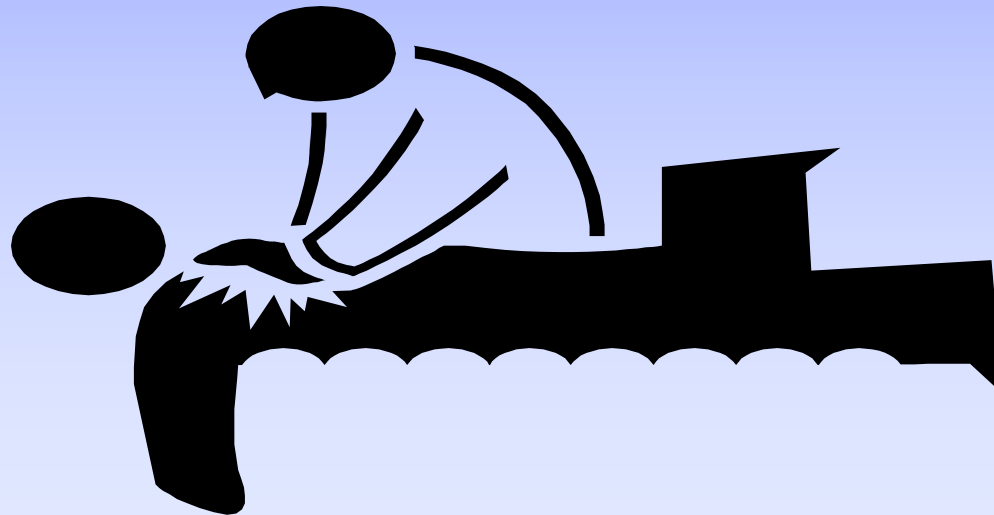
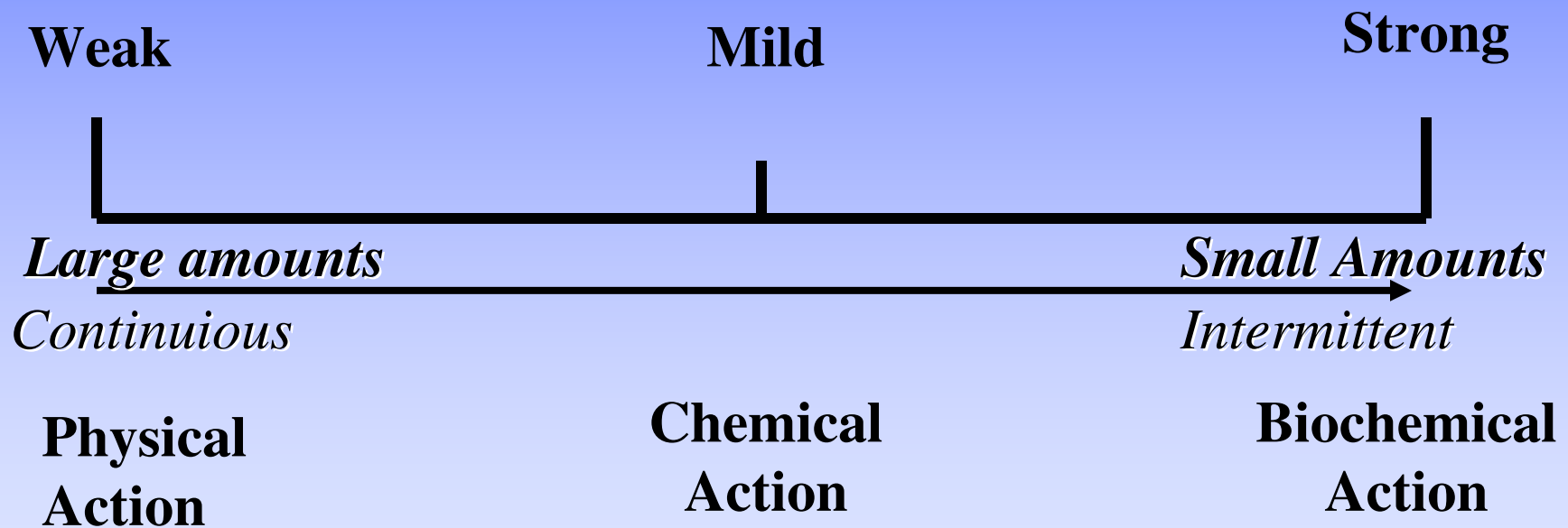


