UNIT 3

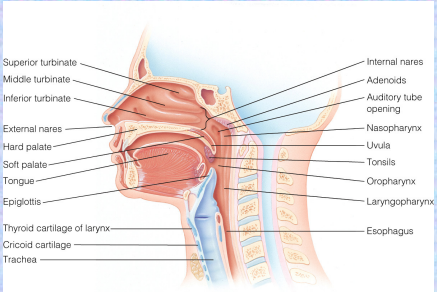
PROBLEMS WITH OXYGENATION

LeMone & Burke Unit 11

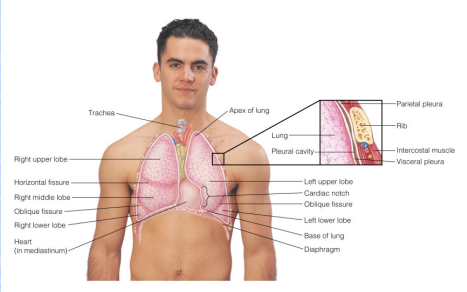
The Respiratory System

- Upper Respiratory System
  - Nose, sinuses, pharynx, larynx, trachea
  - Passage way for air, cleanses, humidifies, warms
- Lower Respiratory System
  - Lungs, bronchi, alveoli
  - Respiratory membrane for gas exchange

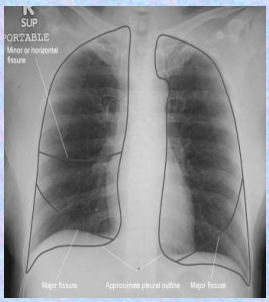
The Respiratory System



The Respiratory System



Structures



- Trachea
- Heart
- Rt. Lung
- Lt. Lung

Health History

- Current Illness
- Observe for Respiratory Compromise
- Present Health Status, Medical History, Family History, Risk Factors
- Lifestyle Questions
  - Smoking history
  - Exposure to environmental substances
  - Exercise
  - Use of recreational drugs

Focused Health History

- Health perception
- Activity Pattern
- Functional levels

Age-related Changes

- Decrease in elastic recoil of the lung
- Loss of skeletal muscle strength in thorax and diaphragm
- Fibrosis in the alveoli
- Fewer functional capillaries
- Less effective cough
- Decrease in PO2

Changes with Aging

- Gradual decline after the age of 20
- Increases the risk and severity of pulmonary disorders
- Effects of aging are physiologically and anatomically similar to those occurring in the development of mild emphysema

  - Aging and the Lungs – *The Merck Manual of Geriatrics*

Laboratory and Diagnostics

Diagnostic Assessments

- X-ray
  - CT & Digital CT
  - Pulse Oximetry

Procedural Assessments

- Bronchoscopy

Laboratory Assessments

- Nasal Swab
- CBC with diff
- Sputum
  - Gram stain
  - Culture and Sensitivity
  - Acid-Fast Stain
  - Cytologic tests

O_2 Delivery Systems

What you have seen

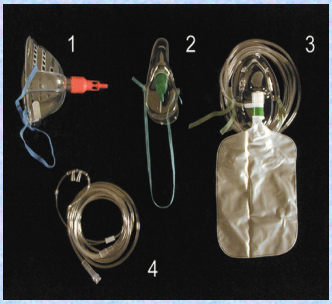
- Nasal Cannula
- Simple Face Mask
- Partial Re-breather Mask
- Non-Re-breather Mask
- Venturi mask

Adding new

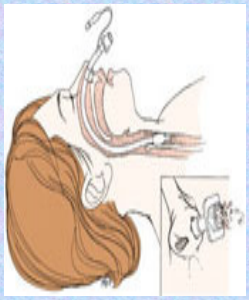
- Face tent or Tracheostomy collar
- T-Tube or T-Piece apparatus
- BiPAP (pg. 1251)
- CPAP (pg 1251)

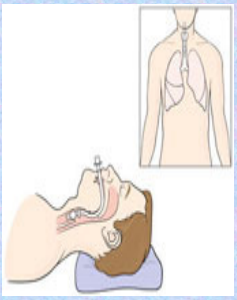
Types of assistive devices

- O2 delivery
  - NC
  - Simple Mask
  - NRB
  - Face Shield
  - Etc.
- Airways
  - NasoPharyngeal
  - Oral
  - Tracheostomy

