How to approach emergencies in Al Hajj

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With the rise of the awareness among medical students to volunteer in Al Hajj season, it is becoming essential to find a booklet that would be helpfull to give you the necessary information to manage and act during the Emergencies situations. The purpose of this project is to help you to Approach Emergencies In Al Hajj

We hope you will find this information useful and May your work be successful and full of rewards.

Table of Content

Approach to Infections Disease

1- Meningitis

Meningitis is a clinical syndrome characterized by inflammation of the meninges.

1. Clinical features:

A. The classic triad of bacterial meningitis consists of the following:

- Fever
- Headache
- Neck stiffness

Other symptoms can include nausea, vomiting and signs of cerebral dysfunction (lethargy, confusion and coma)

B. Patients with viral meningitis may have systemic symptoms (myalgias, fatigue, or anorexia).

C. The examination should evaluate the following:

- Focal neurologic signs.
- Neck regidity.
- Systemic and extracranial findings.
- Level of consciousness.

2. Diagnosis:

The diagnostic challenges in patients with clinical findings of meningitis are as follows:

- Early identification and treatment of patients with acute bacterial meningitis
- Assessing whether a treatable CNS infection is present in those with suspected subacute or chronic meningitis
- Identifying the causative organism

1-Blood studies that may be useful include the following:

- Complete blood count (CBC) with differential
- Serum electrolytes
- Serum glucose (which is compared with the CSF glucose)
- Blood urea nitrogen (BUN) or creatinine and liver profile

2- Lumbar puncture and CSF analysis (Most Important)

3- blood, nasopharynx, respiratory secretion, urine or skin lesion cultures or antigen/polymerase chain reaction (PCR) detection assays

4- Syphilis testing (syphilis disease became a history as it is not seen now adays)

5- Serum procalcitonin testing

6- Neuroimaging (CT of the head or MRI of the brain)

3. Management:

A.Initial measures include the following:

- Assesment of ABCD of patient, looking for compromized airway, shock)
- Altered mental status – Seizure precautions and treatment (if necessary), along with airway protection (if warranted)
- Stable with normal vital signs – Oxygen, IV access, and rapid transport to the emergency department (ED)

b.Treatment of bacterial meningitis includes the following:

• Prompt initiation of empiric antibacterial therapy broad spectrum antibiotics. Example: Ceftriaxone 2 gm iv stat .

• After identification of the pathogen, targeted antibiotic therapy as appropriate for patient age and condition

• Steroid (typically, dexamethasone) therapy

• In certain patients, consideration of intrathecal antibiotics

The systemic complications of acute bacterial meningitis must be treated.

c. Most cases of viral meningitis are benign and self-limited, but in certain instances, specific antiviral therapy may be indicated, if available.

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2- Pneumonia

(community acquired pneumonia)

community acquired pneumonia develops in people with limited or no contact with medical institution or setting , it can be typical or atypical.

A- Typical CAP

1. Common agents:

- S. pneumoniae (60%)
- Haemophilus influenzae (15%)
- Aerobic gram-negative rods (6% to 10%)—Klebsiella (and other Enterobacteriaceae)
- S. aureus (2% to 10%)

2. Clinical features:

a.Symptoms

- Acute onset of fever and shaking chills
- Cough productive of thick, purulent sputum
- Pleuritic chest pain (suggests pleural effusion)
- Dyspnea

b.Signs

• Tachycardia, tachypnea

• Late inspiratory crackles, bronchial breath sounds, increased tactile and vocal fremitus, dullness on percussion

• Pleural friction rub (associated with pleural effusion)

3. CXR:

a. Lobar consolidation

b. Multilobar consolidation indicates very serious illness

C. Atypical CAP

1. Common agents :

- Mycoplasma pneumoniae (most common)
  Chlamydia pneumoniae
- Chlamydia psittaci
- Coxiella burnetii (Q fever)

- Legionella spp.
- Viruses: influenza virus (A and B), adenoviruses, parainfluenza virus, RSV

2. Clinical features :

a. Symptoms

• Insidious onset—headache, sore throat, fatigue, myalgias • Dry cough (no sputum production)

• Fevers (chills are uncommon)

b. Signs

- Pulse-temperature dissociation—normal pulse in the setting of high fever is suggestive of atypical CAP
- Wheezing, rhonchi, crackles

3. CXR

a. Diffuse reticulonodular infiltrates

b. Absent or minimal consolidation

D. Diagnosis:

1. PA and lateral CXR required to confirm the diagnosis (Considered sensitive)
2. Pretreatment expectorated sputum for Gram stain and culture—low sensitivity and specificity,
3. special stains of the sputum in selected cases:
   Acid-fast stain (Mycobacterium spp.) if tuberculosis (TB) is suspected. and Silver stain (fungi, P. carinii) for HIV/immunocompromised patients.
4. Urinary antigen assay for Legionella in selected patients.

E. Manegment:

Antimicrobial therapy.

a. Because the specific cause is usually not determined on initial evaluation, empiric therapy is often required.

b. For outpatients.

- In people younger than 60 years of age, the most common organisms are S. pneumoniae, Mycoplasma, Chlamydia, and Legionella. Macrolides (azithro- mycin or clarithromycin) or doxycycline cover all of these organisms and are the first-line treatment. Fluoroquinolones are alternative agents. Penicillins or cephalosporins do not cover the atypical organisms in this age group.
- In older adults and patients with comorbidities (more likely to have typical CAP) or those treated with antibiotics in the last 3 months, a fluoroquinolone is the first-line agent (levofloxacin, moxifloxacin). A second- or third-genera- tion cephalosporin is the first-line treatment.
- For outpatients, treatment is continued for 5 days. Do not stop treatment until patient has been afebrile for 48 hours.

c. For hospitalized patients, a fluoroquinolone alone or a third-generation cephalosporin plus a macrolide (i.e., .ceftriaxone plus azithromycin) is appropriate

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3- Seasonal influenza

Seasonal influenza is an acute respiratory infection caused by influenza viruses which circulate in all parts of the world.

A. Clinical features:

Seasonal influenza is characterized by a sudden onset of fever, cough (usually dry), headache, muscle and joint pain, severe malaise, sore throat and a runny nose. The cough can be severe and can last 2 or more weeks. Most people recover from fever and other symptoms within a week without requiring medical attention. But influenza can cause severe illness or death especially in people at high risk. The time from infection to illness, known as the incubation period, is about 2 days.

B. Transmission:

Seasonal influenza spreads easily, with rapid transmission in crowded areas through droplets containing viruses. The virus can also be spread by hands contaminated with influenza viruses. To prevent transmission, people should cover their mouth and nose with a tissue when coughing, and wash their hands regularly.

C. Group at risk:

pregnant women, children aged 6–59 months, the elderly, individuals with specific chronic medical conditions such as HIV/AIDS, asthma, and chronic heart or lung diseases, and health-care workers.

D. Prevention:

The most effective way to prevent the disease is vaccination. However, among the elderly, children , pregnant women, immunocompromised patients influenza vaccination may be less effective in preventing illness but reduces severity of disease and incidence of complications and deaths.

E. WHO recommends annual vaccination for:

- pregnant women at any stage of pregnancy
- children aged between 6 months to 5 years
- elderly individuals (aged more than 65 years)
- individuals with chronic medical conditions
- health-care workers.

F. Treatment:

Treatment is largely supportive. Antiviral agents are available but these antiviral agents
are only indicated in patients with severe disease (requiring hospitalization) or at high risk of complications and must be given within the first 48 hours of illness.
There are 2 classes of such medicines:

1- inhibitors of the influenza neuraminidase protein (oseltamivir and zanamivir; as well as peramivir and laninamivir which are licensed in several countries).

2- M2 proton channel blockers adamantanes (amantadine and rimantadine), to which virus resistance has been frequently reported, limiting the effectiveness of treatment.

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4- TB

A. Microbiology:

a. Most commonly caused by Mycobacterium tuberculosis

b. Mycobacteria are acid-fast bacilli (AFB)—considered slow growing but hardy organisms

B. Transmission:

a.Transmission occurs via inhalation of aerosolized droplets containing the active organism

b.Only those people with active TB are contagious (e.g., by coughing, sneezing)

c.People with primary TB are not contagious

C. Clinical features:

A.Primary TB

a.Usually asymptomatic

b.Pleural effusion may develop

c.If the immune response is incomplete, the pulmonary and constitutional symptoms of TB may develop. This is known as progressive primary TB

B.Secondary (active) TB

a.Constitutional symptoms—fever, night sweats, weight loss, and malaise are common

b.Cough progresses from dry cough to purulent sputum. Hemoptysis suggests advanced TB

c.Apical rales may be present on examination

D. Diagnosis :

1. Must have a high index of suspicion, depending on patient's risk factors and presentation

2. CXR

a.Classic findings are upper lobe infiltrates with cavitations

b.Other possible findings

• Pleural effusion(s)

• Ghon complex and Ranke complex: evidence of healed primary TB • Atypical findings common in immunocompromised patients

3. Sputum studies (sputum acid-fast testing)

4. Tuberculin skin test (PPD test)

Tuberculin skin test is a screening test to detect those who may have been exposed to TB. It is not for diagnosis of active TB, but rather of latent (primary) TB (if positive, a chest x-ray is used to diagnose active TB). PPD is not a screening test for everyone, only patients with one or more of the risk factors mentioned above should have this test. If patient is symptomatic or has abnormal chest x-ray, order a sputum acid-fast test, not a PPD.

E. Treatment :

1.Patients with active TB must be isolated until sputum is negative for AFB.

a.First-line therapy is a four-drug regimen: isoniazid (INH) rifampicin, pyrazinamide, and ethambutol or streptomycin.

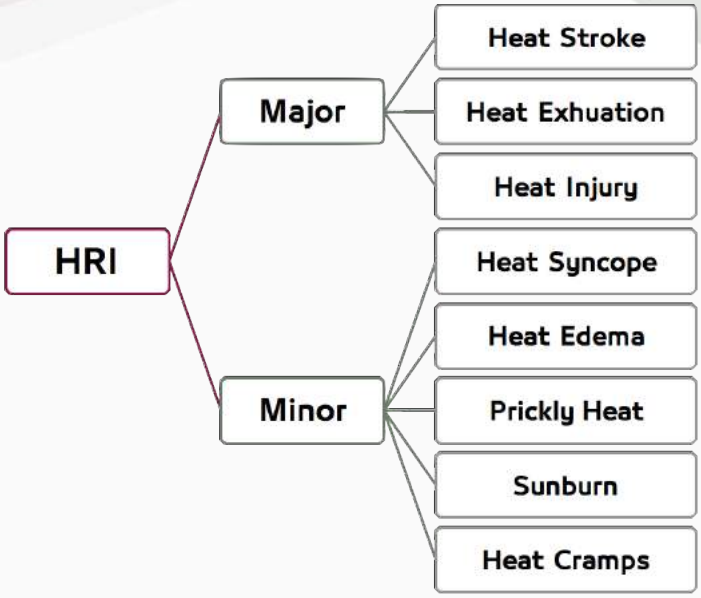
b.The initial treatment regimen consists of 2 months of treatment with the four drug regimen. After this initial 2-month phase, a phase of 4 months is recommended using INH and rifampin.

2.Prophylactic treatment for latent (primary) TB (i.e., positive PPD skin test):

consists of 9 months of INH after active TB has been excluded (negative CXR, sputum, or both).

Approach to Heat Related Illness

Heat illnesses are strongly related to morbidity and mortality during Hajj, specially in Summer. In Makkah, temperatures can rise higher than 45°C. Lack of acclimatization, high intensity physical exertion, poor physical fitness, and exposed spaces are considered risk factors in many pilgrims.



Major Heat Illnesses :

1) Heat Stroke:

It is a **life-threatening** condition, defined as a core body temperature usually in excess of **40°C** (104°F) with associated **central nervous system dysfunction** in the setting of a large environmental heat load.

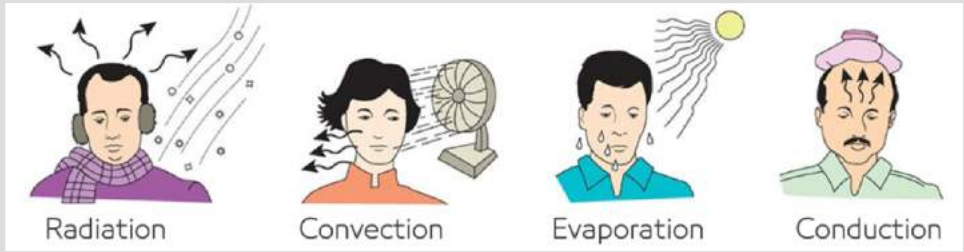
There are two types of heat stroke:

1. **Classic (non-exertional) heat stroke**: it affects elderly individuals with risk factors that impair thermoregulation, prevent removal from a hot environment, or interfere with access to hydration or attempts at cooling.
2. **Exertional heat stroke**: it generally occurs in young, otherwise healthy individuals who engage in heavy exercise during periods of high ambient temperature and humidity.

A. Pathophysiology:

Body normal temperature is maintained by balancing heat load with heat dissipation. The body's heat load results from both metabolic processes and absorption of heat from the environment. As core temperature rises, the preoptic nucleus of the anterior hypothalamus stimulates efferent fibers of the autonomic nervous system to produce **sweating** and cutaneous **vasodilation**.

Evaporation is the principal mechanism of heat loss in a hot environment, but this becomes **ineffective** above a relative humidity of 75 percent. The other major methods of heat dissipation: **Radiation** (emission of infrared electromagnetic energy), **conduction** (direct transfer of heat to an adjacent, cooler object), and **convection** (direct transfer of heat to convective air currents)—cannot efficiently transfer heat when environmental temperature exceeds skin temperature.



As the temperature reaches 42°C, the cells of the body start to breakdown and lose their functional capability, resulting in **multi-organ system failure** and disseminated intravascular coagulation (DIC).

B. Risk factors:

1. Extremes of age, especially pilgrims above 65 years old.
2. Cardiovascular disease or hypertension.
3. Diabetes.
4. Neurologic, psychiatric disorders or Central nervous system.
5. medications.
6. Liver diseases.
7. Kidney diseases or diuretics.
8. Obesity.
9. Anhidrosis.
10. Physical disability.
11. The use of recreational drugs, such as alcohol or cocaine.
12. Anticholinergic agents.
13. Lack of acclimatization.

Heat stroke high **mortality** is directly correlated to the duration of core temperature elevation, time to initiation of cooling measures, and the number of organ systems affected.

C. Clinical features:

– History:

- Hx of exposure to severe environmental heat.
- If they can respond coherently, patients with heat stroke may complain of weakness, lethargy, nausea, or dizziness.

– Physical findings:

- Elevated core body temperature (generally >40°C [104°F]), some patients with heat stroke **may not** exceed 40°C, particularly if cooling measures were initiated prior to the patient's arrival at the hospital.
- **Rectal** assessment of core body temperature is the most accurate.
- **Central nervous system dysfunction** (eg, altered mentation, slurred speech, irritability, inappropriate behavior, agitation, ataxia and other signs of poor coordination, delirium, seizures, and coma).
- Lack of another explanation for their hyperthermia (eg, infection).
- Vital sign abnormalities (eg. tachycardia, tachypnea,
- hypotension).
- Flushing (cutaneous vasodilation), diarrhea, crackles due to noncardiogenic pulmonary edema and aspiration pneumonia.
- The skin may be moist or dry, depending upon underlying medical conditions, the speed with which the heat stroke developed, and hydration status, not all victims of heat stroke are volume-depleted.

The severity of a heat illness may not be apparent during the initial presentation.

Complications: include acute respiratory distress syndrome (ARDS), heat-related myocardial ischemia or infarction, disseminated intravascular coagulation (DIC), acute kidney injury (AKI), hepatic injury, hypoglycemia, and rhabdomyolysis.

D. Treatment Goals:

- Normal vital signs.
- Euhydration state.
- Full consciousness.
- Normal investigations.
- Avoid and treat complications.

E. Management:

1. Remove the patient from the hot place and move him to a shaded or air-conditioned area.
2. Ensure airway, breathing and circulation:
   - Initiate resuscitative measures and monitoring if indicated.
3. Remove excess clothing and equipment.
4. Rapid cooling:
   - Start evaporative Cooling measures (Fan and body water spray). With evaporative cooling, the naked patient is sprayed with a mist of lukewarm water while fans are used to blow air over the moist skin.

     Other effective cooling methods:
     - Special beds called body cooling units, in which the patient is placed supine on a porous stretcher, alternate warm and cold mist with air.
     - Applying cold compresses to the glabrous (smooth, hairless) skin surfaces of the cheeks, palms, and soles.
     - Applying ice packs to the axillae, neck, and groin (areas adjacent to major blood vessels), but may be poorly tolerated by the awake patient.
     - Immersing the patient in ice water (cold water immersion) is an efficient, noninvasive method of rapid cooling, but it complicates monitoring and intravenous access, and may be harmful to elder patients.
5. Give fluid and salt replacement, to treat dehydration.
6. Continuously observe and frequently monitor heart rate, blood pressure, respiratory rate, rectal temperature, and mental status.
7. Stop cooling measures whenever rectal temperature reaches 39°c.
8. Avoid using pharmacologic therapy (antipyretics) as it can exacerbate Heat stroke complications.
9. Look for other complications and treat them accordingly.
10. Transport the patient to an emergency department if rapid improvement does not occur.

Note: Pharmacologic therapy — Pharmacologic therapy is not required in heat stroke. There is **NO** role for antipyretic agents such as acetaminophen (Paracetamol) or aspirin in the management of heat stroke, since the underlying mechanism does not involve a change in the hypothalamic set-point and these medications may **exacerbate** complications such as hepatic injury or disseminated intravascular coagulation (DIC)!

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2) Heat Exhaustion:

It is defined as a heat illness with core body temperature elevation, usually **less** than 40°C (104oF) with **normal central nervous system function** in the setting of strenuous physical exertion and environmental heat stress.

A- Pathophysiology:

Inability to maintain adequate cardiac output due to loss of salt and water, in non-acclimatized patient.

B. Clinical features:

- History:

- Most often Heat exhaustion manifests as physical collapse during exercise.
- Body temperature elevation.
- Headache, nausea, vomiting, dizziness, weakness and cramps.

- Physical findings:

- Patient is presented with normal or increased core body
- (rectal) temperature < 40°c, (milder than with heat stroke or
- heat injury).
- Sweating, postural hypotension.
- The central nervous system is not affected.

C. Treatment Goals:

- Normal vital signs.
- Euhydration state.
- Normal investigations.

D. Management:

1. Remove the patient from the hot place and move him to a shaded or air-conditioned area.
2. Place the patient supine and raise his legs.
3. Remove excess clothing and equipment.
4. Cool the patient until the patient starts shivering by running ice or cool water over him or using evaporative cooling measures, mentioned in heat stroke management.
5. Give fluid and salt replacement, to treat dehydration.
6. Continuously observe and frequently monitor heart rate, blood pressure, respiratory rate, rectal temperature, and mental status.
7. Transport the patient to an emergency department if rapid improvement does not occur.

E. Admission criteria:

Patient who fail to improve after two hours despite these measures, maybe he is a candidate of developing late complications, consistent with possible heat injury, and should be admitted for observation and diagnostic testing.

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3) Heat Injury:

Exertional heat injury is defined as a progressive multisystem disorder with hyperthermia, **less** than 40°C (104oF) following vigorous activity that is associated with **end-organ damage** (eg. kidney, liver, muscle) in the **absence** of significant neurologic injury.

