Principles of resuscitation

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Goals

- Define shock through the concept of cellular respiration
- Discuss concepts in cellular perfusion microscopic and macroscopic
- Describe oxygen and carbon dioxide transport and utility
- Give an overview of the common resuscitation algorithms(BLS,ACLS,PALS,NRP,ATLS)

Definitions

- Resuscitation

"any effort to reverse a clinical death in progress.“

- Shock

’’mismatch between tissue demand of oxygen and tissue supply of oxygen’’

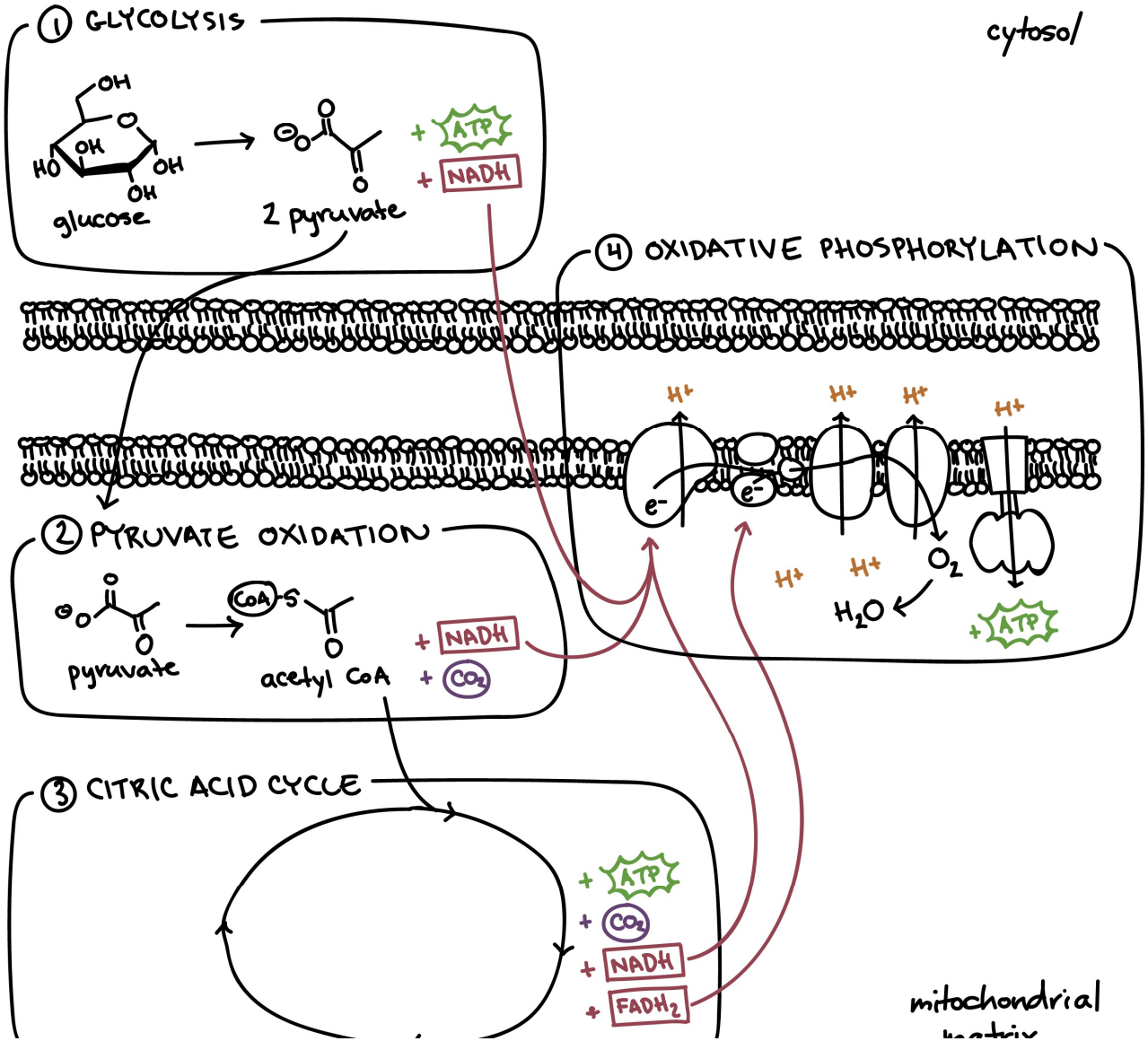
How do tissues maintain life

- How do things function in normal physiological parameters

How does the body maintain life(cellular respiration)

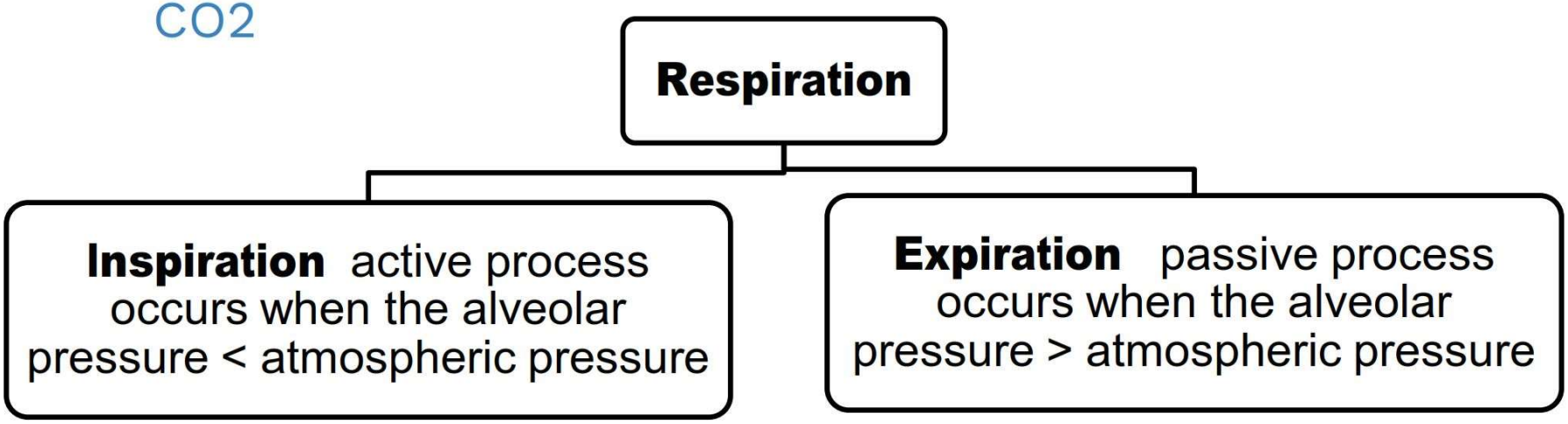
-cellular respiration

1. Glycolysis.
2. Pyruvate oxidation.
3. Citric acid cycle(krebs cycle)
4. Oxidative phosphorylation



Mechanics of respiration

- Mechanical process causing gas flow into and out of the lungs according to volume changes in the thoracic cavity
- General function is to obtain O2 and to eliminate the CO2



Respiratory function of the lung

- **Ventilation**: Movement of air between the atmosphere and respiratory portion of the lung
- **Perfusion**: Flow of blood through the lung
- **Diffusion**: Transfer of gases between the air-filled space in the lung and blood

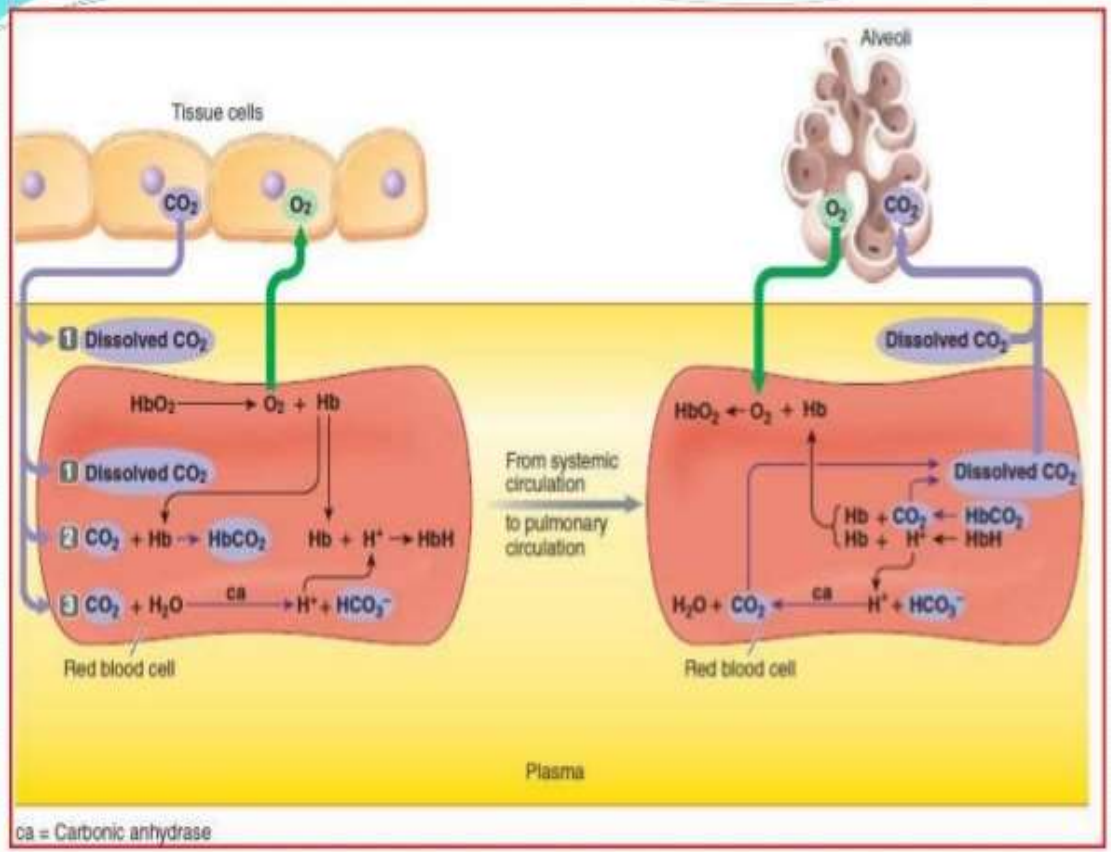
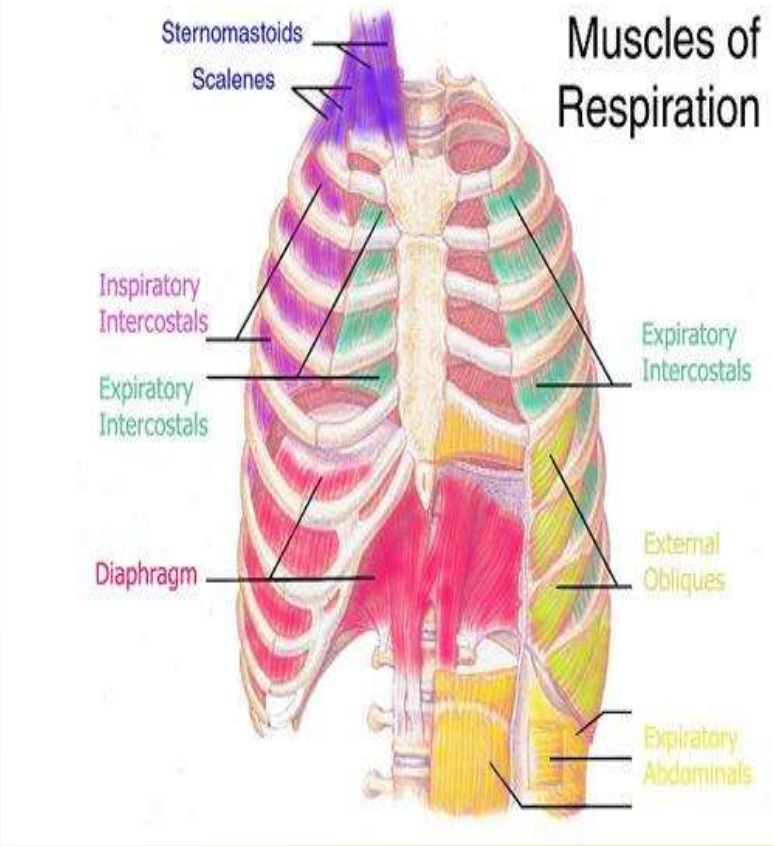
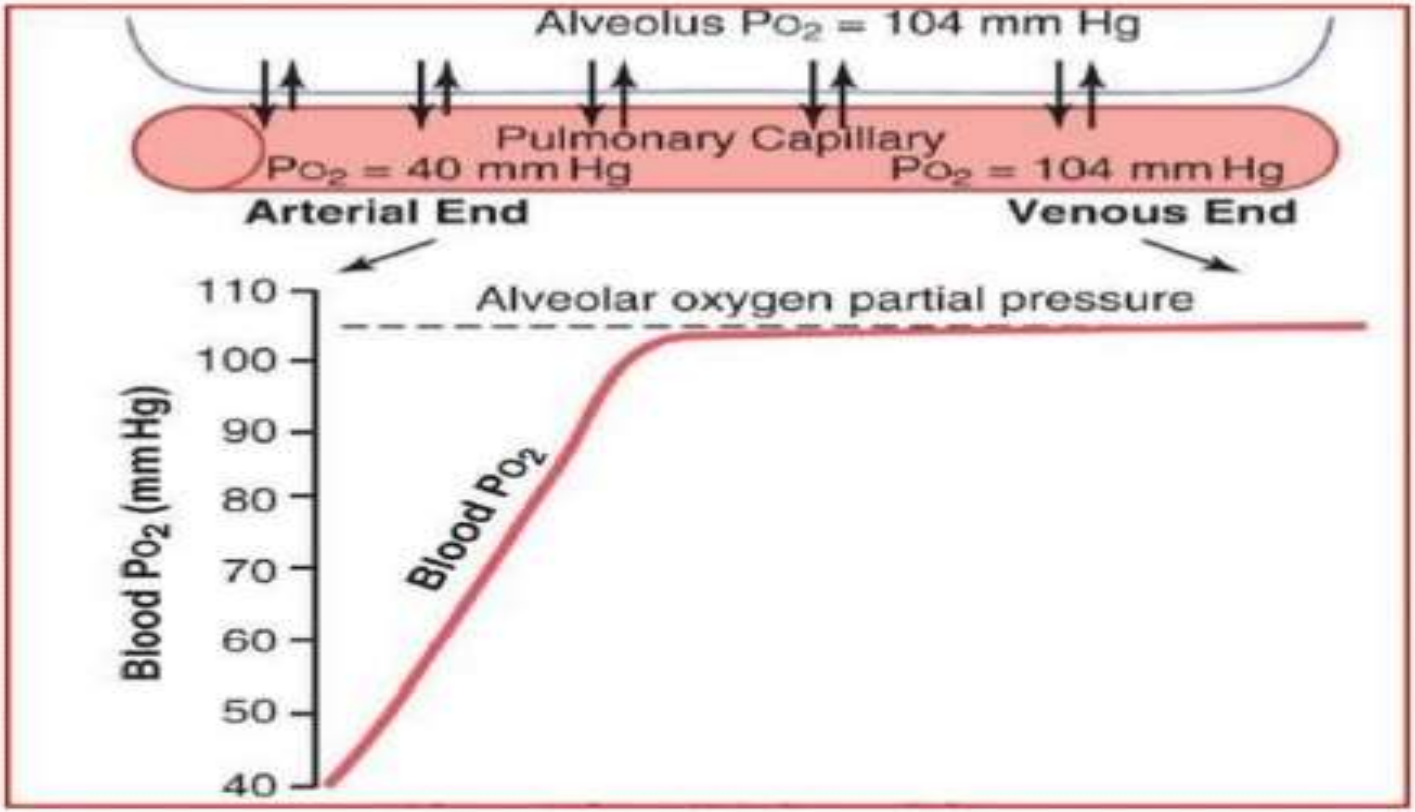

