Airways and Mechanical Ventilation

There are two types of airways that are primarily used...the endotracheal and the tracheostomy. The goal with each of these is to maintain a patent airway and thereby effectively oxygenate the patient. For patients who cannot ventilate adequately, they will have mechanical ventilation. This is a supportive intervention for oxygenation and ventilation. Keep in mind that curative interventions are initiated to correct the underlying problem...you don't just want to treat the symptoms, you want to fix whatever is really wrong with this pt. If you can't, then the pt is looking at long term ventilation.

- If the underlying problem is ARF r/t pneumonia: Abx and IV fluid
- If the underlying problem is acute respiratory therapy r/t asthma: Steroids for inflammation and bronchodilators

What is respiratory failure?

Respiratory failure is defined as the patient being unable to maintain the appropriate balance of oxygen and carbon dioxide in the blood. By definition, it is when the PO2 and the PCO2 are equalizing. Normal O2 level is 50-100 mm Hg, and normal CO2 is 35-45 mm Hg. When the pt is not ventilating correctly, the carbon dioxide will rise b/c they are not exchanging CO2 for O2. If the pt has pneumonia (for example) and the alveolar sacs are full of fluid, the pt will not perfuse oxygen, and the oxygen level will decrease. So...as you approach a O2 level of 50 and a CO2 level of 50 you are looking at respiratory failure.

Endotracheal Airway

- Tube is inserted in the mouth or nose and it ends in the trachea to keep airway physically open.
- A pt with an endo tube will ALWAYS be on a ventilator.
- Intubation is the process of putting the tube in
- Extubation is the process of removing the tube

Tracheostomy Airway

- Tube is inserted surgically into the trachea
- More long-term than the endo tube
- This pt wouldn't necessarily have a vent, they may be able to ventilate on their own.
- Percutaneous tracheostomy can be done at the bedside, otherwise this is an OR procedure.

What are the critical respiratory assessments?

- RR
- WOB
- Depth
- O2 Sats
- LOC
- Cyanosis (a late sign)
- Tests: CBC, CXR, ABG

A&P Review!

Recall that the diaphragm does 80% of respiratory work! If the phrenic nerve is damaged, your pt is in big trouble and needs to be on a vent!

What are the **indications for mechanical ventilation**?

- Impaired gas exchange. This can occur with ARF, pneumonia, asthma. The PaCO2 is higher than the O2...a classic V/Q mismatch. The patient is ventilating (moving air in and out), but the oxygen is not getting to the tissues b/c the alveolar sacs are full of fluid, collapsed or ineffective d/t disease.
- Regulation of respiration. Your pt with a spinal cord injury (SCI) or one who overdosed on drugs may need respiration to be regulated. Anyone with a decreased LOC will likely be intubated. Glasgow of 8 = intubate.

- Paralysis of respiratory muscles. MS, Myasthenia Gravis, Guillian-Barre
- Abnormal/injured chest wall. This is your trauma patient with the flail chest, or a pt with kyphosis severe enough to impede lung expansion.

Preparing for intubation
Prior to intubating the pt, make sure the suction in the work is working, get an Ambu-Bag ready to go by checking your oxygen source and filling the reservoir with oxygen. If the ET tube is being placed orally, there is a chance that it won't work and they will need to do an emergency tracheostomy, so I imagine you'd want to have an emergency trach kit nearby. Things that could make the intubation difficult are swelling, blood in the airway, anatomical anomalies and neck problems that prevent us from placing pt in good position for intubation.

To the right is a picture of a ET tube. You can't really see it very well, but the little blue stuff on the bottom of the tub is the balloon. You fill this iwth 5-7 cm of air. Along the length of the tube are little numbers...this tells you how deep the tube goes into the neck. You will want to verify this placement number with your nurse when you get report on your pt, and ensure the tube does not deviate from this! In general, women are usually around the 20 cm mark, and men are around 22 cm. You will always get an X-Ray to confirm placement!

The Intubation
The tongue is placed using a laryngoscope. Note that this could knock some teeth loose. Anyway, the blade of the scope fits in the vallecula and lifts the tongue off the soft palate and the posterior pharynx. At this point, the practitioner should be able to SEE the vocal cords and past the tube through the cords. Once the tube is in place, it is important to listen for breath sounds in all four quadrants of the chest and over the stomach. The chest should rise with manual ventilation, and there should be an increase in oxygen saturation. Many times there will be an EtCO2 detector that will change from yellow to purple when the tube is in the correct space. Note that the tube can easily slip into the esophagus, which would mean that your pt is not getting oxygen...this is bad! Once placement is confirmed, the cuff is inflated and the pt can be connected to the mechanical vent.

