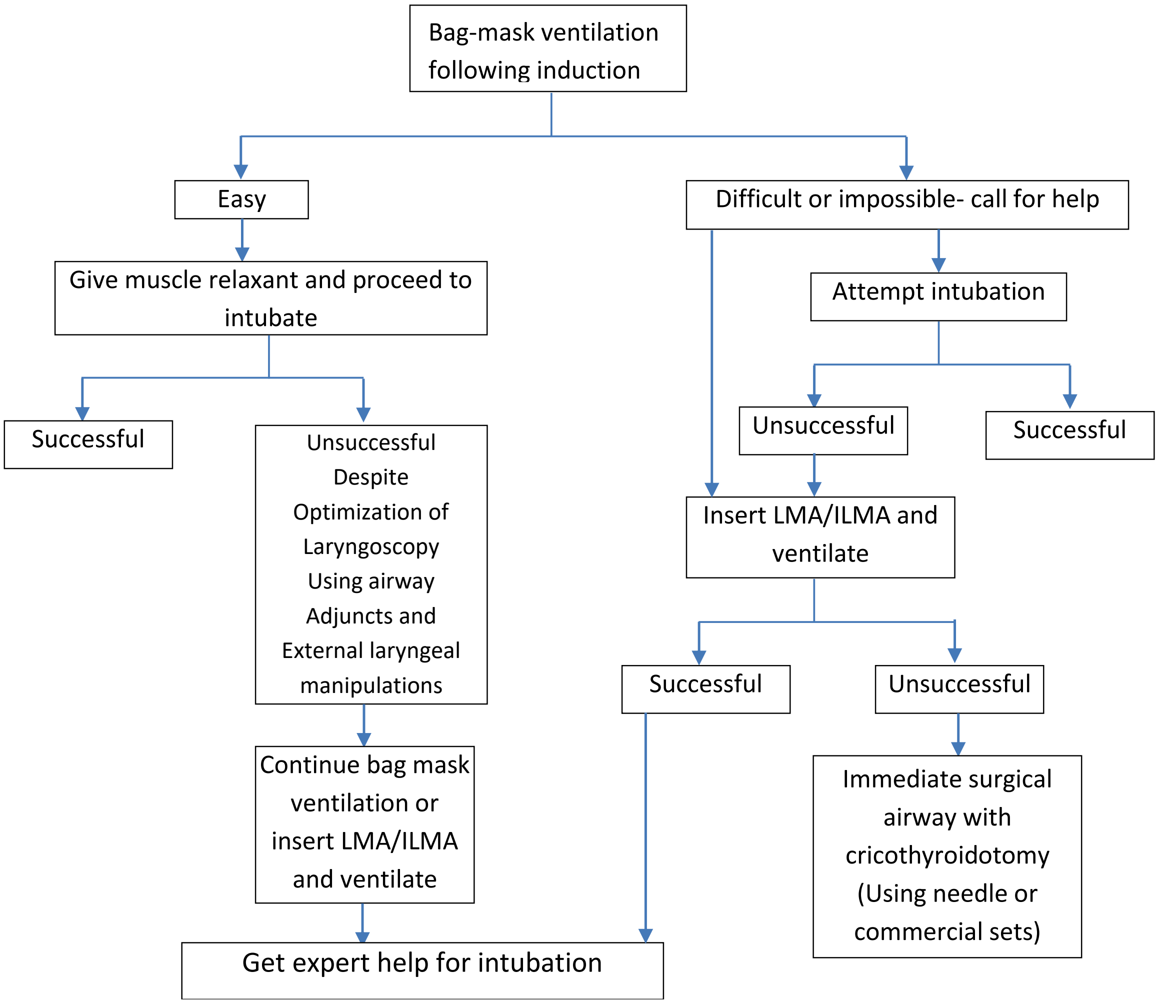


Figure 49: Unanticipated difficult airway algorithm

Chapter 5: Drugs used in ALS

Learning objectives:

At the end of the session, participants will learn-

- Drugs frequently used in ALS.
- Indications and dosage of the above-mentioned drugs.

The following chapter 5 contains brief description of the commonly used drugs in ALS.

1. Adrenaline

Adrenaline produces beneficial effects in patients during cardiac arrest primarily because of its α adrenergic receptor stimulating (i.e. vasoconstrictor) properties which increase coronary perfusion pressure (CPP) & cerebral perfusion pressure during CPR.

Indications of Adrenaline:

1. Anaphylaxis
2. Refractory Circulatory Shock.
3. Bradycardia

Dose of Adernaline in cardiac Arrest:

☑ 1 mg (1:10,000 dilution) I/V or I/O every 3 to 5 minutes during adult cardiac arrest.

☑ If, I/V or I/O access is delayed or cannot be established, Adrenaline may be given endotracheally at a dose of 2 to 2.5 mg. Flush with 5 ml or N/S & follow with 5 ventilations.

*****Higher I/V dose not recommended.**

☑ **In Profound Symptomatic Bradycardia & Refractory Circulatory Shock**
Infusion: 1 mg (1ml of 1:1000 solution) added to 500ml N/S or 5% D/W, run at 2- 10 µg/ min, Titrate according to response.

2. Amiodarone

☑ **Characteristics:** Complex drug with effects on sodium, potassium, & calcium channels as well as a and b adrenergic blocking properties.

Indications of Amiodarone:

1. Haemodynamically stable monomorphic VT.
2. Poly morphic VT with normal QT interval.
3. SVT with aberrant conduction.
4. VF or pulseless VT unresponsiveness to shock delivery.
5. AF with CHF
6. Adjunct to electrical cardioversion in refractory PSVTs, atrial tachycardia & AF.

Doses of Amiodarone:

☑ **VF or Pulseless VT:** 300 mg over 5-15 min followed by 150mg.

☑ **Antiarrhythmic dose:**

- **First dose:** 150mg given over 1 minute & repeated if necessary.
- **Maintenance infusion:** 1mg/min for first 6 hours.
- Followed by 0.5mg/min for next 18 hours.
- Total dose over 24 hours should not exceed 2.2 mg

Side Effects of Amiodarone: Bradycardia, Hypotension, Phlebitis.
****Comments:** Antiarrhythmic drug of choice if cardiac function is impaired, EF<40%, or CHF.

3. Lidocaine

☑ Anti-arrhythmic drug.
☑ Relatively weak **sodium channel blocker.**

Indications of Lidocaine:

1. CPR
2. Haemodynamically stable monomorphic VT
3. Premature ventricular ectopic.

** Used only as second line therapy, thus consider only if Amiodarone is unavailable.

Doses of Lidocaine:

☑ 1 to 1.5mg/kg I/V, repeated if required at 0.5 to 0.75 mg/kg I/V every 5 to 10 minutes, up to maximum cumulative dose of 3mg/kg.
☑ 1 to 4 mg/kg for maintenance infusion after successful resuscitation.

Side effects of Lidocaine: Bradycardia, altered consciousness, seizures, myocardial depression.

4. Adenosine

☑ Endogenous purine nucleoside.
☑ Briefly depress sinus node Rate & AV node conduction.
☑ Vasodilator.

Indication of Adenosine:

☑ Stable, narrow complex regular tachycardia.

Dose: 6 mg I/V as a rapid I/V push, followed by a 20 ml saline flush, repeated if required as 12 mg I/V push. Max 18 mg.
Side effects: Hypotension.

Contraindication of Adenosine: Bronchial Asthma

****Adenosine is safe & effective in Pregnancy.**

5. Atenolol/Esmolol/Metoprolol/Propranolol

☑ All are β blocking drugs.
☑ **Mechanism of action:**
  - Reduce heart rate, AV node conduction, and reduce blood pressure.
  - Negative inotropes.
  - Also reduces effect of circulating catecholamines.

Indications of β blocking drugs:

1. Stable narrow complex tachycardia if rhythm remains uncontrolled or unconverted by adenosine or vagal manoeuvres of if SVT is recurrent.
2. Control ventricular rate in patients with atrial fibrillation or atrial flutter.
3. Certain form of polymorphic VT.

Doses of β blocking drugs:

☑ Atenolol (β_1 selective blocker):
- 5 mg I/V over 5 minutes, repeat 5 mg in 10 minutes if arrhythmia persist or recurs.

☑ Esmolol: (β_1 selective blocker with 2 to 9 minutes half-life)
- Loading dose 0.5 mg/kg I/V over 1 min followed by an infusion of 0.05 mg/kg per minute till response.
- If response is inadequate, infuse second loading bolus of 0.5 mg/kg over 1 minute & increase maintenance infusion to 0.1 mg/kg per minute. Titrated according to response. Maximum infusion rate 0.3mg/kg.

☑ Metoprolol:
☑ 5 mg over 1 to 2 minutes repeated as required every 5 minutes. Maximum dose of 15 mg.

6. Sotalol:

☑ Potassium channel blocker & non-selective β blocker.

Indication of Sotalol: Haemodynamically stable monomorphic VT.

Dose of Sotalol:
☑ 1.5 mg/kg I/V infused over 5 minutes.
☑ Avoid if prolonged QT & CHF.

Side Effects of Sotalol: Bradycardia, Hypotension, Torsades de Pointes.