Carbon dioxide transport in the blood
Tissue cells
Alveoli
CO_2
O_2
1 Dissolved CO_2
$HbO_2 \rightarrow O_2 + Hb$
2 $CO_2 + Hb \rightarrow HbCO_2$
$Hb + H^+ \rightarrow HbH$
3 $CO_2 + H_2O$ ca $H^+ + HCO_3^-$
Red blood cell
From systemic circulation
to pulmonary circulation
Dissolved CO_2
$HbO_2 \leftarrow O_2 + Hb$
$Hb + CO_2 \leftarrow HbCO_2$
$Hb + H^+ \leftarrow HbH$
$H_2O + CO_2$ ca $H^+ + HCO_3^-$
Red blood cell
Plasma
ca = Carbonic anhydrase

Figure 1.


Muscles of Respiration
Sternomastoids
Scalenes
Inspiratory Intercostals
Expiratory Intercostals
Diaphragm
Expiratory Intercostals
External Obliques
Expiratory Abdominals

Diffusion of Oxygen from the Alveoli to the Pulmonary Capillary Blood



The transport of 02 and C02

- Once oxygen has diffused from the alveoli into the pulmonary blood, it is transported to the peripheral tissue capillaries almost entirely in combination with hemoglobin.
- The presence of hemoglobin in the red blood cells allows the blood to transport 30 to 100 times as much oxygen as could be transported in the form of dissolved oxygen in the water of the blood.
- In the body's tissue cells, oxygen reacts with various foodstuffs to form large quantities of carbon dioxide.
- This carbon dioxide enters the tissue capillaries and is transported back to the lungs.
- Carbon dioxide, like oxygen, also combines with chemical substances in the blood that increase carbon dioxide transport 15- to 20-fold.

Oxygen(O2) transport

- Carried in blood(normal state)

1) 97% bound to hemoglobin
2) Dissolved in plasma and RBC

-02 bound with hemoglobin= oxyhemoglobin

-02 unbound deoxyhemoglobin

- O2 transport

02 transport

- The total amount of oxygen available each minute for use in any given tissue is determined by

(1) the quantity of oxygen that can be transported to the tissue in each 100ml of blood

(2) the rate of blood flow. (If the rate of blood flow falls to zero, the amount of available oxygen also falls to zero)

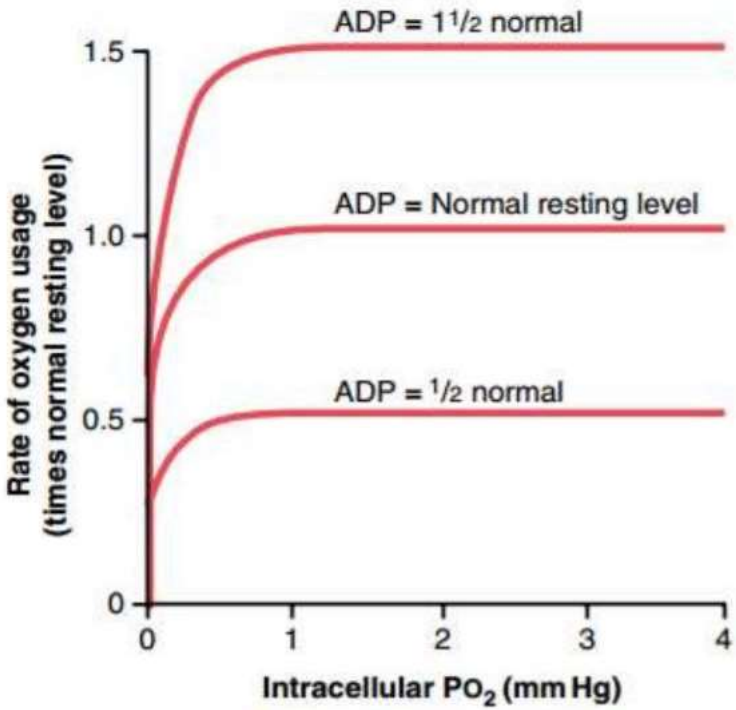
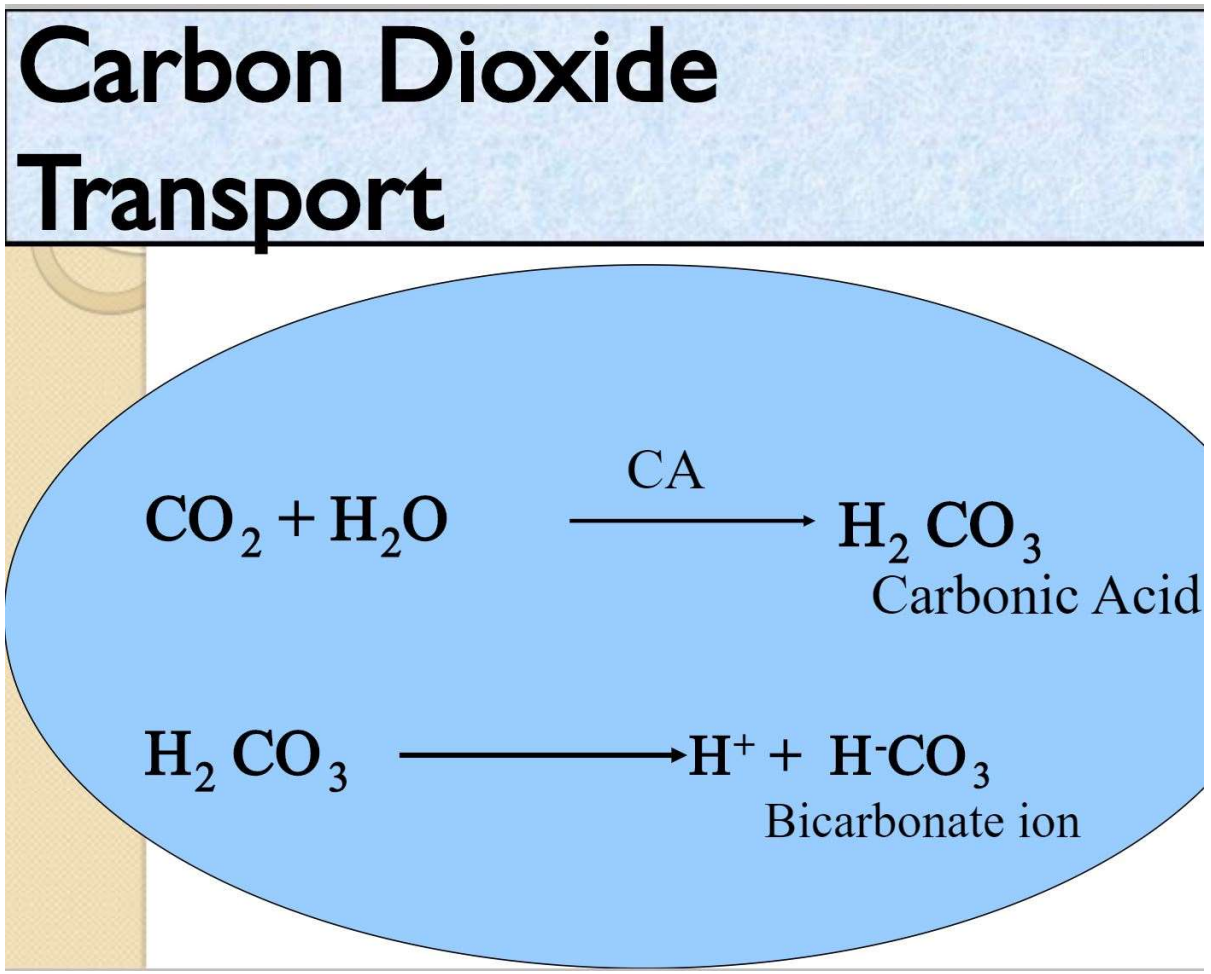


