**Equipment and Devices**

- Provide review of oxygen and aerosol equipment
- Discuss Inomax® delivery system
- Review non-invasive blood gas analysis equipment and technique
- Discuss equipment quality control and disinfection measures

**Oxygen Delivery Device**

**Low Flow System**

- Partially support the patient’s total flow demand and volume
- For stable infants (normal RR, pattern and constant VT)
- Nasal Cannula flow range
- Delivers FiO₂ 0.24 to 0.40
- Newborn 0.025 – 2 L/min
- Pediatric 1- 6 L/min
- FiO₂ increase by 4% for every 1 L/min increase in flow
- Special low flow meter used for flow less that 0.5L/min
- The flow is titrated first prior to the FiO₂
- Humidification should be provided to minimize drying of upper airway mucus
Factors Affecting Oxygen Delivery

Factors Affecting the amount of oxygen delivered via nasal cannula
- Flow rate
- FiO₂ setting on the blender
- Tidal volume, respiratory rate, inspiratory time
- Patient inspiratory flow pattern
- Open-mouth or closed mouth
- Anatomy of the nasal and nasopharyngeal airway

Oxygen Delivery Device
High Flow System
- Meets the patient's total inspiratory flow demand and volume
- Flow range 6-15 L/min
- Correct mask fit and the addition of a reservoir determine the amount of oxygen delivered to the patient
- Mostly used on pediatric patients
- High Flow Therapy via Nasal Cannula used in the neonate/pediatric population

High Flow System
Non-rebreather Mask
- Commonly used to deliver up to 90% O₂ during emergency situation
- Its also used to administer mixed gas (He/O₂, CO₂ / O₂)
- Do not administer Nitric oxide via NRB mask
- If bag collapses more than half during inspiration increase the flow rate
**Non-rebreather Mask**

Problem: If the reservoir bag does remain inflated during inspiration then:

Reason: There is a bag or mask leak
Corrective action: Tighten the mask

Reason: The one-way valve on the reservoir bag is stuck,
Corrective action: Replace the non re-breather mask

Reason: The flow rate is too high (>15 L/min)
Corrective action: Decrease the flow rate

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**Venturi Mask**

- Able to deliver specific or precise concentration of FiO\(_2\)
- Increasing or decreasing the flow rate **does not** change the set FiO\(_2\)
- **But increasing or decreasing FiO\(_2\) can change the total flow delivered to the patient**
- Any change made to the FiO\(_2\) will change the size of the orifice on the jet adapter and the entrainment port
- Mask should be made of clear material
- Humidification can be provided with a nebulizer

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**Oxyhood/Tot huts/Oxygen Hood**

- Is made of clear plastic square or cylindrical in structure
- It encompass the infants head
- Flow rate of 10-15L/min is recommended in order to maintain higher FiO\(_2\)
- Minimum flow rate of 7 lpm to prevent CO\(_2\) build up in the Oxyhood
- FiO\(_2\) should be monitored close to the infants face due to layering of Oxygen.
- **Heated** humidification should be provided using a nebulizer or humidifier delivery device
Oxyhood/Tot huts/Oxygen Hood

- Maintain normal temperature inside the hood
- If using heated humidification device make sure overheating does not occur. Increased temperature can cause apnea and dehydration.
- If the temperature is too cold the infant’s oxygen consumption will increase due to an increase in the patient’s physical metabolism.

Humidity

The presence of water vapor or water molecule in a gas is considered humidity
- **Body Humidity** - is the 100% saturation of the delivered gas at normal body temperature (37°C)
- So at normal body temperature (37°C) the content of water vapor is 44mg/L of gas at a water vapor pressure of 47mmHg
- Humidification should be added while administering any therapeutic dry gas
  - Prevent insensible water loss
  - Prevent the formation of thick secretions
  - Increase airway resistance

Types of Humidifiers

**Heat and Moisture Exchanger (HME)**
- It has a absorptive hygroscopic material that recycles the heat and moisture from the patient’s own exhaled air
- Used for short term ventilation
- It should be connected between the circuit wye and the patient’s artificial airway
- The HME should be removed prior to aerosol therapy
Types of Humidifiers

Heat and Moisture Exchanger (HME)

- Addition of HME will create a small amount dead space
- Patients who have thick or copious secretions are not ideal candidate for HME
- HMEs that are clogged due to excessive secretions can cause airway resistance and increase in peak pressures