7. Atropine:

- ☑ It remains first line drug for acute symptomatic bradycardia.
- ☑ M/A: anticholinergic, increase SA nodal rate & automaticity.

Dose of Atropine:

- ☑ 0.5 -1 mg I/V in every 3 to 5 minutes to a maximum. Total dose of 3 mg.

** **Precaution:** Atropine cautiously used in acute coronary ischemia or MI.

***** Do not use in intranodal (Mobitz II) block**

8. Dopamine:

- ☑ It is α and β adrenergic, Dopaminergic receptor agonist.
- ☑ DA_1 present in CVS, Renal & Mesenteric blood vessels. DA_1 stimulation causes vasodilatation of renal, mesenteric, coronary & cerebral vessels.
- ☑ DA_2 receptor activation inhibits nor-adrenaline release.
- ☑ Plasma Half-life 2 to 5 minutes.

Indications of Dopamine:

1. Dopamine infusion may be used for patients with symptomatic bradycardia, particularly if associated with hypotension in whom atropine may be inappropriate or after atropine fails.
2. Treatment of circulatory shock to improve cardiac output, support blood pressure & maintain renal function.

Doses of Dopamine:

- ☑ **Low dose:** Dopaminergic (0.5-2μg/kg/min.) Vasodilate renal vasculature & promote diuresis.
- ☑ **Moderate doses (2-10μg/kg/min) :** β_1 stimulation increase myocardial contractility, heart rate, & cardiac output, decrease urinary output.
- ☑ **At higher doses (>10 μg/kg/min):** Stimulates α adrenoceptor, α_1 effect become prominent which increase peripheral vascular resistance & fall in renal blood flow.

Side effects of Dopamine:

- ☑ Tachycardia
- ☑ Arrhythmia

Contraindications of Dopamine:

- ☑ Pheochromocytoma
- ☑ Cardiac dysrhythmia

9. Adrenaline:

☑ Infusion at 2-10 µg/min and titrate according to patient response.

10. ** Drugs not recommended during cardiac arrest:

1. Atropine:

☑ Routine use of atropine during PEA or Asystole is unlikely to have a therapeutic benefit.

2. Sodium Bicarbonate:

☑ Routine use of Sodium bicarbonate is not recommended for patients in cardiac arrest.

☑ In some special resuscitation, such as pre-existing metabolic acidosis, hyperkalaemia, TCA overdose, Bicarbonate can be beneficial.

3. Calcium: It is also not recommended.

4. Magnesium:

- Routine use of Magnesium for VF/pulse less VT is not recommended in adult patient unless Torsades de pointes is present.

Chapter 6: Post cardiac arrest care

Learning objectives:

At the end of the session, participants will learn-

- Management of cardiac arrest survivors
- Brief overview of post-resuscitation care guidelines
- Brief overview of mechanical ventilation

Algorithm of Post Cardiac Arrest Care

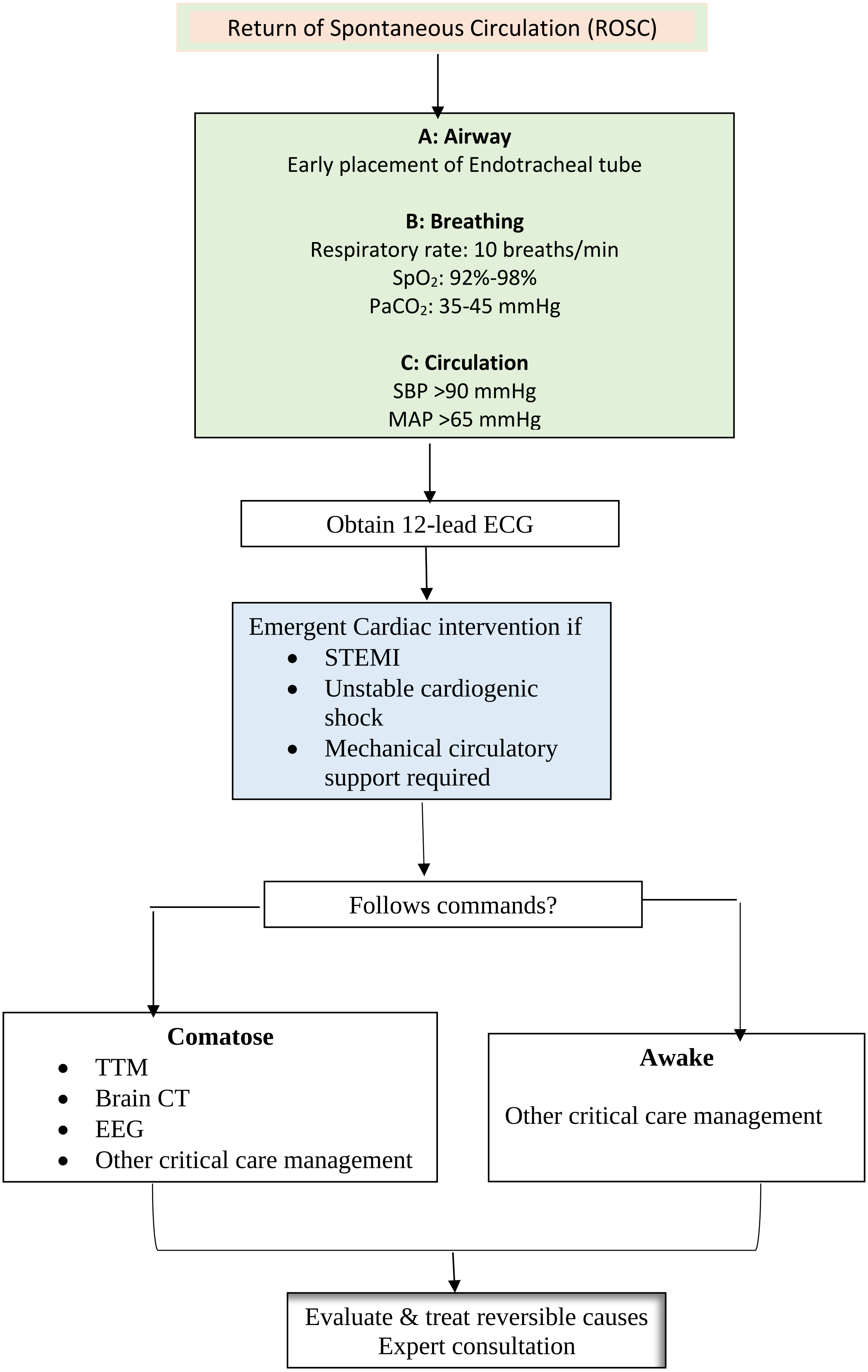


Figure 50: Algorithm of Post Cardiac Arrest Care

6.1 Phases of Post Cardiac Arrest Care

Aim of ALS providers is survival of cardiac arrest patients with good quality of life. After providing high quality CPR, an integrated post cardiac arrest care is essential for this purpose. The care can be divided into two phases:

A. Initial stabilization phase
B. Continued management & additional emergent activities

A. Initial stabilization phase: It should be started as soon as return of spontaneous circulation (ROSC) occurs (F**igure 50**).

i. **Airway:** Airway should be secured by placing endotracheal (ET) tube if not placed earlier. In Intensive Care Unit (ICU), head end of the bed should be elevated at 30° to minimize risk of aspiration, ventilator associated pneumonia (VAP) and cerebral oedema.

ii. **Breathing:** Survivors of cardiac arrest are usually placed on mechanical ventilator. Respiratory rate should be adjusted in ventilators to 10 breaths/min. Respiratory rate should be adjusted with target of $PaCO_2$ (Partial pressure of CO_2 in arterial blood) 35-45 mmHg. Inspired oxygen should be adjusted to the lowest level to achieve SpO_2 92% to 98%, or arterial partial pressure of oxygen (PaO2) of 10–13 kPa or 75–100 mmHg, and to avoid potential oxygen toxicity.

Too fast and/or too much ventilation should be avoided as it causes increase in intrathoracic pressure and thus decreases BP.

iii. **Circulation:** Target of Systolic BP (SBP) is >90 mmHg, or mean arterial pressure is >65 mmHg in patients who have ROSC following cardiac arrest. If BP is lower than this target, then crystalloid fluid boluses (1-2L normal saline or lactated Ringer's solution) and/or vasopressor/inotropes (table 4) should be given. Less amount of fluid should be given if patient has features of volume overload, cardiac failure or renal failure.

Table 3: Vasopressors used for post-cardiac arrest care

Drugs	Doses
Norepinephrine	0.1 to 0.5 mcg/kg/min
Epinephrine	2 to 10 mcg/min
Dopamine	5 to 20 mcg/kg/min

iv. A 12-lead ECG should be obtained. Any new changes, or ST-elevation, or presence of arrhythmia must be identified and treated accordingly.

B. Continued management & additional emergent activities

i. Consider emergent cardiac interventions if patient has any of the following criteria:

- ☑ STEMI
- ☑ Unstable cardiogenic shock
- ☑ Mechanical circulatory support is required

ii. Conscious level of the patients should be assessed by asking them some simple questions (like, '**move your right hand'**, or '**show your tongue'**). Further management depends on whether they can follow commands or not.