A. Pathophysiology:

Exertional heat injury is **similar** to Heat stroke, but the patient's central nervous system is **not affected** and core body temperature does not have to exceed 40°C. It is **unlike** heat exhaustion, there is clear evidence of end-organ injury such as rhabdomyolysis, AKI, DIC, or acute liver failure.

B. Clinical features:

- **History:**

- Most often Heat injury manifests as physical collapse during exercise.
- Body temperature elevation.
- May complain of weakness, lethargy or nausea.
- No significant neurologic manifestation.
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- **Physical findings:**

- Patient is presented with normal or increased core body (rectal) temperature < 40°c.
- Sweating, postural hypotension.
- The central nervous system is not affected.
- Lack an other explanation for hyperthermia (eg. Infection).
- Vital sign abnormalities (eg. tachycardia, tachypnea, hypotension).
- The severity of the heat injury may not be apparent during the initial presentation.
- Frequently encountered complications include acute respiratory distress syndrome (ARDS), DIC, AKI, hepatic injury, hypoglycemia, and rhabdomyolysis.

C. Management:

1. Rapid cooling: using any of the methods suitable for heat stroke.
2. Continuous core temperature monitoring rectally and cooling measures should be stopped once a temperature less than 39oc has been achieved in order to reduce the risk of iatrogenic hypothermia.
3. Monitoring of vital signs and urine output.
4. Initial care is largely supportive.
5. Laboratory studies including but not limited to urinalysis, urine, myoglobin and creatine kinase, complete blood count, serum electrolyte concentrations, arterial or venous blood gas, serum lactate, blood urea nitrogen (BUN) and creatinine concentrations, liver function tests (serum aminotransferases (AST, ALT), cardiac enzymes, prothrombin time (PT) and partial thromboplastin time (PTT), septic screening. And Exclude other causes of hyperthermia.

Note: Organ damage does not always manifest with laboratory abnormalities early in the course of illness and clinicians should admit and monitor patients, with possible heat injury, closely.

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Minor Heat Illnesses

1) Heat Syncope:

Heat syncope is a transient loss or near-loss of consciousness due to the indirect effects of high ambient temperature that generally occurs during the first few days when a pilgrim is exposed to high environmental temperatures, before acclimatization is complete.

A. Pathophysiology:

Exertion associated collapse in non-acclimatized pilgrims, due to heat induced peripheral vasodilatation and **pooling of blood**, with subsequent loss of consciousness.

B. Clinical features:

- **History:**

Most often Heat syncope manifests as physical collapse during or after exertion, with a feeling of heaviness in the legs, Blurred vision, Confusion, Feeling warm or hot, Lightheadedness, dizziness, a floating feeling, Nausea, Sweating, Vomiting or Yawning.

- Physical findings:

There may be a drop in blood pressure and weak pulse.

C. Management:

1. The management plan is the same as in heat exhaustion. The patient should recover within 15 to 20 minutes with these maneuvers, until that time, he/she should avoid sudden or prolonged standing.
2. Transport the patient to an emergency department if rapid improvement does not occur.

2) Heat Edema:

It is a condition characterized by dependent edema from **vasodilatory pooling**, due to the indirect effects of high ambient temperature that generally occurs during the first few days when a pilgrim is exposed to high environmental temperatures, before acclimatization is complete.

A. Pathophysiology:

Heat in non-acclimatized pilgrims induce peripheral vasodilatation and pooling of blood, with subsequent gravitational edema of hands, feet and legs.

B. Clinical features:

- History:

Older adults and People visiting hot climates from colder climates have an increased risk of heat edema, especially if they have other medical conditions that affect their circulation.

Physical findings:

Mild swelling of hands and feet.

C. Management:

1. Move the patient to a shaded area.
2. Have the patient lay supine in a cool environment.
3. Raise the legs of the patient.
4. Give fluids to drink.

Usually heat edema Disappears after acclimatization.

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3) Prickly Heat:

Prickly heat, also called miliaria, is a rash that can develop after a person sweats far more than usual and sweat glands become blocked.

A. Pathophysiology:

Heat rash begins with excessive perspiration, usually in a hot, humid environment. The perspiration makes it easier for dead skin cells and bacteria on the skin to block the sweat glands, forming a barrier and trapping sweat beneath the skin, where it builds up, causing the characteristic bumps. As the bumps burst and sweat is released, there may be a prickly, or stinging sensation that gives this condition its name.

B. Clinical features:

- Manifests as an itchy rash of small raised red spots with a prickling or stinging sensation.
- Usually affects parts of the body covered by clothes, such as the back, abdomen, neck, upper chest, groin or armpits.

C. Management:

1. In most cases, heat rash will clear up on its own in a few days if the affected area is kept cool and dry.

2. Advise the patient to avoid excessive heat and humidity and cool off with a fan Advise the patient to take a cool shower and let skin air dry.
3. Avoid using any type of oil-based product, which might block sweat glands.
4. Calamine lotion and/or hydrocortisone cream can relieve itching and irritation.

4) Sunburn:

Sunburn is defined as red, painful skin that feels hot to the touch due to exposure to sunshine.

A. Pathophysiology:

Sunburn usually appears within a few hours after too much exposure to ultraviolet (UV) light from sunshine. Many people don't produce enough melanin to protect the skin well. Eventually, UV light causes the skin to burn, bringing pain, redness and swelling. Sunburn may take several days or longer to fade.

B. Clinical features:

- Signs and symptoms of sunburn usually appear within a few hours after sun exposure:
- Pinkness or redness.
- Skin that feels warm or hot to the touch.
- Pain, tenderness or itching.
- Swelling.
- Small fluid-filled blisters, which may break.
- Headache, fever, chills and fatigue if the sunburn is severe.

C. Management:

1. Pain relievers as MEPO gel or calamine lotion.
2. Medications that control itching: skin corticosteroids, combined with pain relievers.
3. Advise to avoid sun exposure between 10 a.m. and 4 p.m.
4. Cover up with white clothes and umbrella.

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5) Heat Cramps:

Heat cramps (which do not appear to be caused by increased ambient temperatures) are muscle cramps that occur during or after exertion).

A. Pathophysiology:

Exertion associated cramps in non-acclimatized pilgrims, due to fluid deficiencies (dehydration), electrolyte imbalances, neuromuscular fatigue, or any combination of these factors.

B. Clinical features:

- Painful involuntary muscle contraction, involving large muscles groups specially legs.
- Moist cool skin, a normal body temperature, and minimal distress.

C. Management:

1. Relax in cool environment, stretch and massage the involved muscle to reduce acute discomfort.
2. Give oral salt solution to hydrate the patient and replace sodium loss, can be made by adding one-fourth to one-half teaspoon of table salt to 1L of water.

D. Preventive measures for heat illnesses:

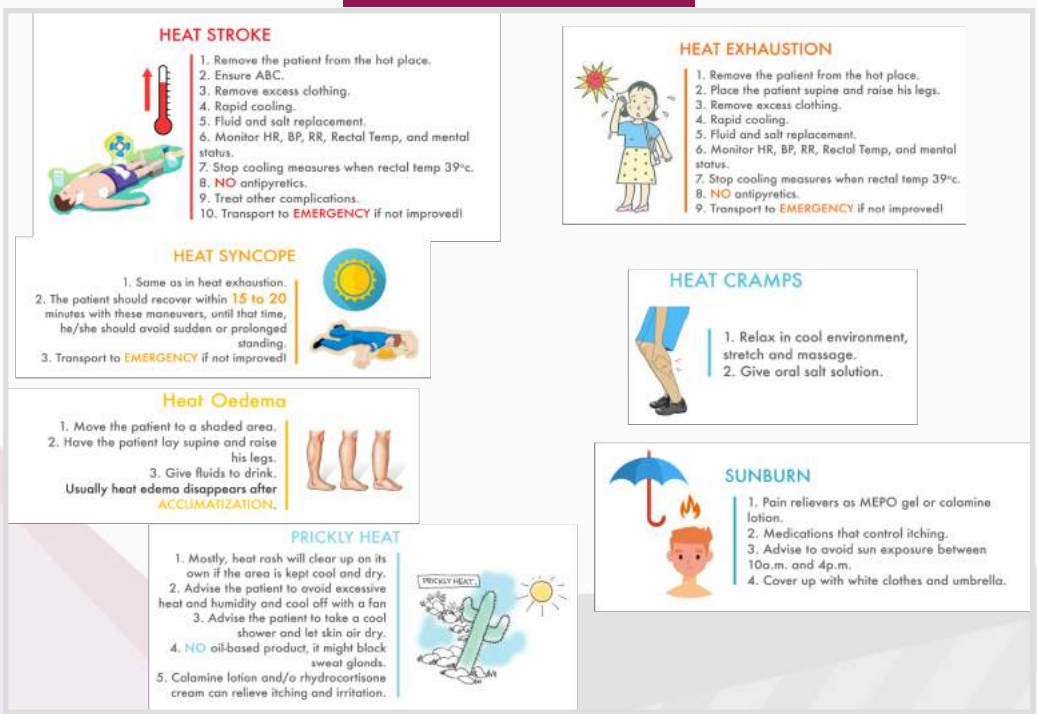
1. Institute prevention policies, including an emergency action plan.

2. Educate staff and pligrims about heat illness.
3. Acclimatize gradually to exercising in hot and/or humid conditions; the process of heat acclimatization generally requires 7 days, under a heat stress comparable to the target competition. Training sessions for heat acclimatization should last at least 60 minutes per day, and induce an increase in core and skin temperatures, as well as stimulate sweating.
4. Direct sun light exposure should be avoided.
5. Remain at air-conditioned places as long as possible.
6. Use white-colored umbrella whenever exposed to sun, and take rest at shady areas.
7. Provide frequent breaks for hydration and cooling.
8. Hydrate before activity and keep well hydrated throughout activity.
9. Dress light cotton-made clothes and minimize equipment and clothing that hinder heat loss in hot or humid conditions.
10. Avoid activity during severe heat and/or humidity.
11. Take all medications regularly.

E. Acclimatization:

Acclimatization is the body's ability to improve its response and tolerance of heat stress over time.
Full acclimatization requires at least **10 to 14 days** of exercise at an intensity that raises body temperature to at least 38.51°C for at least 60 minutes. Any improved tolerance of heat stress generally dissipates within 2 to 3 weeks of returning to a more temperate environment.
The major physiologic adjustments that occur during heat and humidity acclimatization include:
1. Plasma volume expansion.
2. Improved cutaneous blood flow.
3. Lower threshold for initiation of sweating.
4. Increased sweat output.
5. Lower salt concentration in sweat.
6. Lower skin and core temperatures for a standard exercise.
These adaptations allow for better dissipation of heat and limit increases in body temperature.

Management of HRI



Approach to Diabetic Ketoacidosis (DKA)

A. Definition:

DKA is a metabolic consequence of insulin deficiency, glucagon excess, and counter regulatory hormonal responses to stressful triggers in patients with diabetes (more common in T1DM).[1]

B. Pathophysiology:

Normally, two hormones regulate blood glucose level: Insulin and glucagon. As the serum glucose level rises after meals, the glucose inters the Pancreas initiating sequence of events that ends by releasing of Insulin resulting in normoglycemia. [1]

In patient with uncontrolled diabetes, either Insulin deficiency or –less common- anti-insulin hormones excess (e.g. glucagon, catecholamines) can contribute to DKA resulting in

1- Hyperglycemia
2- Ketosis (Ketone production)
3- Anion gap metabolic acidosis
4- Electrolytes imbalance. [1]

The most common precipitating factors are infection (most often pneumonia or urinary tract infection) and discontinuation of or inadequate insulin therapy.[2]

C. Clinical features: [3]

The symptoms evolve rapidly over 24 hrs. The earliest symptoms of marked hyperglycemia are polyuria, polydipsia, and weight loss. As the degree or duration of hyperglycemia progresses:

- Neurologic symptoms (occur if the effective plasma osmolality above 320 to 330 mOsmol/kg), including lethargy, focal signs, and obtundation can develop. This can progress to coma in later stages. (N.B. Neurologic symptoms are most common in HHS).
- GI symptoms including nausea, vomiting, and abdominal pain (common in children) that is associated with the severity of the metabolic acidosis.

D. Physical examination: [3]

Signs of dehydration are common including decreased skin turgor, dry axillae and oral mucosa, low jugular venous pressure, tachycardia, and, if severe, hypotension.

Patients with DKA may have a fruity odor (due to exhaled acetone; this is similar to the scent of nail polish remover) and deep respirations reflecting the compensatory hyperventilation (Kussmaul breathing).

E. Investigations: [3]

The initial laboratory investigations of suspected DKA should include determination of:

- Serum glucose.
  N.B Euglycemic DKA (i.e. serum glucose is normal or near normal) may be seen in patients with poor oral intake, treatment with insulin prior to arrival in the emergency department, or in pregnant women.
- Serum electrolytes.
  With calculation of the anion gap, blood urea nitrogen (BUN), and plasma creatinine.
  N.B Serum anion gap = Serum sodium - (serum chloride + bicarbonate),
- Complete blood count (CBC) with differential.
- Urinalysis and urine ketones by dipstick.
- Plasma osmolality.
- Serum ketones (if urine ketones are present).

- Arterial blood gas if the serum bicarbonate is substantially reduced or hypoxia is suspected.
- Electrocardiogram.
- Need to exclude secondary DKA due to different causes as sepsis (Pneumonia, Abscess, Appendicitis).

Typical laboratory characteristics of DKA: [3]

	DKA		
	Mild	Moderate	Severe
Plasma glucose (mg/dL)	>250	>250	>250
Plasma glucose (mmol/L)	>13.9	>13.9	>13.9
Arterial pH	7.25 to 7.30	7.00 to 7.24	<7.00
Serum bicarbonate (mEq/L)	15 to 18	10 to <15	<10
Urine ketones ¶	Positive	Positive	Positive
Serum ketones - Nitroprusside reaction	Positive	Positive	Positive
Serum ketones - Enzymatic assay of beta hydroxybutyrate (normal range <0.6 mmol/L) Δ	3 to 4 mmol/L	4 to 8 mmol/L	>8 mmol/L
Effective serum osmolality (mOsm/kg) ◇	Variable	Variable	Variable
Anion gap §	>10	>12	>12
Alteration in sensoria or mental obtundation	Alert	Alert/drowsy	Stupor/coma

DKA: diabetic ketoacidosis; HHS: hyperosmolar hyperglycemic state.
* There may be considerable diagnostic overlap between DKA and HHS.
¶ Nitroprusside reaction method.
Δ NOTE: Many assays for beta hydroxybutyrate can only report markedly elevated values as >6.0 mmol/L.
◇ Calculation: 2[measured Na (mEq/L)] + glucose (mg/dL)/18.
§ Calculation: (Na+) – (Cl– + HCO3–) (mEq/L). See text for details.

N.B. Additional tests may be required according to the case e.g. cultures, CXR. [3]

F. Diagnostic criteria: [3]

The triad of hyperglycemia, anion gap metabolic acidosis, and ketonemia characterizes DKA.

G. Treatment: [3]

The goal is to correct the fluid and electrolyte abnormalities that are typically present (hyperosmolality, hypovolemia, metabolic acidosis, and potassium depletion) and the administration of insulin.

H. Monitoring: [3]

- Serum glucose should initially be measured every hour until stable.
- Serum electrolytes, blood urea nitrogen (BUN), creatinine, and venous pH should be measured every 2 to 4 hours (depending on the severity).
- Repeated arterial blood gases are unnecessary. (To avoids pain and complications of repeated arterial punctures).
- Monitoring venous pH is to monitor the serum bicarbonate concentration (to assess correction of the metabolic acidosis) and the serum anion gap (to assess correction of the ketoacidemia) as alternatives for ABG.
- Every 2 hrs, bedside ketone meters that measure capillary blood beta-hydroxybutyrate for monitoring the response to treatment (if available).

Emergent DKA management (Rapid overview)[3]:

Management
Stabilize the patient's airway, breathing, and circulation.
Obtain large bore IV (≥16 gauge) access; monitor using a cardiac monitor, capnography, and pulse oximetry.
Monitor serum glucose hourly, and basic electrolytes and venous pH or bicarbonate every two to four hours until the patient is stable.
Determine and treat any underlying cause of DKA (eg, pneumonia or urinary infection, myocardial ischemia).
Replete ECF volume and free water deficits:
• Give several liters of IV isotonic (0.9%) saline as rapidly as possible to patients with signs of shock.
• Give IV isotonic (0.9%) saline at 15 to 20 mL/kg per hour (ie, 1 to 1.5 L per hour for an average-sized adult), in the absence of cardiac compromise, for the first few hours to hypovolemic patients without shock.
• After intravascular volume is restored, give one-half isotonic (0.45%) saline at 4 to 14 mL/kg per hour if the corrected serum Na+ ¶ is normal or elevated; isotonic saline is continued if the corrected serum Na+ ¶ is reduced.
• Add dextrose to the saline solution when the serum glucose reaches ~200 mg/dL (11.1 mmol/L).
Replete potassium (K+) deficits:
• Regardless of the initial measured serum K+, patients with DKA have a large total body K+ deficit.
• If initial serum K+ is below 3.3 mEq/L, hold insulin and give potassium chloride 20 to 40 mEq/hour IV until K+ concentration is above 3.3 mEq/L; rarely, additional potassium supplementation may be necessary to avoid life-threatening muscle weakness and cardiac arrhythmias.
• If initial serum K+ is between 3.3 and 5.3 mEq/L, give potassium chloride 20 to 30 mEq per liter IV fluid; maintain serum K+ between 4 to 5 mEq/L.
• If initial serum K+ is above 5.3 mEq/L, do not give potassium; check serum K+ every 2 hours; delay administration of potassium chloride until serum K+ has fallen to 5 to 5.2 mEq/L.
Give insulin:
• Do not give insulin if initial serum K+ is below 3.3 mEq/L; replete K+ and fluid deficit first.
• Give all patients without a serum K+ below 3.3 mEq/L regular insulin. Either of two regimens can be used: 0.1 units/kg IV bolus, then start a continuous IV infusion 0.1 units/kg per hour; **OR** do not give bolus and start a continuous IV infusion at a rate of 0.14 units/kg per hour.
• If serum glucose does not fall by at least 50 to 70 mg/dL (2.8 to 3.9 mmol/L) in the first hour, double the rate of insulin infusion.
• When the serum glucose reaches 200 mg/dL (11.1 mmol/L), it may be possible to decrease the infusion rate to 0.02 to 0.05 units/kg per hour.
• Continue insulin infusion until ketoacidosis is resolved, serum glucose is below 200 mg/dL (11.1 mmol/L), and subcutaneous insulin is begun.
Give sodium bicarbonate to patients with pH below 6.90:
• If the arterial pH is below 6.90, give 100 mEq of sodium bicarbonate plus 20 mEq of potassium chloride in 400 mL sterile water over two hours; may be repeated if venous pH remains below 7.00.

Approach to Seizures

A. Definition:

Sudden abnormal discharge of of electrical activity in the brain.