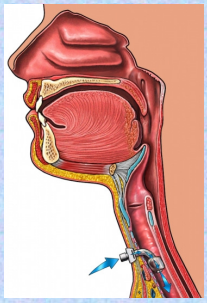


Endo-tracheal and Naso-tracheal Intubation

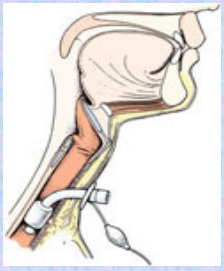




Artificial Airways



Tracheostomy Shield



Care of the Patient with a Tracheostomy

- Impaired verbal communication
- Imbalanced Nutrition: Less than body requirements related to physical barrier
- Risk for Infection related to invasive procedures
- Impaired social interaction related to communication barrier

CPAP vs. BiPAP

- What is C-PAP?
  - *Continuous Positive Airway Pressure*. In the 1980s, people used a C-PAP in their homes to help combat breathing difficulties such as sleep apnea
  - The extra pressure from C-PAP allowed users to sleep by keeping the airways open. The problem with C-PAP was that the person had to exhale against the extra pressure. This made it unsuitable for people suffering from neuromuscular diseases.

CPAP vs. BiPAP

- What is BiPAP?
  - With the development of BiPAP, air delivered through a mask can be set at one pressure for inhaling and another for exhaling. This makes BiPAP much easier for users to adapt to and also allows neuromuscular disease sufferers to use the device. Because of these dual settings, BiPAP allows people to get more air in and out of the lungs without the natural muscular effort needed to do so.

Increases Tidal Volumes and eliminates CO_2 while decreasing work of breathing!!

BiPAP

- If a patient is deemed unable to tolerate or is refusing intubation, BiPAP may be indicated as a means of decreasing accumulated pCO2
- **"Non-invasive Ventilation"**

Suctioning

- Maintains a patent airway
- Promotes gas exchange
- Indications for suctioning
  - Audible or noisy secretions
  - Crackles or wheezes on auscultation
  - Restlessness
  - Increased pulse and or respiratory rate

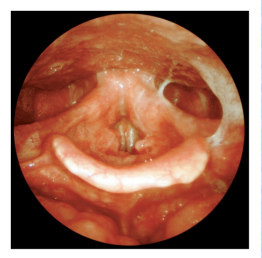
Methods of suctioning

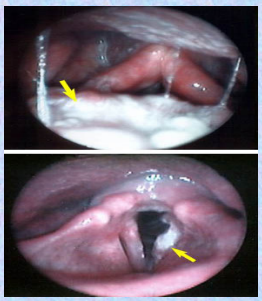
- Orally
- Nasal
  - Use of naso-pharyngeal airway helps prevent pain and mucosal trauma
- Artificial airway (tracheostomy)

Upper Respiratory Tract Disorders and Risk Factors

- Nasal Polyps
  - Benign grapelike growths of lining of nose
  - Interfere with air movement
  - May obstruct openings, leading to sinusitis
- Laryngeal Tumor (pg 1252-1262)
  - Benign
    - Papillomas (wart-like growths)
    - Nodules
    - Polyps
  - Malignant
    - Fairly uncommon
    - Often curable if detected early

Laryngeal Tumors/Cancer





Manifestations

- Hoarseness
- Change in the voice
- Painful swallowing
- Dyspnea
- Foul breath
- Palpable lump in the neck
- earache

Treatment of Laryngeal Cancer

- Determined by staging the cancer
- Radiation therapy
- Chemo-radiotherapy
- Chemotherapy

Goals of Surgery

- Remove the malignancy
- Maintain airway patency
- Achieve optimal cosmetic appearance

Procedures

- Laser laryngoscopy
- Laryngectomy
- Radical neck dissection
- Modified neck dissection

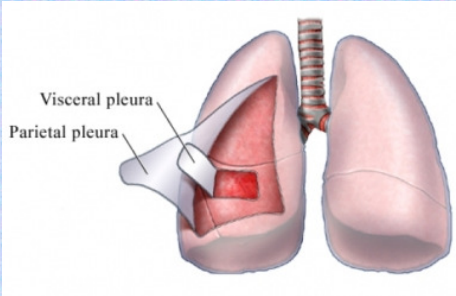
ABNORMALITIES OF THE PLEURAL SPACE

- Disease states cause the pleural space to fill
  - Pneumothorax
  - Hemothorax
  - Pleural effusion
- Air, blood or fluid introduced into the pleural space
  - Destroy the intra-pleural pressure
  - Becomes atmospheric or above.
  - Pleural membranes separate.
  - When this occurs the affected portion of the visceral pleura and lung are displaced away from the chest wall