- ☑ If patient does not follow commands, then immediately Targeted Temperature Management (TTM) should be started. TTM is necessary for achieving good neurological outcome. Target temperature is 32° to 36°C for first 24 hours following cardiac arrest in adults, & first 72 hours in newborns. To achieve this target, external and internal cooling method can be used. These include rapid infusion of ice-cold, isotonic, non-glucose containing fluid (30 ml/kg), endovascular catheter, simple surface interventions (e.g., ice bags, lowering room temperature, water spraying followed by fanning etc.) and surface cooling devices. After 24 hours, temperature should be slowly raised to normal body temperature.

  A CT scan of brain should be done to find out any structural injury. To rule out non-convulsive status epilepticus (NCSE), electroencephalogram (EEG) monitoring has to be done in association with other critical care management.

- ☑ If patient follows commands, then only other critical care management should be provided. This includes continuous monitoring of core temperature (oesophageal, rectal and bladder); maintaining normoxia, normocapnia and euglycemia (blood glucose 150 to 180 mg/dl); providing continuous or intermittent EEG monitoring; and providing lung-protective ventilation.

iii. All survivors of cardiac arrest should be evaluated for rapidly reversible aetiologies of cardiac arrest (5H's and 5T's) and treated accordingly (Figure 1). Expert Consultants should be involved for continued management of patients with ROSC.

Hypoxic-ischemic brain injury is the leading cause of poor outcome after resuscitation. Combination of high-quality CPR and effective post cardiac arrest care is necessary for good neurological outcome. Other than TTM, no neuroprotective agents show any efficacy in clinical outcomes. Multimodal neuroprognostication should be used at a minimum of 72 hours after normothermia. This is very important to avoid inappropriate withdrawal of treatment of patients by their surrogates, and to avoid continued treatment in patients with possible poor outcome.

6.2 Post-resuscitation care guidelines (Additional points)

6.2.A Immediate post-resuscitation care

Post-resuscitation care is started immediately after sustained ROSC, regardless of location. Following out-of-hospital cardiac arrest, consider transport to a recognized centre of care (e.g cardiac arrest centre).

Airway management after return of spontaneous circulation

- ☑ Airway and ventilation support should continue after return of spontaneous circulation (ROSC) is achieved.
- ☑ Patients who have had a brief period of cardiac arrest and an immediate return of normal cerebral function and are breathing normally may not require tracheal intubation but should be given oxygen via a face mask if their arterial blood oxygen saturation is less than 94%.
- ☑ Patients who remain comatose following ROSC, or who have another clinical indication for sedation and mechanical ventilation, should have their trachea intubated if this has not been done already during CPR.
- ☑ Correct placement of the tracheal tube must be confirmed with waveform capnography.
- ☑ In the absence of personnel experienced in tracheal intubation, it is reasonable to insert a supraglottic airway (SGA) or maintain the airway with basic techniques until skilled intubators are available.

Control of oxygenation

- ☑ After ROSC, use 100% (or maximum available) inspired oxygen until the arterial oxygen saturation or the partial pressure of arterial oxygen can be measured reliably.
- ☑ Avoid hypoxaemia (PaO_2 < 8 kPa or 60 mmHg) following ROSC.
- ☑ Avoid hyperoxaemia following ROSC.

Control of ventilation

- ☑ Obtain an arterial blood gas and use end tidal CO_2 in mechanically ventilated patients.
- ☑ In patients requiring mechanical ventilation after ROSC, adjust ventilation to target a normal arterial partial pressure of carbon dioxide ($PaCO_2$) i.e. 4.5–6.0 kPa or 35–45 mmHg.
- ☑ In patients treated with targeted temperature management (TTM), monitor $PaCO_2$ frequently as hypocapnia may occur.
- ☑ During TTM and lower temperatures, use consistently either a temperature or non-temperature corrected approach for measuring blood gas values.

- ☑ Use a lung protective ventilation strategy aiming for a tidal volume of 6–8 mL kg^{-1} ideal body weight.

Circulation

Coronary reperfusion

- ☑ Emergent cardiac catheterisation laboratory evaluation (and immediate PCI if required) should be performed in adult patients with ROSC after cardiac arrest of suspected cardiac origin with ST-elevation on the ECG.
- ☑ In patients with ROSC after out-of-hospital cardiac arrest (OHCA) without ST elevation
- ☑ On ECG, emergent cardiac catheterization laboratory evaluation should be considered if there is an estimated high probability of acute coronary occlusion (e.g. patients with haemodynamic and/or electrical instability).

Haemodynamic monitoring and management

- ☑ All patients should be monitored with an arterial line for continuous blood pressure measurements, and it is reasonable to monitor cardiac output in haemodynamically unstable patients.
- ☑ Perform early (as soon as possible) echocardiography in all patients to detect any underlying cardiac pathology and quantify the degree of myocardial dysfunction.
- ☑ Avoid hypotension (< 65 mmHg). Target mean arterial pressure (MAP) to achieve adequate urine output (> 0.5 mL $kg^{-1}h^{-1}$) and normal or decreasing lactate.
- ☑ During TTM at 33°C, bradycardia may be left untreated if blood pressure, lactate, $ScvO_2$ or SvO_2 is adequate. If not, consider increasing the target temperature, but to no higher than 36°C.
- ☑ Maintain perfusion with fluids, noradrenaline and/or dobutamine, depending on individual patient need for intravascular volume, vasoconstriction or inotropy.
- ☑ Do not give steroids routinely after cardiac arrest.
- ☑ Avoid hypokalaemia, which is associated with ventricular arrhythmias.
- ☑ Consider mechanical circulatory support (such as intra-aortic balloon pump, left-ventricular assist device or arterio-venous extra corporal membrane oxygenation) for persisting cardiogenic shock from left ventricular failure if treatment with fluid resuscitation, inotropes, and vasoactive drugs is insufficient. Left-ventricular assist devices or arterio-venous extra corporal membrane oxygenation should also be considered in hemodynamically unstable patients with acute coronary syndromes (ACS) and recurrent ventricular tachycardia (VT) or ventricular fibrillation (VF) despite optimal therapy.

Disability (optimizing neurological recovery)

Control of seizures

- ☑ We recommend using electroencephalography (EEG) to diagnose electrographic seizures in patients with clinical convulsions and to monitor treatment effects.

- ☑ To treat seizures after cardiac arrest, we suggest levetiracetam or sodium valproate as first-line antiepileptic drugs in addition to sedative drugs.

- ☑ We suggest that routine seizure prophylaxis is not used in post-cardiac arrest patients.

6.2.B General intensive care management

- ☑ Use short-acting sedatives and opioids.
- ☑ Avoid using a neuromuscular blocking drug routinely in patients undergoing TTM, but it may be considered in case of severe shivering during TTM.
- ☑ Provide stress ulcer prophylaxis routinely in cardiac arrest patients.
- ☑ Provide deep venous thrombosis prophylaxis.
- ☑ Target a blood glucose of 7.8–10 mmol L-1 using an infusion of insulin if required; avoid hypoglycemia (< 4.0 mmol L-1).
- ☑ Start enteral feeding at low rates (trophic feeding) during TTM and increase after rewarming if indicated. If TTM of 36°C is used as the target temperature, gastric feeding rates may be increased early during TTM.
- ☑ We do not recommend using prophylactic antibiotics routinely.

Prognostication

- ☑ In patients who are comatose after resuscitation from cardiac arrest, neurological prognostication should be performed using clinical examination, electrophysiology, biomarkers, and imaging, to both inform patient's relatives and to help clinicians to target treatments based on the patient's chances of achieving a neurologically meaningful recovery.
- ☑ No single predictor is 100% accurate. Therefore, a multimodal neuro-prognostication strategy is recommended.
- ☑ When predicting poor neurological outcome, a high specificity and precision are desirable, to avoid falsely pessimistic predictions.
- ☑ The clinical neurological examination is central to prognostication. To avoid falsely pessimistic predictions, clinicians should avoid potential confounding from sedatives and other drugs that may confound the results of the tests.
- ☑ When patients are treated with TTM, daily clinical examination is advocated but final prognostic assessment should be undertaken only after rewarming.

- ☑ Clinicians must be aware of the risk of a self-fulfilling prophecy bias, occurring when the results of an index test predicting poor outcome is used for treatment decisions, especially regarding life-sustaining therapies.
- ☑ Tests for neurological prognostication are aimed at assessing the severity of hypoxic-ischaemic brain injury. The neurological prognosis is one of several aspects to consider in discussions around an individualʹs potential for recovery.

Multimodal prognostication

- ☑ Start the prognostication assessment with an accurate clinical examination, to be performed only after major confounders (e.g. residual sedation, hypothermia) have been excluded.
- ☑ In a comatose patient with M ≤ 3 at ≥ 72 h from ROSC, in the absence of confounders, poor outcome is likely when two or more of the following predictors are present: no pupillary and corneal reflexes at ≥ 72 h, bilaterally absent N20 somatosensory evoked potential (SSEP) wave at ≥ 24 h, highly malignant EEG at >24h, neuron specific enolase (NSE) > 60 mcg L-1 at 48 h and/or 72 h, status myoclonus ≤ 72 h, or a diffuse and extensive anoxic injury on brain CT/MRI. Most of these signs can be recorded before 72 h from ROSC, however their results will be evaluated only at the time of clinical prognostic assessment.