B. Classification:

Epileptic Seizures

1) Partial		2) Complete				
Simple (Consciousness is Intact)	Complex (Impaired of consciousness)	Tonic (Muscles of body become stiff)	Atonic (Muscles in the body relax)	Tonic-Clonic (Clonic:period of jerking parts of the body)	Myoclonic (Short jerking in parts of the body)	Absence

C. History:

Aimed to determine:

1- Time of seizure
2- Frequency
3- Severity

- **Aura.**
- **LOC.**
- **Dyspnea.**
- **Fixed and dilated pupil.**
- **Incontinence.**

To obtain a good history:

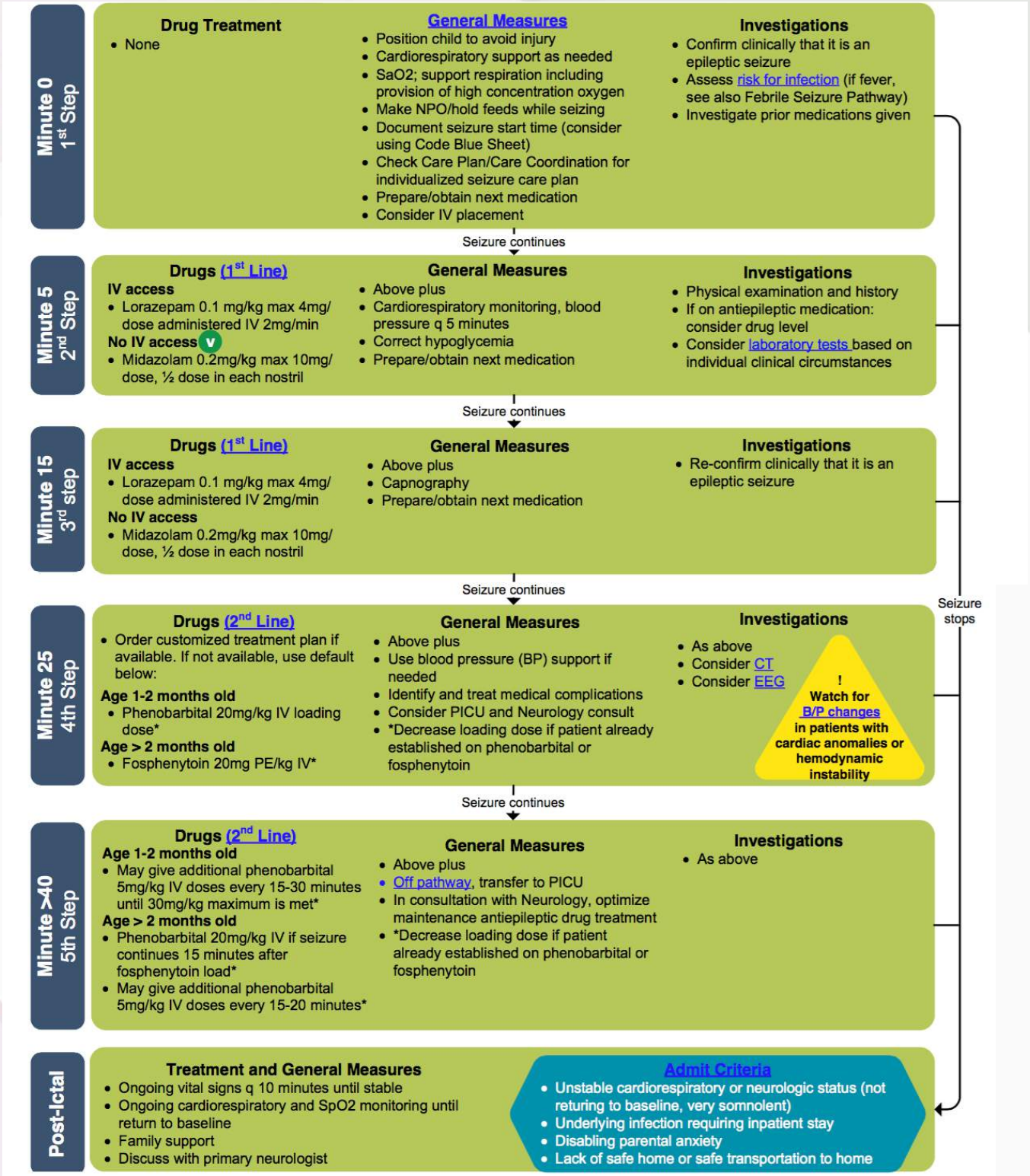
Use the mnemonic FACTS:
F- Focus (Generalized or Partial?)
A- Activity (Type of movement?)
C- Color or Cocaine (Cyanosis? Indications of cocaine use?)
T- Time (How long did the seizure last?)
S- Secondary Information (Medications? Events leading up to seizure? Incontinence? Tongue biting?)

4-Factors that precipitate them: infectious process (such as meningitis), a toxin, or a metabolic disorder.
5-Developmental history taking (events of pregnancy and childbirth).
6-Questioned about illness, head injury, recent health, problems and recent trauma.

D. Examination:

1-Elevated temperature should prompt a search for a source of infection.
2-Laceration of the tongue often occurs during a seizure.
3-Examine the neck for nuchal rigidity (i.e., evidence of meningitis).
4-Examine the lungs for rales, as pneumonia may have precipitated the seizure activity.
5-The extremities should be examined for evidence of trauma (seizures are the most common cause for posterior dislocation of the shoulder).
6-Serial neurologic exams should be performed as the patient progresses through the postictal course.

E. Management:



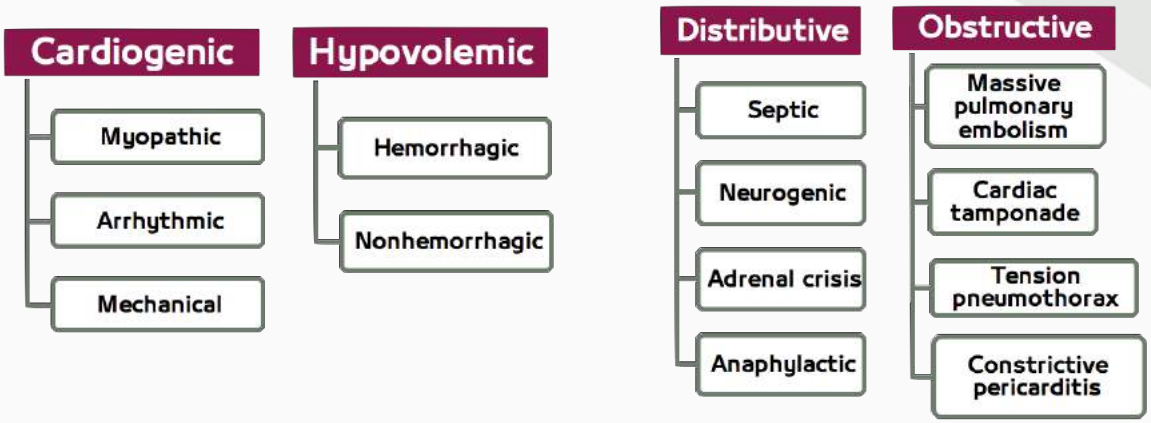
Approach to Shock

A. Definition:

Shock is a life-theatening condition of circulatory failure. The effects of shock are initially reversible, but rapidly become irreversible, resulting in multiorgan failure (MOF) and death.

Shock is defined as a state of cellular and tissue hypoxia due to reduced oxygen delivery and/or increased oxygen consumption or inadequate oxygen utilization.

B. Shock Categories:



C. Clinical manifestations:

- **Signs of Hypoperfusion / inadequate oxygenation:**
  - **Early signs of shock :**

1) Altered mental status
2) cool pale skin
3) tachycardia with thready pulse
4) Oliguria need time to see it (more than 2 hrs)

- **Late sign of shock :** Hypotension
- **Metabolic acidosis** (Found in septic and hemorrhagic shock. we shouldn't wait for lab results to discover shock)
- ↑ **Lactate** (Found in septic and hemorrhagic shock. we shouldn't wait for lab results to discover shock)

- **Compensatory mechanisms :**
  - Vasoconstriction.
  - Tachycardia.

D. Therapeutic Goals in Shock:

- Increase O2 delivery.
- Optimize O2 content of blood
- Improve cardiac output and blood pressure.
- Match systemic O2 needs with O2 delivery.
- Reverse/prevent organ hypoperfusion.

E. Management Approach:

- Start with (ABCDE) :

♣ Airway:

- Protect cervical spine , if injury possible .
- Assessment : Any sign of obstruction ?
- Management : Establish a patent airway .

♣ Breathing:

- Assessment : Determine RR , check bilateral chest movement , percuss and auscultate .
- Management : If breathing compromised , give high concentration O_2 . If no respiratory effort , intubate and ventilate .

♣ Circulation:

- Assessment : Check pulse and BP , check capillary refill , look for evidence of hemorrhage .
- Management : Insert 2 large caliber IV canula and withdraw a blood for Grouping X-Matching and basic investigations. Start 2 L of crystaloid (RL, NS). Consider Blood and blood product transfusion in heamorrhagic shock. Vasopressors in Distributive shock.

♣ Disability:

- Assessment : Asses level of consciousness with AVPU Score (Alert ? responds to Voice ? to Pain ? Unresponsive ?) .

♣ Exposure:

- Undress patient , then cover to avoid hypothermia .

- Take a quick history :

- **Events :** surrounding onset of illness , evidence of overdose / suicide attempt , any suggestion of trauma ?
- **Past medical :** DM , HTN , asthma , COPD , coronary artery disease, alcohol , opiate or street drug abuses , epilepsy , recent head injury , recent travel .
- **Medication .**
- **Allergies .**

- Remember :

- Cold and clammy suggests Cardiogenic shock or fluid loss , look for sign of anemia or dehydration eg : skin turgor , postural hypotension .
- Raised JVP suggest Cardiogenic shock .
- Warm and well perfused , with bounding pulse points to Septic shock .
- Any feature suggestive of anaphylaxis – Hx , urticarial , angioedema , wheeze .
- β – blocker may mask tachycardia in patient with shock .
- In young and fit patient or pregnant women the systolic BP may remain normal .

- Specific Management according to type of shock :

- **Hypovolemic :**

Identify and treat underlying cause . Raise legs .

- Give fluid bolus 10-15Ml/kg crystalloid in peadiatrics & In adults we give 1-2 L then check for response or 3-5ml/kg colloid (we don't use it as the studies didn't show a benefit superior to crystaloids. But is can be used in overloaded Patients with hypovolemia (CHF, liver failure, CRF)) , if shock improves, repeat, titrate to HR (aim <100) , BP (SBP >90) and UO (aim >0.5ml/kg/h) .

- If no improvement after 2 boluses, consider referral to ICU .

- **Hemorrhagic Shock :**

Stop bleeding if possible . See TABLE for grading .

- If still shocked despite 2L crystalloid or present with class III/IV shock (blood cross matching should be done at the start once shock is recognized), then then start blood transfusion.

- Give Packed RBC, FFP, Platelets (once massive blood transfusion is needed. And consider tranexamic acid 1gm iv stat then 1gm infusion over 8 hrs)

F. Class of Shock:

	Class I	Class II	Class III	Class IV
Blood loss %,ml	<750ml or <15%	750-1500ml 15-30%	1500-2000ml 30-40%	>2000ml >40%
Heart rate	<100bpm	>100bpm	120-140bpm	>140pbm
Systolic BP	Normal	Normal	Low	Unrecordable
Pulse pressure	Normal	Narrow	Narrow	V narrow/ absent

- **Septic Shock :**

- Ideally take culture before antibiotics (2 × peripheral blood culture plus , eg : urine , sputum , csf) but do not delay starting treatment.

- Give antibiotics within first hour , choice depends on local policy and suspected source . Empirical treatment if no clear source.

- After fluid bolus of 20ml/kg crystalloid (or 7ml/kg colloid) repeat BP .

- If SBP remains <90 or lactate >4mmol/L then consider referral to IUC for early goal-directed therapy (aim CVP 8-12, MAP>65mmHg , UO >0.5ml/kg/h).

- **Cardiogenic Shock :**

Manage in coronary care unit or ICU .

- Give O_2 maintain arterial saturation of 94-98% .

- Diamorphine 1.25mg IV for pain and anxiety .

- Aspirin, Heparin to reduce blood clotting.

- Investigations and close monitoring (ECG, U&E, troponins/cardiac enzyme, ABG, CXR, echocardiogram. if indicated CT thorax (aortic dissection /PE) . Monitor CVP, BP, ABG, ECG, urine output. Do a 12-lead ECG in every 6 hours if the clinical picture is going with ACS. Consider a CVP line and an arterial line to monitor pressure. Catheterize for accurate urine output .

- Correct arrhythmias , U&E abnormalities or acid-base disturbance (Consider thrombolytic therapy or coronary angiography as indicated) .

- Optimize filling pressure with clinical assessment of pulse, BP, JVP/CVP .

- If Underfilled , give a plasma expander 100mL every 15min IV (aim MAP 70mmHg , CVP8-10mmHg) . If Well/over filled, Inotropic support eg dobutamine 2.5-10μg/kg/min IVI. (aim MAP 70 mmHg) .

- **Anaphylaxis Shock :**

  - Give 100% O_2, remove the cause .

  - Give adrenaline IM 0.5mg , repeat every 5min , if needed as guided by PB, pulse and respiratory function , until better .

  - Give Chlorphenamine10mg IV and hydrocortisone 200mg IV .

  - If still hypotensive , admission to ICU and an IVI of adrenaline may be needed± aminophylline .

Triage

It is the propriety of medical care for patients, according to the severity of their condition. Vital signs, symptoms and signs of disease help to detect the triage decision.
The Canadian Triage and Acuity Scale (CTAS) divided into five levels from resuscitation (1) to non urgent (5). It depends on a patient focus and the need for timely intervention to determine the most appropriate treatment.

* Level 1 Resuscitation:

It is life or limbs threatening conditions, which needs immediate intervention without delay.
e.g. Cardiac arrest, major trauma, severe dehydration and sever respiratory distress.

* Level 2 Emergent:

It is high risk deterioration Conditions, which needs rapid medical intervention in less than 15 mins.
e.g. asthma attack, severe pain, serious infections and altered mental state.

* Level 3 Urgent:

Conditions affect daily activities, which could progress to serious complication, and requiring medical intervention in less than 30 mins.
e.g. high fever, abdominal pain and moderate asthma.

* Level 4 Less Urgent:

It is stable conditions that various according to patient age, distress and potential for deterioration. It's required medical intervention in less than 1 hour.
e.g. simple laceration, headache and minor trauma.

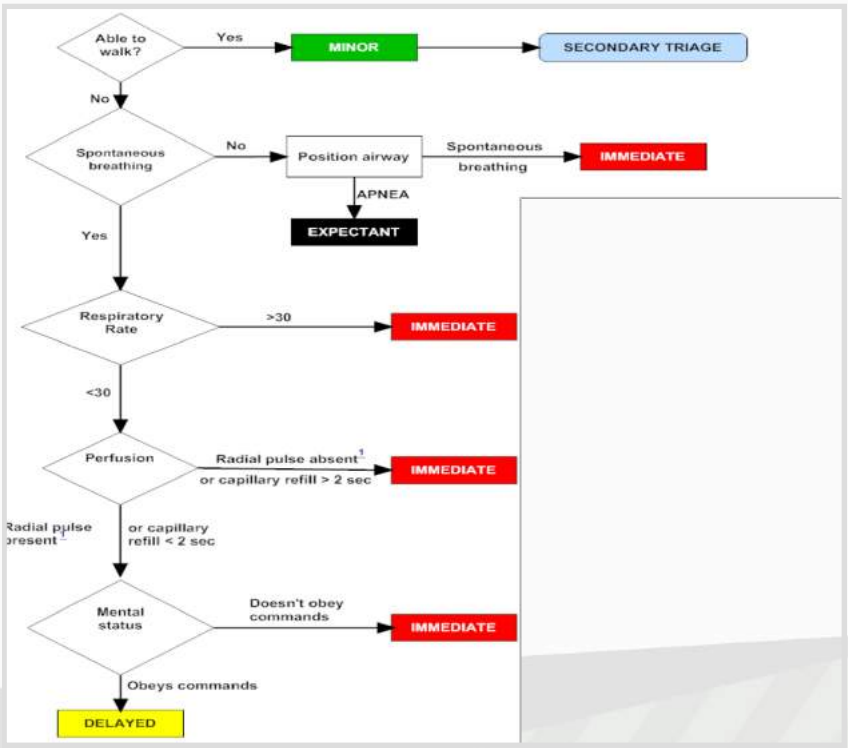
* Level 5 Non Urgent:

It is acute conditions but non urgent and without deterioration. The medical intervention could be delay or refer to other hospital.
e.g. sore throat, vomiting or diarrhea with no signs of dehydration and skin rash.

Remember that you have to reassess patient's condition for detecting rapid and potential change.

In disaster situation different triage score called Simple Triage and Rapid Treatment (START) use. It is four categories with colors tag to triaging large numbers of victims.

1- Red tags use for those who required immediate intervention.
2- Yellow tags use for those who required observation and delayed intervention.
3- Green tags use for those who required medical care after critical cases.
4- Black tags use for deceased.
5- Blue color: EXPECTANT. those with less chance of salvagibility



Trauma Assessment and Management

According to Center for Disease Control and Prevention (CDC); In KSA 9037 death due to motor vehicle crashes in 2016 . 1 death in 30 min

1. Primary Survey:

- A: Airway with c-spine protection.
- B: Breathing/ ventilation/ oxygenation.
- C: Circulation.
- D: Disability.
- E: Expose/ Environment/ Body temperature.

2. Secondary Survey:

- AMPLE History.
- Complete physical exam: Head-to-toe.
- Complete neurologic exam.
- Special diagnostic tests.
- Reevaluation.

1. Head Trauma

Traumatic brain injury is a non-degenerative, non-congenital insult to the brain from an external mechanical force, possibly leading to permanent or temporary impairment of cognitive, physical, and psychosocial functions, with an associated diminished or altered state of consciousness.

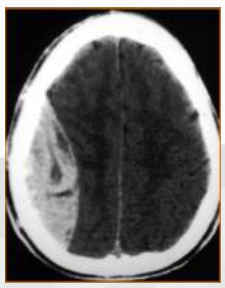
Injuries are divided into 2 subcategories:

1. **Primary Injury:** which occurs at the moment of trauma. It can manifest as focal injuries (e.g. skull fractures, intracranial hematomas, lacerations, contusions, penetrating wounds), or they can be diffuse (as in diffuse axonal injury).

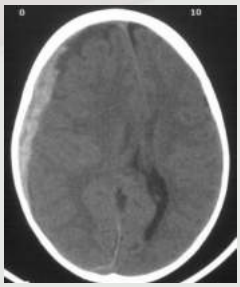
2. **Secondary Injury:** which occurs immediately after trauma and produces effects that may continue for a long time. (Due to hypoxia or hypotension, which should be prevented by physician during resuscitation)

   Secondary types of traumatic brain injury are attributable to further cellular damage from the effects of primary injuries. Secondary injuries may develop over a period of hours or days following the initial traumatic assault.

Epidural Hematoma: is a traumatic accumulation of blood between the inner table of the skull and the stripped-off dural membrane.



Subdural Hematoma: is a collection of blood below the inner layer of the dura but external to the brain and arachnoid membrane.



Subarachnoid Haemorrhage: refers to extravasation of blood into the subarachnoid space between the pial and arachnoid membranes.

Glasgow Coma Scale (GCS):

Defines the severity of a TBI within 48 hours of injury.