Types of Humidifiers

Bubble Humidifier

- Non heated form of humidification
- Prior to patient set up check the pressure pop off valve to make sure it is working
- Most pressure pop off valves set at 2 psig or 40mmHg
- If the inlet gets clogged it would prevent the pop off valve from alarming
- Proper humidification depends on the water level in the humidifier
- Bubble humidifiers should be changed every 24 hr

Types of Humidifiers

Wick Humidifier

- Heated humidification system
- It delivers 100% body humidity (44mg/L at 37 degree centigrade)
- The humidification process is efficient because it increases the surface area of the gas water interface
- Decreased cross contamination due to formation of vapor as opposed to the formation of aerosol particles
- Provides low resistance to flow
- Ideal for patients on mechanical ventilation
Aerosol Therapy

Clinical Use:
- Deliver medications
- Mobilize secretions
- Humidify the respiratory tract
- Prevent or relieve bronchospasm and edema

Hazards:
- Bronchospasm
- Overhydration
- Cross-contamination and infection
- Airway obstruction

Aerosol Delivery Device

Jet Nebulizer - Small Volume Nebulizer (SVN)
- They are pneumatically powered
- Convert drug solutions or suspensions into aerosols
- Used mostly to nebulize small doses of medications
- There are also low flow nebulizers available for flow sensitive ventilator
- Pediatric patients < 4 years should use SVN
- The particles size generated fall anywhere between 0.5 – 3.0 micron
- Loose baffle can alter aerosol delivery
- Change every 24 hours to prevent contamination
- Encourage pediatric patients to use mouthpiece as opposed to mask

Large Volume Nebulizers (LVN)
- Used mostly to deliver bland aerosol, humidification or to decrease upper airway swelling
- Can be heated or non heated
- Continuous drug administration
- Most disposable units have a venturi air entrainment system for precise delivery of oxygen
- Any water buildup in the tubing will cause less air entrainment and hence cause the FIO₂ to increase
- Do not empty condensation in the tubing back into the reservoir
- Clogged capillary tube or an improperly assembled unit can cause a decrease in the mist formation
- Low flow rate also affect the density of the mist
Vibrating Mesh Nebulizer

- Uses electricity to vibrate an aperture plate (1,000 funnel shaped holes) at 128 kHz
- The vibrating mesh produces aerosol through the holes by means of a micro pumping action
- It aerosolize > 90% of the drug dosage with very low residual drug volume
- It generates low velocity aerosol plume compared to Jet nebulizer/ pMDI
- No external gas source is required hence no change in ventilator pressure or volume

Ultrasonic nebulizer

- A piezoelectric crystal is used to convert electrical signal into high-frequency vibrations (1.2 MHz)
- These high frequency vibrations travel through the fluid and the medication cup to form ultrasonic wave
- Ultrasonic waves produce aerosol in the range of 1-5 microns
- It generates low velocity aerosol plume compared to Jet nebulizer/ pMDI
- No external gas source is required hence no change in ventilator pressure or volume

Ultrasonic Nebulizer

Important Points
- Electrical device
  - Uses a piezoelectric crystal to generate aerosol
  - Crystal converts radio waves into mechanical energy
  - A standing wave or geyser is produced
- The frequency of the vibrating crystal is set by the manufacturer
  - Frequency determines the size of the aerosol particles
  - Signal amplitude, unlike frequency, can be adjusted to determine the amount of aerosol output
Ultrasonic Nebulizer

Important Points

- Large-volume units have a built-in fan (blower)
- Fan moves aerosol to the patient
- Gas source flow rate affects aerosol output
- Currently used for:
  - Sputum inductions - Produces a lot of aerosol
  - Can cause airway reactivity
  - Room humidifiers
- Hazards:
  - Overhydration
  - Bronchospasm
  - Sudden mobilization of secretions
  - Electrical hazard
  - Water in tubing

Small Particle Aerosol Generator (SPAG)

- The only nebulizer specifically used to deliver the drug Ribavirin (Virazole) for inhalation in the treatment of Respiratory Syncytial Virus (RSV)
- The particle size 1.3 microns
- Pneumatically powered and the pressure is maintained at 26 psig
- Administered for 12-24 hour per day. The regimen may last 3-5 days
- A scavenger evacuation system should be installed in the room to effectively remove any excess particles and also minimize contamination of the ambient environment

Pressurized Metered Dose Inhaler (pMDI)