Long-term outcome after cardiac arrest

Perform functional assessments of physical and non-physical impairments before discharge from the hospital to identify early rehabilitation needs and refer to rehabilitation if necessary.

Organize follow-up for all cardiac arrest survivors within 3 months after hospital discharge, including:

1. Screening for cognitive problems.

2. Screening for emotional problems and fatigue.

3. Providing information and support for survivors and family members.

Recognized centers of care

- ☑ Adult patients with non-traumatic OHCA should be considered for transport to a recognized center of care (e.g. cardiac arrest centre or heart attack centre) for appropriate specialist treatment, according to local protocols.

☑ Adult patients with a cardiac arrest of presumed cardiac aetiology should be transported directly to a hospital with 24/7 coronary angiography capability.

6.3 Mechanical Ventilation

Mechanical ventilation (MV) is an important part of post-cardiac arrest care. Having a basic familiarity with MV increases the chance of patient survival. Besides use in cardiac arrest survivor, MV is used in type I & type II respiratory failure, stroke, after major surgery, status epilepticus, upper spinal cord injury, poliomyelitis, flail chest etc.

MV can be divided into two types:

- ☑ Positive pressure ventilation
- ☑ Negative pressure ventilation

Ventilators used in cardiac arrest survivors are positive pressure ventilators. These ventilators use a pneumatic system for delivery of gas into the lungs during inspiration. During spontaneous inspiration, both intra-pulmonary and intra-pleural pressures are negative to inhale air into lungs. On the contrary, both of these pressures are positive during mechanically ventilated inspiratory phase as air is pushed inside the lungs by the ventilator. Expiration occurs passively during positive-pressure ventilation. During spontaneous expiration, both intra-pleural and intra-pulmonary pressure rise above their level in inspiratory. In mechanically ventilated expiration, both of these pressures fall from their level in inspiration.

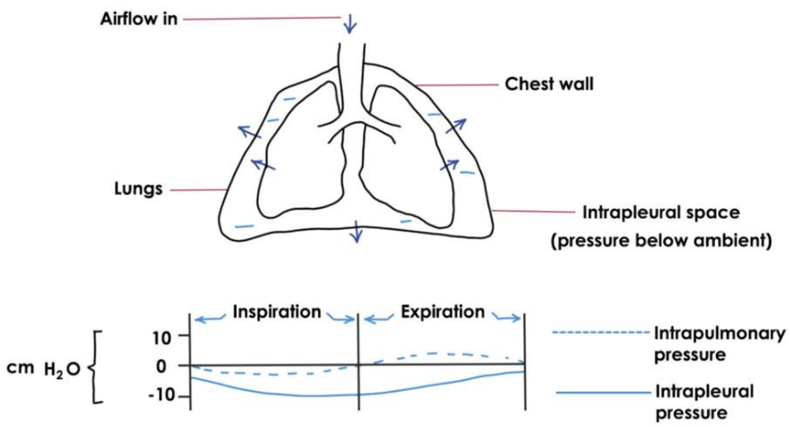


Figure 51: Thoracic pressures during spontaneous respirations

<u>Ventilator settings</u>: Fraction of inspired oxygen (FiO_2), Tidal volume (V_T), Respiratory rate (RR), Flow rate and Inspiratory-to-expiratory ratio (I:E ratio) are needed to be set by the clinicians. In cardiac arrest survivors, FiO_2 should be adjusted to the minimum level to achieve SpO_2 92% to 98%, and to avoid potential oxygen toxicity. RR should be adjusted to 10 breaths/min (1 breath every 6 seconds) with target of $PaCO_2$ 35-45 mmHg. Usually V_T is given 6-8 ml/kg of ideal body weight of the patient with I:E ratio adjusted to 1:2.

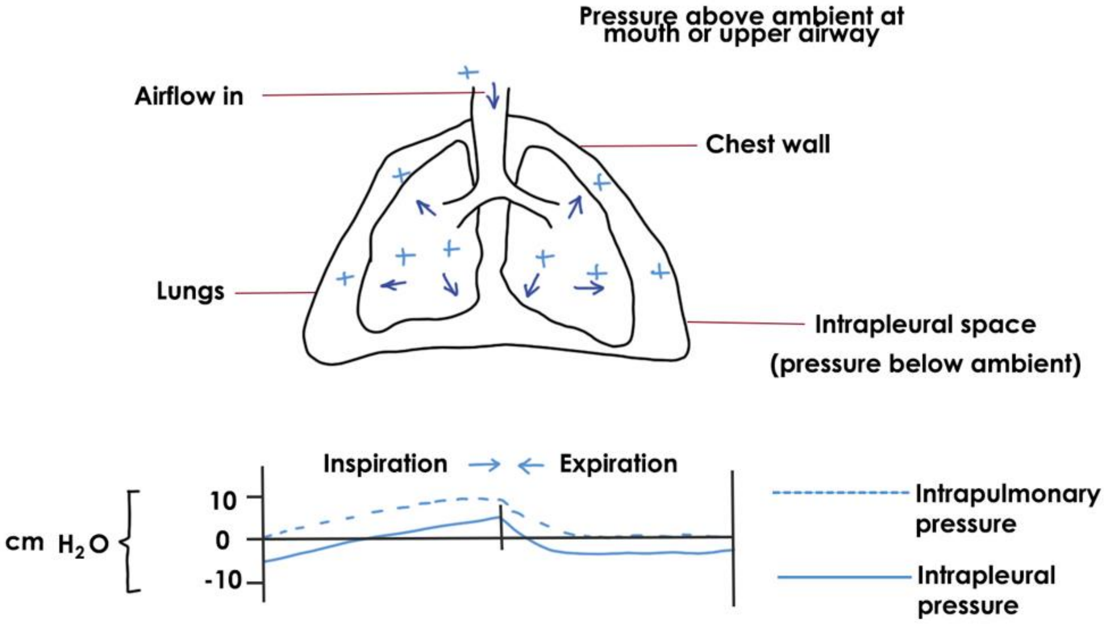


Figure 52: Thoracic pressures during mechanical ventilation

Ventilators have **four basic phases** to provide a ventilatory cycle (i.e., a full breath) to the patients:

- **Expiratory-inspiratory changeover:** It is the 'Trigger' variable that determines the initiation of breath. Inspiration may be initiated by the patient or by the ventilator. How the ventilator trigger into the inspiratory phase is controlled by the clinician.
- **Inspiration:** A preset volume, or pressured air, or airflow is delivered into the lungs during inspiratory phase. All of these variables have maximal setting which does not exceed during inspiration. During this phase, generated positive pressure causes lung inflation. This positive pressure causes most of the complications of MV, like hemodynamic compromise and barotrauma.
- **Inspiratory-expiratory changeover:** Pressure, volume, flow, or time variable ends the inspiration. As example, inspiration ends, and expiration begins after a pre-determined time interval is reached in time-cycled ventilation. Among these four variables (pressure, volume, flow & time), one factor is controlled/adjusted by the Clinician, and other three factors are needed to be monitored.
- **Expiration:** Exhalation occurs passively because of the elastic recoil of the lungs.

Vital signs of the **patients undergoing MV** should be monitored at regular interval along with full respiratory system examination (including inspection, palpation, percussion, and auscultation of chest). This will help in identify patient-ventilator asynchrony, complications due to MV (table II) and any mechanical error of ventilator. Effect of respiratory cycle on interpretation of hemodynamic should be monitored also.

Table 4: Complications due to Mechanical Ventilation

Problems related to positive pressure	Ventilator induced lung injury (Barotrauma including pneumothorax, Volutrauma, Biotrauma, Oxygen toxicity etc.) Reduction in cardiac output & Hypotension Positive fluid balance due to alteration in renal function Increased intracranial pressure Ventilation-perfusion mismatch
Problems related to artificial airway	Trauma, Cardiac arrhythmia, Necrosis, Erosion, Laryngeal incompetence
Ventilator associated Pneumonia (VAP)	
Patients' anxiety and stress	
Gastric distress	Abdominal distension, Gastritis, Ulcers

Chapter 7: Cardiac arrest / CPR in special situation

Learning objectives:

At the end of the session, participants will gain knowledge on-

- Management of cardiac arrest in pregnant ladies
- Management of cardiac arrest due to Opioid overdose
- Management of critically ill patients due to Anaphylaxis including cardiac arrest
- Management of critically ill patients due to Accidental Hypothermia including cardiac arrest
- Management of critically ill patients due to Drowning including cardiac arrest

7.1 Cardiac arrest associated with Pregnancy [10,11]

Cardiac arrest in pregnancy involves two lives to be saved: the pregnant lady and the fetus. Survival of fetus may be possible at 24 weeks or more.

At approximately 20 weeks or more of pregnancy, gravid uterus exerts significant pressure on abdominal aorta & inferior vena cava. Compression of the vena cava causes reduction in venous return, which in turn decreases stroke volume and cardiac output. This adversely affects attempted resuscitation during CPR and may even precipitate arrest in critically ill patients.