Glasgow Coma Scale		
Response	Scale	Score
Eye Opening Response	Eyes open spontaneously	4 Points
	Eyes open to verbal command, speech, or shout	3 Points
	Eyes open to pain (not applied to face)	2 Points
	No eye opening	1 Point
Verbal Response	Oriented	5 Points
	Confused conversation, but able to answer questions	4 Points
	Inappropriate responses, words discernible	3 Points
	Incomprehensible sounds or speech	2 Points
	No verbal response	1 Point
Motor Response	Obeys commands for movement	6 Points
	Purposeful movement to painful stimulus	5 Points
	Withdraws from pain	4 Points
	Abnormal (spastic) flexion, decorticate posture	3 Points
	Extensor (rigid) response, decerebrate posture	2 Points
	No motor response	1 Point
Minor Brain Injury = 13-15 points; **Moderate Brain Injury** = 9-12 points; **Severe Brain Injury** = 3-8 points		

The severity of TBI according to the GCS score within 48h is:

Severe TBI = 3-8

Moderate TBI = 9-12

Mild TBI = 13-15

Cervical Injury: General management of spine and spinal cord trauma includes immobilization, intravenous fluids, medications, and transfer, if appropriate.

Cervical Spine Immobilization (C-Collar)

2. Thoracic Trauma

- Significant cause of mortality
- Blunt trauma: < 10% require operation
- Penetrating trauma: 15-30% require operation
- Majority: Require simple procedures
- Most life-threatening injuries are identified during the primary survey

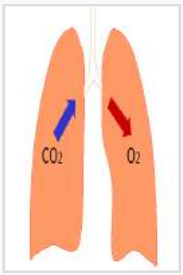
What are the immediately life-threatening chest injuries?

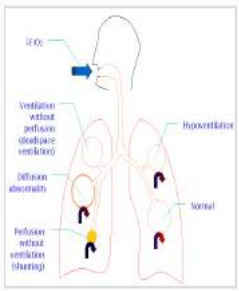
- Laryngeotracheal injury / Airway obstruction
- Tension pneumothorax
- Open pneumothorax
- Flail chest and pulmonary contusion
- Massive hemothorax
- Cardiac tamponade

What are the pathophysiologic consequences of these chest injuries?

- Hypoxia
- Hypoventilation
- Acidosis
  - Respiratory
  - Metabolic
- Inadequate tissue perfusion

Manage in the primary survey as identified





Laryngeotracheal Injury:

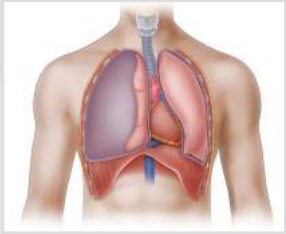
Airway Obstruction:

- Rare
- Hoarseness
- Subcutaneous emphysema
- Manage in the primary survey as soon as possible
  - Intubate cautiously
  - Tracheostomy

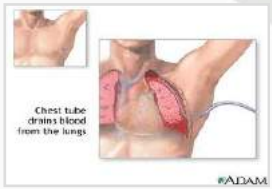
General Appearance of patient with Life-threatening Thoracic Trauma:

- Tachypnea
- Respiratory distress
- Cyanosis
- Hypotension
- Tachycardia

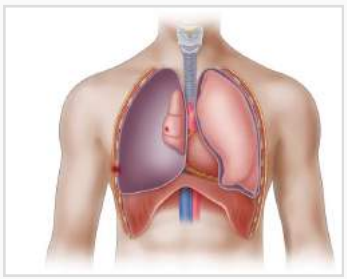
Tension pneumothorax: Distended neck veins, Unilateral decrease in breath sounds, Hyperresonance, Cyanosis (late sign).



- Clinical diagnosis, not by x-ray
- Immediate decompression
    - **Needle**
    - **Chest tube**



Open Pneumothorax



Flail Chest and Pulmonary Contusion

- Oxygen
- Reexpand lung
- Intubate as indicated
- Judicious fluids
- Analgesia

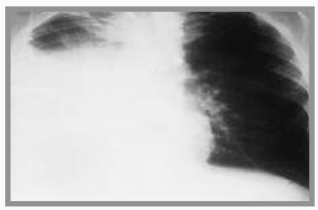
Rt. Flail Chest

Massive Hemothorax

Systemic / pulmonary vessel disruption

- > 1500 mL blood loss
- Flat vs. distended neck veins
- Shock with no breath sounds and/or percussion dullness

Rt. Hemothorax



So in massive hemothorax we will do

- Rapid volume restoration
- Chest decompression and x-ray
- Autotransfusion
- Operative intervention

Indications for immediate thoracotomy

1) Evacuation of >1500 ml via ICT at incertion
2) Drainage of 200 ml /Hr in more than 2 consecutive hours

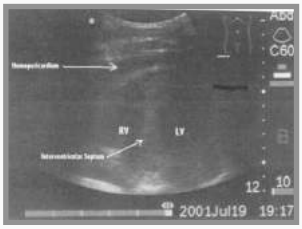
- Resuscitative Thoracotomy

When should I consider resuscitative thoracotomy?

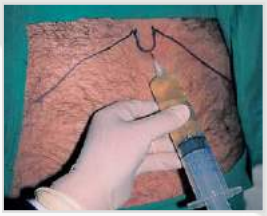
- Patients with penetrating thoracic injury arriving with PEA may be a candidate
- When a surgeon with appropriate skills is present
- ED thoracotomy not indicated in blunt trauma with PEA

Cardiac Tamponade :

- A : Secure airway
- B : Ventilate and oxygenate
- C : Volume resuscitation
- FAST, operation



Pericardiocentesis



Potentially Life-Threatening injuries

What are the potentially life-threatening chest injuries?

- Blunt cardiac injury
- Traumatic aortic disruption
- Blunt esophageal rupture
- Traumatic diaphragmatic injury

How do I identify potentially life-threatening thoracic injuries?

- Physical examination
- Chest x-ray
- Pulse oximetry
- ABG
- ECG

Tracheobronchial Tree Injury:

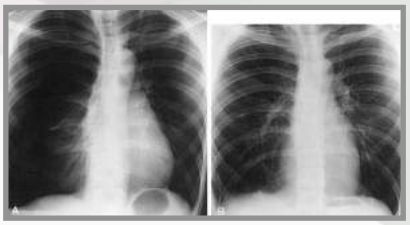
- **Often missed**
- **Blunt or penetrating**
- **Persistent pneumothorax**
- **Bronchoscopy**
- **Treatment :**

- **Airway and ventilation**
- **Tube thoracostomy**
- **Operation**

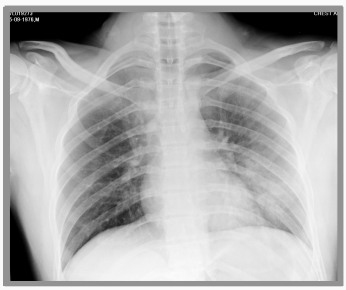
Simple Pneumothorax : Penetrating / blunt trauma, Ventilation / perfusion defect, Hyperresonance, Decreased breath sounds, tube thoracostomy.

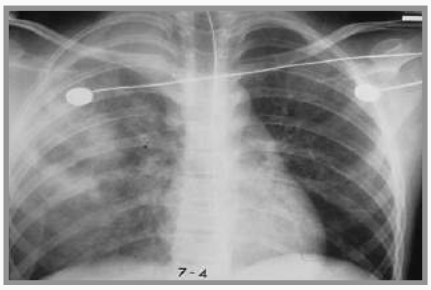
Rt. Pneumothorax

Rt. Pneumothorax pre and post treatment



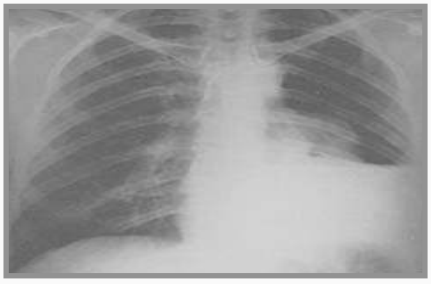
Pulmonary Contusion : Common, Oxygenate and ventilate, Selective intubation, Delayed X-ray changes.





Rt. Pulmonary Contusion

Hemothorax : Chest wall injury, Lung / vessel laceration, Tube thoracostomy.



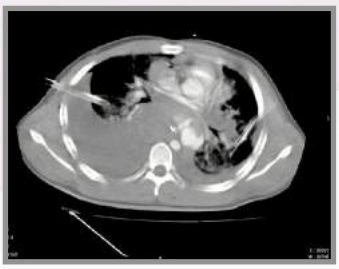
Lt. Hemopneumothorax

Blunt Cardiac Injury :

- Injury spectrum
- Abnormal ECG / monitor changes
- Echocardiography
- Treat
  - **Dysrhythmias**
  - **Perfusion**
  - **Complications**

Traumatic Aortic Disruption : Rapid acceleration / deceleration mechanism, X-ray signs, High index of suspicion, Surgical consult

Traumatic Aortic Disruption : Diagnosis by Helical CT or Aortography



Blunt Esophageal Rupture : Blunt vs. penetrating injury, Severe epigastric blow, Pain / shock out of proportion to injury, Left pneumothorax or hemothorax without rib fracture

So in Esophageal injury we will do:

- Chest tube: Particulate matter
- Mediastinal air
- Contrast swallow, esophagoscopy
- Operation

Diaphragmatic Injury : Most diagnosed on left, Blunt: Large tears, Penetrating: Small perforations, Misinterpreted x-ray, Contrast radiography, Operation

Subcutaneous Emphysema : Airway injury, Pneumothorax, Blast injury, Iatrogenic

Fractures and Associated Injuries :
Sternum, Scapular, and Rib

Sternal Fracture

Ribs 1-3 :

- Severe force
- Associated injuries have high mortality risk

Ribs 4-9:

- Pulmonary contusion and pneumothorax

Ribs 10-12:

- Suspect abdominal injury

3. Abdominal Trauma

1. **Primary Survey:** The goal of the primary survey, as directed by the Advanced Trauma Life Support (ATLS) protocol, is to identify and expediently treat life-threatening injuries. The protocol includes the following:
    - Airway, with cervical spine precautions.
    - Breathing.
    - Circulation.
    - Disability.
    - Exposure.
2. **Secondary Survey:** is the identification of all injuries via a head-to-toe examination.

Important factors relevant to the care of a patient with abdominal trauma, specifically those involving motor vehicles, include the following:

- The extent of vehicular damage.
- Whether prolonged extrication was required.
- Whether the passenger space was intruded.
- Whether a passenger died.
- Whether the person was ejected from the vehicle.
- The role of safety devices such as seat belts and airbags.
- The presence of alcohol or drug use.
- The presence of a head or spinal cord injury.
- Whether psychiatric problems were evident.

Also the AMPLE history is often useful as a means of remembering key elements of the history.

- Allergies.
- Medications.
- Past medical history.
- Last meal or other intake.
- Events leading to presentation.

3. **Adjuncts:**
    - Chest, Pelvis and Cervical X-rays.
    - FAST
    - DPL

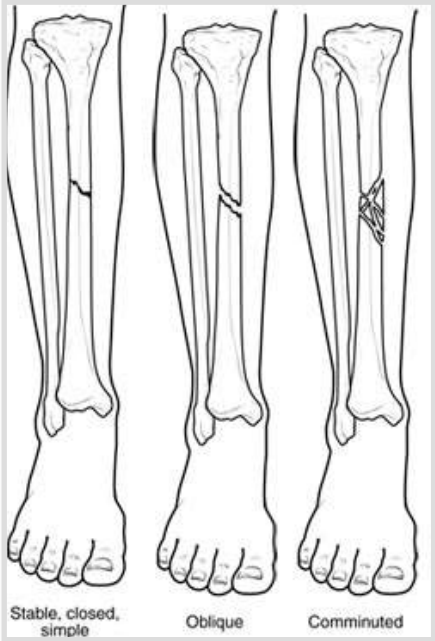
Fractures (Broken Bones)

A fracture is a broken bone. A bone may be completely fractured or partially fractured in any number of ways (crosswise, lengthwise, in multiple pieces).

- Types of Fractures:

Bones are rigid, but they do bend or "give" somewhat when an outside force is applied. However, if the force is too great, the bones will break, just as a plastic ruler breaks when it is bent too far.

The severity of a fracture usually depends on the force that caused the break. If the bone's breaking point has been exceeded only slightly, then the bone may crack rather than break all the way through. If the force is extreme, such as in an automobile crash or a gunshot, the bone may shatter.
If the bone breaks in such a way that bone fragments stick out through the skin, or a wound penetrates down to the broken bone, the fracture is called an "open" fracture. This type of fracture is particularly serious because once the skin is broken, infection in both the wound and the bone can occur.



Common types of fractures include:

- Stable fracture. The broken ends of the bone line up and are barely out of place.
- Open, compound fracture. The skin may be pierced by the bone or by a blow that breaks the skin at the time of the fracture. The bone may or may not be visible in the wound.
- Transverse fracture. This type of fracture has a horizontal fracture line.
- Oblique fracture. This type of fracture has an angled pattern.
- Comminuted fracture. In this type of fracture, the bone shatters into three or more pieces.

- Cause:

The most common causes of fractures are:

- Trauma. A fall, a motor vehicle accident, or a tackle during a football game can all result in fractures.
- Osteoporosis. This disorder weakens bones and makes them more likely to break.
- Overuse. Repetitive motion can tire muscles and place more force on bone. This can result in stress fractures. Stress fractures are more common in athletes.

- Symptoms:

Many fractures are very painful and may prevent you from moving the injured area. Other common symptoms include:

- Swelling and tenderness around the injury
- Bruising
- Deformity — a limb may look "out of place" or a part of the bone may puncture through the skin

Doctor Examination:

Your doctor will do a careful examination to assess your overall condition, as well as the extent of the injury. He or she will talk with you about how the injury occurred, your symptoms, and medical history.

The most common way to evaluate a fracture is with x-rays, which provide clear images of bone. Your doctor will likely use an x-ray to verify the diagnosis. X-rays can show whether a bone is intact or broken. They can also show the type of fracture and exactly where it is located within the bone.

- Treatment:

All forms of treatment of broken bones follow one basic rule: the broken pieces must be put back into position and prevented from moving out of place until they are healed. In many cases, the doctor will restore parts of a broken bone back to the original position. The technical term for this process is "reduction."
Broken bone ends heal by "knitting" back together with new bone being formed around the edge of the broken parts.
Surgery is sometimes required to treat a fracture. The type of treatment required depends on the severity of the break, whether it is "open" or "closed," and the specific bone involved. For example, a broken bone in the spine (vertebra) is treated differently from a broken leg bone or a broken hip.

Doctors use a variety of treatments to treat fractures:

Cast Immobilization:

A plaster or fiberglass cast is the most common type of fracture treatment, because most broken bones can heal successfully once they have been repositioned and a cast has been applied to keep the broken ends in proper position while they heal.

Functional Cast or Brace:

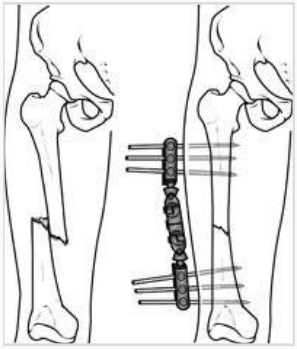
The cast or brace allows limited or "controlled" movement of nearby joints. This treatment is desirable for some, but not all, fractures.

Traction:

Traction is usually used to align a bone or bones by a gentle, steady pulling action.

External Fixation:

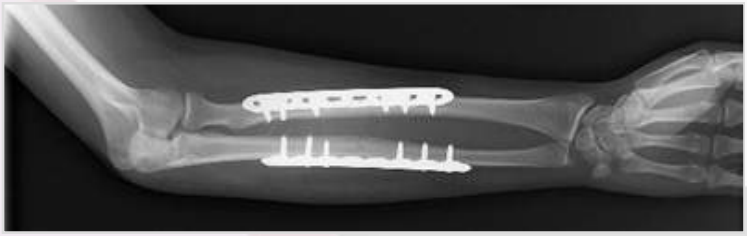
In this type of operation, metal pins or screws are placed into the broken bone above and below the fracture site. The pins or screws are connected to a metal bar outside the skin. This device is a stabilizing frame that holds the bones in the proper position while they heal.
In cases where the skin and other soft tissues around the fracture are badly damaged, an external fixator may be applied until surgery can be tolerated.



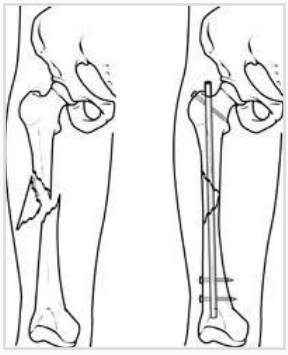
An external fixator applied to a broken thighbone.

Open Reduction and Internal Fixation:

During this operation, the bone fragments are first repositioned (reduced) in their normal alignment, and then held together with special screws or by attaching metal plates to the
outer surface of the bone. The fragments may also be held together by inserting rods down through the marrow space in the center of the bone.



The broken bones of the forearm are held in position by plates and screws while they heal.



A specially designed metal rod, called an intramedullary nail, provides strong fixation for this thighbone fracture.

- Recovery:

Fractures take several weeks to several months to heal, depending on the extent of the injury and how well you follow your doctor's advice. Pain usually stops long before the fracture is solid enough to handle the stresses of normal activity.

Even after your cast or brace is removed, you may need to continue limiting your movement until the bone is solid enough for normal activity.
During your recovery you will likely lose muscle strength in the injured area. Specific exercises will help you restore normal muscle strength, joint motion, and flexibility.

- Prevention:

Proper diet and exercise may help in preventing some fractures. A diet rich in calcium and Vitamin D will promote bone strength. Weightbearing exercise also helps keep bones strong.

.....

Orthopaedic Emergencies

- Objectives:

- Unstable Pelvic Fractures
- Open Fractures
- Compartment Syndromes

1) Unstable Pelvic Fracture:

Hemodynamic Instability (20%)
GU injury (15%)
Nerve injury (8%)
MORTALITY (15%)

- Initial Evaluation

• ATLS protocol – ABCDE's
– 1° and 2° surveys
• Physical exam
– Open/soft tissue injuries – N/V status
– Assess stability
– Associated injuries

- Open Pelvic Fractures:

- Perineal Lacerations
- Vaginal Injuries
- Rectal Injuries
- Life threatening
- Mortality 6-70%
- Requires early diagnosis

-Associated Injuries:

- Major blood vessels:

– Internal iliac/branches – Pelvic veins

- Neurologic compromise:

– Lumbosacral plexus
– Cauda equina

- Lower GI tract.
- Lower GU tract:

– Bladder – Urethra

- Radiographic Evaluation:

- Trauma(C-spine ,chest, and pelvis)

- Urethrogram
- AP pelvis+inlet and outletview
- CT scan with bone windows

Ap pelvis

Inlet (40°caudad)

Outlet (40°cephalad)

- CT SCAN:

- Imperative for all pelvic fractures
- 2-3mm cuts
- 3D for overall picture
- Fractures/dislocations
- Bladder disruption
- Hematoma
- Arterial Injuries.