Disorders of the Pleura

- Pleuritis
- Pleural Effusion
- Empyema
- Transudate
- Exudate

Pleuritis

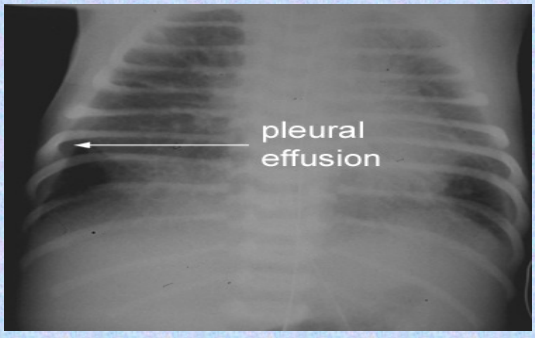


Pathophysiology of Lower Respiratory Infections

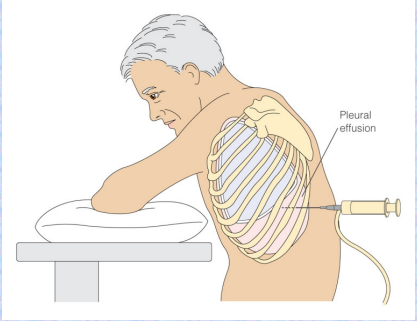
Pleuritis

- Manifestations
  - Pain aggravated by deep breathing, coughing, and movement
  - Rapid shallow respirations
  - Limitation of chest wall movement on affected side
  - Diminished breath sounds
  - Pleural friction rub

Pleural Effusion



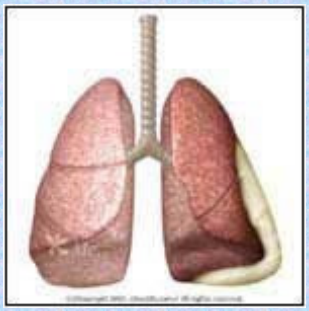
Pathophysiology of Lower Respiratory Infections



Thoracentesis

- Procedure care
  - Monitoring pulse, color, oxygen saturation
  - Applying a dressing
  - Positioning the client on the unaffected side
  - Sending specimens to the laboratory
- Post-procedure care
  - Monitoring vital signs
  - Oxygen saturations
  - Respiratory status
  - http://www.youtube.com/watch?v=7rwLdRluOW8

Empyema Thoracis



Pathophysiology of Lower Respiratory Infections

Spontaneous Pneumothorax

- Manifestations
  - Pain
  - Shortness of breath
  - Increase heart rate
  - Increased respiratory rate
  - Asymmetrical chest wall movement
  - Diminished or absent breath sounds

What is a Pneumothorax?

- Symptoms of a Pneumothorax:
  - Sudden SOB
  - Decreased breath sounds on affected side
  - Decreased chest expansion on affected side
  - Tracheal deviation to unaffected side
  - Chest pain

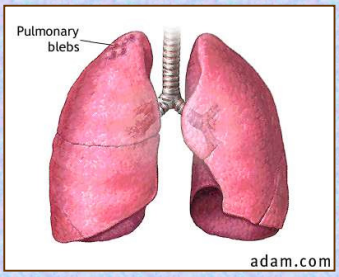
Spontaneous Pneumothorax

- Unknown etiology
- Population
  - Previously healthy people
  - Usually tall, slender men
- Risk factors primary pneumothorax
  - Smoking
  - Familial factors

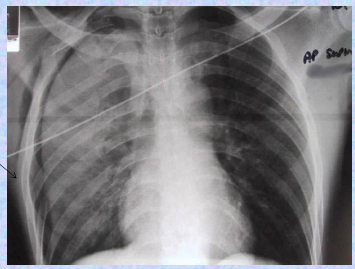
Spontaneous Pneumothorax

- Risk factors primary pneumothorax (cont.)
  - High altitude flying
  - Rapid decompression
- Risk factors secondary pneumothorax
  - Over distention and rupture of an alveolus
    - COPD
    - Asthma
    - Cystic fibrosis
    - Pulmonary fibrosis
    - TB
    - ARDs