- When a critically ill pregnant lady is admitted in hospital, she should be advised to lie in left lateral decubitus position. If patient is semiconscious or unconscious, then it can be achieved with help of several pillows, or angled back of 2/3 chairs kept in inverted position, or even with angled thighs of people who sit in kneel down position beside the pregnant lady.
- Oxygen reserves are lower and metabolic demands are higher in pregnant ladies compared to non-pregnant. So, to prevent or treat hypoxia, 100% oxygen should be provided via face mask.
- When a pregnant lady develops cardiac arrest, CPR should be started immediately following BLS and ACLS algorithm (Figure 53).
- At the same time, 'Maternal cardiac arrest team' should be informed in case of in-hospital cardiac arrest. This team is made in collaboration with the obstetric, neonatal, emergency, intensive care, anaesthesiology and cardiac arrest services.

- High quality CPR should be provided to the pregnant patients. Defibrillation and other steps of ALS algorithm must be provided when indicated. Reasons of arrest should be looked for while performing CPR. Reversible causes of cardiac arrest (5H's and 5T's) and pre-existing medical conditions should be identified and treated accordingly.

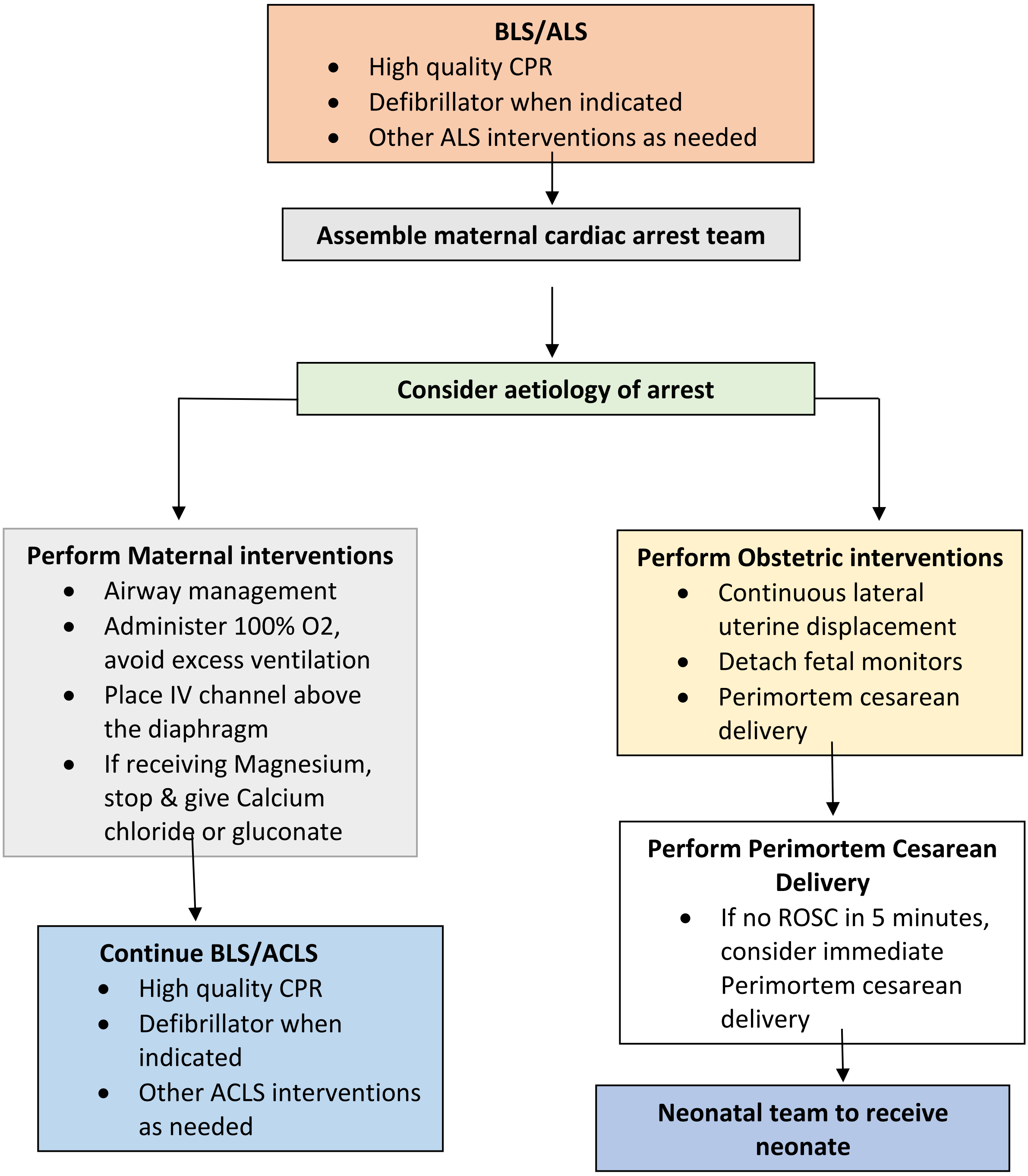


Figure 53: ACLS algorithm at in-hospital cardiac arrest in pregnancy

Several 'Maternal interventions' should be provided to all pregnant ladies in cardiac arrest. These include:

- Airway management: The most experienced provider should manage the airway in pregnant as difficult airway is common in pregnancy. Either endotracheal intubation or supraglottic advanced airway should be placed during CPR.
- 100% oxygen should be provided to pregnant patient in cardiac arrest. Endotracheal (ET) intubation is done with narrow ET tube (6 to 7mm inner diameter) with the most experienced provider in the team. Excessive ventilation should be avoided. **One breath is to be given in every 6 seconds when advanced airway is placed successfully (10 breaths/min).** If facility for waveform capnography or capnometry is available, then it should be performed to confirm and monitor ET tube placement.
- IV channel should be opened above the diaphragm to ensure that drug delivery is not hampered by aorto-caval compression by gravid uterus. If patient has hypotension (Systolic BP <100 mmHg, or less than 80% of baseline), it should be managed accordingly.
- If patient was receiving IV magnesium before cardiac arrest, then it should be stopped immediately when cardiac arrest occurs. After discontinuation of IV magnesium, calcium chloride or gluconate should be given.

'Obstetric interventions' are for pregnant ladies who have an obviously gravid uterus that causes aorto-caval compression. This usually occurs at 20 weeks of gestational age, or when the fundus of the uterus is at/above the level of the umbilicus. These interventions include the followings:

- Left uterine displacement can be done manually by standing on the left side of the patient and pulling the uterus with two hands of the provider towards himself/herself (**Figure 54**). It can also be done by standing on right side of the patient and pushing the uterus to the left side **(Figure 55**). Aorto-caval decompression can also be done by tilting patient to left by placing rolled bed sheets under the right flank of the patient; or by tilting the bed of the patient (**Figure 56**). Though it is feasible to perform chest compressions in tilted patient, but chest compressions in tilted position are not as forceful as in supine position. So, **manual left uterine displacement is mainly suggested for pregnant ladies in cardiac arrest.**

- If there are attached foetal monitors, those should be detached when pregnant lady develops cardiac arrest to facilitate further management.
- If there is no return of spontaneous circulation (ROSC) in 5 minutes of starting CPR, immediate Perimortem caesarean delivery should be considered. It causes improvement in maternal circulation and is associated with ROSC. Assessment of foetal survival is not recommended during resuscitation. The foetus may survive outside the womb at 24 weeks of gestation or more. Chances increase with advanced gestational age and availability of resources. After delivery, the Neonatal team should receive the neonate and do needful.

If there is no ROSC, high quality CPR should be continued.

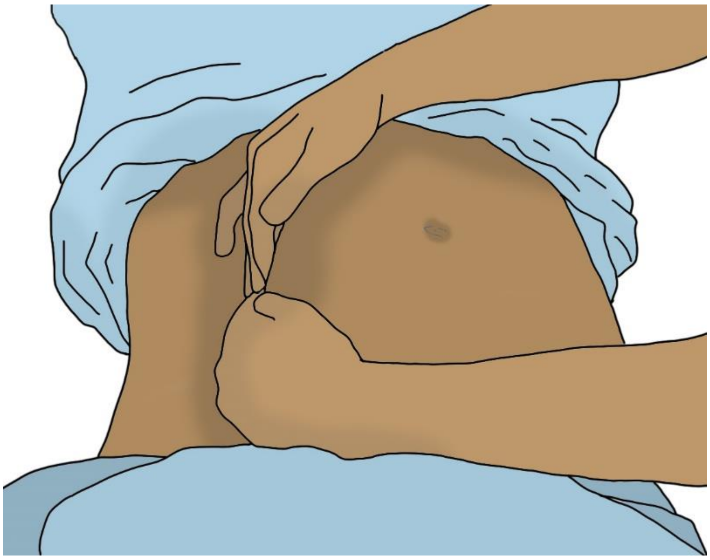


Figure 54: Manual left uterine displacement by standing on left side of pregnant lady