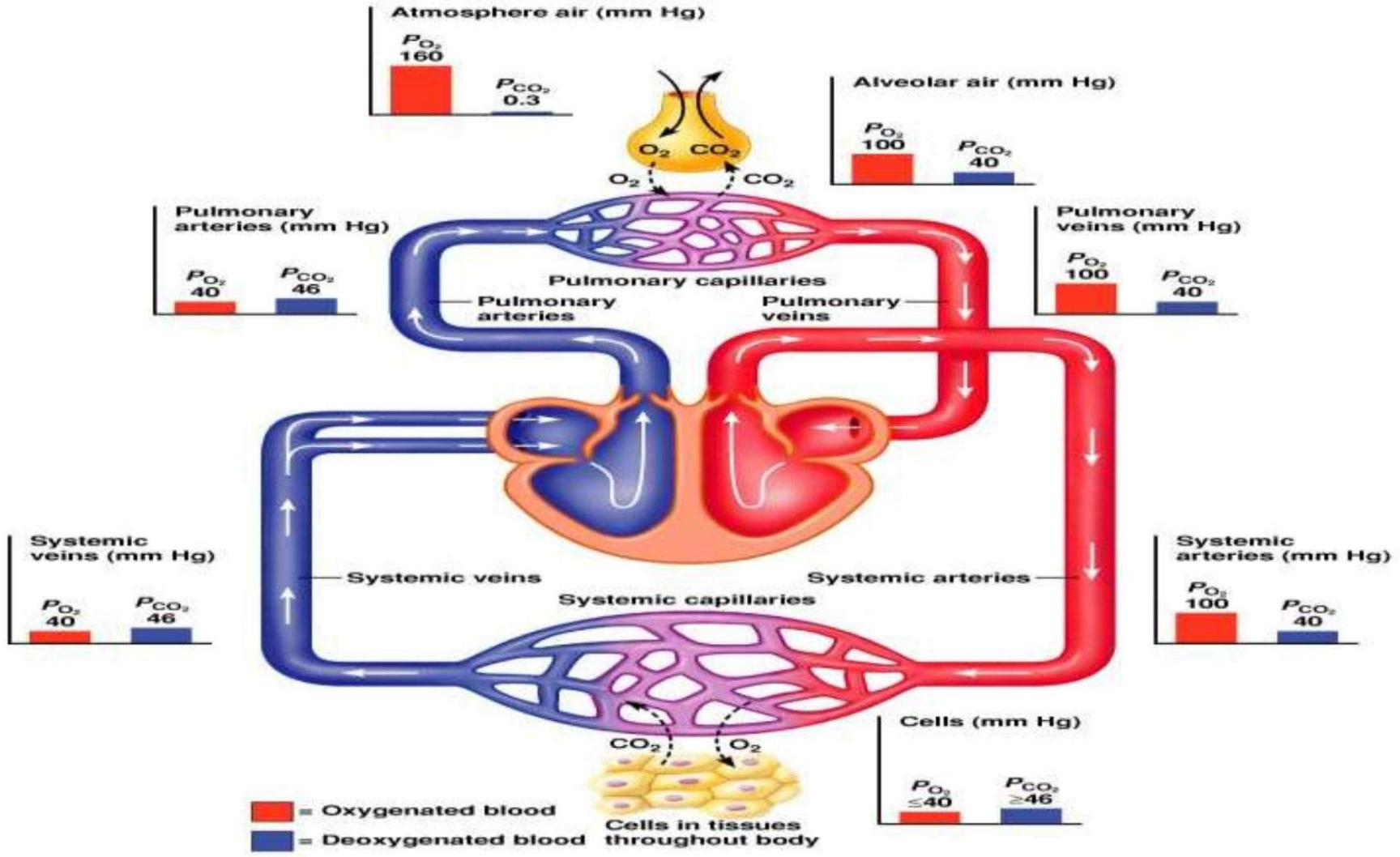
Figure 40-11 Effect of intracellular adenosine diphosphate (ADP) and Po_2 on rate of oxygen usage by the cells. Note that as long as the intracellular Po_2 remains above 1 mm Hg, the controlling factor for the rate of oxygen usage is the intracellular concentration of ADP.

CO_2

- Transport

1. Dissolved 10%(blood and plasma)
2. Bound to hemoglobin 20%
3. Bicarbonate(HCO3) 70%



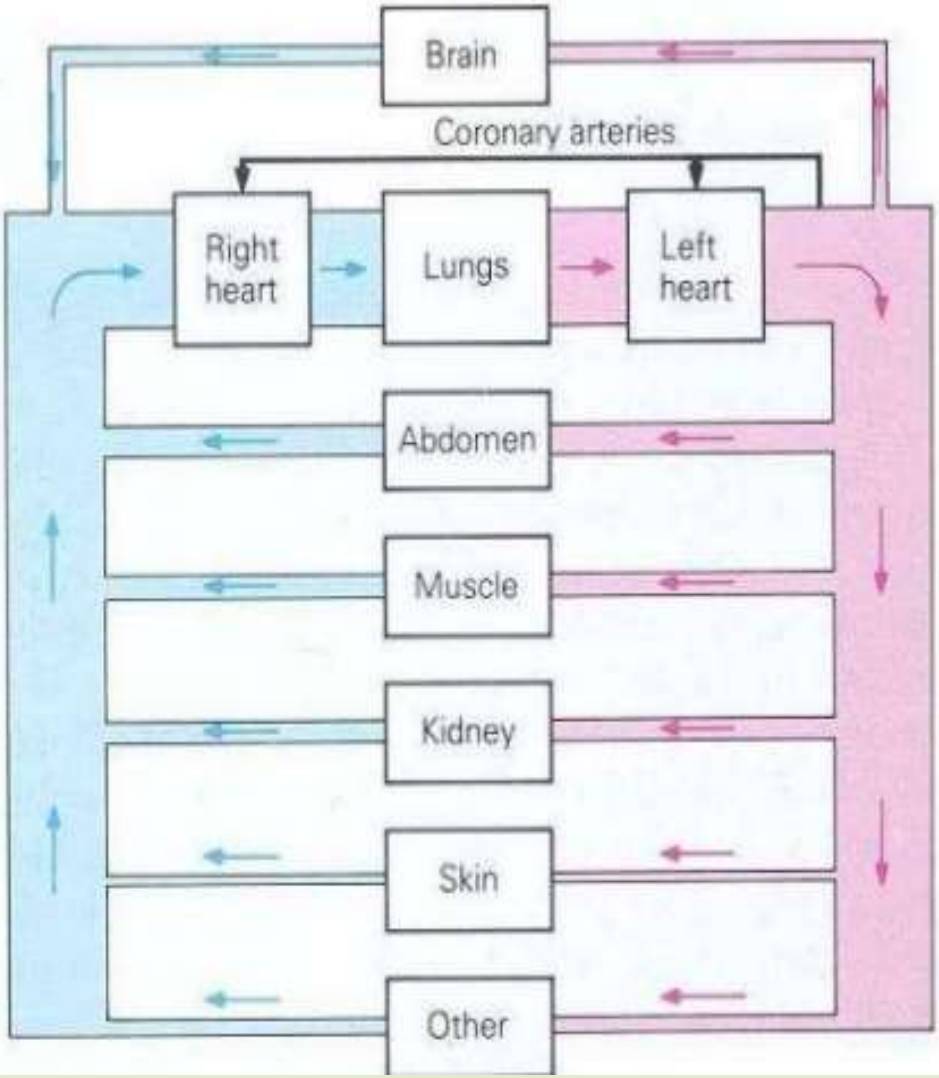


Vascular system

- Closed system designed to transport 02 and nutrients to the cells and remove carbon dioxide and metabolic waste from the body

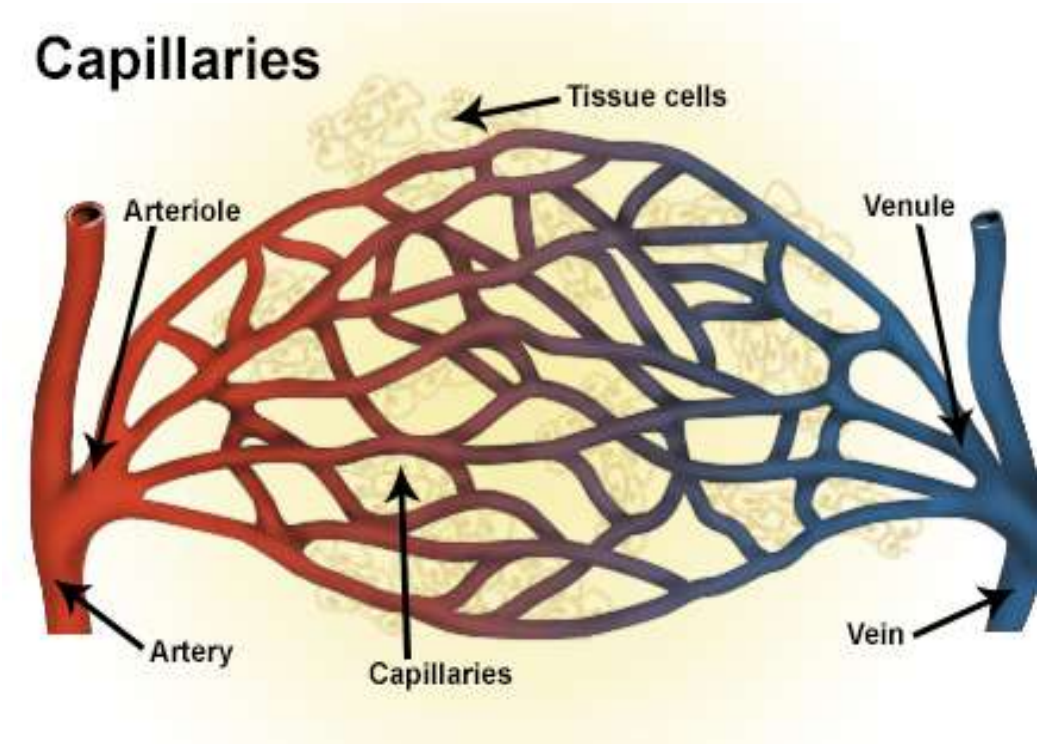
- Heart
- Arteries
- Capillaries
- Veins

- Two-sided system:
- RT side(pulmonary artery, pulmonary capillaries and return through pulmonary veins to RT atrium
- LT side aorta, arteries, capillary and return the RT atrium through great veins



The heart output

- The vascular system is high resistance circuit with large pressure gradient between arteries and veins
- The heart functions as pump with systole and diastole
- The large arteries distend in response to pressure from the contracting heart(they hold energy during systole and release it during diastole)
- The arterioles are resistance vessels
- Cappilaries are where exchange Substances occur including water (proximal portion), oxygen, and glucose



So what happens when things go wrong?

Types of shock

PROVED pneumonic

- cardiogenic (**P**ump)

- **R**hythm abnormalities

- **O**bstructive

- hypovolemia (**V**olume)

- **E**ndocrine causes (often mixed classification, but a useful subheading to make sure endocrine causes aren't missed!)

- **D**istributive (due to vasodilation)

Cardiogenic shock(Poor Myocardial contractility)

- Ischemia and compilations
- Acute mitral regurgitation due to papillary muscle rupture
- Ventricular septal rupture
- Left ventricular free wall rupture and tamponade
- Myocarditis
- Myocardial contusion
- Tako-Tsubo cardiomyopathy
- Septic shock
- Poisoning or toxic exposure including calcium channel blockers, beta-blockers and digoxin
- End stage cardiomyopathy

Pump failure continued

- rhythm abnormalities
  - Tachycardias
  - Bradycardias

- Valvular dysfunction
  - Severe aortic regurgitation
  - Severe aortic or mitral stenosis

- Left ventricular outflow tract obstruction
  - Hypertrophic cardiomyopathy
  - Left atrial myxoma

Obstructive

--Within the circulatory system

- Massive pulmonary embolus
- atrial thrombus or myxoma
- occlusive valvular lesion

-- External to the circulatory system

- Cardiac tamponade
- abdominal compartment syndrome
- Tension pneumothorax
- Dynamic hyperinflation (e.g. severe asthma)
- Tension pneumomedistinum
- caval compression (e.g. supine hypotension syndrome in the pregnant female)

Hypovolemic

-**Hemorrhage**

- Traumatic
- Major vessel injury
- Pelvic vessel disruption
- Massive hemothorax
- Intra-abdominal hemorrhage
- Retroperitoneal hemorrhage
- Long bone fracture
- External blood loss

Non traumatic

- Gastrointestinal bleeding
- Epistaxis
- Hemorrhagic pancreatitis
- Aneurysm rupture
- Ectopic pregnancy
- Postpartum
- Coagulopathy

Fluid loss

- GI losses (vomiting, diarrhea, short gut, etc)
- Excessive diuresis (diabetes insipidus, diuretics)
- Excessive diaphoresis (heat-related illness)
- Diabetic ketoacidosis
- Burns
- "Third spacing" (pancreatitis, severe sepsis, anaphylaxis)
- Iatrogenic (post-dialysis)

DISTRIBUTIVE SHOCK

- neurogenic shock
- liver failure
- adrenal insufficiency
- anaphylaxis
- septic shock
- post-bypass vasoplegia
- drugs and toxic exposures, e.g. calcium channel blockers, epidural anaesthesia

ENDOCRINE AND METABOLIC CAUSES OF SHOCK

- Adrenal insufficiency
- Hypothyroidism
- Hyperthyroidism
- Diabetic ketoacidosis
- Severe acidosis/ alkalosis and electrolyte disturbances (e.g. hypocalcemia)

Tissue hypoxia tolerance

- Survival time

1. Brain<3 min
2. Kidney and liver 15-20 min.
3. Skeletal muscle 60-90 min.
4. Vascular smooth muscle 24-72 h
5. Hair and nails -Several days

How do we diagnose tissue hypoperfusion ?