Most common cause of Spontaneous Pneumothorax



Chest Trauma

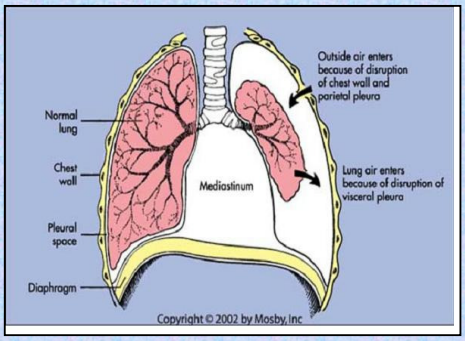


Pathophysiology of Lower Respiratory Infections

Traumatic Pneumothorax

- Manifestations
  - Similar to those of spontaneous pneumothorax
  - May be overlooked if subtle
  - May be masked by the primary injury

Open vs Closed



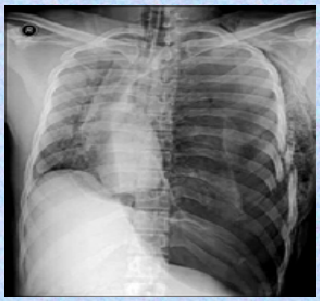
Pathophysiology of Lower Respiratory Infections

Tension Pneumothorax

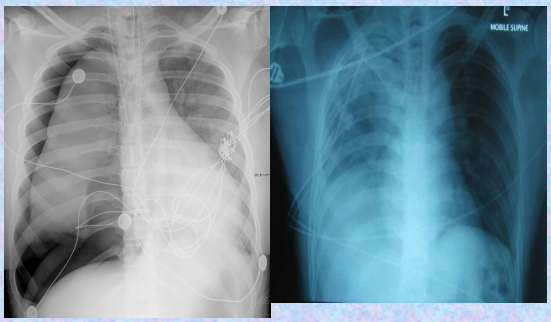
- Manifestations
  - Like pneumothorax
  - Presence of hypotension
  - Distention of the neck veins
  - Displacement of trachea to unaffected side
  - Shock

Tension Pneumothorax

- L tension PTX
- Many rib fractures
- Look at Heart
- Look at Trachea
- Look at aorta



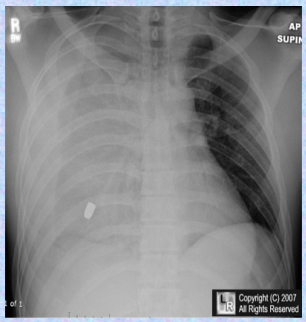
Pneumothorax Hemothorax



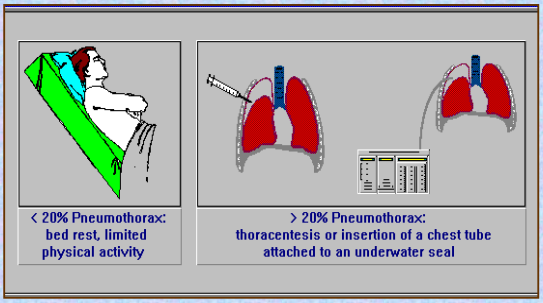
Pathophysiology of Lower Respiratory Infections

Hemothorax

- Manifestations
  - Similar to pneumothorax or pleural effusion
  - Risk of shock exists

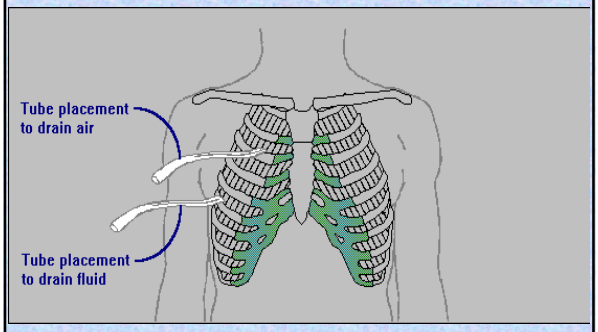


When is a Pneumothorax treated?