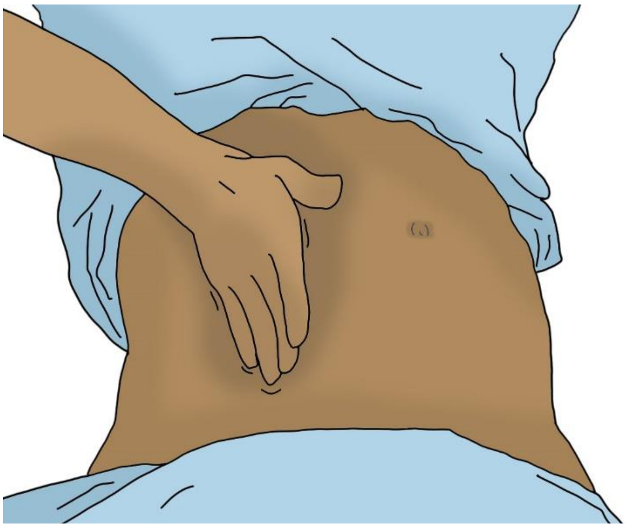


Figure 55: Manual left uterine displacement by standing on right side of pregnant lady of pregnant lady of pregnant lady

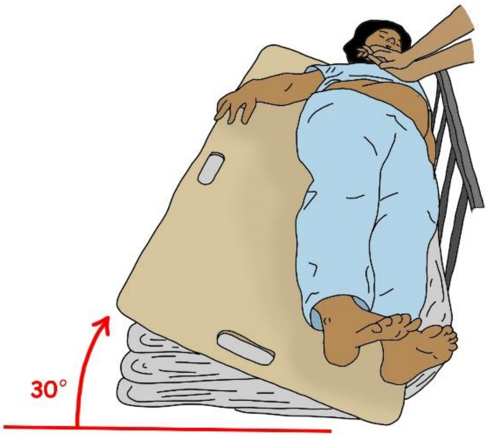


Figure 56: Chest compression and simultaneous aorto-caval decompression by left lateral tilt side of pregnant lady

In the absence of necessary facilities, it should be remembered always that **'maternal resuscitation is the best foetal resuscitation**'. If effective and high-quality CPR can result in ROSC in mother, it will be helpful for foetal survival also. If pregnant lady remains comatose after ROSC, then targeted temperature management (TTM) must be provided. As TTM may cause foetal bradycardia, so continuous foetal monitoring is needed.

7.2 Opioid overdose [12]

Substance abuse especially opioid like substance is becoming common in Bangladesh. [13] Examples of opioid includes - oxycodone, hydrocodone, codeine, morphine etc. The typical symptoms seen in opioid overdose are pinpoint pupils, respiratory depression, and a decreased level of consciousness. There are incidences of respiratory or cardiac arrests due to opioid overdoses. Opioid causes central nervous system and respiratory depression, leading to arrest. Some also cause cardiotoxicity. Methadone and propoxyphene can cause Torsades de pointes.

Naloxone is potent opioid receptor antagonist which can be administered during opioid-associated resuscitation. It causes rapid reversal of CNS and respiratory depression. Naloxone can be given intravenously, intramuscularly, subcutaneously, intranasally, through nebulization, or through endotracheal tube into the bronchial tree. Management of cardiac arrest due to opioid overdose is showed on **figure - 57**.

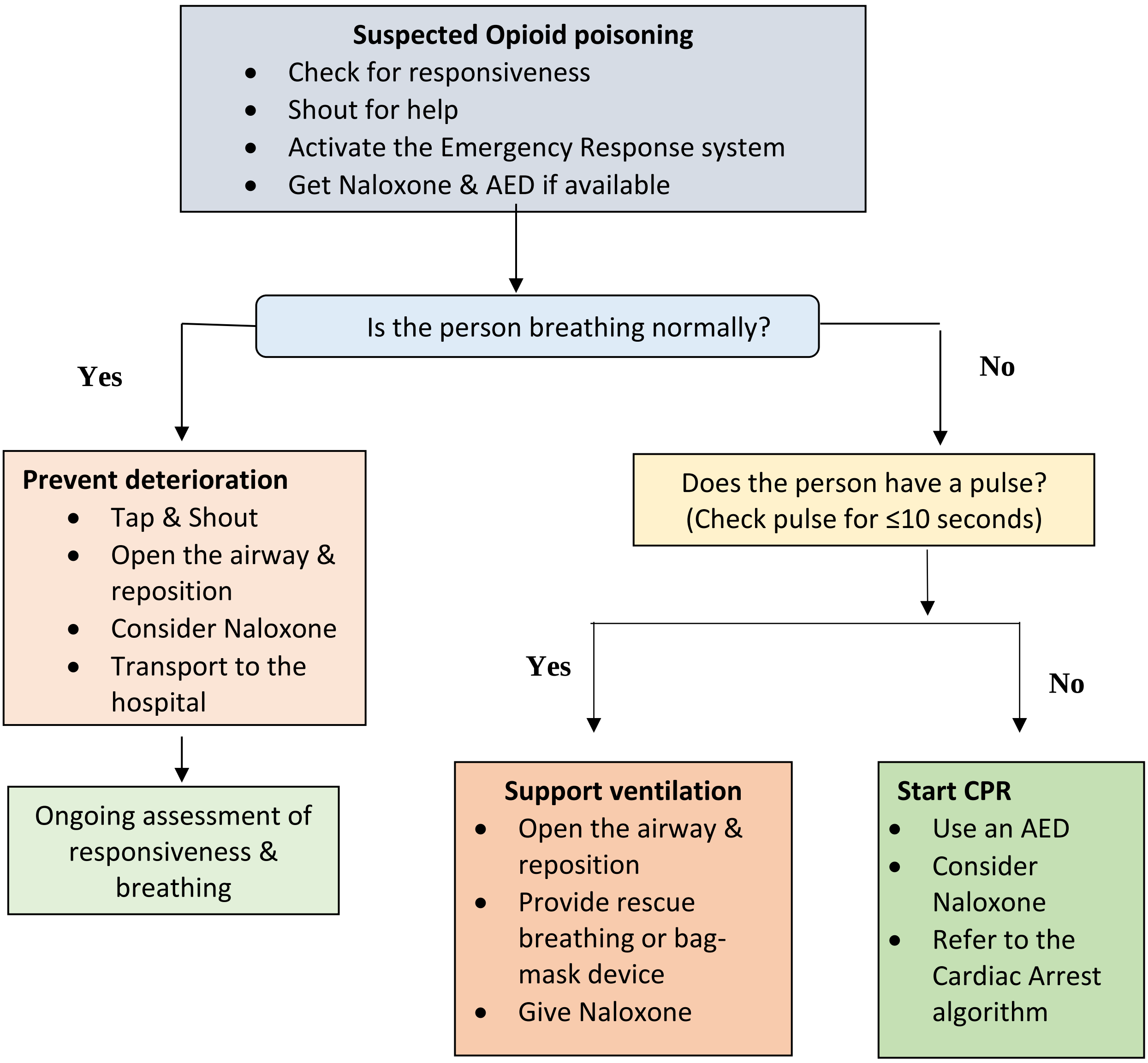


Figure 57: Algorithm of Opioid-associated emergency

7.3 Anaphylaxis

Anaphylaxis is an allergic reaction causing multisystem involvement. Severe cases cause complete obstruction of the airway and cardiovascular collapse from vasogenic shock. Management includes:

- Adrenaline administration in anaphylaxis and also during CPR: It should be administered in patients with anaphylaxis having airway swelling, difficulty in breathing, hypotension, or in cardiac arrest. If Adrenaline auto-injector is available, then it is administered in antero-lateral aspect of middle third of thigh of the patient. Recommended dose is 0.2 to 0.5 mg (1:1000) intramuscularly; and can be repeated every 5 to 15 minutes if there is no clinical improvement. When intravenous (IV) channel has been opened, then it can be given in IV (0.05 to 0.1 mg) route.
- Advanced airway, including surgical airway, must be placed due to rapid development of oropharyngeal and laryngeal oedema.
- Anaphylactic shock requires aggressive fluid management. Bolus doses (minimum 1-2L) of isotonic crystalloid should be administered with a target of systolic BP of ≥90 mmHg. In profound shock, IV infusion of Adrenaline is recommended. If patient is not responding to Adrenaline infusion, then alternative vasopressor agents, like noradrenaline, vasopressin etc. can be given in infusion in cardiac arrest.
- Antihistamines (both H-1 and H-2 antagonists), inhaled bronchodilator and IV corticosteroid are given as adjunctive therapy.

7.4 Accidental Hypothermia

CPR should be given according to BLS and ALS algorithms along with active rewarming of patients having hypothermia (core temperature <35ºC or <95ºF). If severely hypothermic (body temperature <30ºC or <86ºF) patients have shockable rhythm (VF or pVT), then defibrillation must be attempted. It should be remembered that drugs may accumulate in toxic level at standard doses in hypothermic patients due to reduced metabolism. Active core rewarming should be attempted in all patients with hypothermia. These patients may have profound bradycardia. So, pulse should be checked for at least 30 to 45 seconds.