- You cannot use one marker

It is combination of:

-Physical exam

- Measured hemodynamics parameters

- Specific laboratory testing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"Correct. And in the case of a cardiac arrest, every second counts. Who can tell me why? Anyone? Clock's ticking."

How do we measure perfusion to tissues?

-Physical exam

-Bedside monitors

-Blood testing

Evidence based algorithms in management of shock (or its most extreme form **cardiac arrest** = hemodynamic collapse)

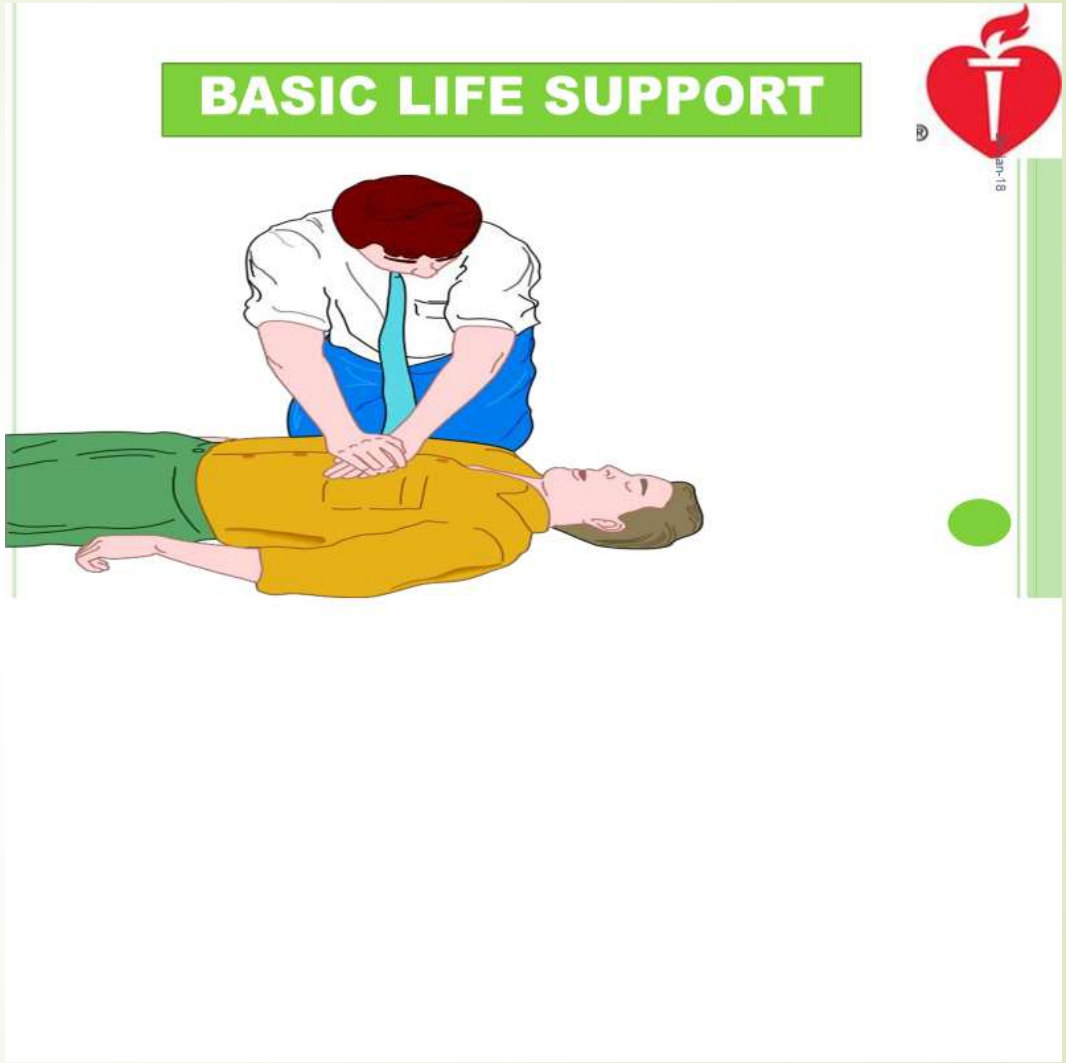
- BLS
- ACLS
- PALS
- NRP
- ATLS

AMERICAN HEART ASSOCIATION (AHA) protocols/algorithms

CHAIN OF SURVIVAL

BLS

- Basic Life Support (BLS) refers to the care healthcare providers and public safety professionals provide to patients who are experiencing respiratory arrest, cardiac arrest or airway obstruction.
- Target audience is laypersons and all health care professionals



Components

- cardiopulmonary resuscitation (CPR)
- using an automated external defibrillator (AED)
- Providing rescue breaths
- relieving an obstructed airway for patients of all ages

Pearls: C-A-B rather than A-B-C

Compression/airway/breathing

(especially in adults)

-most common cause of arrest is cardiac(adults)

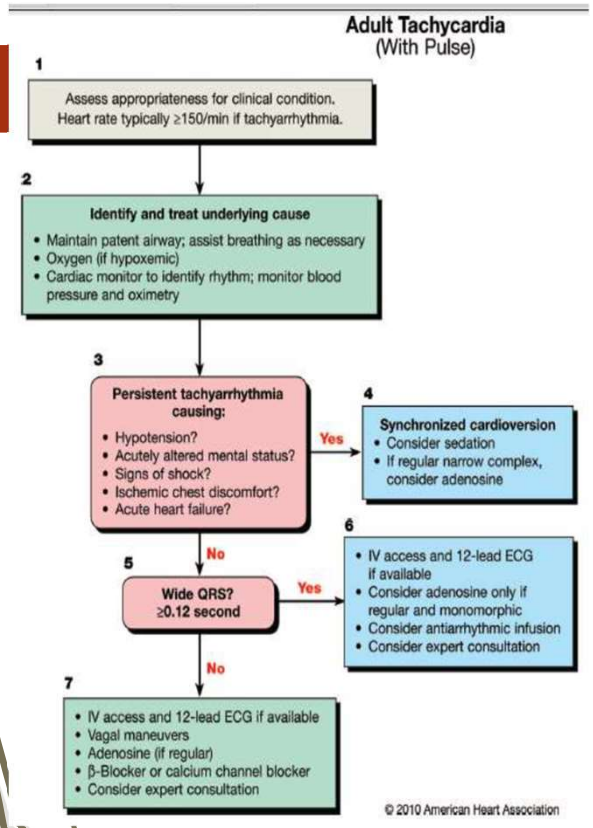
-airway and breathing causes delays in initiation

-people are hesitant to start CPR when providing rescue breathes

-the most important outcomes are based in good CPR and early defibrillation

ACLS(advanced cardiac life support)

- ACLS is a series of evidence based clinical responses, simple enough to be committed to memory and recall under moments of stress.
- Its builds upon the basics of BLS but adds advanced rhythm recognition and interventions(tachy arrythmia ,brady arrythmia) and use of the manual defibrillator as opposed to the AED as well as understanding of causes and treatment of arrest.
- Target audience health care professionals who deal with critical patients and conditions


Adult Tachycardia
(With Pulse)
1
Assess appropriateness for clinical condition.
Heart rate typically ≥150/min if tachyarrhythmia.
2
Identify and treat underlying cause
• Maintain patent airway; assist breathing as necessary
• Oxygen (if hypoxemic)
• Cardiac monitor to identify rhythm; monitor blood pressure and oximetry
3
Persistent tachyarrhythmia causing:
• Hypotension?
• Acutely altered mental status?
• Signs of shock?
• Ischemic chest discomfort?
• Acute heart failure?
Yes
4
Synchronized cardioversion
• Consider sedation
• If regular narrow complex, consider adenosine
No
5
Wide QRS? ≥0.12 second
Yes
6
• IV access and 12-lead ECG if available
• Consider adenosine only if regular and monomorphic
• Consider antiarrhythmic infusion
• Consider expert consultation
No
7
• IV access and 12-lead ECG if available
• Vagal maneuvers
• Adenosine (if regular)
• β-Blocker or calcium channel blocker
• Consider expert consultation
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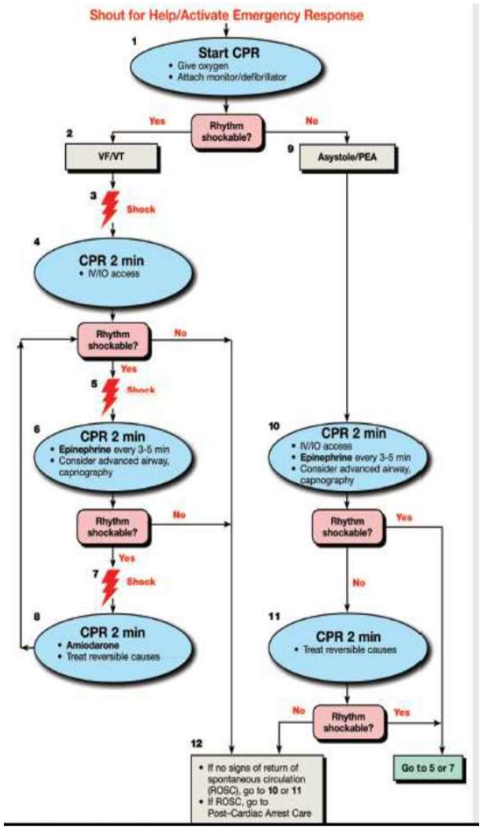
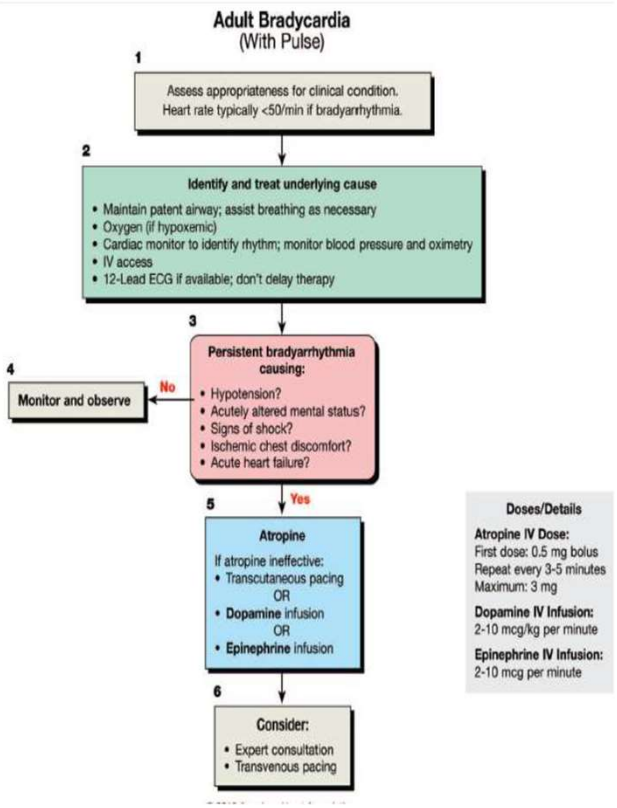
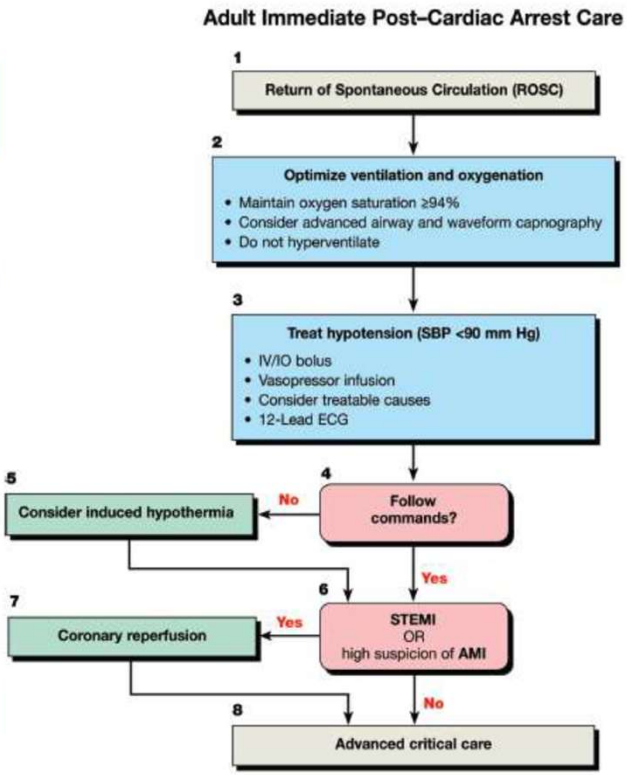
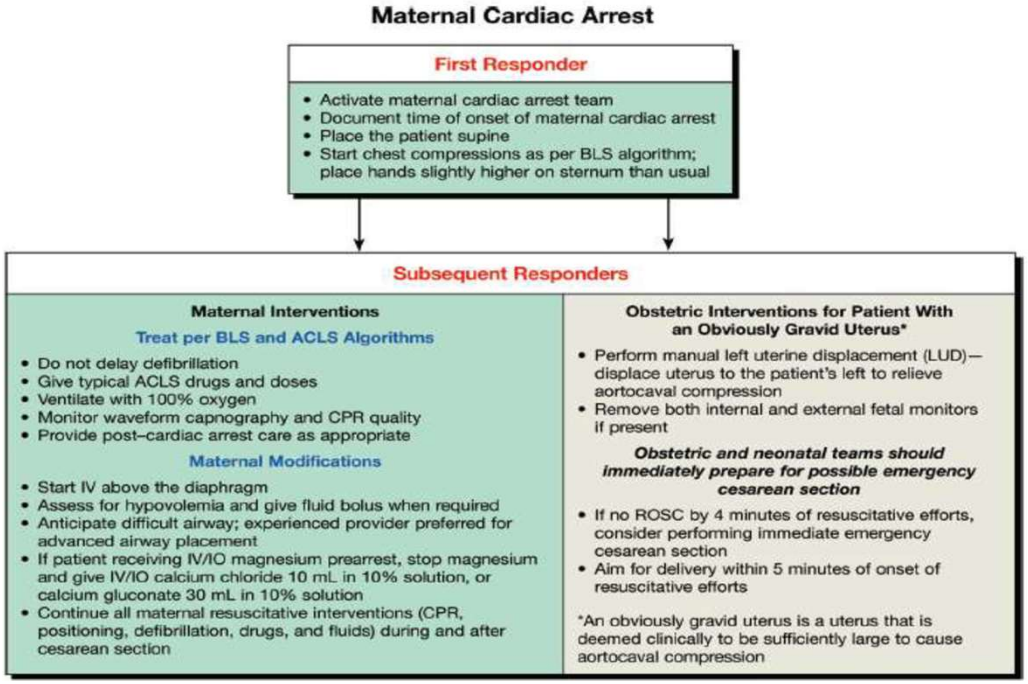