Risks of intubation
- Esophageal intubation
- Right mainstem intubation (went too far, went past the carina)
- Ruptured trachea or bronchus
- Aspiration of gastric contents (we're looking at pneumonia here)
- Tooth damage or loss (and possible aspiration)
- Hypoxemia
- Tracheal stenosis, erosion, necrosis
- Cardiac arrhythmias (vagal response?)

The Angle of Luis is the external landmark that indicates where the carina is. You want the tube to be pulled back about 2 cm from here.

Advantage and Disadvantages of Intubation
The advantage is that it protects the airway, provides oxygenation, protects pt from aspiration, and allows us to remove tracheobronchial secretions in pts who cannot cough effectively. Disadvantages would be that it bypasses normal respiratory defenses against infection, reduces cough effectiveness, is very uncomfortable and prevents verbal communication. Pts who are intubated for a prolonged period of time suffer from muscle wasting, and the respiratory muscles will become non-functional. There are also problems with nutrition since this pt can't "eat". Poor nutrition also leads to muscle wasting and these

patients will be very difficult to wean from the vent. As soon as the patient is intubated, we start working to get them OFF the ventilator.

Post Intubation

- Listen to the lungs...you want bilateral breath sounds.
- Secure the tube (tape or tube holder). Reposition q 24 hours and do frequent skin assessments.
- Confirm ETT by CXR. If the tube goes too deep, it's heading into the right lung. If it is too high it will damage the vocal cords and be extubated easily.
- Be careful when turning and transferring the intubated pt. ALWAYS assign someone to watch the tube and the vent tubing.
- Document the ETT cm mark at the lip (women ~20 cm, men ~22 cm).
- Patient will usually be restrained, so keep an eye on skin integrity if physical restraint used.
- Medicate routinely for comfort/sedation

Chemical Restraints

Neuromuscular blockade agents eliminate spontaneous breathing efforts that can interfere with the ventilator's function. These agents cause paralysis without altering the patient's LOC. Sedatives need to be administered as well to ensure the pt's comfort.

- Short acting is Succinylcholine. This drug causes bradycardia, respiratory depression, apnea and increased K+. Wears off in about 5-7 minutes.
- Long acting is Vecuronium. You will need to watch electrolyte levels, acid/base balance and hepatic fxn before and after administration.
- Propofol is more common than Vercuronium.

Tracheostomy Tubes

The tube is placed between the 2nd and 3rd tracheal ring. It is a surgical procedure to create an opening (stoma) into the trachea. This opening allows for the insertion of an indwelling tube to keep the airway open. Trach tubes are frequently used for pts who need prolonged ventilation. Keep in mind that this is still an artificial airway that precludes the normal respiratory defenses...the patient will be very prone to pneumonia. You will give "exquisite" oral care! A cuffed tube will prevent an unconscious or paralyzed pt from aspirating food or secretions.

Indications for a Tracheostomy Tube

- Prolonged mechanical ventilation (> 2 weeks or failure to wean)
- Facial surgery or trauma
- Unable too place an oral ETT

Tracheostomy Tube Types

- Cuffed (disposable inner canulla). A high volume/low pressure is used to prevent tracheal erosion. the seal keeps air from moving over the vocal cords, so the pt will not be able to speak.
- Fenestrated. The fenestrated and uncuffed are used as the site becomes more stable. Can talk.
- Uncuffed

Practice Alert!
Make sure that the obturator is taped to the wall...you will need this if the pt is accidentally extubated.

Tracheostomy Securing Devices

- Tape
- Tube holder

Be aware that thee trach can cause a lot of bloody drainage and edema. You will change the inner cannula 1x per shift and change the dressing prn. Don't change the ties for 24-48 hrs to avoid over manipulation.

The Ventilator

The ventilator delivers oxygen by pumping it into the

patient with positive pressures. The goal of ventilation is to correct respiratory failure and the acidosis that accompanies it. Recall that normal pH is 7.35 to 7.45. When the lungs are ventilating effectively, CO2 builds up and this creates acidosis. Acidosis interferes with nearly all the body's biochemical processes. The physical aspects of ventilation have a profound effect on hemodynamics in that there is no more negative intrathoracic pressure (we're at positive pressure). This increased pressure decreases venous return to the right side of the heart and blood pressure may drop 10-15% initially. The body will usually compensate for this fairly quickly. BE AWARE that a MAP < 65 is bad news! With a ventilator, exhalation is still a passive process that gets rid of CO2. The goals of using mechanical ventilation are to get the oxygen in, get the carbon dioxide out, rest the respiratory muscles and correct respiratory failure.

If your pt is on FiO2 > 50% for three or more days, this is a poor prognosis.