Instability:

Clinical
-Hemodynamic
Systolic BP<90
- Radiographic
Perfomed once to assess stability
Identify source
Beware coagulopathy
Keep warm

- Radiographic Instability:

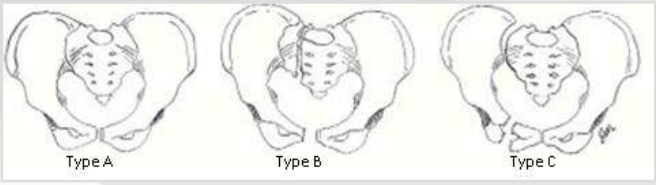
- Signs

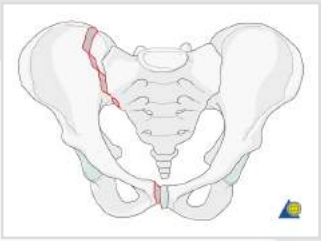
– >2.5cm displacement of symphysis
– >5mm displacement of posterior SI complex
– Presence of posterior fracture gap
– Avulsion fracture

- Ischial spine/tuberosity
- Sacrum
- L5TP

Classification

A - stable.
B - rotationally unstable, vertically stable.
C - rotationally and vertically unstable.





Disrupted Pelvic Ring

Patients should be assumed to be hemodynamically unstable and volume- depleted on arrival!

- Associated Injuries:

- Lateral Compression

(most common)
– CHI (50%)
– Chest trauma
– UE fractures

- AP Compression

– Shock (67%)
– ARDS (18.5%)
– Death (37%)

- Vertical Shear

– CHI (56%)
– Pulmonary injury (23%) – Splenic injury (25%)
– Shock (63%)
– Death (25%)

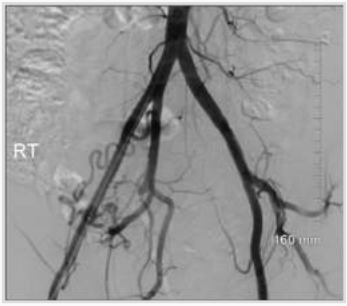
- Angiography

- Selective embolization if unresponsive to fluid/blood
- Decreased mortality in unstable patients with angiography prior to laparotomy (25 vs 60%).

- Treatment : Remember disrupted pelvic ring is a cause of life-threatening heamorrhagic shock needs agressive resuscitation as described in shock above.

Treatment is based on a number of factors, including:

- The specific pattern of the fracture
- How much the bones are displaced
- Your overall condition and associated injuries



- Nonsurgical Treatment:

Your doctor may recommend nonsurgical treatment for stable fractures in which the bones are nondisplaced or minimally displaced.
Nonsurgical treatments may include:
Walking aids: To avoid bearing weight on your leg, your doctor may recommend that you use crutches or a walker for up to three months—or until your bones are fully healed. If you have injuries above both legs, you may need to use a wheelchair for a period of time so that you can avoid bearing weight on either leg.

Medications: Your doctor may prescribe medication to relieve pain, as well as an anti-coagulant, or blood thinner, to reduce the risk of blood clots forming in the veins of your legs and pelvis.

- Surgical Treatment:

Patients with unstable pelvic fractures may require one or more surgical procedures.
External fixation: Your doctor may use external fixation to stabilize your pelvic area. In this operation, metal pins or screws are inserted into the bones through small incisions into the skin and muscle. The pins and screws project out of the skin on both sides of the pelvis where they are attached to carbon fiber bars outside the skin. The external fixator acts as a stabilizing frame to hold the broken bones in proper position.
In some cases, an external fixator is used to stabilize the bones until healing is complete. In patients who are unable to tolerate a lengthy, more complicated procedure, an external fixator may be used as a temporary treatment until another procedure can be performed.
Skeletal traction: Skeletal traction is a pulley system of weights and counterweights that helps realign the pieces of bone. Skeletal traction is often used immediately after an injury and removed after surgery. Occasionally, acetabular fractures can be treated with skeletal traction alone. This is rare, however, and will be a decision made jointly with input from your doctor.

During skeletal traction, metal pins are implanted in the thighbone or shinbone to help position the leg. Weights attached to the pins gently pull on the leg, keeping the broken bone fragments in as normal a position as possible. For many patients, skeletal traction also provides some pain relief.

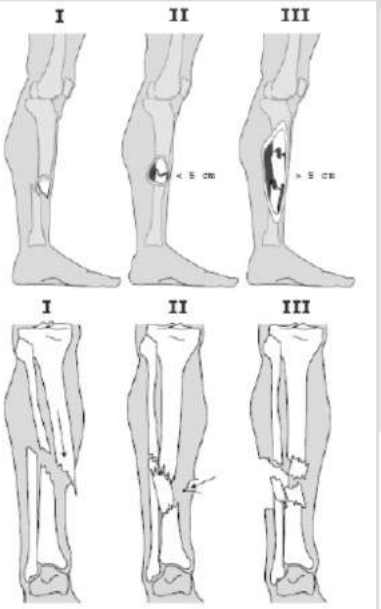
Open reduction and internal fixation:During this operation, the displaced bone fragments are first repositioned (reduced) into their normal alignment. They are then held together with screws or metal plates attached to the outer surface of the bone.

2) Open Fractures

-Contaminated open wound represents an orthopedic emergency
-Operative debridement within 6 hours from injury

Gustilo classificatie

For open fractures	
1	A fracture with a clean cutaneous wound less than 1 cm in length
2	A fracture with laceration greater than 1 cm in length lacking any severe soft-tissue damage
3	A fracture with extensive soft-tissue damage and ...
A	... adequate coverage of the fracture by soft tissue despite extensive cutaneous lacerations or flaps. High-energy trauma irrespective of wound size
B	... more extensive injury to and contamination of the soft tissues, periostal stripping and soft-tissue gaps are present
C	... any open fracture with an arterial injury requiring repair regardless of degree of soft tissue disruption



Evaluation of Open Fractures in the ED:

-Appropriate antibiotics
-Tetanus status
-Realign extremity and splint

Initial Evaluation:

-Apply sterile dressing
-Avoid multiple exams
-Do not probe or culture

Operative Debridement:

- Skin

• Regions of marginal viability can be left and reassessed
• Can be conservative

- Examine Entire Zone of Injury

-Muscle/Fascia
Debride liberally - Necrotic muscle is bacterial substrate

3) Compartment Syndrome:

Compression/constriction of vessels, nerves and muscles in closed fascial compartment resulting in

• Decreased perfusion
• Ischemia
• Cell death

- Sites

• Calf
• Thigh
• Buttocks
• Foot
• Shoulder
• Forearm/Hand

- Etiology

• Fracture –Open or closed

• Blunt trauma
• Crush/MangledExtremity
• Vascular injury
– Concern with >6hrs ischemic time
• Cast or constrictive dressings
• Burns
• Gunshot
• Coagulopathy
• Snake/insect bite

- Diagnosis

Clinical diagnosis
– Pain
– Pallor
– Paresthesia
– Pulselessness
– Paralysis
• Pain with passive motion
• Progressive/disproportionate pain
• Pulses last to go!!!

- Compartment Syndrome Treatment:

- Surgical Release

-Delay can mean permanent functional loss, renal failure, and possible death.

Treatment Principles

• Fasciotomy
– Long, extensile incisions – Release all fascial compartments
– Leave wounds open
• Skeletal stabilization when necessary
• DO NOT DELAY
• Anticipate future incisions

Airway

Introduction:

Effective airway management is central to the care of critically ill and injured patients. Competency in assessment and maintenance of the airway using basic airway manoeuvres first, followed by advanced skills such as rapid sequence induction of anaesthesia and tracheal intubation, are core skills for doctors who treat seriously ill or potentially ill patients.

Skills and judgement, as well as knowledge, are essential for treating patients who require emergency airway intervention. Careful judgement is required to determine whether an intervention is appropriate, how and when it should be undertaken, and what additional personnel and equipment are needed.

A. Delivery of oxygen:

Devices used for delivery of oxygen:

1. Spontaneous ventilation:

- Variable-performance devices: masks or nasal cannulae
- Fixed-performance devices

Face mask

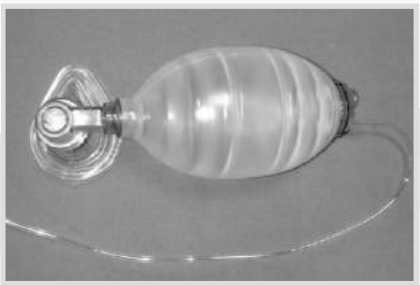
Nasal cannulae

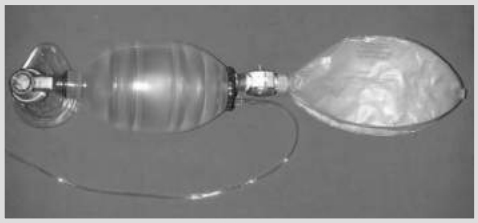
Face mask with reservoir

2. Assisted ventilation:

Bag-Valve-Mask device

Bag-mask with oxygen attached





Bag-mask with oxygen and reservoir.

- Airway assessment

Difficult mask ventilation

Difficult mask ventilation occurs when the patient's anatomy or injuries make it impossible to maintain adequate ventilation and oxygenation with a face mask and simple airway adjuncts alone.

Difficult view at laryngoscopy

The view at laryngoscopy has been classified by Cormack and Lehane.

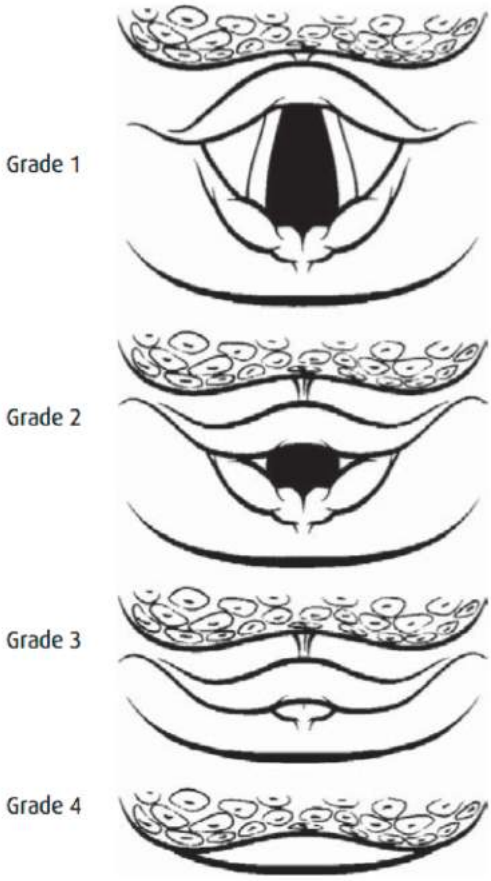
A difficult view is defined as being unable to see any portion of the vocal cords with conventional laryngoscopy (Cormack and Lehane grades 3 and 4).

Difficult intubation

Difficult intubation has been defined as occurring when an experienced laryn- goscopist, using direct laryngoscopy, requires:
1 more than two attempts with the same blade or;
2 a change in the blade or an adjunct to a direct laryngoscope (e.g. bougie) or; 3 use of an alternative device or technique following failed intubation with direct laryngoscopy.

Difficult cricothyroidotomy

Failure to intubate the trachea combined with an inability to ventilate the patient's lungs, using a bag-mask or laryngeal mask airway (LMA), will necessitate a surgical airway.



The Cormack and Lehane classification of laryngeal view: Grade 1 The vocal cords are visible; Grade 2 The vocals cords are only partly visible; Grade 3 Only the epiglottis is seen; Grade 4 The epiglottis cannot be seen.

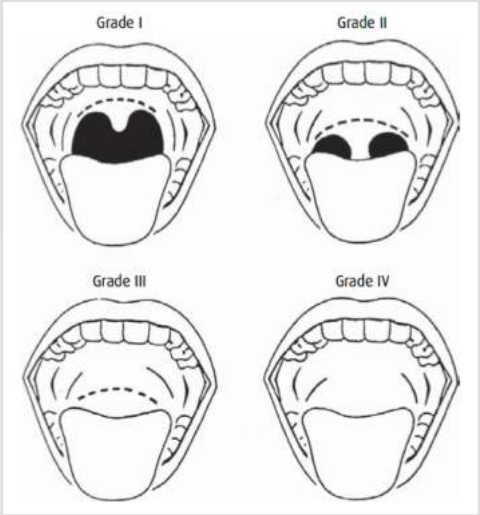
HAVNOT

A simple reminder for assessing predictors of a difficult airway is:

H History – **including previous airway problems**

A Anatomy–**features of the face, mouth and teeth that may suggest intubation will be difficult**

V Visual clues – **obesity, facial hair, age**



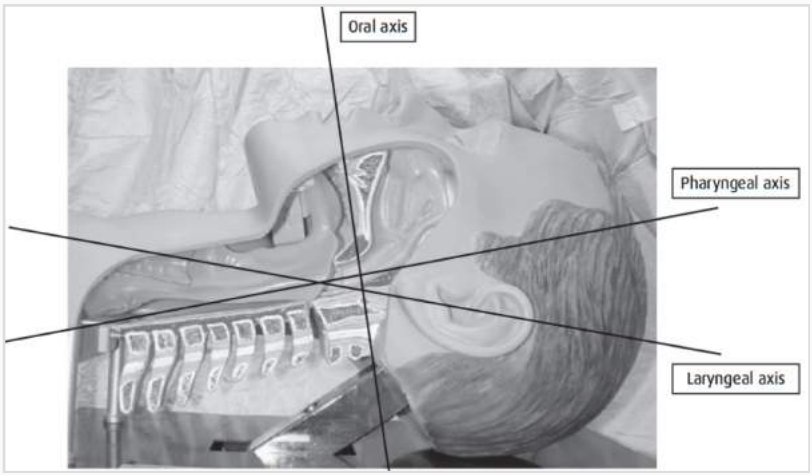
The Mallampati score, modified by Samsoon and Young.

N Neck mobility and accessibility, including the presence of in-line stabilization
O Opening of the mouth – less than three fingers' breadth suggests potential difficulty with intubation
T Trauma – the possibility of anatomical disruption and blood in the airway.

Basic airway management techniques:

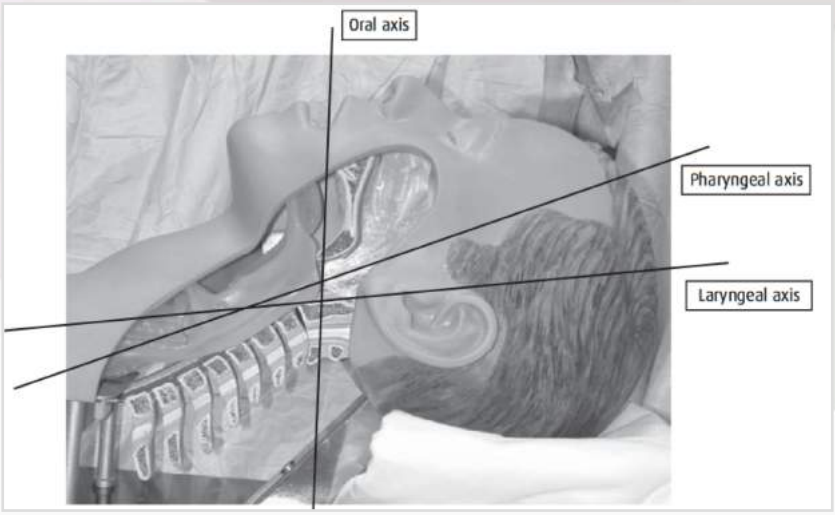
- Positioning:

To optimize air-flow the head, neck and torso must be positioned to align the oral, pharyngeal and laryngeal axes. Picture shows the sub-optimal C-shaped alignment of the airway axes when the adult head and neck are in the neutral position.



The C-shaped curve that is formed between the oral axis, pharyngeal axis and laryngeal axis when the head and neck are in the neutral position.

In an adult patient the airway axes are better aligned when the neck is flexed on the torso and the head is extended on the neck: the so-called 'sniffing the morning air' position.

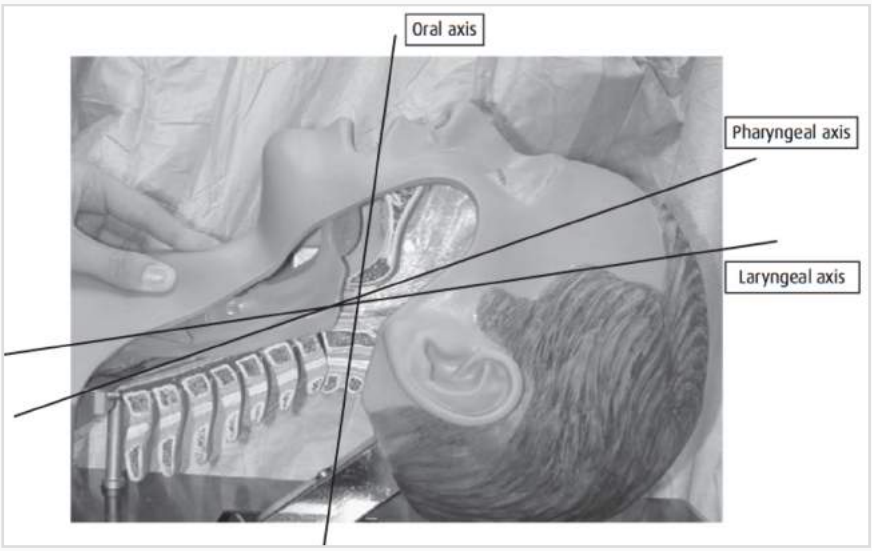


Aligning the oral axis, pharyngeal axis and laryngeal axis by flexing the neck and extending the head.

This position is easily achieved by placing a pillow or folded blanket under the patient's head. This flexes the neck on the torso, the thickness of the support determining the amount of neck flexion. Once this is maintained satisfactorily, the practitioner may gently extend the head on the neck to align the three airway axes.

If a cervical spine injury is suspected the neck must be maintained in a neutral position.

If the head cannot be positioned optimally, e.g. when cervical stabilization is required after trauma, backwards upwards and rightwards laryngeal pressure (the BURP manoeuvre) may help to align the axes.



Improvement in the alignment of the oral axis, pharyngeal axis and laryngeal axis with the BURP manoeuvre (backwards, upwards and rightwards laryngeal pressure).

These principles of positioning apply equally to basic airway interventions and to the more advanced airway skills of laryngoscopy and tracheal intubation.

- Airway manoeuvres:

Once the airway is positioned, two other movements may further improve the airway: chin lift and jaw thrust.

- Chin lift

Chin lift opens the airway by pulling the mandible forward and lifting the tongue off the posterior pharyngeal wall. The practitioner places the fingers of one hand under the mandible and lifts gently upwards. The thumb of the same hand can be used to depress the lower lip, thereby opening the mouth.

- Jaw thrust

The jaw thrust manoeuvre enables the simultaneous application of a facemask. In this technique, the practitioner's fingers are placed under and behind the angles of the mandible. The thumbs may be placed as for the chin lift, to open the mouth, or used together with the index fingers to hold a mask onto the patient's face. The mandible is then lifted forwards and upwards, lifting the tongue off the posterior pharyngeal wall.

- Suction

Suction is essential for removing any liquid in the upper airway. The sucker is not used as a diagnostic tool to see if liquid is present: it must be used gently, under direct vision. Advancing the tip blindly may cause airway trauma, vagal stimulation, increased intracranial pressure and vomiting. To avoid mucosal occlusion of the sucker tip an intermediate setting should be used initially, and then adjusted as required.

- Airway adjuncts:

1- Oropharyngeal airways:

Oropharyngeal airways are hard plastic devices that are shaped to follow the contours of the oropharynx. They are manufactured in various colours and materials but share the same overall design, consisting of a flange and body comprising straight and curved components.