7.5 Drowning

Cardiac arrest in drowning victim is mostly caused by a severe lack of oxygen in the body (asphyxial arrest). Duration and severity of hypoxia are the most important determinants of mortality. Therefore, **rescue breathing is prioritized** in drowning patients with cardiac arrest. The CPR algorithm is Airway-Breathing-Circulation (A-B-C)[12] in drowning. If trained rescuer is present, then rescue breathing should be initiated while in-water. During resuscitation, especially at time of airway opening, cervical spine stabilization is indicated only if there is suspicion of spinal injury. Otherwise, routine stabilization is not needed. After ROSC, all drowning patients should be admitted in hospital and must be monitored at least for minimum of 4-6 hours for signs of late complications like acute respiratory distress syndrome (ARDS). **(Figure 58)**

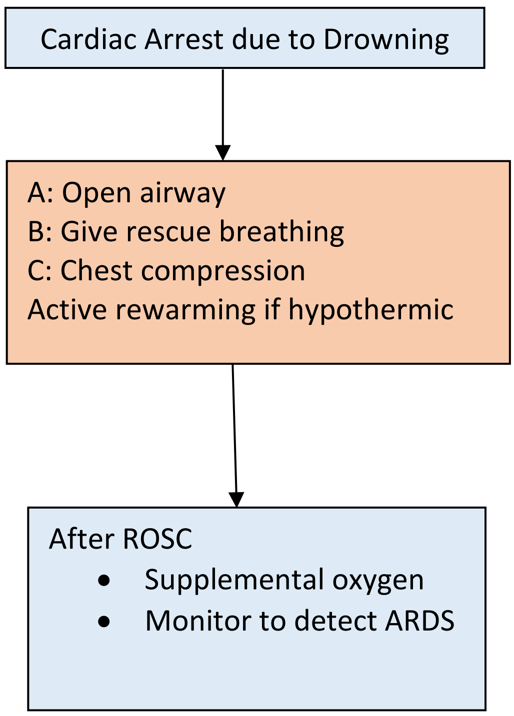


Figure 58: ALS in drowning

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Annexure

Annex 1: Pre & Post Test

Training on Advanced Life Support (ALS)

Pre test/Post test

20 marks; 15 minutes

Click the (√) mark on correct answers. Each question carries one mark.

1. Which statement best describes sudden cardiac arrest?
    a. When respiratory distress in adults occurs and the heart rate does not change.
    b. When the heart rate is 40 to 60/min and respirations increase.
    c. When blood flow to the heart is blocked and the heart rate increases
    d. When an abnormal rhythm develops and the heart stops beating unexpectedly

2. What are the rate and depth for chest compressions on an adult?
    a. A rate of 60 to 80 compressions per minute and a depth of about 1 inch
    b. A rate of 80 to 100 compressions per minute and a depth of about 1½ inches
    c. A rate of 120 to 140 compressions per minute and a depth of about 2½ inches
    d. A rate of 100 to 120 compressions per minute and a depth of at least 2 inches

3. What is the most appropriate first step to take as soon as the AED arrives at the victim's side?
    a. Power on the AED
    b. Apply the pads
    c. Press the analyze button
    d. Press the shock button

4. If a victim of cardiac arrest has an implanted pacemaker or defibrillator, what special steps should be taken?
    a. Avoid placing the AED pad directly over the implanted device
    b. Avoid using the AED to prevent damage to the implanted device
    c. Turn off the implanted device before applying the AED pads
    d. Consider using paediatric pads to decrease the shock dose delivered

5. What is not an example of an opioid?
    a. Heroin
    b. Hydrocodone
    c. Morphine
    d. Naloxone

6. Which of the following is a characteristic symptom of opioid poisoning?

    a) Hypertension
    b) Hyperthermia
    c) Pupillary constriction
    d) Increased respiratory rate

7. You encounter an unresponsive 56-year-old man who has been taking hydrocodone (opioid) after a surgical procedure. He is not breathing and has no pulse. You notice that his medication bottle is empty. You suspect an opioid-associated life-threatening emergency. A colleague activates the emergency response system and is retrieving the AED and naloxone. What is the most appropriate action for you to take in this situation?
    a. Wait for the naloxone to arrive before doing anything
    b. Begin CPR, starting with chest compressions
    c. Provide 1 rescue breath every 5 to 6 seconds until naloxone arrives
    d. Provide rapid defibrillation with the AED

8. You are attempting to rescue a person who has experienced drowning. What do you do if there are no signs of breathing?

    a. Attempt to clear the airway of aspirated water
    b. Perform abdominal thrusts to remove any water.
    c. Open the airway and administer rescue breaths.
    d. Use spinal stabilization regardless of neck injury.

9. What would your next step be if you had a 79-year-old that is in SVT, with a BP of 80/50, complaining of chest discomfort and becoming unconscious?
    a. Carotid sinus massage
    b. DC cardioversion
    c. Amiodarone
    d. Lidocaine

10. You are treating an individual in ventricular fibrillation with CPR, one attempt at defibrillation, and now his new rhythm is third-degree AV block. What would be your next step?
    a. Repeat defibrillation
    b. Vasopressin
    c. Transcutaneous pacing
    d. High dose epinephrine

11. What intervention would you take to improve the underlying issue if a known alcoholic collapses and is found to be in torsades de pointes?
    a. Rewarm the individual to correct hypothermia.
    b. Administer intravenous magnesium sulfate.
    c. Administer glucose to correct hypoglycemia.
    d. Administer naloxone to correct narcotic overdose.

12. What next step would you take if you were transporting a person that went into cardiac arrest and IV access is not possible?
    a. Terminate resuscitation.
    b. Obtain intraosseous access.
    c. Place a central line.
    d. Administer all medications through ET tube.

13. What is the recommended dose of adrenaline (in every 3-5 minutes) for the treatment of cardiac arrest in adults?
    a. 0.5 mg
    b. 1 mg
    c. 2 mg
    d. 5 mg

14. What actions should you take while the AED is analyzing the heart rhythm?
    a. Check pulse
    b. Continue chest compression
    c. Give rescue breaths only
    d. Stand clear of the victim

15. Which medication is recommended for the treatment of acute symptomatic bradycardia?
    a. Epinephrine
    b. Atropine
    c. Adenosine
    d. Amiodarone

16. What is the first-line medication for treating ventricular fibrillation or pulseless ventricular tachycardia?
    a. Adenosine
    b. Epinephrine
    c. Amiodarone
    d. Atropine

17. Which is one of the recommended positions for a pregnant patient in cardiac arrest according to the American Heart Association?
    a) Supine position
    b) Left lateral tilt position
    c) Trendelenburg position
    d) Right lateral tilt position

18. What is the recommended second-line treatment for anaphylaxis if the initial dose of epinephrine is not effective?

a) IM glucagon
b) IV glucagon
c) IV vasopressors
d) IM antihistamines

19. During resuscitation in a team, the team leader asks you to perform bag-mask ventilation (BVM), but you have not perfected that skill. What would be your appropriate action in this situation?
    a) Pick up the bag-mask device and give it to another team member.
    b) Pretend you did not hear the request and hope that the team leader chooses someone else to do it.
    c) Tell the team leader you are not comfortable performing that task.
    d) Try to do the procedure as best as you can and hope that another team member will see you struggling and take over.

20. In which of the following case, an Oropharyngeal airway can be used?
    a) Unresponsive patient with presence of cough or gag reflex
    b) Unresponsive patient with no cough or gag reflex
    c) Conscious patient with an intact gag reflex
    d) Conscious patient having a foreign body that causes airway obstruction

Annex 2: Scenario for group work

Scenario 1: Airway Management in a Critical Patient

You are working as a healthcare provider in an emergency department. A 45-year-old male patient is brought in by ambulance, and his vital signs are unstable. The patient is unconscious, and his airway is obstructed. The patient's medical history indicates he has a history of drug abuse and smoking. You are in charge of managing the patient's airway and must perform the necessary interventions to support his breathing.

Scenario 2: Cardiac Arrest Asystole in a Hospital Setting

You are working as a healthcare provider in a hospital's emergency department. An elderly female patient is brought in by ambulance, and the patient is found to be unresponsive, pulseless, and not breathing. The patient has no previous medical history of cardiac disease. As you approach the patient, you found that the patient is in asystole.

Your task is to lead the resuscitation efforts and perform the necessary interventions to support the patient's vital signs and restore her cardiac function.

Annex 3: Skill Station Checklist

Skill Station 1: Airway Management

Participant Name: ____________________________ Date: _______________________

Equipment:

- ✓ Bag-valve-mask device
- ✓ Oropharyngeal airway
- ✓ Nasopharyngeal airway
- ✓ Laryngeal mask airway
- ✓ Endotracheal tube
- ✓ Suction device

Steps:

- ☐ Assesses the patient's airway and breathing.
- ☐ Selects and assembles the appropriate airway equipment.
- ☐ Administers high-flow oxygen.
- ☐ Inserts an oropharyngeal airway.
- ☐ Inserts a nasopharyngeal airway.
- ☐ Inserts a laryngeal mask airway.
- ☐ Performs endotracheal intubation.
- ☐ Verifies correct placement of the endotracheal tube.
- ☐ Provides positive pressure ventilation.
- ☐ Secures the airway with appropriate devices.
- ☐ Monitors the patient's airway and breathing continuously.
- ☐ Uses the suction device as needed.
- ☐ Removes airway equipment safely and appropriately.
- ☐ Documents the procedure in the patient's chart.