# Humidity & Aerosol Therapy: Bronchial Hygiene



# Spectrum of Aerosol/Humidity

## Rx: The Big Picture!



# BRONCHIAL HYGIENE:

- Are we providing adequate bronchial humidification, fluid, etc.
- Are we bypassing the normal humidification of incoming air?
- No=less humidity need
- Yes=body humidity needed

# BRONCHIAL HYGIENE:

- Are we providing adequate bronchial humidification, fluid, etc.
- IS PATIENT ABLE TO MANAGE SECRETIONS EFFECTIVELY:
  - WHAT COLOR ARE THEY?
  - CONSISTENCY
  - VOLUME
  - NATURE OF COUGH
    - DRY? , PRODUCTIVE? , WEAK, ETC.
    - VITAL CAPACITY OR INSPIRATORY CAP.
  - INFECTION PRESENT OR LIKELY.
  - LAB ANALYSIS OF SPUTUM?

# Humidity

- Can you see humidity?
- What determines how much water vapor a liter of gas can hold (its capacity)?
- What is the difference between humidity and aerosol?
- Which can deliver the most water?

# Humidity Therapy

- Primary goal
- To provide adequate humidification and heat the inspired gas to approximate normal inspiratory conditions at the point of entry into the airway.
- Insures normal operation of the mucociliary transport system

# Humidity

- **Primary indications for humidifying inspired gas**
- **Administration of medical gases**
- **Delivery of gas to the bypassed upper airway**
- **Thick secretions in nonintubated patients**

# Humidity

- **Additional indications for warming inspired gases**
- **Hypothermia**
- **Reactive airway response to cold inspired gas**

# Humidity

- **Primary indications for aerosol administration**
- **Delivery of medication to the airway**
- **Bronchial Hygiene**
- **Humidify inspired gases**

# Humidity

- **Upper airway inflammation**
- **Croup**
- **Epiglottitis**
- **Post extubation swelling**
  
- **Cool mist promotes localized vasoconstriction, reduces swelling, and relieves discomfort**

# Humidity

- **Hypothermia**
- **Warmed, humidified gases used to warm the patient as well as the inspired gases being delivered to the patient**

# Humidity

- **Airway hyperreactivity to cold inspired gases (especially Dry)**
  - **Cold weather masks**
    - **Asthma, copd, etc.**
- **Bronchospasm**
- **Increased airway resistance**

# Humidity

- **Treatment of thick secretions**
- **Systemic hydration the best**
- **It has not been proven that external humidification improving the character and mobilization of thick secretions**

# Humidity

- **Indications for humidification**
- **To prevent dry gas from drying mucosa**
- **To provide near body humidity when upper airway function is impaired.**
- **Impairs functions of the upper airway**
- **Tracheotomy**
- **Intubation**

# Humidity

- **When a patient has an increased temperature, he needs to be hydrated.**
- **Humidity is temperature dependent!!!!**

# Humidity

- **Humidity:**
  - water in a vapor state of matter
  - Or molecular water in air
- **Absolute Humidity**
- **Relative Humidity**

# Humidity

- **Absolute Humidity**
- **Actual amount of H<sub>2</sub>O vapor in the gas at that time. mg/L**
  
- **Relative Humidity**
- **Is the content of water vapor expressed as a percentage of the maximum capacity of vapor that can be held at the same temperature.**

# Humidity

- **Relative Humidity**
- **Calculated by dividing the amount of water in the air (content) by the capacity (amount of water vapor that a gas can hold at a given temperature) of the air to hold water when totally saturated at a given temperature.**
- **$RH = \text{Content} / \text{Capacity} \times 100$**
- **$RH = \text{Absolute} / \text{Potential} \times 100$**

# Humidity

- **At body temperature 37 C air has a maximum absolute humidity of approximately 44mg/L**
- **Alveolar air is 100% humidified at 37 C and contains 44 mg of water vapor per liter of gas.**
- **Ambient air inspired through the nose is warmed to 34C and is 80-90% humidified in the oropharynx.**

# Factors that affect Relative Humidity

- **Surface area exposure**
  - the larger the area for gas/H<sub>2</sub>O interface, the higher the relative humidity
- **Time**
  - the longer the time to interface, the higher the relative humidity
- **Temperature**
  - the higher the temperature, the higher the Water vapor capacity(directly effects), therefore RH will decrease(indirectly effects).