Shout for Help/Activate Emergency Response
1
Start CPR
• Give oxygen
• Attach monitor/defibrillator
Rhythm shockable?
Yes
No
2
VF/VT
9
Asystole/PEA
3
Shock
4
CPR 2 min
• IV/IO access
Rhythm shockable?
No
Yes
5
Shock
6
CPR 2 min
• Epinephrine every 3-5 min
• Consider advanced airway, capnography
Rhythm shockable?
No
Yes
7
Shock
8
CPR 2 min
• Amiodarone
• Treat reversible causes
10
CPR 2 min
• IV/IO access
• Epinephrine every 3-5 min
• Consider advanced airway, capnography
Rhythm shockable?
Yes
No
11
CPR 2 min
• Treat reversible causes
No
Rhythm shockable?
Yes
12
• If no signs of return of spontaneous circulation (ROSC), go to 10 or 11
• If ROSC, go to Post-Cardiac Arrest Care
Go to 5 or 7

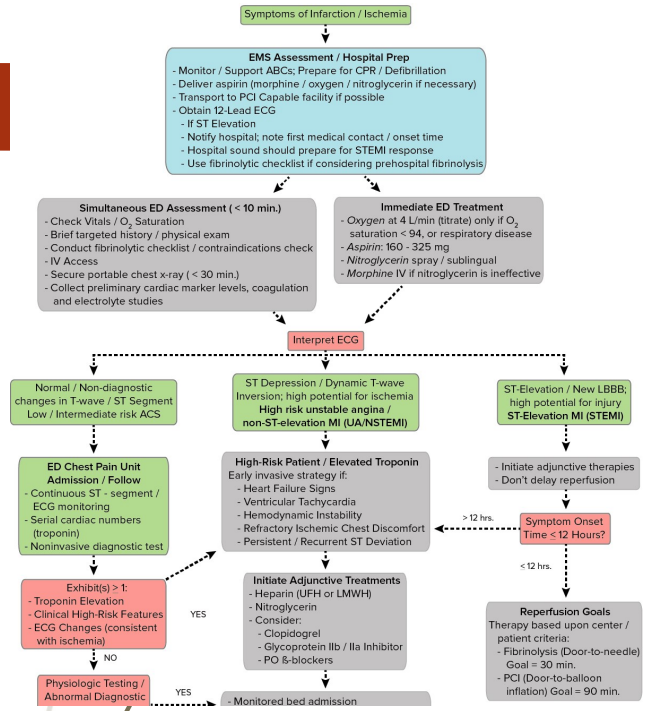

Adult Bradycardia
(With Pulse)
1
Assess appropriateness for clinical condition.
Heart rate typically <50/min if bradyarrhythmia.
2
Identify and treat underlying cause
• Maintain patent airway; assist breathing as necessary
• Oxygen (if hypoxemic)
• Cardiac monitor to identify rhythm; monitor blood pressure and oximetry
• IV access
• 12-Lead ECG if available; don't delay therapy
3
Persistent bradyarrhythmia causing:
• Hypotension?
• Acutely altered mental status?
• Signs of shock?
• Ischemic chest discomfort?
• Acute heart failure?
4
Monitor and observe
No
Yes
5
Atropine
If atropine ineffective:
• Transcutaneous pacing
OR
• Dopamine infusion
OR
• Epinephrine infusion
6
Consider:
• Expert consultation
• Transvenous pacing
Doses/Details
Atropine IV Dose:
First dose: 0.5 mg bolus
Repeat every 3-5 minutes
Maximum: 3 mg
Dopamine IV Infusion:
2-10 mcg/kg per minute
Epinephrine IV Infusion:
2-10 mcg per minute

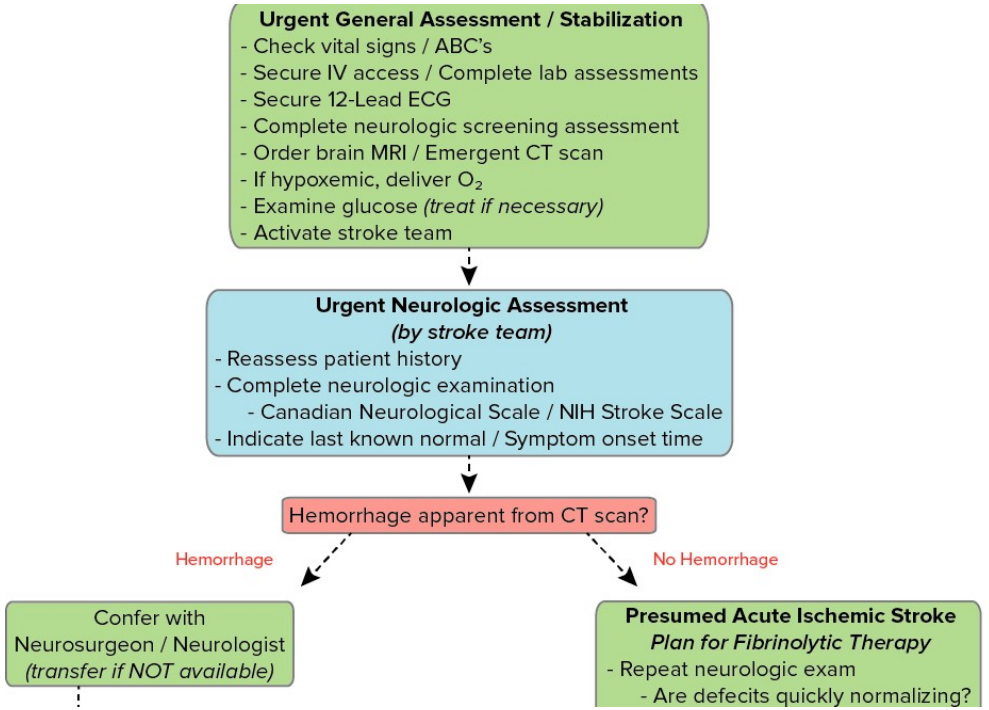


Post arrest care



cardiac arrest in special populations





Expanded to include stroke diagnosis and treatment

The H and Ts(Common reversible causes of cardiac arrest)

- Hypoxia
- Hypovolemia
- Hydrogen ion(acidosis)
- Hypo-/hyperkalemia
- Hypothermia

- Toxins
- Tamponade (cardiac)
- Tension pneumothorax
- Thrombosis, pulmonary
- Thrombosis, coronary

Drugs in ACLS

ACLS Algorithms and Their Primary Drugs

Vent. Fib./Tach.

Epinephrine
Vasopressin
Amiodarone
Lidocaine
Magnesium

Asystole/PEA

Epinephrine
Vasopressin
~~Atropine~~ (removed from algorithm per 2010 ACLS Guidelines)