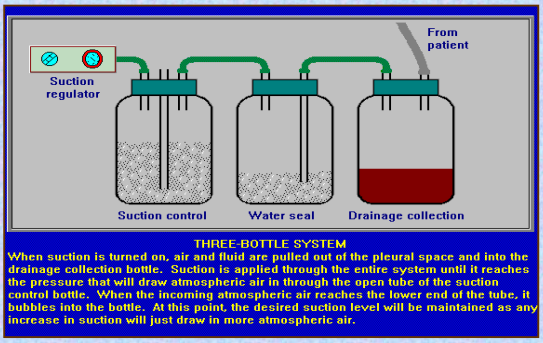


Chest Tubes

- Pre-procedure care
  - Verification of signed informed consent
  - Providing information about the procedure
  - Positioning the client
  - Assisting with the procedure as necessary
- Post-procedure care
  - Assessment of respiratory status
  - Maintaining the closed chest tube drainage apparatus
  - Assisting with position changes
  - Sterile occlusive petroleum jelly dressing post chest-tube removal
  - http://www.youtube.com/watch?v=B0wGmWn8Ubs&feature=related



3 Bottle system



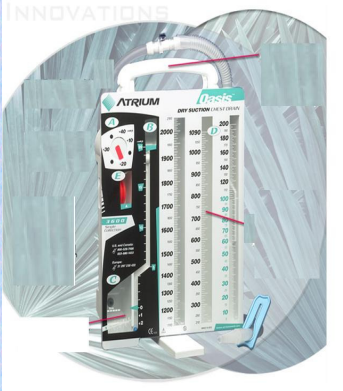
Set Up

Step 1. Fill Water Seal to 2cm Line
Hold funnel down and fill to top. Raise funnel to fill water seal to 2cm fill line.

Step 2. Fill Suction Control Chamber to Desired Pressure Level
Remove vent plug, pour water to desired suction level. Replace vent plug.

Step 3. Connect Patient Tube to Patient
Connect chest drain to patient prior to initiating suction.

Step 4. Connect Suction to Chest Drain
Attach suction line to suction port on top of chest drain. Turn suction source on until constant, gentle bubbling occurs in chamber A.



Set up

Step 1 **Fill water seal to 2cm line.**

Step 2 **Connect patient tube to patient -** Connect chest drain to patient prior to initiating suction

Step 3. **Connect suction to chest drain –** Attach suction line to suction port on top of chest drain

Step 4. **Connect suction to chest drain –** Increase suction source to 80mm Hg or higher. The suction regulator is preset to -20cm H_20. Adjust as required

Step 5. **Turn on suction source**

Pathophysiology of Lower Respiratory Infections

Rib Fracture

- Manifestations
  - Pain on inspiration
  - Coughing
  - Diminished breath sounds with rapid and shallow respirations
  - Bruising over the fracture
  - Crepitus

Pathophysiology of Lower Respiratory Infections

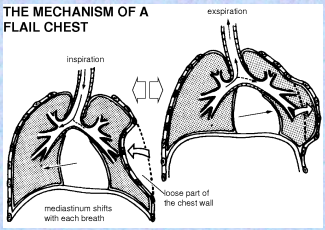
Flail Chest

- Manifestations
  - Dyspnea
  - Pain
  - Paradoxic chest wall movement
  - Diminished breath sounds
- Palpable crepitus

Pathophysiology of Lower Respiratory Infections

Pulmonary Contusion

- Manifestations (may not occur until 12-24 hours after injury)
  - Shortness of breath
  - Restlessness
  - Apprehension
  - Chest pain
  - Copious sputum
  - Tachycardia
  - Tachypnea
  - Dyspnea
  - Cyanosis



Neoplasms

- Lung cancer is the leading cause of cancer related deaths world wide.
- There are more deaths form Lung cancer than breast, colon and prostate cancer combined in the US
- Population
- Over all survival rate is 14%

Major Types of Lung Cancer

- Small cell lung cancer
- Non-small cell lung cancer
- Squamous cell carcinoma
- Adeno-carcinoma
- Large cell carcinoma

» LeMone chapter 38 page1309

Manifestations

- Dependent on location and spread of disease
  - Presentation may be related to primary or metastatic disease

Pathophysiology of Lower Respiratory Infections

Lung Cancer

- Manifestations
  - Chronic cough
  - Hemoptysis
  - Wheezing, shortness of breath
  - Dull, aching chest pain or pleuritic pain
  - Hoarseness and/or dysphagia
  - Weight loss, anorexia
  - Fatigue, weakness
  - Bone pain
  - Clubbing of the fingers and toes
  - Endocrine, neuromuscular, cardiovascular, hematologic symptoms