# Humidity

- **Humidity Deficit**
- **The difference between water vapor content in alveolar air and inspired air.**
- **O<sub>2</sub> out of a cylinder has no humidity**
- **RH = 100% 37 C ABSOLUTE=44mg/L**

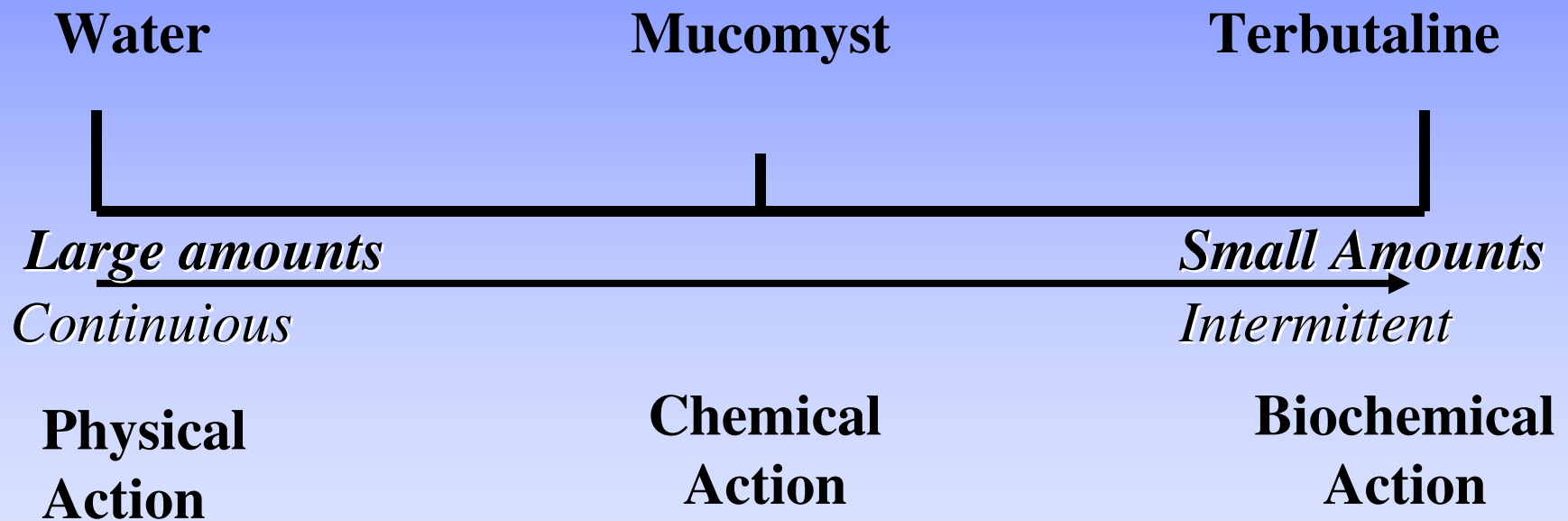
# Humidity

- **Results of inadequate humidification**
- **Decreased cilia activity**
- **Decreased movement of mucosa**
- **Inflammation and necrosis (drying) of pulmonary epithelium**
- **Retention of secretions**
- **Bacterial culture media**
- **Atelactasis**
- **Pneumonia**

# AEROSOL THERAPY

- USED TO DELIVER MEDICATION TOPICALLY.
- FAST, ECONOMICAL.
- DECREASED SYSTEMIC SIDE EFFECTS.
- PATIENT MUST BE ABLE TO DO
  - VOLUME
  - COOPERATION

# Spectrum of Aerosol/Humidity Rx



# AEROSOL THERAPY

- MDI vs SVN ARE TYPICAL METHODS OF ADMINISTRATION.
- PROPER TECHNIQUE AND OR ADAPTERS TO INCREASE EFFECTIVENESS.
- IF PATIENT CAN'T DEEP BREATH THEN ASSISTED DEEP BREATHING IS INDICATED TO DELIVER AEROSOL.