Indications The primary indication for oropharyngeal airway insertion is an obstructed airway, or an airway that requires active manoeuvres for maintenance. These devices should be used only in patients with obtunded cough and gag reflexes (see below).

Sizing The airway is sized by placing it on the patient's face and measuring its length along a vertical line from the patient's incisors to the angle of the jaw. Correct sizing is important to reduce the likelihood of obstruction.

Insertion The airway is inserted upside down into the mouth. Once the tip has passed the hard palate the airway is rotated 180 degrees and advanced over the tongue. An alternative method is to use a tongue depressor or a laryngoscope blade to depress the tongue and then insert the airway the correct way up under direct vision.

Complications Insertion of an oropharyngeal airway in a patient who retains some airway reflexes may cause gagging, laryngospasm, vomiting, raised intracranial pressure and predispose to aspiration of gastric or oropharyngeal contents.

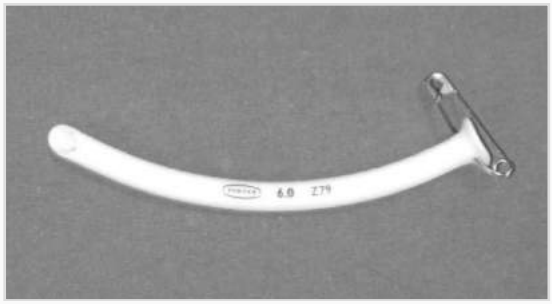
Limitations As a general guide, a patient who tolerates an oropharyngeal airway has impaired airway protective reflexes indicating the need for placement of a definitive airway. The oropharyngeal airway maintains, but does not protect, the airway; however, it will enable oxygenation before tracheal intubation. Should the increase in oxygenation improve the conscious level then intubation may not be necessary. If this occurs, or if the patient's conscious level improves for any other reason, the oral airway may need to be removed.

#A patient with an oral airway must not be left unattended#

2- Nasopharyngeal airways:

Nasopharyngeal airways are soft, curved tubes with a bevel at one end and a

flange at the other. Like oropharyngeal airways, they are manufactured in various colours and materials but share the same overall design. Some airways are supplied with safety pins to avoid displacement into the



nostril: the safety pin should be placed through the flange of the device before the airway is inserted.

Indications Nasopharyngeal airways improve the airway by splinting open the posterior nasopharynx. Their great advantage over oropharyngeal airways is that they may be inserted in patients with intact airway reflexes without the signifi- cant risk of gagging, vomiting or aspiration associated with oral devices. They are also very useful in patients with limited mouth opening.

Sizing The traditional methods for sizing a nasopharyngeal airway (measure- ment against the patient's little finger or anterior nares) do not correlate with airway anatomy, and are unreliable. An appropriate size of airway in adults is 6mm internal diameter for an average female and 7mm internal diameter for an average male. If the airway is too long it may stimulate airway reflexes and induce vomiting. If too short, the tip may become occluded by the nasal mucosa.

Insertion The technique of insertion is simple and must be gentle. Select the nostril that appears larger and less obstructed by the nasal septum. The airway and the nostril should both be well lubricated with a water-based gel. The tip of the airway is inserted into the nostril and directed posteriorly along the transverse floor of the nose. Slight rotation of the airway during insertion may be helpful.

#If insertion of a nasopharyngeal airway into a nostril is difficult, it is usually easier (and safer) to use the other nostril#

Some resistance is often felt as the airway passes the turbinates, but if this is significant a smaller airway should be selected to minimize complications. Insertion of a second airway into the other nostril may improve air flow further.

Complications Nasopharyngeal airways may cause profuse haemorrhage: use of a vasoconstrictor spray before insertion may reduce the risk of bleeding.

Limitations Relative contraindications to nasopharyngeal airway insertion include basal skull fracture or significant facial injury with damage to the cribriform plate. The presence of these injuries may result in intracranial placement of the airway; however, this complication is unlikely and in the presence of life-threatening hypoxaemia and where insertion of an oropharyngeal airway is not possible, gentle and careful insertion of a nasopharyngeal airway using the above technique may be life-saving.

#The effectiveness of any airway manoeuvre or adjunct must always be assessed after it has been completed#

3- Oxygenation

- Spontaneous ventilation
- Assisted ventilation

Indications for intubation

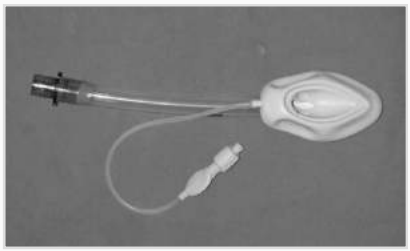
- Clinical indications for intubation

- Failure to oxygenate
- Failure to ventilate
- General anesthesia

Difficult and failed airway

Use of the laryngeal mask airway (LMA)

The LMA has transformed the airway management of patients undergoing elective surgery. If used correctly, it provides an excellent airway for the spontaneously breathing patient, and can also be used for controlled ventilation.



Technique of insertion:

1. Remove the LMA from the packaging and lubricate the posterior surface with a water-soluble lubricant.
2. Place an inflation syringe in the cuff valve, and deflate the cuff completely for insertion, ensuring that the leading tip is not folded backwards.
3. Unless contraindicated, place the head and neck in the 'sniffing the morning air' intubation position.
4. Open the mouth with a 'scissor' grip (in which the fingers and thumb cross), lifting the chin forward.

5. Press the LMA against the hard palate, and guide it along the posterior oropharynx until it sits in position at the upper oesophagus. This technique minimizes the risk of the epiglottis folding downwards as the LMA is advanced.
6. Remove the cricoid pressure during insertion to enable the LMA to sit correctly in the upper oesophagus.
7. Inflate the cuff to 60cmH_2O (if a pressure device is available) or until a seal for ventilation is achieved (typically 20–30ml for size 4 LMA and 30–40ml for a size 5 LMA). Small movements of the mask may improve the seal and ventilatory efficiency.
8. Fix the LMA in position with self-adhesive tape round the tube, and insert a bite-block.
   If spontaneous respiratory effort resumes, assisted ventilation should be synchronized with breathing to minimize the leakage of gas from the larynx and risk of gastric distension. Insertion of the LMA is usually easy and improve- ment in ventilation rapid. Failure to achieve adequate ventilation may be caused by laryngospasm or obstruction from a folded-down epiglottis. If there is not rapid improvement, make a second attempt to place the LMA. Avoid repeated attempts at insertion if the patient's condition is deteriorating. If oxygenation cannot be maintained with an optimally placed LMA, a surgical approach to the airway is indicated (see below). Although this is a rare event, delay in recognizing the need for a surgical airway can be lethal.

The final choice of surgical airway will depend upon the clinical situation, practitioner skills and experience. Options are:

- needle cricothyroidotomy
- surgical cricothyroidotomy
- tracheostomy.

1- Needle cricothyroidotomy:

Insertion of a wide-bore, non-kinking cannula through the cricothyroid mem- brane and using this to deliver oxygen can be life-saving. The correct equipment must be available to connect to an oxygen source.

- Equipment required:

1. stiff cannula and needle (minimum 14 gauge in adults).
2. syringe (preferably 20ml).
3. ventilation system that can be attached securely at one end to a high-pressure oxygen source at 400kPa (4bar), and at the other to the cannula. This should enable control of inspiration and expiration with effective pressure release.

- Technique:

1. Attach the syringe to the rear of the cannula and needle assembly, and insert the cannula through the cricothyroid membrane into the airway at an angle of 45 degrees, aiming caudally in the midline. Confirm cannula position by aspiration of air with the syringe and advance the cannula fully over the needle into the trachea. Remove the needle, and aspirate air from the cannula to confirm position.
2. Hold the cannula in place, attach the ventilation system and commence ventilation.
3. One second of oxygen supplied at a pressure of 400kPa (4bar) and flow of 15l min^{1} should be sufficient to inflate adult lungs adequately. This is followed by a four-second pause to enable expiration via the upper airway (expiration does not occur via the cannula). In children, the initial oxygen flow rate in l min^{1}

should equal the child's age in years, and this is increased in 1l min ^{1} increments until one second of oxygen flow causes the chest to rise.

4. Look carefully for adequate exhalation through the upper airway. This usually occurs without difficulty, but it is essential to ensure that the chest falls adequately after each ventilation.
5. If ventilation fails or complications occur, proceed immediately to surgical cricothyroidotomy.

2- Surgical cricothyroidotomy:

The cricothyroid membrane is relatively avascular and normally easy to feel. Extension of the neck (if possible) will improve surgical access and exposure.

- Equipment required:

1. scalpel (preferably 20 blade: rounded rather than pointed)
2. 6 or 7mm cuffed tracheal tube
3. tracheal dilator (artery clip if unavailable).

Technique:

1. Rapidly but accurately identify the cricothyroid membrane.
2. Make a horizontal stab incision through the membrane into the airway.
3. Open the incision with tracheal dilators (with the scalpel blade still in situ).
4. Remove the scalpel blade and insert the tube. Inflate the cuff and confirm tube position.

3- Tracheostomy:

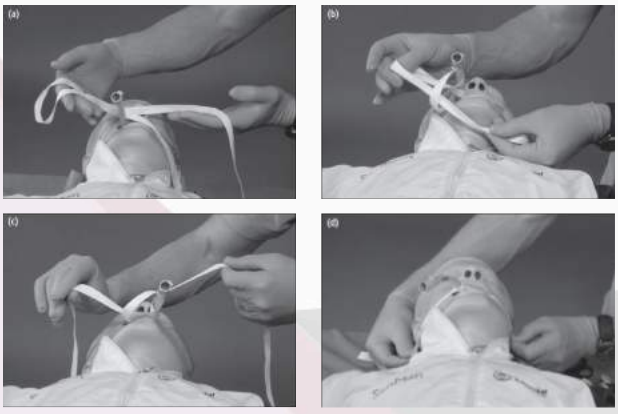
A surgical tracheostomy will rarely be indicated as a primary method of securing the airway. This is a formal surgical procedure that cannot be undertaken safely without training. Percutaneous tracheostomy can be used in emergencies, but only by individuals experienced in the single-stage dilatational approach.

- Post-intubation management

- Airway

Is the airway secure?

Secure the tracheal tube at the correct length with a tie or tape to avoid unplanned extubation, or intubation of the right main bronchus. There are many methods of securing a tracheal tube: choose one that is safe, effective and familiar. A common method for tying the tube is shown in pictures below.



Method of securely tying the tracheal tube in position (a) A loop of ribbon is made above the tracheal tube: the two free ends should be of different lengths so the final knot is located away from the midline. (b) Both ends of the ribbon are passed through the loop, forming a 'slip knot' around the tracheal tube: this automatically tightens as tension is applied. (c) The two ends of ribbon are separated, and the loop is pulled tight around the tube. (d) The two ends of the ribbon are passed in opposite directions around the patient's neck, and secured away from the midline with an appropriate knot.

- Breathing

Is ventilation satisfactory?

This is mainly assessed clinically, based on chest expansion and breath sounds, but is augmented by pulse oximetry, $ETCO_2$ measurement and arterial blood gas analyses.

Non-invasive ventilatory support

- Continuous positive airway pressure

- Bi-level positive airway pressure

Bi-level positive airway pressure is a combination of CPAP with pressure support. Two pressure settings are selected: a higher, inspiratory positive airway pressure (IPAP), and a lower, expiratory positive airway pressure (EPAP). The difference between them generates a tidal volume (ventilation). Expiratory positive airway pressure is effectively CPAP – it recruits under ventilated alveoli and increases FRC (improving oxygenation), and reduces threshold work in the presence of auto-PEEP (see above). When the patient is breathing spontaneously, the patient's respiratory effort triggers both the inspiratory and expiratory phase of the respira- tory cycle. In this mode, if the patient develops apnoea, no respiratory assistance will occur; however, many BiPAP machines incorporate a back-up rate of six to eight breaths per minute. In timed mode, mandatory breaths are delivered, although patient triggering is also possible. Use of BiPAP decreases respiratory rate and work of breathing, and improves alveolar ventilation.

Clinical uses:

In the acute setting, the two principal indications for NIV are acute exacerbations of COPD and acute cardiogenic pulmonary oedema. Other indications include chest wall deformity and neuromuscular disease, decompensated sleep apnoea, chest trauma, pneumonia and to assist weaning in the intensive care unit.

Equipment:

The figure on the right shows a simple CPAP valve that is easy to use and can deliver almost 100% oxygen. The figure on the left shows a typical portable non-invasive ventilator that is able to provide both CPAP and BiPAP.

A Boussignac valve.

Respironics Synchrony non-invasive ventilator.

These ventilators were designed initially for home ventilation: they are simple to use and usually portable. However, because air is entrained with high-flow oxygen in an open circuit, it is not possible to measure FiO_2 or deliver an FiO_2 of greater than 50–60%.

A more sophisticated ventilator is shown in figure. This will provide CPAP and BiPAP with an FiO_2 of up to 100%. This machine has significant monitoring capabilities, but it is more complicated to use, not portable and significantly more expensive than alternatives.

Respironics Vision non-invasive ventilator.

Several patient–machine interfaces are available, including nasal masks, face- masks and helmets. The most widely used interface in an emergency setting is the facemask. The mask must be sized and fitted correctly, and not applied too tightly. Most modern NIV machines and masks are designed to allow some leakage around the mask to improve patient triggering and tolerance. The correct position of the mask is illustrated in figure.

Procedure:

Correct mask position for non-invasive ventilatory support.

1. With the patient sitting, turn on the NIV system and gas flow, set the desired oxygen concentration, select the correct size of facemask and apply it to the patient's face. Patient acceptance may be facilitated if the mask is applied manually for the first few minutes.
2. Once the patient is comfortable with the system, apply the straps to produce a snug, but not excessively tight, fit.
3. When using CPAP, start with a pressure of 5–10cmH_2O and titrate up to 15cmH_20 depending on the patient's oxygen saturation, respiratory rate and the degree of mask leak.
4. When using BiPAP, typical initial ventilator settings are EPAP 3–5cmH_2O and IPAP 12–15cmH_2O, which can be increased as tolerated up to 20cmH_2O.
5. Observe the patient closely and assess: chest wall movement, co-ordination of respiratory effort with the ventilator, accessory muscle recruitment, respiratory rate, heart rate, patient comfort and mental state.
6. Monitor the oxygen saturation continuously and measure the arterial blood gas values after 30 minutes to 1 hour. The frequency of subsequent arterial blood gas analysis will depend on the patient's response to treatment.
7. If the patient has COPD, titrate the FiO_2 to an oxygen saturation of 88–92%.

Chest Tube

Indications

- ♣ Chylothorax.
- ♣ Empyema.
- ♣ Hemopneumothorax.
- ♣ Hemothorax.
- ♣ Pleural effusion with symptoms and signs of instability.
- ♣ Pneumothorax (Symptomatic or simple but beyond 25%).
- ♣ Iatrogenic pneumothorax (e.g., Post Central line insertion for tension pneumothorax).

- Anatomical Placement:

- 5^{th} intercostal space at the midaxillary line (note: in most patients this is lateral to the nipple at the point of the midaxillary line).
- Considerations & Special Circumstances:
  - Avoid placement directly over an area of infected soft tissue (e.g., cellulitis or skin abscess)
  - Avoid going below or through the diaphragm, which can extend up as high as the nipple during full expiration.
  - Consider going into the 4^{th}intercoastal space at the midaxillary line in patients who are pregnant, have ascites from cirrhosis, or large hemoperitenum where the increased intraabdominal contents and pressure can further elevate the diaphragm.

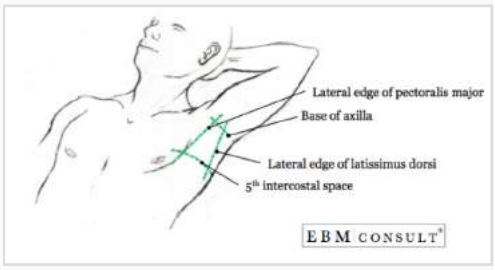
- Supplies:

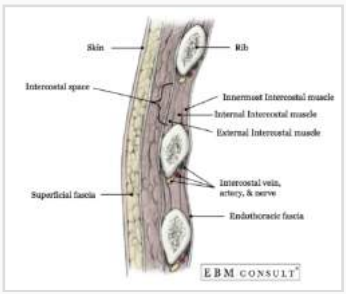
- Chest tube tray (that includes Kelly clamps x 2 and forceps x 1).
- Sterile gloves, gown, hair covering, drapes and towels.
- Chest tube (size is influenced by the reason for placement).
  - Adults:
    - 36 - 38 F for large pneumothorax or hemothorax.
    - 24 - 32 F for simple/nontraumatic pneumothorax.
  - Pediatrics:
    - Based on Broselow tape but ranges 12 - 28 F for children and 12 - 18 F for infants.
    - Note: Consider having a back up chest tube available one size smaller to avoid delays.
- Pleurivac system (or alternative suction device with reservoir) and connection tubing.
- Betadine or chlorhexidine skin cleansing preparation.
- Scalpel #10 blade and handle.
- Nonabsorbable suture (e.g., 1-0 or 2-0 silk).
- Xeroform or Vaseline gauze dressing.
- Sterile 4" x 4" bandages with slits.
- Elastoplast dressing roll.
- Adhesive tape.
- 20-guage and 25-gauge needle with 10 ml syringe.
- Local anesthetic (e.g., 1 - 2% lidocaine with or without epinephrine).
- Parenteral analgesia and/or sedative hypnotic.

- Pre-Procedure Preparation:

- Explain the procedure to the patient and obtain informed consent if not emergent
- Place the patient on the cardiac monitor, pulse oximetry and supplemental oxygen

- Ensure 2 points of functioning intravenous (IV) access with 2 large bore (16 - 18 G) catheters.
- Determine the right position for the patient:
  - Lying in the supine position:
    - Least preferred
    - Used when the patient is hemodynamically unstable
  - Sitting in the supine position:
    - Preferred if stable.
    - Head of bed elevated to 30 degrees
  - Regardless if the patient is sitting up or lying down, the patients arm on the side of the chest tube placement should be abducted and flexed at the elbow with hand up above the head to expose the area of insertion
- Identify the anatomical landmark to giving consideration to special circumstance



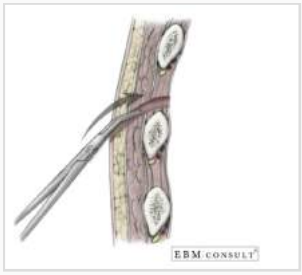


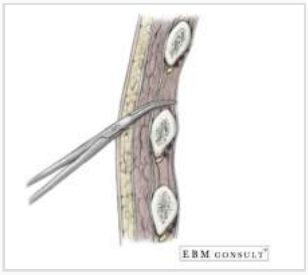
- Set up the Pleurivac system by injecting water to create the water seal (per manufacturer), then attach to high-volume suction capable of creating at least 60 cm of water pressure at a flow of at least 15 - 20 L/min
- Verify all supplies required for chest tube insertion are present at bedside and prepared
- Initiate procedural sedation and/or injection of local anesthetic for intercostal nerve block (described in detail below).