Skill Station 2: Asystole/PEA Management

Participant Name: ___________________________ Date: ______________________

Equipment:

- ✓ Epinephrine
- ✓ Atropine
- ✓ Vasopressin
- ✓ Transcutaneous pacing device
- ✓ Intravenous access equipment
- ✓ Bag-valve-mask device
- ✓ Advanced airway equipment

Steps:

- ☐ Assess the patient's cardiac rhythm and confirm Asystole/PEA.
- ☐ Provide high-quality CPR (compressions, airway, breathing).
- ☐ Administer adrenaline 1 mg IV/IO every 3-5 minutes.
- ☐ Administer atropine 1 mg IV/IO if PEA rhythm is suspected to be due to bradycardia.
- ☐ Consider alternative treatments such as vasopressin 40 IU IV/IO.
- ☐ Identify and treat underlying causes, such as hypovolemia or hypoxia.
- ☐ Consider transcutaneous pacing if appropriate.
- ☐ Obtain intravenous access, if not already present.
- ☐ Secure an advanced airway, if indicated.
- ☐ Confirm the absence of a shockable rhythm before defibrillation.
- ☐ Document the procedure in the patient's chart.

Answers to Pre & Post test

1. d)When an abnormal rhythm develops and the heart stops beating unexpectedly.
2. d)A rate of 100 to 120 compressions per minute and a depth of at least 2 inches
3. a) Power on the AED
4. a) Avoid placing the AED pad directly over the implanted device
5. d) Naloxone
6. c) Pupillary constriction
7. b) Begin CPR, starting with chest compressions
8. c) Open the airway and administer rescue breaths
9. b) DC cardioversion
10. c) Transcutaneous pacing
11. b) Administer intravenous magnesium sulfate.
12. b) Obtain intraosseous access.
13. b) 1 mg
14. d) Stand clear of the victim
15. b) Atropine
16. c) Amiodarone
17. b) Left lateral tilt position
18. c) IV vasopressors
19. c) Tell the team leader you are not comfortable performing that task.
20. b) Unresponsive patient with no cough or gag reflex

Discussion on Annex 2: Scenario for group work (For facilitator)

Scenario 1: Airway Management in a Critical Patient

You are working as a healthcare provider in an emergency department. A 45-year-old male patient is brought in by ambulance, and his vital signs are unstable. The patient is unconscious, and his airway is obstructed. The patient's medical history indicates he has a history of drug abuse and smoking. You are in charge of managing the patient's airway and must perform the necessary interventions to support his breathing.

Stepwise Answer:

☑ Assess the patient's airway: The first step is to evaluate the patient's airway and identify any obstructions. Look for any foreign bodies or fluids that may be blocking the airway.

☑ Open the airway: If the airway is obstructed, open the patient's airway using the head-tilt, chin-lift maneuver. Place your hands on the patient's forehead and chin and tilt the head back while lifting the chin.

☑ Check for breathing: Check the patient's breathing by observing chest rise and fall. If the patient is not breathing, initiate rescue breathing using a bag-valve-mask (BVM) device.

☑ Insert an Oropharyngeal airway: If the patient's tongue is obstructing the airway, insert an Oropharyngeal airway to keep the tongue away from the back of the throat. Select an appropriate size of the Oropharyngeal airway and insert it into the patient's mouth, positioning it over the tongue.

☑ Consider intubation: If the patient is not breathing adequately or cannot maintain a patent airway, consider endotracheal intubation. Ensure that you have the necessary equipment ready, including a laryngoscope, endotracheal tube, and suction.

☑ Administer medication: If the patient is agitated or cannot tolerate the procedure, consider administering sedatives and analgesics to reduce discomfort and anxiety.

☑ Monitor the patient: After airway management, continuously monitor the patient's vital signs and oxygen saturation. Ensure that the endotracheal tube is in the correct position and secure.

Key Learning Objectives:

- ✓ Understand the anatomy and physiology of the airway and the importance of maintaining a patent airway in critically ill patients.

- ✓ Demonstrate proficiency in performing airway assessments and interventions, including the head-tilt, chin-lift maneuver, oral airway insertion, and endotracheal intubation.
- ✓ Understand the indications and contraindications for medication administration during airway management.
- ✓ Identify potential complications and implement appropriate measures to prevent and manage them.

Evaluation Criteria:

- ✓ Proper assessment and management of the patient's airway.
- ✓ Proficiency in performing airway interventions, including the head-tilt, chin-lift manoeuvre, oral airway insertion, and endotracheal intubation.
- ✓ Effective use of medications and equipment.
- ✓ Proper monitoring of the patient and prevention of complications.

Scenario 2: Cardiac Arrest Asystole in a Hospital Setting

You are working as a healthcare provider in a hospital's emergency department. An elderly female patient is brought in by ambulance, and the patient is found to be unresponsive, pulseless, and not breathing. The patient has no previous medical history of cardiac disease. As you approach the patient, you found that the patient is in asystole.

Your task is to lead the resuscitation efforts and perform the necessary interventions to support the patient's vital signs and restore her cardiac function.

Stepwise Answer:

Assess for responsiveness: Call the patient's name, tap the shoulders, and check for a response.

Activate the emergency response team: Shout for help and ask your team to bring additional equipment and support.

Check the patient's breathing: Check if the patient is breathing normally. If not, start rescue breathing immediately, using a bag-mask device with high-flow oxygen.

Assess the patient's cardiac rhythm: Check the patient's cardiac rhythm using a cardiac monitor. If the monitor shows asystole, it indicates a non-shockable rhythm, and chest compressions should be initiated.

Start high-quality chest compressions: Start high-quality chest compressions with a compression rate of 100-120 per minute and a depth of at least 2 inches. The compression-ventilation ratio is 30:2 for single rescuer, and 15:2 for two rescuers.

Initiate advanced airway management: Insert an advanced airway adjuncts, such as- an endotracheal tube, to secure the airway and enable more effective ventilation.

Administer epinephrine: Administer 1mg of epinephrine intravenously or via endotracheal tube every 3-5 minutes.

Check for reversible causes: Check for and treat reversible causes of cardiac arrest (5H and 5T).

Consider other advanced interventions: Consider advanced interventions such as transcutaneous pacing, or intravenous fluids based on the patient's condition and the underlying cause of the cardiac arrest.

Continuously monitor and reassess: Continuously monitor the patient's cardiac rhythm and vital signs while performing resuscitation. Reassess the patient's condition regularly to determine the effectiveness of interventions and adjust the treatment plan accordingly.

Discussion on Annex 3: Skill Station Checklist (For facilitator)

Skill Station 1: Airway Management

Participant Name: ____________________________ Date: _______________________

Equipment:

- ✓ Bag-valve-mask device
- ✓ Oropharyngeal airway
- ✓ Nasopharyngeal airway
- ✓ Laryngeal mask airway
- ✓ Endotracheal tube
- ✓ Suction device

Steps:

- ☐ Assesses the patient's airway and breathing.
- ☐ Selects and assembles the appropriate airway equipment.
- ☐ Administers high-flow oxygen.
- ☐ Inserts an oropharyngeal airway.
- ☐ Inserts a nasopharyngeal airway.
- ☐ Inserts a laryngeal mask airway.
- ☐ Performs endotracheal intubation.
- ☐ Verifies correct placement of the endotracheal tube.
- ☐ Provides positive pressure ventilation.
- ☐ Secures the airway with appropriate devices.
- ☐ Monitors the patient's airway and breathing continuously.
- ☐ Uses the suction device as needed.
- ☐ Removes airway equipment safely and appropriately.
- ☐ Documents the procedure in the patient's chart.

Comments:

If the learner performs all steps accurately and safely, they have successfully completed the skill station.

If the learner misses a step or makes a mistake, they should be provided with feedback and given the opportunity to repeat the station until they have demonstrated competence.

Skill Station 2: Asystole/PEA Management

Participant Name: ____________________________ Date: _______________________

Equipment:

- ✓ Epinephrine
- ✓ Atropine
- ✓ Vasopressin
- ✓ Transcutaneous pacing device
- ✓ Intravenous access equipment
- ✓ Bag-valve-mask device
- ✓ Advanced airway equipment

Steps:

- ☐ Assess the patient's cardiac rhythm and confirm Asystole/PEA.
- ☐ Provide high-quality CPR (compressions, airway, breathing).
- ☐ Administer adrenaline 1 mg IV/IO every 3-5 minutes.
- ☐ Administer atropine 1 mg IV/IO if PEA rhythm is suspected to be due to bradycardia.
- ☐ Consider alternative treatments such as vasopressin 40 IU IV/IO.
- ☐ Identify and treat underlying causes, such as hypovolemia or hypoxia.
- ☐ Consider transcutaneous pacing if appropriate.
- ☐ Obtain intravenous access, if not already present.
- ☐ Secure an advanced airway, if indicated.
- ☐ Confirm the absence of a shockable rhythm before defibrillation.
- ☐ Document the procedure in the patient's chart.

Comments:

- If the learner performs all steps accurately and safely, they have successfully completed the skill station.
- If the learner misses a step or makes a mistake, they should be provided with feedback and given the opportunity to repeat the station until they have demonstrated competence.