- A pressurized canister that contains the drug suspended in a mixture of propellants, surfactant, preservatives and dispersal agents
- No more Chlorofluorocarbon (CFC)
- Mostly hydrofluoroalkane (HFA) are used in MDI
- New MDI have built in dose counters
- Can be used in line with a ventilator
- The canister has to be primed prior to each actuation
- Patient coordination is very essential for the correct delivery of the drug
- MDI should be used with a chamber or spacer to increase efficacy of delivery of the drug
- The patient should hold their breath for 4-10 seconds before exhaling (use inspiratory breath hold on a ventilator)
Spacers and Valved Holding Chambers (VHC)

Accessory device that are used mostly with MDIs
• to reduce drug deposition in the oropharyngeal area
• improve drug delivery in the distal region
• minimize drug loss associated with improper hand – breath coordination

Use VHC with mask for infant/pediatric patients
Valved holding chambers have a one way valve that permits the aerosol particles to exit the chamber only during inspiration
Spacers can be used in line with a ventilator circuit
Actuate only one dose at a time into the spacer/chamber

Dry Powder Inhaler (DPI)

• Medication is in a powder form
• They are breath actuated so requires less patient coordination
• DPI require higher inspiratory flow rate compared to MDI (>60 Lpm)
• Do not exhale into the device to avoid clumping or caking of the powder
• They are available as multi dose or single dose devices
• Cannot be used with a ventilator
• Most DPI have steroid medication so instruct the patient to rinse their mouth post treatment

Delivery Systems for Inhaled Nitric Oxide (iNO)

INO max  INOvent  AeroNOx

Three FDA approved devices
### Nitric Oxide

- Colorless, non flammable and almost odorless gas used for therapeutic purpose via inhalation
- Nitric oxide *aka* Endothelium derived relaxing factor (EDRF) is a compound produced by many cell in our body
- Nitric oxide gas is also a component of smog measured in urban air at 10-100 ppb
- Nitric oxide is present in cigarette smoke at 400-1000 ppm
- Nitric Oxide is also found in our airway tract at 100-1000 ppb

### Inhaled Nitric Oxide (iNO) Therapy

#### FDA Indications for Nitric Oxide Therapy

iNO is only FDA approved for near term/term (> 35 week gestation) infants with acute respiratory failure associated with Persistent Pulmonary Hypertension of the Newborn

- **Off Label Use**
  - Respiratory distress syndrome (RDS)
  - Congenital Heart Disease

#### Inhaled Nitric Oxide (iNO) Therapy

- Produce selective pulmonary vasodilation
- Improves blood flow and improves V/Q matching
- Reduces pulmonary vascular resistance
- Reduces pulmonary artery pressure
- Improves PaO$_2$
- Increases cardiac output
Inhaled Nitric Oxide (iNO) Therapy

• NO is a short lived vasodilator
• Have a half life of 0.1 – 3.0 seconds
• After NO diffuses into the capillaries it quickly binds with hemoglobin
• This forms nitrosylhemoglobin which gets rapidly oxidized to methemoglobin (MetHb) and nitrates
• >70% of the inhaled NO dose is eliminated as nitrate by the body

Hence NO has very minimal systemic effect compared to other vasodilator drugs

Doses of Delivered Nitric Oxide

• Starting therapeutic dosage is 20ppm
• Normal range dose is between 2-20 ppm
  • Clinically effective with relatively few adverse effects noted in clinical trials
• 40 – 60 ppm dose
  • Generally not an initial starting dose
  • Increase to this amount acceptable if all other treatment and ventilator strategies have been optimized

iNO Route of Administration

• Nitric Oxide can be administered to both patient group
  • Mechanically ventilated patient
  • Non intubated patient
• NO can be administered to non intubated patients via nasal cannula or simple mask. (Do not use Non rebreather mask)
Inhaled Nitric Oxide (iNO) Therapy

- The delivery system calibrates three sensors NO, NO\textsubscript{2} and O\textsubscript{2}
- There are two calibration processes
  - Low range calibration: done prior to patient set up and once each shift
  - High range calibration: done at least once a month or when sensor malfunctions after low calibration
- Calibrations can be performed with the patient still connected to the ventilator but care should be taken not to make any changes during the calibration process

Injector Module = Brain

- The module delivers the set NO dose (ppm) with every inspiration regardless of the change in flow rate
- The module is always connected to the dry port of the humidifier
- Avoid medications interfering with the gas monitoring system; administer any aerosolized medications distal to the sampling tee.