# Aerosol

- **Water particles suspended in air.**
- **Much larger than air**
- **Good examples include fog and mist**
- **Each participle is made up of H<sub>2</sub>O molecules**
- **Gas exerts a force to hold a particle in air**
- **(Particle smaller and gas stronger than H<sub>2</sub>O)**

# Aerosol

- **Rain-droplets get bigger and gas can not hold it any longer, so it drops or burns into vapor as humidity**
- **Aerosol therapy with distilled water and hypertonic saline can used to promote cough**
- **Aerosol particles are large enough to carry bacteria (germs) but not in humidity.**

# Aerosol

- **Stability-how long a gas hold on to a particle**
- **The longer the better.**
- **Factors**
- **Increased concentration of H<sub>2</sub>O particles in gas makes it less stable.**
- **Increased particles(density), increases the chance of rain out or humidity.**

# Aerosol

- **Factors**
- **Size of particles ideal=.5-15 (3-5)microns**
- **Relative humidity- particles evaporate and turns into humidity**
- **Humid days- decreased temperature-rain**
- **When RH increases it rains**
- **Small particles- humidity or evaporates**
- **Large particles-rain out**

# Aerosol

- **Penetration**
- **How deep something goes**
- **Depth of bronchiole tree that a particle reaches**
- **Deposition**
- **Where does this particle rain out?**
- **Particles rain out at particle areas of the tracheobronchial tree**

# Aerosol

- **Factors that impact penetration and deposition**
- **Gravity**
- **The larger the particle, the more likely to rain out**
- **Kinetic movement**
- **The more the particles move, the more likely to rain out do to collision**

# Aerosol

- **Factors continued**
- **Inertial Impaction**
- **As airways get more narrow and change direction, the particles continue to bump into airway walls causing them to break up and rain out-keep going straight...**

# Aerosol

- **Factors continued**
- **Ventilatory pattern**
- **Deep, slow breathing with an inspiratory hold**
- **Deep breath - 300 lpm**
- **Slow breath - 2X the  $V_t$**
- **Hold up to 15 sec**

# Aerosol

- **Physiologic**
- **Ways of clearing out the lungs:**
- **Mobilization of the mucosal blanket**
  - 2cm per min
- **Cough**
- **Lymphatic uptake**
- **Phagocytes**
  - eating cells of bacteria and foreign bodies
- **Mechanical suctioning**

# Aerosol

- **Indications of an aerosol treatment**
  - **To thin secretions**
  - **To improve cough**
  - **To deliver medication**
  - **Artificial airway support**

# Aerosol

- **Hazards of aerosols**
- **Swelling of secretions**
  - **obstruction**
  - **can be fatal**
  - **happens to somebody with a weak cough**
- **Infection-aerosols infect easily!**

# Aerosol

- **Hazards:**
- **Bronchospasm**
  - reactive airways
  - asthma
- **Fluid over-load**
  - neonates
  - high output systems

# Equipment

- **Types of Humidifiers**
  - **Not heated**
  - **Passover**
  - **Bubble**
  - **Jet (Bernoulli's principle)**

# Equipment

- **Types of Humidifiers**
- **Usually used for ventilator patients**
- **Cascade**
- **Wick-type**
- **HME**

# Equipment

- **Nebulizers**
- **Jet**
- **Babington**
- **USN**
- **Spinning Disk**

# Equipment

- **Jet (HHN or small volume)**
- **Uses Bernoulli's principle**
- **50% particles are 1-5 microns**
- **Medication climbs up baffle where it is hit by air breaking up medications into particles (mist).**
- **Backdrop of pressure causes medications to climb**
- **Pneumatically powered (compressed air)**
- **Allows high flow systems to produce accurate FIO<sub>2</sub>'s**
- **Can be heated**

# Equipment

- **Jet**
- **4 types**
- **large reservoir**
- **standard jet**
- **mainstream**
- **side stream**

# Equipment

- **Large reservoir**
  - **1. 250 ml fluid or more**
  - **2. For long time(continuous) nebulization**
  - **3. 50-75% RH**
- **Standard**
  - **1. Used with IPPB, small nebulizers for delivery of medications**

# Equipment

- **Mainstream**
  - **1. 2 sources of gas**
  - **2. Venturi is in mainstream of gas flow (nebulization)**
  - **3. Gas evacuates chamber with main gas flow**
- **Sidestream**
  - **1. Venturi is below the main gas flow system**
  - **2. Not as efficient as mainstream, to deliver H<sub>2</sub>O**
  - **3. Nebulization happens below or other than in mainstream gas flow**
- **Better for particle shrinkage, small particles, potent meds.**

# Equipment

- **Babington or Hydro-Sphere**
- **1. Based on Bernoulli's principle**
- **2. Gives high-volume nebulization(density mg/liter)**
- **3. Particle size 3-5 microns**

# Equipment

- **USN**
- **1. Converts electrical energy into mechanical energy**
- **2. Uses Piezoelectric disk**
  
- **Determined by frequency**
  - **How many times vibrations happen**
- **Amplitude**
  - **the depth or height of the vibrations**