Tumor Classification

- TNM

Classification and Range	Definition
T (T0 - T4)	T describes the size of the primary tumor ranging from the smallest, T0, through the largest, T4, which indicates the extent to which the cancer has spread to another organ or organs.
N (N0 - N3)	N describes the extent to which any cancer cells have reached any lymph nodes. The code ranges from no regional lymph nodes metastasis, N0, through the highest, N3.
M (M0 - M1)	M indicates whether or not any metastases were found. The range is from M0, which means the cancer has not spread to other parts of the body, through M1, which means the cancer has spread.

Lung Cancer Staging

	PRIMARY TUMOR (T STAGE)	REGIONAL LYMPH NODES (N)	DISTANT METASTASIS (M)
	T_0—No evidence of primary tumor		
Stage 0	T_c—Malignant cells in bronchopulmonary secretions, but no tumor visualized		M_X—Presence of distant metastasis cannot be assessed
Stage I	T_1S—Carcinoma in situ	N_0—No regional lymph node metastasis	M_0—No distant metastasis
	T_1—Tumor that is 3 cm in diameter or less, with no evidence of invasion		
Stage II	T_2—Tumor that is greater than 3 cm in diameter, or invades visceral pleura, or has associated atelectasis or pneumonitis	N_1—Metastasis or direct extension to peribronchial or ipsilateral hilar nodes	
Stage III	T_3—Tumor with direct extension into an adjacent structure, or any tumor with associated pleural effusion or atelectasis or pneumonitis of entire lung	N_2—Metastasis to ipsilateral mediastinal or subcarinal nodes	
Stage IV	T_4—Tumor that invades mediastinum or involves the heart, great vessels, trachea, esophagus, vertebral body, or carina; presence of malignant pleural effusion	N_3—Metastasis to contralateral mediastinal, scalene, or supraclavicular nodes	M_1—Distant metastasis present

Lung Cancer

- Combination chemotherapy treatment of choice for small-cell lung cancer

Collaborative Management

- Diagnostic Phase
  - Radiology
  - Laboratory
  - Cardiopulmonary Services
- Treatment Phase
  - Pharmacy
  - Surgery
  - Radiation Therapy
  - Nutritional services

Lung Surgery

- Pre-procedure care
  - Routine preoperative care
  - Taking a history
  - Providing emotional support
  - Instructing about postoperative procedures
  - Establishing a means of communication if necessary for post-op care

Lung Surgery

- Post-procedure care
  - Provision of routine postoperative care
  - Assessing for pain control
  - Frequent assessment of respiratory status
  - Assist with effective coughing technique
  - Monitoring and maintaining effective mechanical ventilation
  - Maintaining patent chest tubes and drainage system
  - Assessing for development of infection
  - Assisting with early ambulation
  - Maintaining nutritional status

Nurse at work

A 72 year old man presents to his physician stating he has been coughing up blood. The chest x-ray shows an area of density in the middle lobe of his right lung. He is admitted to the hospital for diagnostic tests. The initial assessment done by you includes the following data: BP: 168/88, P: 90, R:36, T: 98.4 Pulse OX 87% on room air
He believes himself to be "pretty healthy". He reports smoking about a pack of cigarettes per day since he was 16. There have been numerous unsuccessful attempts to stop smoking always with return to the smoking with six months.

Physical assessment: Inspiratory and expiratory wheezes in the right chest, but good breath sounds throughout. No other abnormalities noted

Case continuation

- Test results from admission work up
  - CBC shows mild anemia all other routine labs normal
  - Sputum cytology is positive for small cell bronchogenic cancer
  - CT shows a 6 cm mass with mediastinal and subclavicular node involvement
  - A second mass is noted on the lumbar spine
- The client as decided to undergo chemotherapy and is referred to an oncologist

Nursing Diagnosis

- Remember ABC's
- What must we have to heal?
- Who will be affected by this diagnosis?
- What does the client understand?