InNO Therapy and HFV

- When using with HFV always use a one way valve
**Inhaled Nitric Oxide (iNO) Therapy Discontinuation Process**

Patient on NO therapy should be weaned slowly to minimize **rebound effect**
- Oxygen is weaned first to achieve an acceptable PaO₂ on FiO₂ of 0.40 or less
- The nitric oxide dose should be decreased in small increments 2 ppm after 10 ppm
- Once the nitric dose is decreased to 2ppm or less the therapy can be discontinued
- Rapid decrease or discontinuation can lead to severe hypoxemia, & increased pulmonary artery pressure

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**Inhaled Nitric Oxide (iNO) Therapy-Toxicity and Adverse Effects**

- Methemoglobinemia
- Nitrogen Dioxide (NO₂)
- Platelet inhibition
- Paradoxical or poor response
- Rebound hypoxemia & pulmonary hypertension

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**Toxicity of Inhaled Nitric Oxide (iNO)**

- Methemoglobin is an abnormal type of hemoglobin that is incapable of oxygen transport, thus reducing delivery capacity, which can cause arterial & tissue hypoxia at high levels.
- Monitor metHb to determine if the patient has the ability to metabolize metHb
- Clinical presentation - Blood turns chocolate brown color and can produce slate gray skin coloration with higher level of methemoglobin
- Normal metHb < 3%
  - <15% typically no symptoms
  - 15% - 20% asymptomatic cyanosis
  - 20% - 50% weakness and progresses to acidosis
  - >70% coma and death
Toxicity of Inhaled Nitric Oxide (iNO)

Nitrogen Dioxide (NO₂)
• By-product of NO + O₂
• The rate and the amount of NO₂ formed is dependent on the amount of contact time between nitric oxide and oxygen
  • Neonatal ventilators have continuous flow and starting dose is 20 ppm; NO₂ <1 ppm
  • Inhaled NO delivery systems have pretreatment purging and testing procedures; done to minimize NO₂

Toxicity of Inhaled Nitric Oxide (iNO)

Nitrogen Dioxide (NO₂)
• NO, NO₂, and oxygen monitored continuously
  • OSHA safety limit for NO₂ < 5 ppm
  • Clinically keep level < 2 ppm
  • NO₂ > 10 ppm can cause pulmonary hemorrhage, pulmonary edema and death

Manual iNO Delivery System

• Patients on mechanical ventilation receiving inhaled nitric oxide therapy should always be ventilated with inhaled nitric oxide (same ppm) and O₂
• Manual resuscitator bag must be set-up and ready to use
• Squeeze the resuscitator bag 3-5 times prior to using to minimize delivered concentration of NO₂
• Check with the system being used to know the amount of nitric oxide that can be delivered via the manual resuscitator bag
iNO Therapy – Trouble shooting

• The NO, NO\textsubscript{2} and O\textsubscript{2} value reading disappeared and there are three dashes on the monitor – Check the sample line for any occlusion or kinks. Also check the water trap and the filter
• The NO, NO\textsubscript{2} and O\textsubscript{2} value are constantly fluctuating – Perform a low calibration
• The monitor display NO, NO\textsubscript{2} and O\textsubscript{2} cell malfunction sign – Perform a low calibration first, if the issue still persists then perform a high calibration
• The monitor display a big X and the machine alarms constantly – The NO\textsubscript{2} levels are out of the set range and the machine needs to be shut Off and turned back On

Non Invasive Monitoring Devices
Capnography (monitors ventilation)

Noninvasive measurement of the partial pressure of carbon dioxide (CO\textsubscript{2}) in exhaled breath over time
• Qualitative device – displays the measured end tidal CO\textsubscript{2} in range (i.e. between 0-30mmHg
  • Colorimetric EtCO\textsubscript{2} (EZ cap, pedi cap)
  • Take about 6-7 breaths for adequate color change
  • Make sure the litmus paper is not affected by secretions or medication
• Quantitative device – measures the precise EtCO\textsubscript{2} and display it in a number and wave form

Quantitative device (con’t)...