# Equipment

- **Other parts**
  - **couplant chamber**
    - **generates vibration (turning electrical energy into mechanical energy)**
  - **nebulizer chamber**
    - **breaks up fluid into particles**
  - **blower**
    - **blows air into chamber (baffles) breaking particles into a mist**

# Equipment

- **3. High volume-6cc/min pr 360cc /Hr**
- **4. Delivers 100% RH**
- **5. 90% of particles are 0.5 - 3.0 microns**
- **6. Frequency is preset 1-2 megacycles/sec,**
  - usually set at 1.36 MHz
- **7. Amplitude is set by therapist**
- **8. Can be used inline**
- **9. Can cause fluid overload**
- **10. Very effective**

# Equipment

- **Spinning Disk**
- **Uses a rotating plate causing molecules to break**
- **Delivers 25-75% RH**
- **Not very effective**
- **Most common hazard is swelling secretions**

# CPT

- **Two types**
  - **I. Postural drainage**
  - **II. Percussion**
- 
- **I. Postural drainage**
  - **A. Positioning each segmental bronchi in a vertical position allowing gravity to drain that segment**

# CPT

- **Indications**
- **1. Mobilize accumulated secretions**
  - due to COPD
  - dehydration
  - acute pulmonary disease
- **2. Prophylactic**
  - history of pulmonary disease

# CPT

- **Positions**
- **RUL**
- **1. Apical**
- **A. semi fowler at 45 degrees**
  
- **2. Anterior**
- **A. Head of bed flat with pt in supine position**

# CPT

- **3. Posterior**
- **A. Head of bed flat with patient in prone with 1/4 turn to put right side up.**
- **RML**
- **1. Medial**
- **A. Head of bed down 12-15 inches with right side up 1/4 turn from supine**
- **2. Lateral**
- **A. Patient on left side with right side up**

# CPT

- **RLL**
- **1. Superior**
- **A. Head of bed flat with patient in prone with pillows under abdomen**
- **2. Anterior**
- **A. Head of bed down 18-20 inches with patient in supine with pillows under their knees**
- **LUL**
- **1. Apical**
- **A. Semi-fowler at 45 degree**

# CPT

- **Contraindications**
- **Empyema-coughing up blood(hemotysis)**
  - **indicator of TB, CA or Bronchietasis**
- **Flail chest-any chest cavity that cannot hold it's shape**
- **Wounds**
  - **may not be able to position with an open wound**
- **Spinal injury**
  - **risk of nerve damage**

# CPT

- **Pneumothorax**
  - cannot drain air out of chest
- **Head injury**
  - head down position causes intracranial pressure
- **Unstable cardiac status**
  - if patient's BP decreases, you may want the pt in flat position to allow proper distribution of blood.

# CPT

- **COPD**
  - Patient may or may not tolerate head in the down position
- **Obesity**
  - extra fat causes extra pressure on chest cavity
- **Pregnancy**
  - size of baby will not allow patient to tolerate head down position
- **Recent meals or tube feedings**
  - patient may vomit due to gravity on a full stomach

# CPT

- **II. Percussion**
- **Clapping chest wall with cupped hands and relaxed wrist**
- **Indications:**
- **Difficult to immobilize secretions**
- **When postural drainage alone is not effective**

# CPT

- **Contraindications for Percussion**
- **Empyema**
- **Frail chest**
- **Wounds**
- **Frank hemoptysis (acute)**
  - coughing up fresh blood
  - airways are bleeding
- **Anticoagulant therapy**

# CPT

- **Pain or patient intolerance**
- **TB**
- **Metastatic CA**
  - **cancer has spread t/o body**
  - **may loosen CA cells and release to other lung lobes**

# CPT

- **Technique**
- **1. Avoid sternum, spine and bony structures**
- **2. Use sheet or towel to avoid slapping the patient(cup hand, shouldn't sting when done right).**
- **3. Examine skin for any effect-each segment for 3-5 minutes**

# Vibration

- **Can be used alone or with percussion**
- **With vibration hold hand and wrist stiff**
  
- **Indications**
- **1. to move secretions in large airways**
- **2. when percussion is not tolerated**

# Vibration

- **General Caution**
- **1. Use only to lung area**
- **2. Avoid breast tissue in women, bony structures**
- **3. With electrical devices**
  - **Observe electrical and gas precautions**
- **3. Use common sense**
  - **Don't vibrate over an incision**
  - **If patient is in pain, stop and consult with MD**