Expected Outcomes

- Maintain a patent airway
- Maintain current weight
- Express concerns and feelings about cancer and the effects on the family unit
- Participation in care
- Utilization of support groups
- Verbalize understanding of the disease process, treatment and prognosis
- Develop a plan to stop smoking

Planning and implementation

- Teach coughing and deep breathing to facilitate airway clearance
- Discuss reportable symptoms
- Discuss measures to relieve side effects of chemotherapy
- Dietary consult
- Discussion with family to discuss disease
- American Cancer Society referral
- Local Cancer support group
- Home health – further teaching
- Assist in a stop smoking plan
  - Nicotine patches/gum

ABG Interpretation

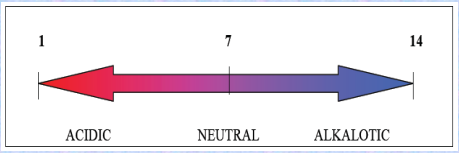
You will understand this better by completing the ABG module

Arterial Blood Gas

For monitoring treatment, adjusting oxygen settings and evaluating client response

- **Partial pressure of oxygen (PaO2).**
- **Partial pressure of carbon dioxide (PaCO2).**
- **pH.**
- **Bicarbonate (HCO3).**
- **Oxygen saturation (O2Sat)**

For starters



Components of the Arterial Blood Gas

- The arterial blood gas provides the following values:
- **pH** - Measurement of acidity or alkalinity, based on the hydrogen (H+) ions present.
  - The normal range is 7.35 to 7.45
    - Remember:
    - pH greater than 7.45 = alkalosis
    - pH less than 7.35 = acidosis
- **PO2 or PaO2** - The partial pressure of oxygen that is dissolved in arterial blood.
  - The normal range is 80 to 100 mm Hg.
- **SaO2** - The arterial oxygen saturation.
  - The normal range is 95% to 100%.

Components of the Arterial Blood Gas

- **pCO2 or paCO2** - The amount of carbon dioxide dissolved in arterial blood.
  - The normal range is 35 to 45 mm Hg.
  - Remember:
    - PCO2 greater than 45 = acidosis
    - pCO2 less than 35 = alkalosis
- **HCO3** - The calculated value of the amount of bicarbonate in the bloodstream.
  - The normal range is 22 to 26 mEq/liter
  - Remember:
    - HCO3 greater than 26 = alkalosis
    - HCO3 less than 22 = acidosis

Steps to an Arterial Blood Gas Interpretation

- The arterial blood gas is used to evaluate both acid-base balance and oxygenation, each representing separate conditions. Acid-base evaluation requires a focus on three of the reported components: pH, PaCO2 and HCO3. This process involves two basic steps.
- **Step One**
- Identify whether the pH, pCO2 and HCO3 are abnormal. For each component, label it as "normal", "acid" or "alkaline".
  - pH 7.30 (7.35-7.45) ACID
  - pCO2 55 (35-45) ACID
  - HCO3 26 (22-26) NORMAL
- The two matching values determine **what the problem is. In this case, an ACIDOSIS.**

Steps to an Arterial Blood Gas Interpretation

- **Step Two**
- If the ABG results are abnormal, determine if the abnormality is due to the kidneys (metabolic) or the lungs (respiratory).
- pH 7.30 (7.35-7.45) ACID
- pCO2 55 (35-45) ACID = Lungs
- HCO3 26 (22-26) NORMAL = Kidneys
- Match the two **abnormalities: Respiratory (lung problem) + Acidosis = *Respiratory Acidosis.***

Example

- James Sim is a 55 year-old male admitted to your nursing unit with recurring bowel obstruction. He has been experiencing intractable vomiting for the last several hours despite the use of anti-emetics. His arterial blood gas result is as follows: pH 7.50, pCO2 42, HCO3 33.
- **Step One**
- Identify whether the pH, pCO2 and HCO3 are abnormal. For each component, label it as "normal", "acid" or "alkaline".
  - pH 7.50 –
  - pCo2 42 –
  - HCO3 33 -
- The two matching values determine **what the problem is. In this case, …**

- **Step Two**
- If the ABG results are abnormal, determine if the abnormality is due to the kidneys (metabolic) or the lungs (respiratory).
  - pH 7.50 (7.35-7.45)
  - PaCO2 42 (35-45)
  - HCO3 33 (22-26)
- Match the two do we have metabolic or respiratory**?**
- **CLINICAL APPLICATION:**
- Treatment of this patient might include the administration of I.V. fluids and measures to reduce the excess base.