• EtCO\textsubscript{2}/PetCO\textsubscript{2}
• CO\textsubscript{2} is measured by infrared (IR) radiation
• The CO\textsubscript{2} molecules absorb the infrared light
• The sensor should be placed between the patient’s airway and the wye
• EtCO\textsubscript{2} reading correlates very well with arterial CO\textsubscript{2} change. EtCO\textsubscript{2} will read lower than actual arterial CO\textsubscript{2} by 3-10mmHg
• Excess secretions and water from the circuit can cause false readings
• Also make sure the appropriate cartridge is used for the correct patient population
• Calibrate the device on room air prior to patient set up
Non Invasive Monitoring Devices: Capnography

Capnography – normal waveform

- mmHg
- Time

Phase I (A-B) - Beginning of exhalation. CO2 free gas from upper airway (dead space) - Baseline waveform

Phase II (B-C) - Rapid mixing of gas (dead space + alveolar) occur here therefore the Ascending waveform

Phase III (C-D) - Rich CO2 gas Alveolar plateau

Phase 0 (D-E) - Beginning of inhalation. CO2 quickly fall to zero due to mixing of fresh gas. Descending waveform

Non Invasive Monitoring Devices: Capnography

Normal Waveform
- EtCO2 within normal range

Hyperventilation
- EtCO2 < 30mmHg
- Rapid rate

Hypoventilation
- EtCO2 > 45mmHg
- Low rate

Asthmatic/COPD
- EtCO2 >45mmHg
- Shark fin wave

Disconnect
- Flat line with reading close to zero

Non Invasive Monitoring Devices: Pulse Oximetry (Monitors Oxygenation)

Continuous non invasive measurement of arterial hemoglobin saturation (%) and pulse
- The probe consists of two light emitting diodes (Red and Infrared) and a photo detector
- Oxygenated hemoglobin absorbs infrared light
- Deoxygenated hemoglobin absorbs more red light
- The spectrophotometer calculates the ratio of the red/infrared signal. The calculated ratio is converted into SpO2 value
- The probes can be placed on foot, fingers, earlobes, toes, hands, cheeks, tongue (Change Q8)
Pulse Oximetry

- Any interference with the light transmission or low perfusion can affect the accuracy of the pulse oximeter
- The accuracy of the measured SpO₂ is accurate to within + or - 2 percent of the calculated value as long as there is good perfusion and the patient's saturation is above 70%
- Inaccurate value in the presence of methHgb and COHgb
- Bright light, hypotension, hypothermia, bright nail polish, improper probe placement, electromagnetic radiation, seizures, shivering, and abnormal hemoglobin can cause false reading

Non Invasive Monitoring Devices: Transcutaneous Monitor

Transcutaneous Monitor

- A heating plate with two electrodes that measure PO₂ (clark) and CO₂ (severinghaus) is placed on the skin surface
- The membrane that covers the sensor should be changed and the sensors calibrated prior to patient set up
- Calibration is done mostly on 0.21 FiO₂ using a calibration gas with known values of PO₂ and PCO₂. A zeroing solution is also used in between the membrane and the sensor
- A base line ABG should be obtained to compare the transcutaneous values.

Non Invasive Monitoring Devices: Transcutaneous Monitor

- The electrode is placed over flat area of the body with a good perfusion- Avoid bony areas
  - Right upper chest
  - Abdomen (lateral side)
  - Thighs
  - Lower back (buttocks)
- The electrode is secured against the skin via a adhesive fixation ring
  - A water based solution is used between the electrode and skin to rid any air and get a good seal
- Electrode placed flat on skin – should not indent or compress skin
Non Invasive Monitoring Devices: 
Transcutaneous Monitor

• The electrode is heated anywhere from 37°C-44°C to improve blood flow and further help gas diffusion across the skin
• The electrode site is changed every 3-4 hours or every 2-3 hours
  • This primarily depends on the infant and the temperature used on the electrode
  • Erythema – red, circular area, can last hours to several days
  • Blistering – can occur at temperatures > 44°C and/or left in one location for too long. Avoid by monitoring temperature.

Non Invasive Monitoring Devices: 
Transcutaneous Monitor

• PtcO$_2$ (Clark electrode) value < PaO$_2$
• PtcCO$_2$ (Severinghaus electrode) correlates with or slightly higher than PaCO$_2$
• CO$_2$ diffuses easier than O$_2$
• Surface area of Severinghaus electrode > Clark electrode

Non Invasive Monitoring Devices: 
Transcutaneous Monitor

Trouble shooting
• Any sudden (decrease) in the PtcCO$_2$ reading mostly indicates a loose sensor
• Decreased perfusion (skin thickness, shock, hypotension) can cause inaccurate reading
• Any sudden increase in the values mostly indicates air bubble or a torn membrane
Pulse Co-Oximeter

- Provides non invasive continuous monitoring of carboxyhemoglobin (COHb), methemoglobin (MethHb), oxyhemoglobin (O$_2$Hb), Total oxygen content
- Use photospectrometry similar to pulse oximeter but uses more light source with different waveform
- Eg Masimo Rad-87(R) Pulse CO-Oximeter(TM)