Bradycardia

Atropine
Epinephrine
Dopamine

Tachycardia

adenosine
Diltiazem
Beta-blockers
amiodarone
Digoxin
Verapamil
Magnesium

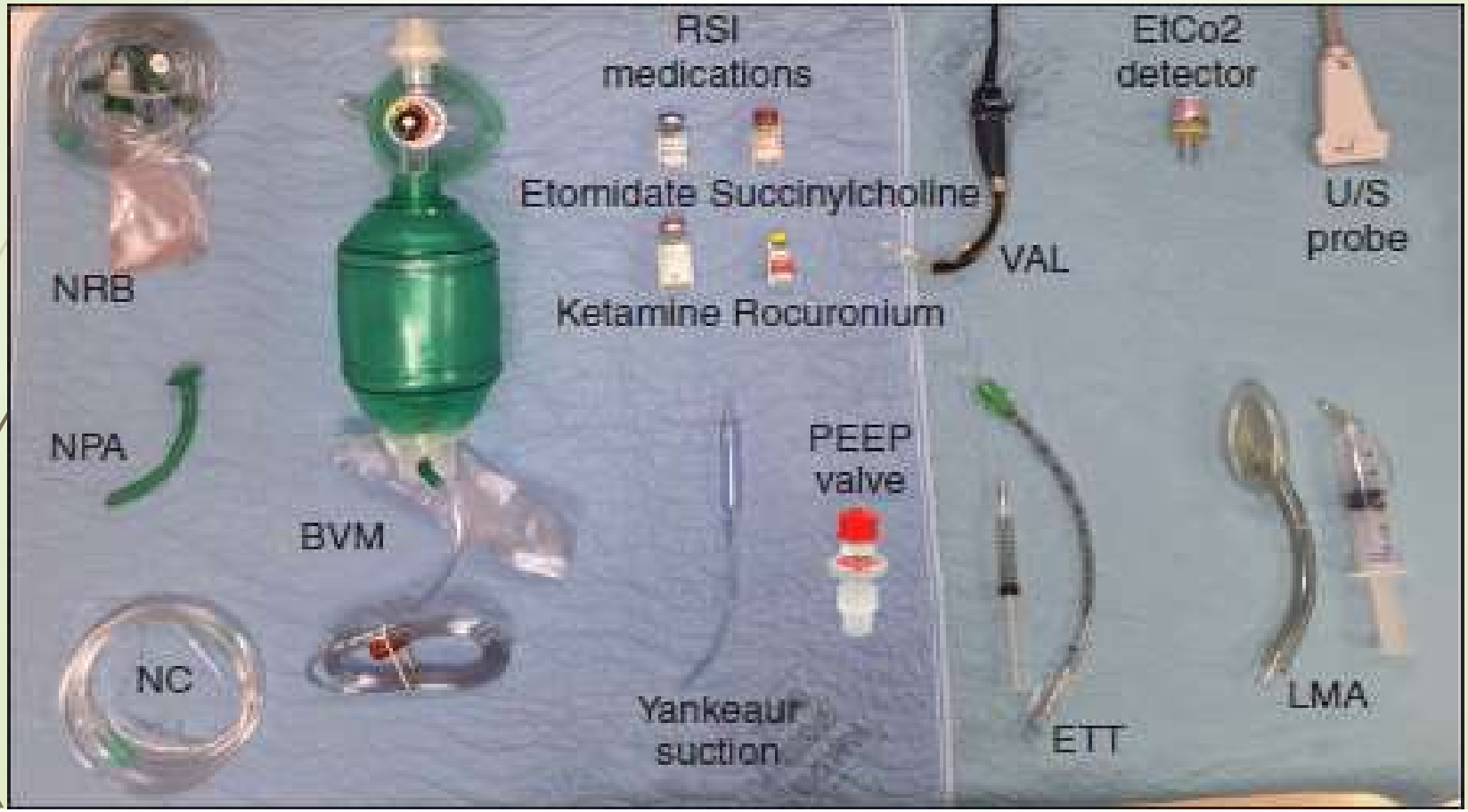
Acute Coronary Syndromes

Oxygen
Aspirin
Nitroglycerin
Morphine
Fibrinolytic therapy
Heparin
Beta-Blockers

Acute Stroke

tPA-tissue plasminogen activator
Glucose (D50)
Labetalol
Nitroprusside
Nicardipine
Aspirin

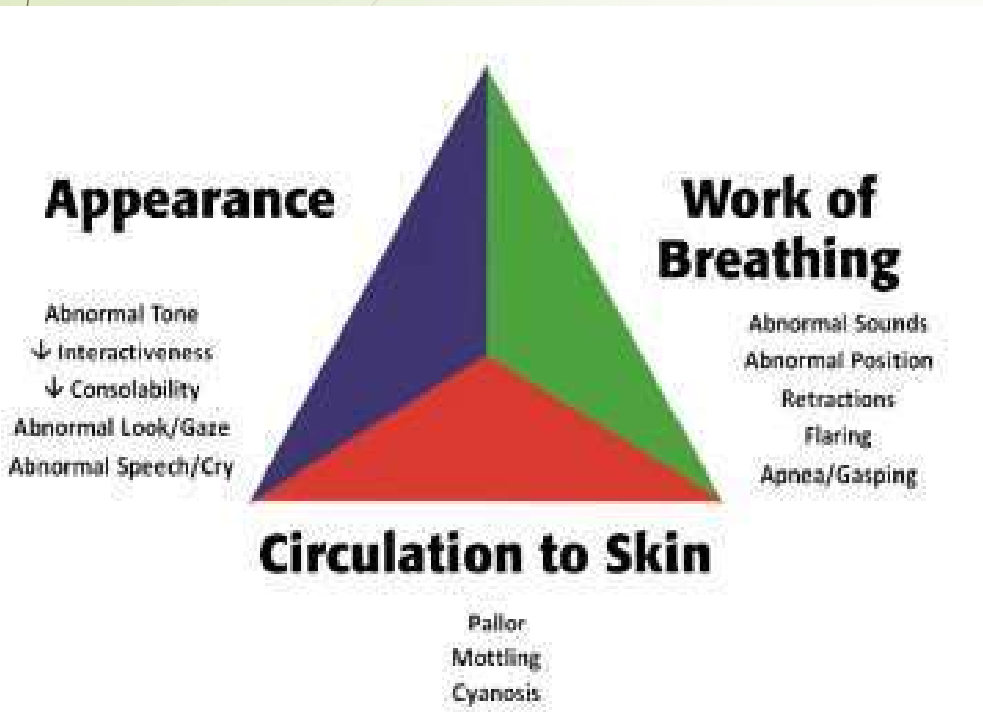
Advanced airway interventions



PALS

- Not ACLS for kids

Initial Assessment (1st
aim : to detect life threatening
conditions
look



PALS Systematic Approach Algorithm

The PALS Systematic Approach Algorithm (Figure 2) outlines the approach to caring for a critically ill or injured child.

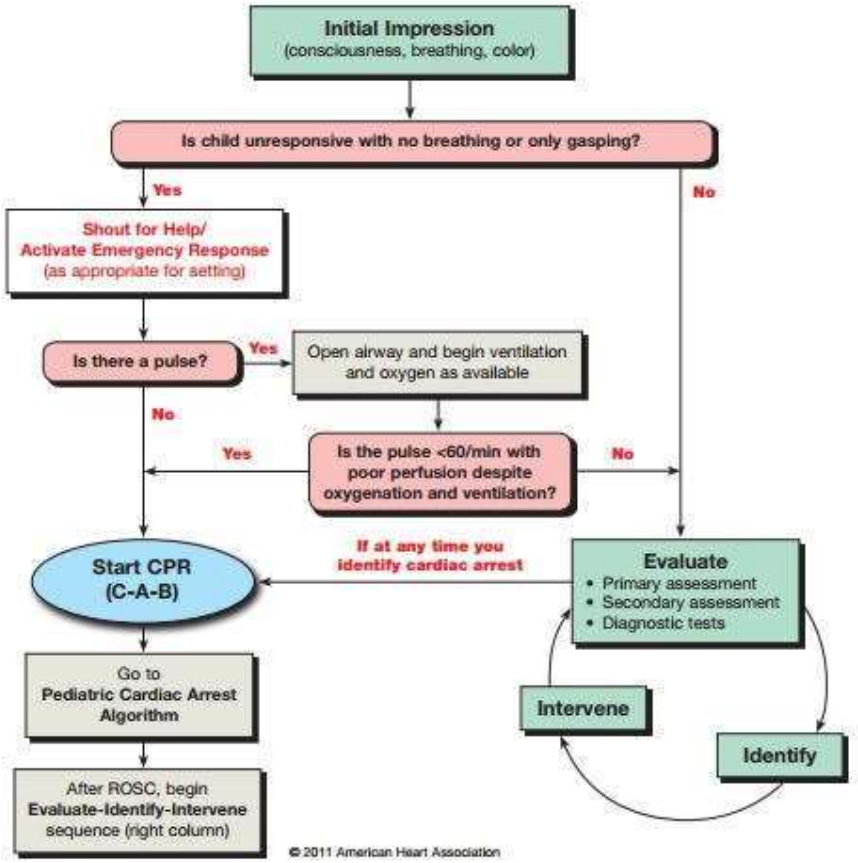


Figure 2. PALS Systematic Approach Algorithm.

Identify and Intervene **If You Identify a Life-Threatening Problem**	If at any time you identify a life-threatening problem, immediately begin appropriate interventions. Activate emergency response as indicated in your practice setting.

Hemodynamics cut offs

Blood pressure

Minimal acceptable systolic BP more than

60 in neonate , more than 70 in infant

in children = 70 + (AGE X 2)

Respiratory rate < 10 or > 60 is sign of impending respiratory failure

Respiratory arrest and distress

• Upper airway obstruction
– Croup/epiglottitis
– Foreign body

• Lower airway obstruction
– Asthma/episodic viral wheeze
– Bronchiolitis

• Disorders affecting lungs
– Pneumonia
– Pulmonary oedema (e.g. in cardiac disease)
– Pneumothorax
– Pleural effusion or empyema ,Rib fractures
– Disorders of the respiratory muscles
Neuromuscular disorders
– Disorders below the diaphragm Peritonitis
,Abdominal distension
• Central causes

cardiac arrest

- Sudden cardiac arrest is less common in children than in adult
- Caused by sudden **tachyarrhythmia (VF Or pulseless VT)**
- Predisposing conditions **:**

– Myocarditis (Muffled heart sounds ,Hepatomegaly,CHF)