- Procedure: Placement of Chest Tube:

- Put on the hair covering, sterile gown and gloves
- Prepare chest tube by placing a Kelly clamp across the end of the chest tube that will enter into the chest cavity and place forceps across the opposite end to prevent fluid from the pleural cavity from escaping freely after the chest tube is in place.
  - Note: Kelly clamp should be placed with the metal tip compressing the chest tube but not extending beyond, as the free end of the Kelly clamp could result in tissue damage to the lung on insertion into the chest cavity.
- Begin procedural sedation and parenteral analgesia based on clinical situation
- Clean the area of skin with topical antiseptic
- Drape the area using sterile technique
- At the 6th rib and intercostal space, anesthetize the skin at insertion point in an area of about 4 cm going down to the periosteum of the rib under the incision. Then anesthetize the subcutaneous tissue along the tract to the 4th or 5th intercostal space.
  - Note: Starting 1 rib and intercostal space below the entry into the chest cavity (just above the 5th intercostal space) allows the tube to tunnel beneath subcutaneous tissue and reduces the chance of air leak, especially at the time of chest tube removal.

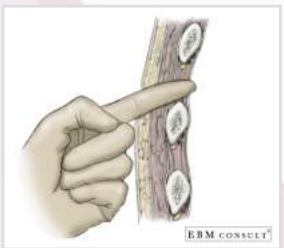
- Anesthetize the pleura in the area of the 4th or 5th intercostal space
    - Note: It is important to anesthetize the pleura well due to the amount of pain in this area when entering into the chest cavity.
- Make an incision over the 6th rib surface that is about 2 - 3 cm and extends down into the subcutaneous tissue.
- With controlled effort, dissect bluntly with a Kelly clamp to the surface of the 5th or 6th rib and continue to dissect bluntly through the underlying subcutaneous tissue muscle, creating a track the extends over the top of the 4th or 5th rib (1 rib superior to your site of skin entry) and into the intercostal space. Note: Going over the top of the rib avoids injuring the neurovascular bundle that is present underneath the inner aspect of the rib.

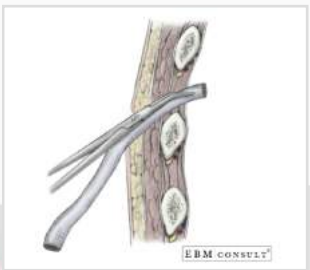




- Once the intercostal muscles have been adequately dissected and the pleura reached, hold the closed Kelly clamp with a grip close to the end of the metal tips, and in a controlled effort, puncture through the pleura.
    - Note: Avoid losing control of the Kelly clamp upon entering into the chest cavity to avoid puncturing the lung and creating a hole. Doing this could create an air leak due to air moving into the lung alveoli but moving into the chest cavity and then taken out by the chest tube.

- Once inside the chest cavity, with the tip of the Kelly clamp near the plane of the pleura, open the Kelly clamp to stretch the tissue larger than the size of the chest tube.
- With the Kelly clamp still inside the chest cavity, insert your index finger into the hole to keep the track open and take out the Kelly clamp.
- Using the index finger, sweep the inside of the chest cavity feeling for adhesions and to make sure you are in the intrathoracic cavity and not in the intraperitoneal cavity. Do not take your index finger out if you are in the right location.
    - Note: You should NOT feel the diaphragm in the cephalad direction, the liver (if on the right side) or the spleen (if on the left side). If you have punctured through the diaphragm, it will need to be repaired surgically. If you feel a significant amount of adhesions then another location will be needed since it can be difficult to appropriately insert the chest tube in a posterior - superior (apically) direction.





While keeping your index finger in the chest cavity, take the chest tube with the Kelly clamp and forceps still in place with your other hand and advance the tip of the chest tube along your index finger to ensure you enter into the intrathoracic cavity.

- Once you have verified the chest tube in the right place, remove the Kelly clamp and advance the tube further in a posterior direction and up towards the apex (superior aspect) of the lung until all of the holes on the chest tube inside the chest cavity.
    - Note: It is important to ensure that the chest tube is advanced far enough that all drain holes are within the thoracic cavity.
- Take out your index finger and now release the forceps attached the end of the chest tube and immediately connect the end of the chest tube quickly to the Pleurovac that is under water seal and set at negative 20 cm of H2O so that the lung can be re-expanded.
- Secure the chest tube with suture to the skin.
    - Note: There are a number of techniques to suture the chest tube to the skin. However, the technique used should be able prevent inadvertent removal of the chest tube or exposure of the holes in the chest tube, be so tight around the chest tube as to clamp off the chest tube, or be too tight on the skin that the skin around the chest tube insertion site does not start to have decreased blood flow.
- Apply antibiotic ointment around the insertion point and then apply an occlusive dressing (Xeroform or Vaseline gauze) over the chest tube insert site to create a seal.
- Apply two or four of the 4 x 4-inch dressings via the slits so that the chest tube is in the center of the bandages and tape down the dressing and tube to the skin.
    - Note: Many clinicians will apply adhesive tape to the patient and then wrap the tape in a spiral fashion or enveloped around the tube a few centimeters to create another anchor of the chest tube to the patient.
- Apply the Elastoplast dressing tape over the dressing and bandages to secure them to the patient and help to maintain the seal around the insertion site.
    - Note: Some clinicians will tape the connections to the suction tubing to help ensure that the suction is not accidentally separated from the chest tube or creates an air leak.

- Post-Procedure Assessment:

- Repeat vital signs including pulse oximetry
- Listen to bilateral lung sounds
- Obtain a portable chest radiograph to verify lung reexpansion and placement of the chest tube
- Evaluate the activity of the Pleurovac to look for continued signs of an air leak and/or the amount of blood or fluid being evacuated
    - Reasons for persistent air leaks or failure of the ling re-expansion:
        - A connection in the tubing is loose or not tight
        - Hole in the tubing
        - One of the holes in the chest tube is now exposed
        - A bronchopleural fistula is present
        - Esophageal rupture

- Complications:

- Intraparenchyemal fistula from injury of the lung by the Kelly clamp or chest tube.
- Inserting the chest tube within a fissure of the lung
- Damage to the neurovascular bundle underneath the rib from using the wrong technique
- Pulmonary edema secondary to lung re-expansion
- Tension pneumothorax from an occluded or clamped tube

- Persistent pneumothorax
- Subcutaneous emphysema
- Injury to the diaphragm
- Placement into the peritoneum
- Infection (specially pneumonia)
- Bleeding from the chest wall (due to injury of the intercoastal artery)

Vinous Access

Cannula's come in various colours, which correspond to the size of the "tube". The size needed depends on what it to be infused e.g. colloid, crystalloid, blood products or medications; or at the rate the infusion is to run. The other factor which could determine which size to use is the patients veins e.g. you may only get a small blue cannula into an elderly patient who has spindly veins!

This is a core clinical skill to know:
Subject steps:

1. Introduce yourself to the patient and clarify the patient's identity. Explain the procedure to the patient and gain informed consent to continue. It is also worth explaining that cannulation may cause some discomfort but that it will be short lived.

Theoretical Maximum Flow Rates

Colour	Gauge	Flow
Yellow	24G	13 ml/min
Blue	22G	30 ml/min
Pink	20G	55 ml/min
Green	18G	80-100 ml/min
White	17G	135 ml/min
Grey	16G	180 ml/min
Orange or Brown	14G	270 ml/min

2. Ensure that you have all of your equipment ready as follows:
- alcohol gel, gloves, an alcohol wipe, a disposable tourniquet, an IV cannula, a suitable plaster, a syringe, saline, a sharps bin (not pictured).

Equipment for intravenous cannulation

3. Sanitise your hands using alcohol cleanser.
4. Position the arm so that it is comfortable for the patient and identify a vein.
5. Apply the tourniquet and re-check the vein.

Apply the tourniquet

Re-check the vein

6. Put on your gloves, clean the patient's skin with the alcohol wipe and let it dry.

Clean the patients skin with the alcohol wipe

7. Remove the cannula from its packaging and remove the needle cover ensuring not to touch the needle.

Remove the needle cover

8. Stretch the skin distally and tell the patient to expect a sharp scratch.

9. Insert the needle, bevel upwards at about 30 degrees. Advance the needle until a flashback of blood is seen in the hub at the back of the cannula

Insert the needle, bevel upwards at about 30 degrees

Flashback of blood is seen in the hub

10. Once this is seen, progress the entire cannula a further 2mm, then fix the needle, advancing the rest of the cannula into the vein.

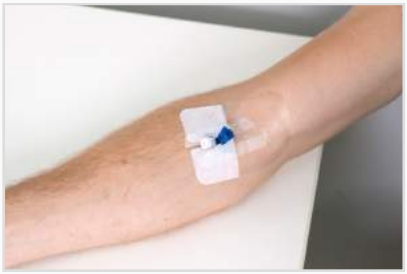
Advance the rest of the cannula into the vein

11. Release the tourniquet, apply pressure to the vein at the tip of the cannula and remove the needle fully. Remove the cap from the needle and put this on the end of the cannula.

Release the tourniquet

Remove the needle

12. Carefully dispose of the needle into the sharps box.
13. Apply the dressing to the cannula to fix it in place and ensure that the date sticker has been completed and applied.



Apply the plaster to the cannula

14. Check that the use-by date on the saline has not passed. If the date is ok, fill the syringe with saline and flush it through the cannula to check for patency. If there is any resistance, if it causes any pain, or you notice any localised tissue swelling; immediately stop flushing, remove the cannula and start again.

15. Dispose of your gloves and equipment in the clinical waste bin, ensure the patient is comfortable and thank them
Note that as an extension to procedure, you may be asked to set up an IV drip.

Arterial blood gas (ABG)

An **arterial blood gas (ABG)** is a blood test that measures the acidity (pH) and the levels of oxygen and carbon dioxide in the blood. Blood for an ABG test is taken from an artery whereas most other blood tests are done on a sample of blood taken from a vein.

Every day, a lot of nursing and medical students assigned in acute areas encounter ABG results, which they may not necessarily be able to interpret with its knotty aspect. They struggle over the interpretation of its measurements, but they are not especially complicated nor difficult if you understand the basic physiology and have a step by step process to analyze and interpret them.

There may be various tips and strategies to guide you, Here are the steps:

1. Know the normal values

Know the normal and abnormal ABG values when you review the lab reports. They're fairly easy to remember: for pH, the normal value is 7.35 to 7.45; 35-45 for $paCO_2$; and 22-26 for HCO_3. Remember also this diagram and note that $paCO_2$ is intentionally inverted for the purpose of this method.

2. Determine if pH is under acidosis or alkalosis

Next thing to do is to determine the acidity or alkalinity of the blood through the value of pH. The pH level of a healthy human should be between 7.35 to 7.45. The human body is constantly striving to keep pH in balance.

pH level below 7.35 is acidosis

pH level above 7.45 is alkalosis

3. Determine if acid-base is respiratory or metabolic

Next thing you need to determine is whether the acid base is Respiratory or Metabolic.

$paCO_2$ = Respiratory

HCO_3 = Metabolic

4. Remember ROME

Still, it all boils down to mnemonics. The mnemonic **RO-ME**.

Respiratory **O**pposite

When pH is up, $PaCO_2$ is down = Alkalosis

When pH is down, $PaCO_2$ is up = Acidosis

Metabolic **E**qual

When pH is up, HCO_3 is up = Alkalosis

When pH is down, HCO_3 is down = Acidosis

5- Determine compensation

The last step is to determine if the ABG is Compensated, Partially Compensated, or Uncompensated. Here's the trick:

If pH is NORMAL, $PaCO_2$ and HCO_3 are both ABNORMAL = Compensated

If pH is ABNORMAL, $PaCO_2$ **and** HCO_3 are both ABNORMAL = Partially Compensated

If pH is ABNORMAL, $PaCO_2$ **or** HCO_3 is ABNORMAL = Uncompensated

Therefore this ABG is **METABOLIC ACIDOSIS, PARTIALLY COMPENSATED .**

By applying the steps above, interpret the following ABGs:

pH:7.44, $PaCO_2$: 30, HCO_3: 21

pH is NORMAL = NORMAL so place pH under Normal

$PaCO_2$ is LOW = BASE so place $PaCO_2$ under Base

HCO_3 is LOW = ACID so place HCO_3 under Acid

Quick Hint :

The mnemonic MUDPILES is commonly used to remember the causes of increased anion gap metabolic acidosis.

M — Methanol

U — Uremia (chronic kidney failure)

D — Diabetic ketoacidosis

P — Paraldehyde but this substance is not commonly used today

I — Infection, Iron, Isoniazid, Inborn errors of metabolism

L — Lactic acidosis

E — Ethylene glycol (Note: Ethanol is sometimes included in this mnemonic as well, although the acidosis caused by ethanol is actually primarily due to the increased production of lactic acid found in such intoxication.)

S — Salicylates

Approach to patient with Diabetic Foot

A. Introduction: [1]

DFUs are complex and costly to patients and health systems alike. As diabetic foot syndrome incorporates endocrine, histologic, neurologic, ischemic and orthopedic factors, it is important that DFU assessment is holistic and multidisciplinary, with a focus not only on evaluating and managing the wound, but diagnosing and treating underlying disease.

B. History & Examination: [2]

Does the patient have a history of?

- Previous leg/foot ulcer or lower limb amputation/surgery?
- Prior angioplasty, stent or leg bypass surgery?
- Foot wound?
- Smoking or nicotine use?
- Diabetes? (if yes, what are the patient's current control measures?).

Does the patient have?

- Burning or tingling in legs/feet?
- Leg or foot pain with activity or rest?
- Changes in skin color or skin lesions?
- Loss of sensation of lower extremity.

Has the patient established regular podiatric care?

Dermatologic exam:

- Does the patient have discoloured, ingrown or elongated nails?
- Are there signs of fungal infection?
- Does the patient have discoloured and/or hypertrophic skin lesions, calluses or corns?
- Does the patient have open wounds or fissures?
- Does the patient have interdigital maceration?

Neurological exam:

Is the patient responsive to light touch (protective sensation) on the feet?

Musculoskeletal exam:

- Does the patient have full range of motion of the joints?
- Does the patient have obvious deformities? If so, for how long?
- Is the midfoot hot, red or inflamed?

Vascular exam:

- Is hair growth on the foot dorsum or lower limb decreased?
- Are the dorsalis pedis AND posterior tibial pulses palpable?
- Is there a temperature difference between the calves and feet or between the left and right foot?

Figure 1 | 3-minute diabetic foot history and examination

C. Investigation: [3]

CBC and ESR, Serum glucose, Urea & creatinine, Electrolytes, Plain x-ray and Doppler study.

D. Admission: [4]

Hospital admission is indicated to those with:

1. Acutely infected ulcers.
2. Infected gangrene.
3. Penetration of digital infections into the forefoot.
4. Septic involvement deep to the plantar fascia.
5. Uncontrolled diabetes.

E. Prevention: [5]

There are some few tips used to prevent ulcer formation:

1. Routine foot care;
   A. Daily inspection for skin breakdown.
   B. Prompt debridement of any callus.
   C. Fitting with orthotic shoes to minimize daily trauma to feet.
   D. Treatment of onychomycosis (nail fungus) with topical or oral agents.
2. Somatosensory (monofilament) testing annually to detect diminished sensation.
3. Early detection of PVD (annual ankle/brachial indices in individuals with diabetes older than 50 years, with follow up studies for falsely increased results) and early revascularization procedures.
4. Smoking cessation.

F. Management: [6]

1. Surgical debridement of hyperkeratotic (callused), necrotic, and infected tissue (including bone) to healthy bleeding wound bed, regardless of depth of wound.
2. Assessment for infection—purulent or foul-smelling drainage, warmth, erythema, tenderness.
3. Osteomyelitis treated by surgical removal of infected bone, followed by IV antibiotics for remaining infection in surrounding soft tissue (usually 6 weeks).
4. Dressings should be designed to keep wound bed moist to promote migration of fibroblasts and epithelialization of wound.
5. Off-loading of pressure from wound is necessary for healing of ulcer.
6. Weekly measurements of wound size to objectively document healing (shrinking).

G. Treatment: [7]

Drug of choice use to treat the infection is: second or third generation cephalosporin, in addition to metronidazole 500 mg 8 hourly.

Wound

A. Definition:

A **wound** is a type of injury which happens relatively quickly in which skin is torn, cut, or punctured (an open wound), or where blunt force trauma causes a contusion (a closed wound).

B. Wound classification:

According to level of contamination, a wound can be classified as:

- Clean wound – made under sterile conditions where there are no organisms present, and the skin is likely to heal without complications.
- Contaminated wound – usually resulting from accidental injury; there are pathogenic organisms and foreign bodies in the wound.
- Infected wound – the wound has pathogenic organisms present and multiplying, exhibiting clinical signs of infection (yellow appearance, soreness, redness, oozing pus).
- Colonized wound – a chronic situation, containing pathogenic organisms, difficult to heal (i.e. bedsore).

C. Open wounds:

Open wounds can be classified according to the object that caused the wound:

- Incision

A sharp object, such as a knife, shard of glass, or razor blade, causes an incision. Incisions bleed a lot and quickly. A deep incision can damage tendons, ligaments, and muscles.

- Laceration

A laceration is a deep cut or tearing of the skin. Accidents with knives, tools, and machinery are frequent causes of lacerations. The bleeding is rapid and extensive.

- Puncture

A puncture is a small hole caused by a long, pointy object, such as a nail, needle, or ice pick. Sometimes, a bullet can cause a puncture wound. Punctures may not bleed much, but these wounds can be deep enough to damage internal organs. If you have a puncture wound (even just a small one), visit your doctor to get a tetanus booster shot and prevent infection.

- Avulsion

An avulsion is a partial or complete tearing away of skin and tissue. Avulsions usually occur during violent accidents, such as body-crushing accidents, explosions, and gunshots. They bleed heavily and rapidly.

- Management of Open Wound:

- **Incisions**

Compression and suturing. The wound will heal from the bottom to the top. A dressing helps absorb drainage and keep the skin from closing before the wound underneath fills in.

- **Lacerations**

Suturing is the preferred technique for skin laceration repair. Tissue adhesives are comparable with sutures in cosmetic results, dehiscence rates, and infection risk.

Applying white petrolatum to a sterile wound to promote wound healing is as effective as applying an antibiotic ointment.

- **Abrasions (grazes)**
  - clean the cut and rinse it with normal saline or scrape with cool water to remove dirt and debris.
  - Hold the area under running water.
  - Use soap to clean the wound. You don't need to use stronger cleaning solutions to treat minor cuts and scrapes, as they may irritate the wound.
  - Stop the Bleeding. Smaller cuts and abrasions usually stop bleeding on their own.
  - A cut to the head or hand may bleed more because those areas have a lot of blood vessels. To stop the bleeding, gently apply firm, direct pressure using a clean cloth or gauze.
  - Continue to hold the pressure steadily. Don't raise the cloth or gauze to check on the wound, because that could cause the wound to start bleeding again.
  - If blood seeps through the dressing, just put more on top and keep applying pressure.
- **Avulsions**

  Control bleeding with direct pressure and elevation, avoiding tourniquets unless bleeding cannot be controlled.

  Rinse the wound with water or saline solution, the cleaner the better.

  If the tissue (skin, fat, and muscle) is not completely removed, replace the flap and dress the wound.

  If the tissue is completely separated from the body, collect it if available and bring it with the emergency department.

Puncture wounds

Remove the object if you can. If the object that caused the puncture is small and you can easily remove it.

Stop the Bleeding. Apply firm, direct pressure with sterile gauze or clean cloth until bleeding stops.

Clean and protect the wound. Rinse the wound under clean water for several minutes. Then wash the area with mild soap and water and rinse again.