Traditional Co Oximeter/Hemoximeter

- Requires blood sample (invasive
- Non continuous measurement

Transillumination

Transilluminat is a device with bright cool led light that is used to pass light through a body part or organ for medical examination

Indications:
- Aid in visualizing artery, vein for ABG puncture or IV insertion
- Used on infants when pneumothorax is suspected
  - Asymmetric chest movement, tracheal/mediastinum shift, decreased breath sound
  - If pneumothorax present - the entire upper thoracic cage will light up
  - If pneumothorax absent - a halo of light will be seen at the point of contact
  - CXR should be ordered to reconfirm pneumothorax

Mixed Gas Delivery

Air Oxygen Blender

A medical device that enables mixing of Air and Oxygen to produce a gas with a desired FiO$_2$ (0.21-1.0)
- Air and Oxygen inlet
- Two/Three outlet for the mixed gas
  - High flow outlet
  - Low flow outlet
- Proportioning valve
- Alarm for low inlet pressure
  - Check air and oxygen source for any loose connection and drop in pressures
- Air Oxygen blender does not have built in oxygen analyzer therefore any device that uses a blender should be checked via O$_2$ analyzer to determine the accuracy of the delivered FiO$_2$
Oxygen Analyzer
Galvanic sensor (fuel cell)
• Consists of two different electrodes in an aqueous electrolyte solution (potassium hydroxide)
• In the presence of oxygen molecule an oxidation/reduction process takes place which produces an electric current
• The current produced is proportional to the oxygen concentration in the sample
• Displayed as a percentage
• Accuracy can be affected by high ventilator pressures, altitude changes and water on the sensor
• Replace the fuel cell if calibration fail

Oxygen Analyzer
Polarographic Sensor (Clark cell)
• Consists of two different electrodes in an aqueous electrolyte solution (potassium chloride)
• Oxidation/reduction process takes place in the presence of oxygen molecule but an external electric charge is used to polarize the electrode
• The current produced is proportional to the oxygen concentration in the sample
• Displayed as a percentage
• Accuracy can be affected by high ventilator pressures, altitude changes and water on the sensor
• Replace battery if false reading occur or unable to calibrate

Disinfection
Is the process of eliminating all vegetative pathogenic microorganism except bacterial spores
There are disinfectants that will kill spores with prolonged exposure time known as chemical sterilant (used for heat sensitive material)

Pasteurization – Uses water for disinfection
• Physical disinfection process that uses hot water to kill all pathogenic organisms
• Time and temperature for hot water is 70 degree centigrade for 30 min
**Disinfection**

Chemical Method – Uses Alcohol for disinfection

- Works by denaturing the protein of the microbe
- Bactericidal, fungicidal, tuberculocidal and virucidal
- They are not sporicidal
- Ethyl alcohol and isopropyl alcohol are most effective in the 70-90% concentration

**Sterilization**

Is the process of destroying all forms of microbial life

Steam Sterilization (Autoclave)

- Is a physical process
- Not for heat sensitive material
- The steam chamber should be free of air because entrapped air greatly affect steam permeation and uniform heating of the chamber
- Heat sensitive test sheets, tapes and biological indicators are used for quality control and to ensure the proper functioning of the equipment

**Steam Sterilization**

- Steam and pressure (15psi) are applied at a certain temperature (121 degrees) for a period of time (20 min)

- All soiled equipment must be separated and cleaned with soap and water prior to sterilization and disinfection.
Sterilization

Chemical Sterilization – Uses Ethylene Oxide (ETO)

• ETO is a chemical gas
• Used for temperature and moisture sensitive material
• ETO’s microbicidal action is due to the alkylation of protein and enzymes
• Ethylene oxide is a carcinogen
• Important parameters that affect the sterilization process
  • Concentration of the gas: 800-1200 mg/l
  • Temperature: 37-63 degree celsius
  • Relative humidity: 40-80%
  • Exposure time: 1-6 hour
  • Aeration time: 12 hour

Chemical Sterilant

Disinfect/Sterilize

Alkaline glutaraldehyde (Cidex)

• pH: 7.5 - 8.5
• Sterilization time 10 hours (sporicidal)
• Fully potent for 14 days
• Common chemical used to disinfect bronchoscope

Acid gluteraldehyde (Sonacide)

• pH: 2.5 - 3.5
• Sterilization time 1 hour (sporicidal)
• Fully potent for 28 days
• Used for disinfecting flow sensors

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