– Hypertrophic cardiomyopathy

– Anomalous coronary artery

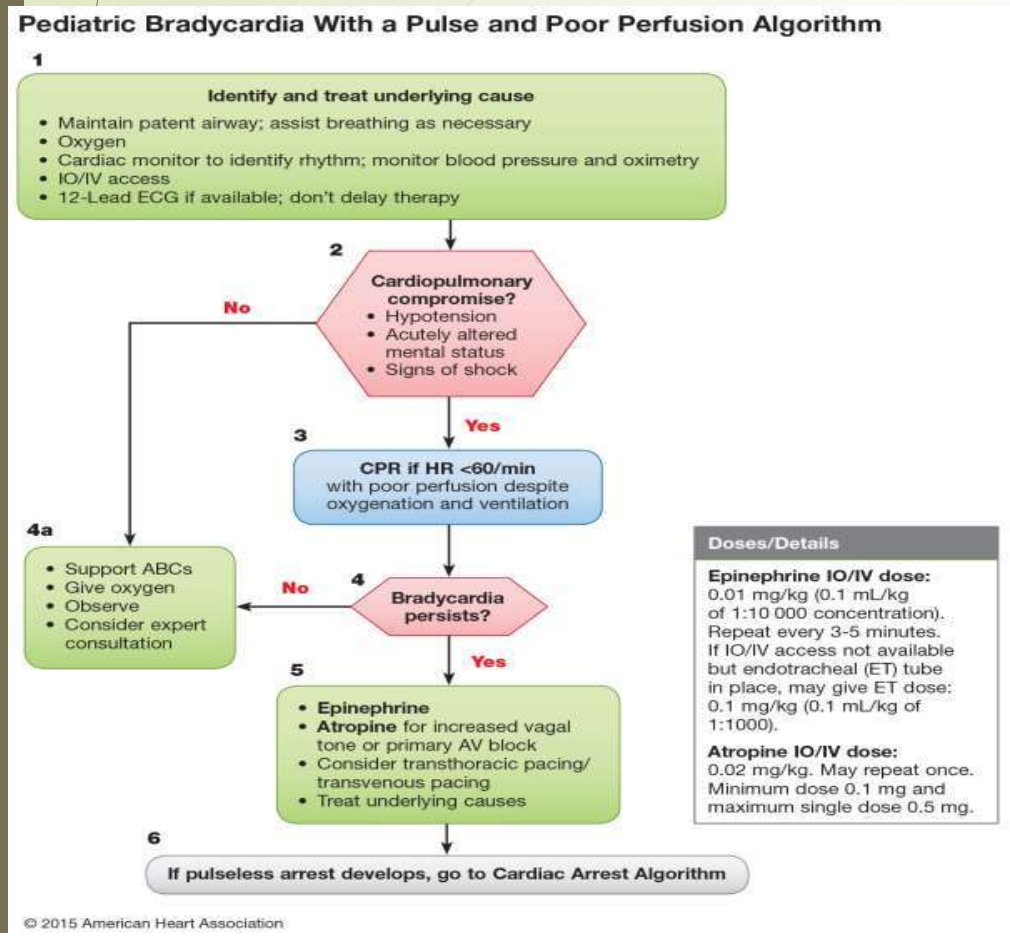
– Long QT syndrome

– Drug toxication

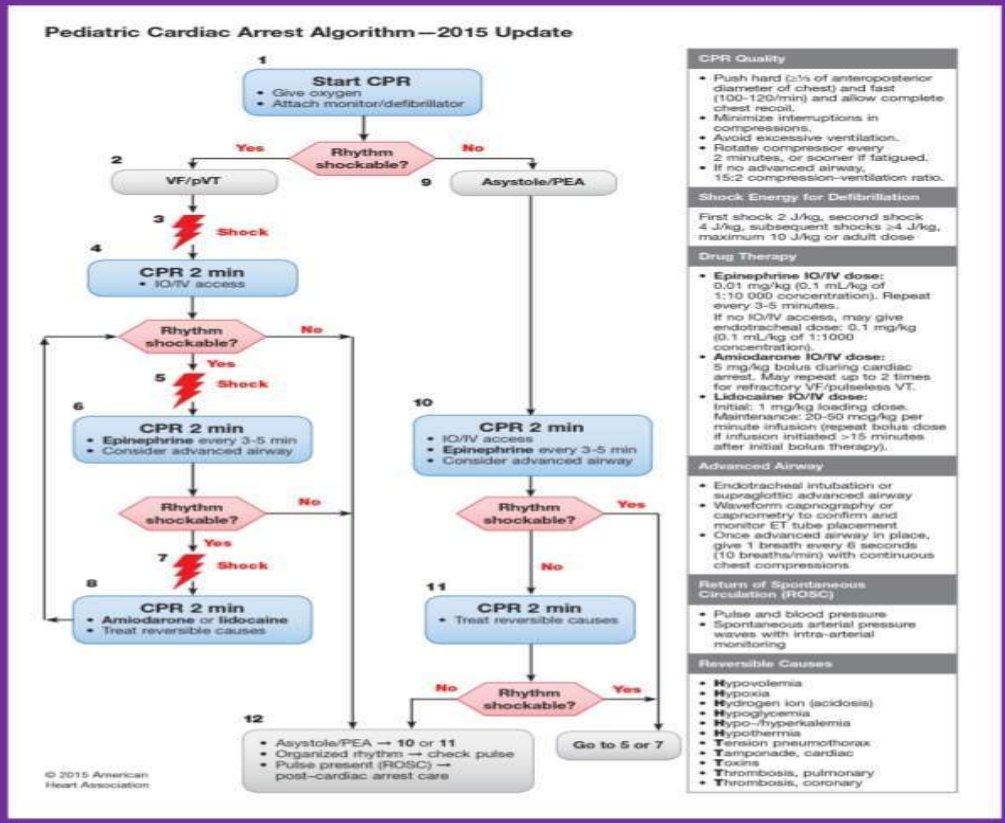
– Commotio cordis (sharp blow to chest)

– Familial Channelopathies

Priorities in resuscitation



PEDIATRIC CARDIAC ARREST ALGORITHM



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- Hypothermia

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- Tamponade (cardiac)
- Tension pneumothorax
- Thrombosis, pulmonary
- Thrombosis, coronary

Neonatal resuscitation program(NRP)

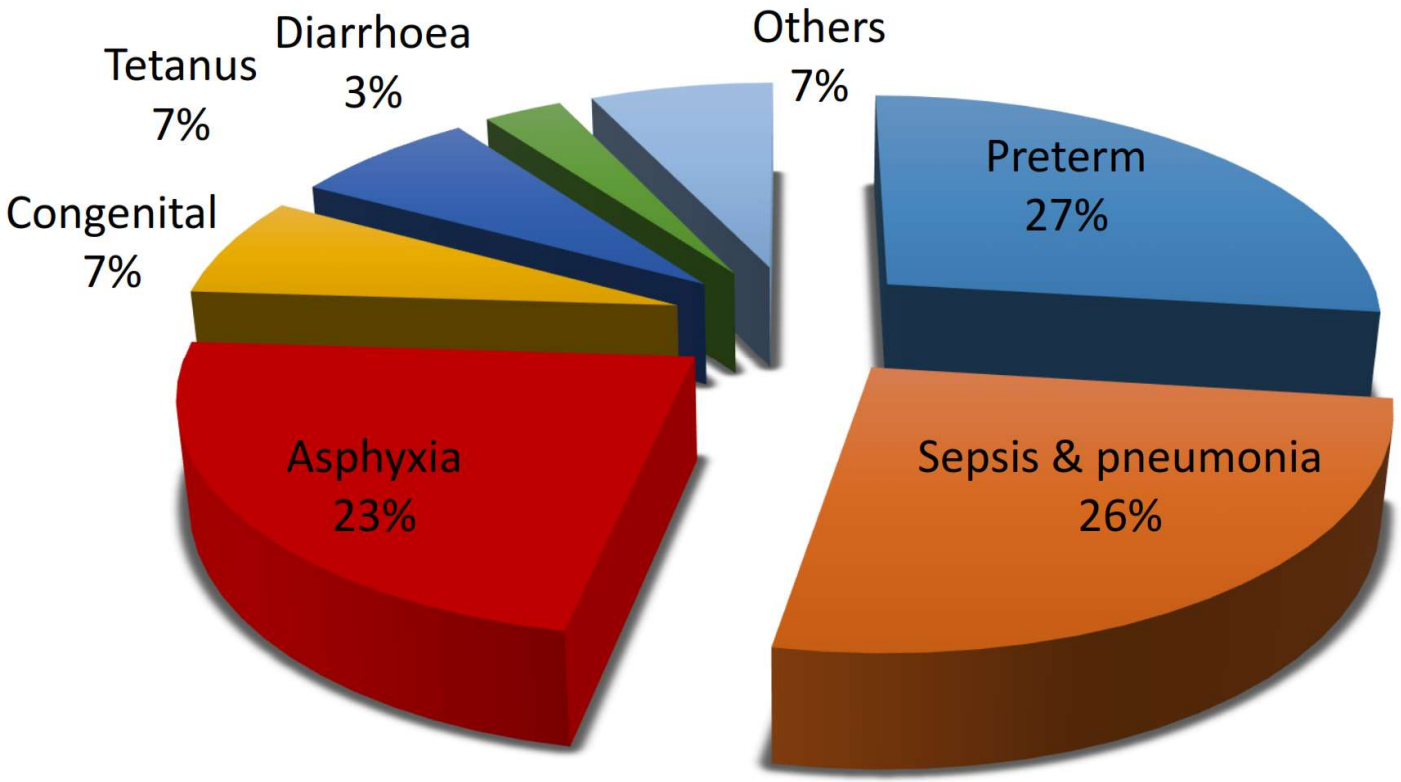
Why ?

- Birth asphyxia accounts for about 1/4th of the neonatal deaths that occur each year worldwide.

- 90% of newborns make smooth transition from intrauterine to extra uterine life requiring little or no assistance.

- **10% of newborns need some assistance with 1% require extensive resuscitation.**

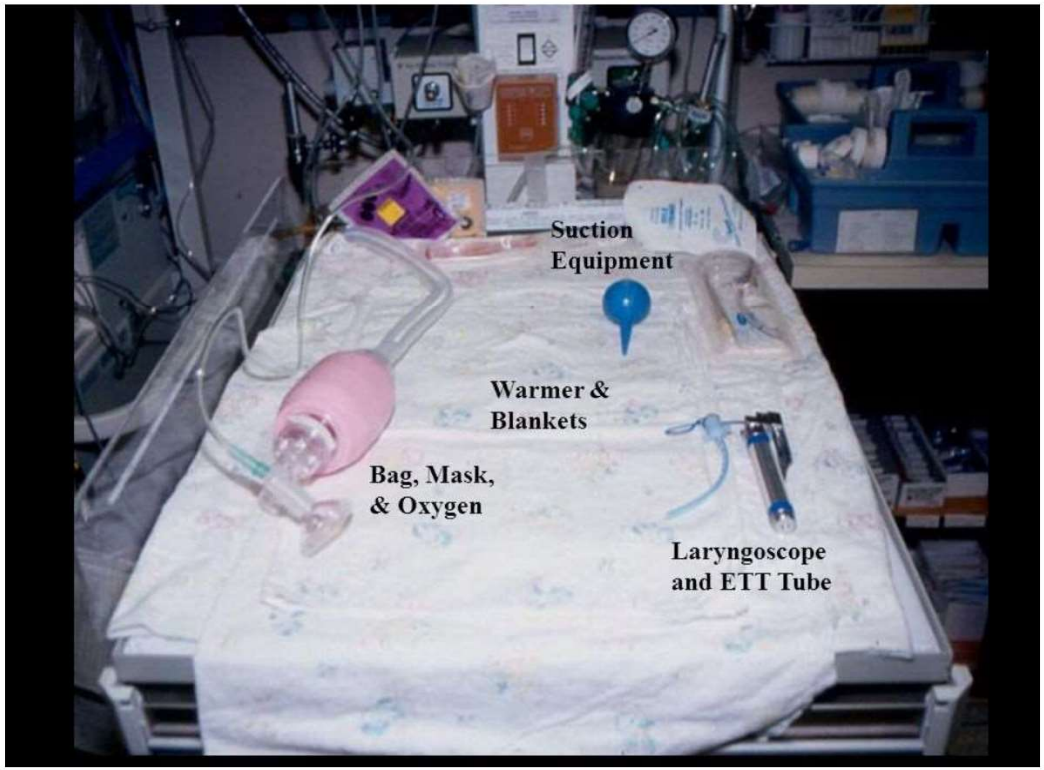
Causes of Neonatal Mortality

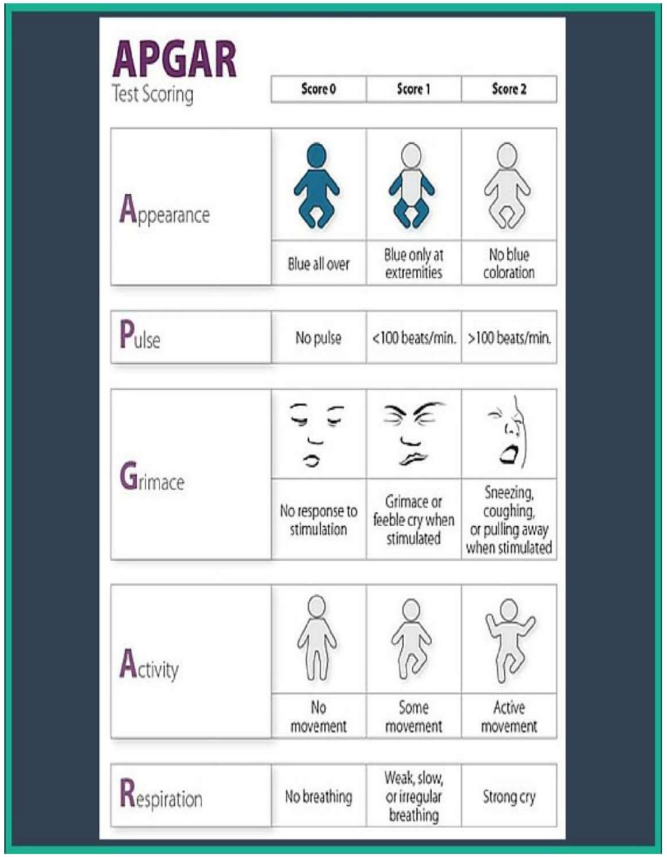


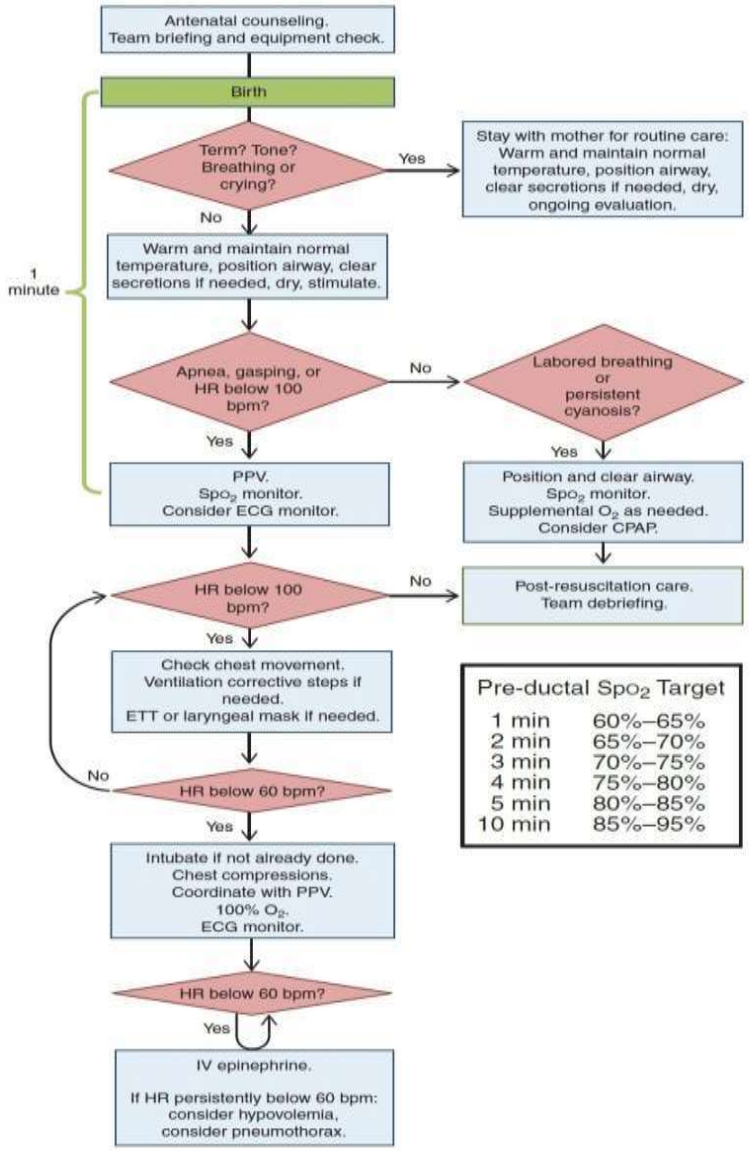
4 million neonatal deaths: When? Where? Why? Lancet *2005; 365: 891–900*