Apply an antibiotic cream. Use a sterile bandage to protect the puncture wound from dirt or further injury.

For pain, give ibuprofen (Advil, Motrin) or acetaminophen (Tylenol). Check first, though, if they have any medical conditions or take any other medicines.

Check for any signs of infection: redness, increasing pain, swelling, or pus at the site.

- Complications of Open Wounds:

Complications include:

infection, cellulitis, deformity, overgrowth of scar tissue (keloid formation), gangrene that may require amputation, bleeding, sepsis, and tetanus.

Open wounds involving vascular injury may result in ischemia and necrosis that require amputation of affected parts.

Wounds involving nerve injury may be complicated by temporary or permanent loss of sensation or function of the affected body part.

Trauma not involving direct nerve injury may lead to delayed involvement of the nervous system (reflex sympathetic dystrophy).

D. Closed wounds:

Closed wounds have fewer categories, but are just as dangerous as open wounds:

Hematomas (or Collection of blood) – caused by damage to a blood vessel that in turn causes blood to collect under the skin.

Hematomas that originate from internal blood vessel pathology are petechiae, purpura, and ecchymosis. The different classifications are based on size.

Hematomas that originate from an external source of trauma are contusions, also commonly called bruises.

Crush injury – caused by a great or extreme amount of force applied over a long period of time.

- Management of Closed Wound:

*** RICE: Rest. Ice. Compress. Elevate.

In closed wounds, the main goal of treatment is to control the pain, and keep the bleeding and inflammation to a minimum. This is done by using ice packs, compression, elevation and immobilization of the affected limb or area.
Topical antibiotic ointment may be applied locally to wounds in cases of associated skin lacerations and abrasions.

- Complications of Closed Wounds:

Closed wounds can be complicated by severe bleeding, large bruises, nerve damage, bone fractures and internal organ damage.

However, the most serious complication of closed wounds is known as the compartment syndrome, which involves the lower and/or upper limbs, where the damage causes swelling and increased pressure in the fascia that surrounds the muscles, nerves and blood vessels. The increased pressure can block the blood supply to the affected limbs, causing severe damage to the muscles and nerves. The damage can be permanent, leading to loss of function, and may necessitate amputation.

E. Type of wound closures:

- Primary intention:

Acute wounds can be managed in several ways. The most common method is to primarily close it, resulting in healing by primary intention. This method is applied to all surgical incisions and lacerations that are closed with sutures, staple, adhesive band, or any technique by which surgeons intentionally approximate the epidermal edges of a wound. It also includes tissue.

- Secondary intention:

The wound is left to close by granulation. it takes longer than the previous method but generally it is good for infected wound where dressing h necessarily. Classically these wounds are treated With "wet-to try" dressings wherein a gauze sponge Is moistened with saint and used to pack the wound, covered with a dry dressing: the moist sponge dries cut, and when it is removed and changed once or twice a day, gentle debridement of the wound is achieved.

- Delayed intention:

In delayed primary closure, sometimes called healing by tertiary intention, the wound Is initially managed as a secondary intention wound, that Is, left open with dressing changes. After sometimes, when the wound is clean and granulation tissue Is abundant, the wound edges are actively approximated. This approach is

successful because granulation tissue, while not sterile, is extremely vascular and as such is highly resistant to infection.

F. Wound dressing:

A. Aim of wound dressing:

Covering the wound surface and moisturizing it facilitates healing and re-epIthelization of the edges and prevent infection by the low pH cleated on the wound surface to be occlusive dressings.

B. Layers of dressings:

Typically dressings usually have three layers:

I. Contact layer - The layer in contact with the wound surface.

2. Absorbing Layer - To absorb the exudate from the wound.

3. Binding layer - the outermost layer which holds the dressing together (bandage).

C. Types of wound dressing

Name	Indication	Advantage	Disadvantage
Non-reabsorbable (gauze)	Most wound types	Easily available, cheap, good absorbing capacity	Sticks to the wound. Painful during change. Can change epithelium. Not truly occlusive. Require frequent change.
Films	Superficial wounds and surgical sites	Occlusive dressing. Impermeable to bacteria	Nonabsorbent, hence not useful in exudative wounds
Foams, colloids	Exudative wounds and cavities	Form an "autolytic" layer to remove debris	Need exudates to function, hence not suitable for dry wounds
Hydrophilic (alginate dressings)	Highly exudative wounds	Form an "autolytic" layer to remove debris	Cannot be used in sites of anaerobic infection/ dry, wounds.

G. Tetanus prophylaxis:

Tetanus is an acute, often fatal, disease caused by an exotoxin produced by the bacterium Clostridium tetani. It is characterized by generalized rigidity and convulsive spasms of skeletal muscles. The muscle stiffness usually involves the jaw (lockjaw) and neck and then becomes generalized.

H. Tetanus Wound Management

	Clean, minor wounds		All other wounds	
Vaccination history	Tdap or Td	TIG	Tdap or Td	TIG
Unknown or fewer than 3 doses	Yes	No	Yes	Yes
or more doses 3	No	No	No	No

Note: Tdap = Tetanus, Diphtheria and Pertussis
Td = Tetanus, Diphtheria
TIG = tetanus immunoglobulin

I. Tetanus Complications

- Laryngospasm
- Fractures
- Hypertension and/or abnormal heart rhythm
- Nosocomial infections
- Pulmonary embolism
- Aspiration pneumonia
- Death

.....

Wound antisepsis and sterile technique

A. Aseptic technique:

1. **Actual preparation of the wound involves cleansing and debridement.**

2. **Clean The skin surface surrounding the wound, should be washed and disinfected with a solution that is rapidly acting, with a broad spectrum of antimicrobial activity.**

3. **Also it should not delay healing or reduce tissue resistance to infection.**

4. **Prior to cleansing, the area around the wound may have to be anaesthetized to reduce the discomfort to the patient.**

5. **Although excellent as skin cleansers, these solutions are potentially toxic to the local wound defenses and may increase the rate of subsequent wound infection if they are spilled into a wound in large quantities. These solutions should be irrigated from the wound with a sterile normal saline solution as the final step in wound cleansing**

6. **Wound irrigation is a form of mechanical wound cleansing that is known to effectively remove bacteria and other debris.**

B. Sterile technique:

1- **open and put gloves on without contamination to the sterile surface of the gloves.**

2- **clean and drape the wound and surrounding area.**

3- **control the instruments and suture, such that they are not contaminated by non-sterile surfaces.**

C. Local Anesthesia:

Drugs which produce reversible block to the transmission of peripheral nerve impulse.

Topical anesthetics agents applied topically to such diverse sites as skin, eye, gingival mucosa, tympanic membrane, tracheobronchial tree, and rectum.

Forms of topical anesthetic preparation include: ointment, spray, solution, suppository.

Example of topical preparations of lidocaine :

- 4% aqueous solutions for endotracheal installations

- 2% gel for intra urethral use

-10% aerosol for anesthesia of gingival mucosa

Infiltration anesthetics: Produced by intra dermal and subcutaneous injection of local anesthetics in the area of the intended surgery. Primarily useful for minor superficial procedures

Dosage of local anesthetic required for adequate infiltration depends on the weight of the patient, extent of the area to be anesthetized and the expected duration of the surgical procedures.

Upper dose limits for commonly used local anesthetics agents		
	Plain solution (without adrenaline)	**with adrenaline**
	mg /kg	mg/ kg
Procaine	7	9
Lidocaine	4	7
Bupivacaine	2	3
Mepivacaine	4	7

- The steps for direct infiltration of local anesthetic are as follows:

1. Ensure that the areas distal to wound show no neurovascular compromise.
2. Explain the procedure to the patient.
3. Provide sedation and restraint, if needed.
4. Cleanse the site of infiltration with povidone-iodine or other similar antiseptic preparation and allow to air dry or dry with sterile gauze.
5. For open wounds, put a few drops of the anesthetic material into the wound and then rapidly place the needle into the subcutaneous layer by inserting it through the wound margin rather than intact skin.
6. For intact skin, rapidly place the needle through the skin into the subcutaneous layer.
7. Slowly inject small volumes of the anesthetic. During anesthetic infiltration, either slowly advance the needle or initially insert it to the hub and infiltrate as the needle is withdrawn.
8. Anesthetize adjacent areas by inserting the needle through the previously injected skin or wound until the entire region requiring anesthesia is infiltrated.
9. After a few minutes, lightly test the skin or wound margins for adequate anesthesia using the injection needle or other sharp object (suture needle, Adson forceps).

D- Type of Suture material

1. Absorbable sutures

An absorbable suture is generally defined as stitch that will lose most of its tensile strength within 60 days after implantation. The ideal absorbable suture has low tissue reactivity, high tensile strength, slow absorption rates, and reliable knot security. Classically, absorbable sutures were only used for deep sutures.

Suture	Raw material	Tensile strength retention in vivo	Absorption rate	Tissue reaction	Uses
Plain Catgut	Natural product derived from sheep or cattle intima	Within five to seven days	Phagocytosis and enzymatic degradation within 7-10 days	High Tissue reaction	For all surgical procedures especially when tissues that regenerate faster are involved.
Chromic catgut	natural product derived from sheep or cattle intima treated with chromium salts to resist body enzymes	Within 21 to 28 days	Phagocytosis and enzymatic degradation within 90 days	moderate tissue reactivity.	Chromic gut is more rapidly absorbed in the oral cavity. as plain catgut.
(Vicryl)	synthetic material made of polyglycolic acid and coated with N-laurin and L-lysine.	within three to four weeks	Complete absorption occurs in 60 to 90 days	mild tissue reactivity	Subcutaneous, intracutaneous closures, abdominal and thoracic surgeries
(Monocryl)	Copolymer of glycoline and capiolactone	21 days maximum	90-120 days	mild tissue reactivity	This suture is often used by plastic surgeons for facial lacerations closed with subcuticular running sutures

(Dexon)	synthetic polyglycolic acid	It maintains at least 50 percent of its tensile strength for 25 days.	Complete absorption occurs in 60 to 90 days	Minimal tissue reactivity	Suture where slightly longer wound support is required
Polydioxanone (PDS)	Polyester and polymer	five to six weeks	Complete absorption within 200 days	Mild tissue reactivity	Pediatric cardiovascular surgery, ophthalmic surgery Fascia closure
Maxon	Blok of copolymer of glycolide and trimethylene carbonate	five to six weeks.		Minimal tissue reactivity	in general soft tissue approximation and/or ligation, and in peripheral vascular surgery.

2. Non-absorbable sutures

Suture	Raw material	Tensile strength retention in vivo	Absorption rate	Tissue reaction	Uses
Silk	Natural protein raw silk from silkworm	Lowest tensile strength of any non-absorbable suture. 80-100%lost by 6 months	Absorbed slowly over 1-2 years	Moderate	It is rarely used for suturing of minor wounds because stronger synthetic materials, Typically used to tie off blood vessels or bowel segments
Nylon	Polyamide polymer	high tensile strength loses 15-20% per year	Degrades at approximately 15-20% per year	low	Used for closure of skin, surgical incisions or drainage tubes

Polypropylene (Surgilene, Prolene)	synthesized from polyolefin plastics	high tensile strength more than 1 year	Remain encapsulated in body tissue	low	It is especially noted for its plasticity, allowing the suture to stretch to accommodate wound swelling , plastic surgery
Polybutester (Novafil)	Polymer of propylene	high tensile strength more than 1 year	Remain encapsulated in body tissue	low	Cardiovascular surgery ,plastic surgery, general surgery

- Characteristics of suture material

Absorbable vs Non-absorbable	• Absorbable sutures are generally used as deep sutures; they do not need to be removed post-operatively. • Non-absorbable sutures are used for surface sutures; require manual removal post-operatively.
Tensile Strength	Surgeons prefer to use the smallest size that will provide adequate strength. The size increases as the first digit decreases. • 3-0 is relatively a strong suture • 6-0 is a thin comparatively weak suture.
Plasticity and Elasticity	The ability to retain length and strength after stretch, and the ability to regain its original length after stretch. This is important: 1. To accommodate post-operative edema without cutting into the tissue 2. To maintain epidermal approximation once the edema has resolved.
Ease of handling and Knot security	Determined by a number of related characteristics. 1. A suture with a low coefficient of friction slides through tissue well but the knot will unravel more easily. 2. A suture with a high memory will spring back to its original position. While these sutures tend to be strong, they may be difficult to handle and have decreased knot security. - A suture with high pliability can be easily bent, and will therefore handle well with good knot security.
Multifilament vs Monofilament	- Multifilament braided sutures handle more easily and tie well, but can potentially harbor organisms between fibers leading to increased infection risk. They also tend to have higher capillarity so can absorb and transfer fluid more easily increasing potential for bacteria to enter from the skin surface. - Monofilament sutures have a lower infection risk and a lower coefficient of friction, but with a lower ease of handling and knot security.
Tissue reactivity	Refers to the degree of inflammatory response to the suture. I. Higher for natural products such and silk and gut II. Lower for synthetic fibers such as nylon.

- Type of Needle:

the needle remains the same, the needle anatomy can be divided into the following parts:

The eye: is the end of the needle attached to the third.

There are three types of the needle eye:

Closed eye French eye Swaged

This one is the only used type now a days the rest became a history

The body: is the portion that is grasped by the needle holder during the procedure. The body of the needle should be as close as possible to the diameter of the stitch to minimize bleeding and leakage.

The curvature of the needle body may come in a variety of shapes.

1. STRAIGHT NEEDLE
2. HALF-CURVED NEEDLE
3. CURVED NEEDLE (The curvature may be 1/4, 3/8, 1/2, or 5/8 circle).

COMPOUND CURVED NEEDLE

SHAPE	APPLICATION
Straight	gastrointestinal tract, nasal cavity, nerve, oral cavity, pharynx, skin, tendon, vessels
Half-curved	skin (rarely used) laparoscopy
1/4 Circle	eye (primary application) microsurgery
3/8 Circle	aponeurosis, biliary tract, cardiovascular system, dura, eye, gastrointestinal tract, muscle, myocardium, nerve, perichondrium, periosteum, pleura, skin, tendon, urogenital tract, vessels
1/2 Circle	biliary tract, cardiovascular system, eye, fascia, gastrointestinal tract, muscle, nasal cavity, oral cavity, pelvis, peritoneum, pharynx, pleura, respiratory tract, skin, tendon, subcutaneous fat, urogenital tract
5/8 Circle	anal (hemorrhoidectomy), nasal cavity, pelvis, urogenital tract (primary application)
Compound Curved	eye (anterior segment) laparoscopy

The needle point: extends from the extreme tip to the maximum cross section of body. Each needle point is designed and produced to the required degree of sharpness to smoothly penetrate specific types of tissue.

-

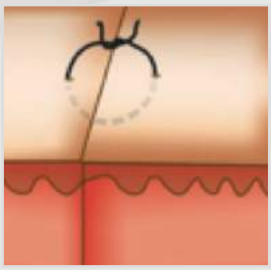
- Suturing instruments:

1-Needle holder: used to grab onto the suture needle.

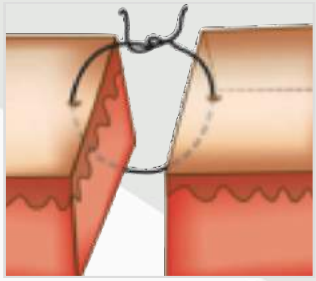
2-Forceps: used to hold the tissues gently and to grab the needle.

3-Suture scissors: used to cut the stitch from the rest of the suture material.

- Type of Suturing techniques:

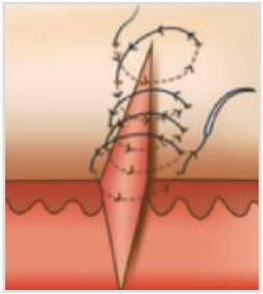


A- Simple Interrupted Suturing:



- The simplest way to close skin wounds.
- Insert the needle at 90° to the skin
- It should be 3-5 mm away from the margin and 3-5 mm away from the each other.
- Equal amount of tissue should be opposed on both sides.
- All knots should be placed on the same side with wound edges

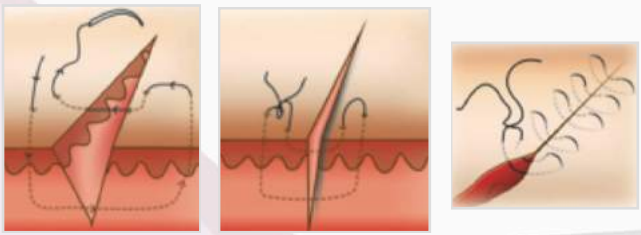
B- Continuous Suturing:



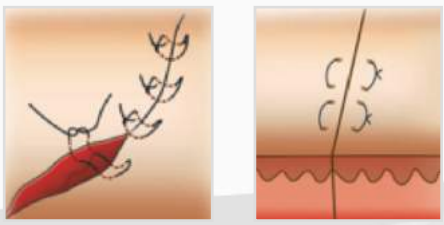
- Commonly applied in case of peritoneum and sheath closure.
- Hemostatic.
- It may cause overlapping of edges.
- Wound dehisces if one stitch is dissolved early or if it breaks.
- It is contraindicated if the skin wound is contaminated because of high risk of infection.

C- Mattress Suturing:

- This is a double stitch, which aims to close the deep part of the wound, to obliterate dead space and slightly invert the edges.
- It also aim to relieve tension from the edges of the wound.
- Starting from one edge of the needle passes through the other edge, and is then returned to the starting side through separate bite
- It is most useful where skin is loose or hemostasis is required.
- If the entry and exit holes lie parallel to the edges, these are called horizontal mattress stitches
- If the entry and exit holes are perpendicular to the edges, these are vertical mattress stitches



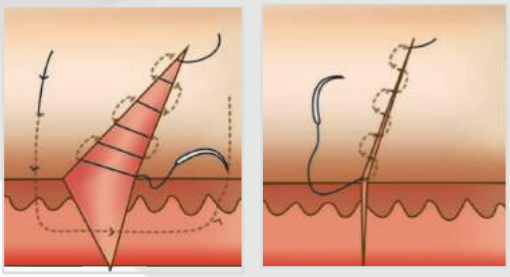
Vertical



Horizontal

- Subcuticular Suturing:

1. When non absorbable prolene or naylon used its easy to remove, When absorbable suture is used doesn't need removal
2. Cosmetically better
3. The suture material can be absorbable or non-absorbable



Enter the skin about 1 cm from the end of the incision using preferably a straight needle. Pass the needle through subcuticular layer and dermis along the wound in regular step-wise fashion.

- Instructing the patient

- If antibiotics are prescribed, take your full prescription as directed.
- Discomfort is usually relieved with Tylenol. If a stronger medication is prescribed, follow directions carefully.
- Keep the wound and sutures dry for 24 hours, unless advised otherwise.
- Baths may be resumed after 24 - 48 hrs from wound closure.
- Inspect incisions daily for signs of infection.
- You may be directed to apply a dressing and medication to the wound. Be sure to ask any questions about your care so that you can perform these dressings at home.

When should you call the doctor?

If you have increased swelling or bruising, if swelling and redness persist for a few days, if you have increased redness along the incision, If you have severe or increased pain not relieved by medication, If you have any side effects to medications; such as, rash, nausea, headache, or vomiting, If you have an oral temperature over 100.4 degrees, If you have any yellowish or greenish drainage from the incisions or notice a foul odor, If you have bleeding from the incisions that is difficult to control with light pressure, or If you have loss of feeling or .motion

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