Compensated / Uncompensated

- What happens when an acid-base imbalance exists over a period of time?
- A patient can be uncompensated, partially compensated, or fully compensated.
- When an acid-base disorder is either uncompensated or partially compensated, the pH remains outside the normal range.

Example

- John Doe is a 21 year-old male admitted to your nursing unit with head injury. His blood gas results are as follows: pH 7.38, pCO2 56, HCO3 35.

Step One

- Identify whether the pH, pCO2 and HCO3 are abnormal. For each component, label it as "normal", "acid" or "alkaline".
  - pH 7.38 – Normal
  - pC02 56 – Acid
  - HCO3 35 – Alkaline
- Notice now, for the first time, that **both the pCO2 and the HCO3 are abnormal. This indicates that there is some degree of compensation taking place. This will require a slightly different approach to the blood gas analysis.**

Step Two

- If both the pCO2 and the HCO3 are abnormal, but the pH is in the normal range, look at the pH again. Instead of using a "normal range" of 7.35-7.45 as we have been doing, we are going to use the single value of 7.4 as our only "normal". Any pH of less than 7.40 is now going to be considered acidosis. Any pH greater than 7.40 is now going to be considered alkalosis. Look at our pH in this example. The pH is less than 7.4.
  - pH 7.38 – Acid
  - pC02 56 – Acid
  - HCO3 35 – Alkaline
- The two ***matching values determine what the problem is. In this case, an ACIDOSIS***

- **Key Concept:**
  - We only use a single value of 7.40 as "normal" when *both the pCO2 and HCO3 are abnormal (indicating that some degree of compensation exits) and the initial pH is normal*

Step Three

- Now, for the two *matching values, determine if the abnormality is due to the kidneys (metabolic) or the lungs (respiratory).*
  - Match the two **abnormalities: Respiratory (lungs) + Acidosis = *Respiratory Acidosis***
- Finally, we need to determine if the condition is *partially or completely compensated.*

- Sometimes, the system that is compensating (respiratory or metabolic) may either have not had sufficient time to correct the situation, or is unable to completely compensate for the degree of abnormality present.
- If the pH is between 7.35-7.45, the condition is *fully compensated.*
- If the pH is outside the range of 7.35-7.45, the condition is only *partially compensated.*
- Remember, neither buffer system has the ability to overcompensate!
- In the prior example, because the pH is 7.38 (within the range of 7.35-7.45), the condition is fully compensated. Our final arterial blood gas analysis indicates that we have a

Compensated Respiratory Acidosis

Best Practice

- Suctioning should only be done when a thorough assessment of the patient establishes the need for such a procedure. Individualized assessment prior to, and close observation during and following the procedure is recommended. Patients should be encouraged to cough up secretions themselves if they are able to do so. (Level IV)
- Because of the potential associated hazards, nurses require procedural skill and gentleness when suctioning. (Level IV)
- Nurses should not instill 0.9% sodium chloride prior to suctioning adults with an artificial airway. Ensuring patients are adequately hydrated is one way nurses can facilitate the removal of respiratory secretions. (Level III.1)Aseptic technique should be used while suctioning adult hospitalized patients with an artificial airway. (Level IV)

- The size of the suction catheter should occlude no more than half of the internal diameter of the artificial airway to avoid greater negative pressures in the airway and to potentially minimize falls in PaO2. (Level IV)
- Expert opinion suggests suction duration times of less than 10-15 seconds. (Level IV)
- Some form of hyper-oxygenation prior to suctioning can minimize the potential of post suctioning hypoxemia in adult hospitalized patients. (Level III.1) Combining hyper-oxygenation and hyperinflation can potentially minimize suctioning induced hypoxemia. (Level III.1)
- Using tidal volumes that are indexed to the size of the patient may assist in minimizing potential difficulties. (Level III.1)

- When hyper-oxygenating, allow time for the increased oxygen percentage to come through the ventilator tubing and reach the patient. (Level IV)
- A ventilator should be used rather than a manual resuscitation bag to provide hyperventilation/hyper-oxygenation prior to suctioning to reduce homodynamic alterations. (Level III.2)
- Use a maximum of two suction passes. Level III.1)
- Thorough individual patient assessment is required when planning suctioning interventions. Hyperinflation may have clinical implications for patients who have raised ICP, are post operative following vascular/cardiac surgery, or for those who are hemodynamically unstable. (Level II)