Apgar scores

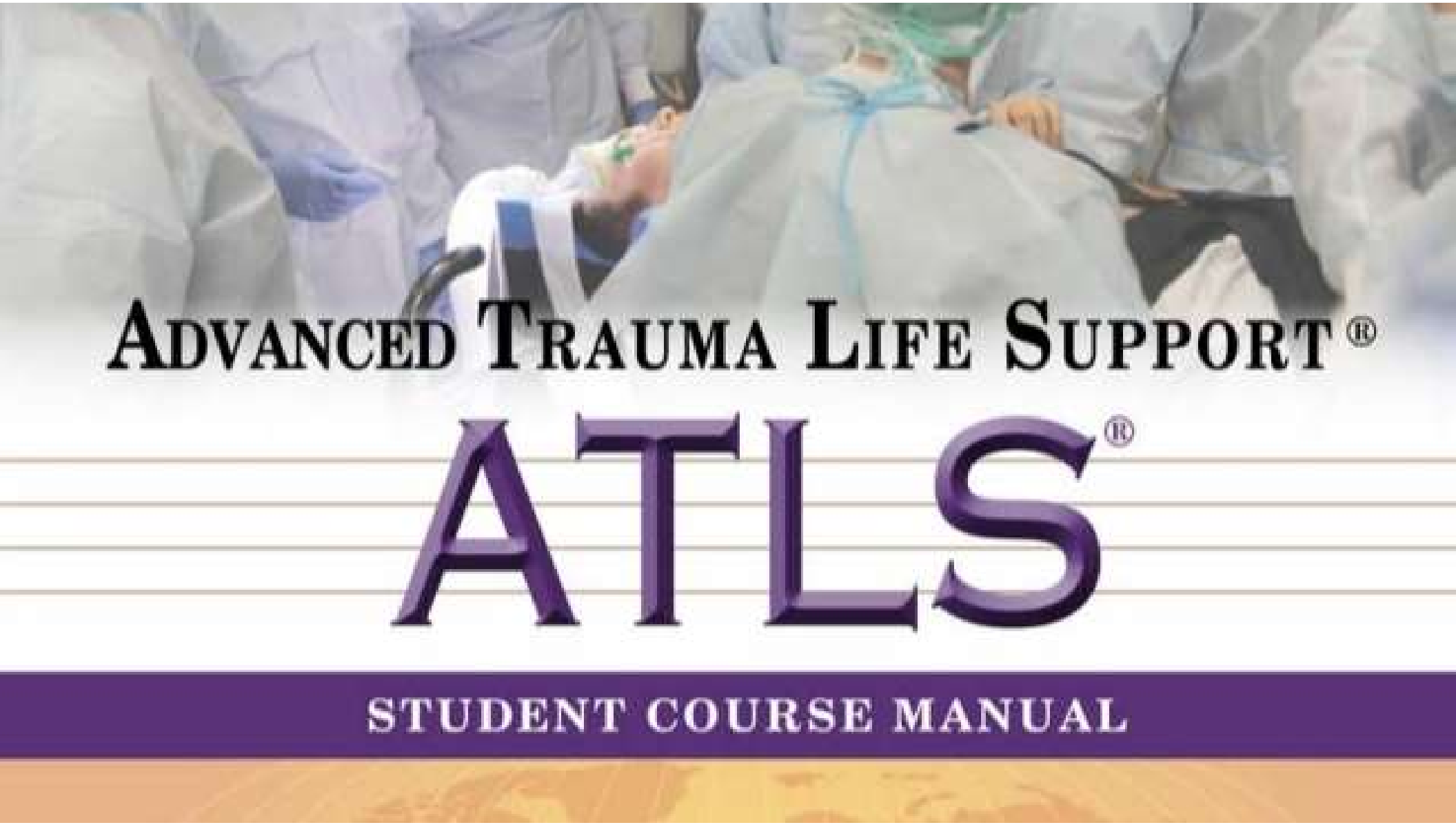
Equipment required







90 compressions to 30 ventilations/minute (3:1- One & two & three & breathe & One & two & three & breathe…



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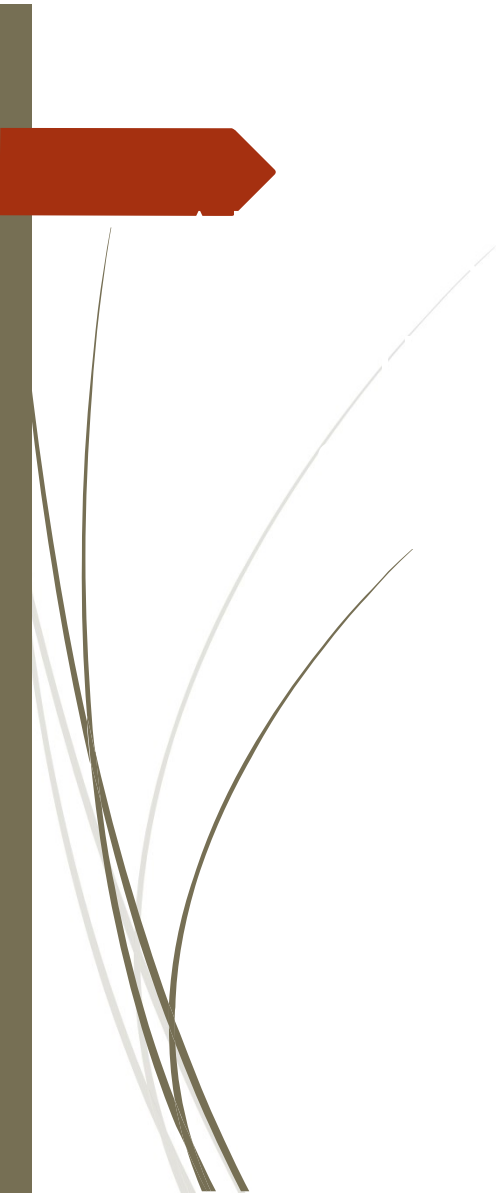


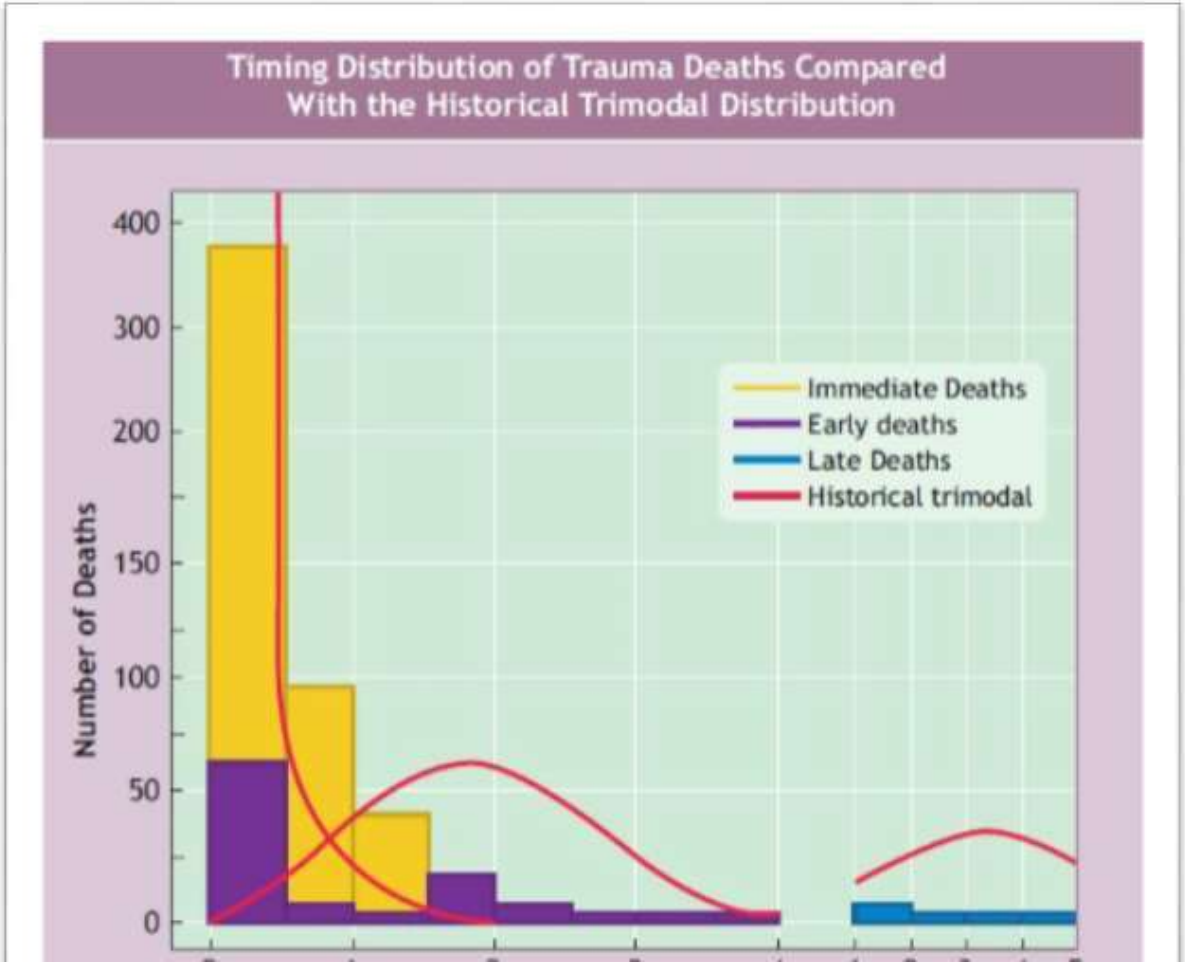
The concepts and principles of the primary and secondary patient assessments.

Establish management priorities in a trauma situation.

Initiate primary and secondary management necessary for the emergency management of acute life-threatening conditions in a timely manner.

Tri-modal of death

- Within Seconds to Minutes
  - Brainstem injury
  - Aortic rupture
- Within Minutes to Hours
  - Subdural Hematoma
  - Rupture of Liver & Spleen
- Within Days t o Weeks
  - Sepsis & multi organ dysfunction(MODS)



The golden hour

- Treating things based on what is more likely to kill first

Pearls

- Resuscitation is the process of halting/reversing shock
- Shock diagnosis is based on a combination clinical assessment parameter(physical exam, diagnostic test, hemodynamic parameters) not a single parameter
- Resusicitation algorithms are meant to give structured evidence based arpouch to critical disease
- Resuscitation algorithms are not interchange between different populations but share in ''Chain of survival approach''
- The process of cellular respiration requires multiple micro/macro processes and understanding these process will aid in diagnosing and treating shock

Thank you

questions?

Email: moe.alageel@gmail.com