Ventilator terminology/settings

Mode: This is HOW we deliver the oxygen/breath to the pt. It determines the amount of work the ventilator does and the amount of work the patient does. The different modes are CMS (Continuous Mechanical Support), IMV (Intermittent Mechanical Support), and Spontaneous.

Tidal Volume: This determines how big a breath the ventilator gives. Approx. 6-10 ml/Kg.

Rate: How many breaths per minute. Average is 12-20

FiO2: The fraction of inspired oxygen. Range is 21% to 100%, but anything > 70& is not good news. Goal level is around 40%.

PEEP: Positive end expiratory pressure. This pressure keeps the alveoli open and improves oxygenation. Normal levels are 5-10 cm H2O. A "PEEP Challenge" tests how high you can set the PEEP without it affecting BP too much. MAP < 65% is bad news.

PS: Pressure support. This is the work of the ventilator to push the air in...makes it easier for the pt to breathe by overcoming the resistance of a small airway. Common settings are 10-20, and you could extubate at a PS of 7.

More on the mode of ventilation

The size of the breath is determined by pressure or by volume. If set to pressure, the pressure limit is set and volume is given until that pressure limit is reached. Avg is 35 cm H2O. If set to volume, the breath is given by the vent until the prescribed volume is reached (6-10 ml/kg/min). A patient who is on the vent with controlled mandatory ventillation (CMV) would have settings of FiO2 50%, Vt 650, RR 14 and PEEP 5. The patient would be paralyzed and not breathing on his own. The only breaths he would get is the 14 bpm delivered by the vent. This might be a trauma patient who has been chemically paralyzed to reduce a flail chest, or a pt with myasthenia gravis or Guillian-Barre, or even a pt with a high spinal cord injury.

Assisted mandatory ventilation helps the pt with each and every breath. The patient initializes the breath and the vent makes sure it is of an adequate Vt and frequency. So this pt might be on FiO2 40%, IMV with BUR 10 and PEEP 5. The BUP (back-up rate) is in case the pt gets tired and does not initiate a breath within the prescribed time. As you assess this pt, you would look to see how many ventilations per minute that the vent has been responsible for. If the patient tires and the vent is giving all the breaths you would only 10...you would never see less than 10 vents per minute.

Modes

- Mechanical Breaths (CMV)
  - Volume Assist Control (AC)
  - Pressure Assist Control (PC)
  - PEEP is usually ordered
- Intermittent Mandatory Ventilation (IMV)

    - Combination of mechanical breaths and spontaneous breaths
    - Pressure support and PEEP are usually ordered
- Continuous Spontaneous Ventilation
    - Spontaneous with pressure support (can also have PEEP)
    - Continuous Positive Airway Pressure (CPAP) = no extra pressure support on inspiration

Types of Breaths
- Volume Control
    - The vent delivers a set tidal volume (Vt)
    - Inspiratory pressure varies
- Pressure Control
    - Vent delivers a set pressure
    - Tidal volume varies
- Pressure Support
    - Patient's spontaneous effort is assisted

Ventilator Adjustments
Oxygenation refers to the perfusion of oxygen through the body. Pts can have adequate ventilation and still have poor oxygenation d/t poor exchange of oxygen and carbon dioxide at the tissue level. This could be because of poor perfusion (shock), V/Q mismatch due to a disease such as COPD, pneumonia, ARDS, embolism, etc... Ventilation refers to the actual movement of air in and out of the lungs. This could be compromised by weak muscles from neuromuscular disease, oversedation, shallow breathing, non-compliant lungs.

The MD will order the adjustments based on the ABGs, clinical assessment, and trending information from pulse ox and end tidal CO2 monitoring. So, if the PaO2 is 53 and the CO2 is 35, what is the problem? Oxygenation! So, you'll want to increase the FiO2 and the PEEP. If the PaO2 is 53 and the CO2 is 52, what is the problem? Ventilation...b/c the CO2 is building up. Try increasing the rate and Vt first and watch for changes. Usually the order will read to get another ABG in 30 mins.

To increase oxygenation:
Increase FiO2, Increase PEEP, Increase PS

To increase ventilation:
Increase Vt, Increase rate

Ventilator Alarms ***DO NOT TURN OFF ALARMS***
- High pressure alarms
    - increased airway resistance (bent tubing or ETT, excessive water in the tubing, excessive secretions, bronchospasms, airway edema)
    - decreased lung compliance (pneumothorax, mainstem intubation, severe atelactasis, ARDS, CHF)
- Low pressure alarms (indicates a leak in patient-ventilator circuit)
    - loose tubing connections
    - disconnected circuit
    - extubation

Nursing care of the pt on a vent
- Respiratory assessments
    - Assess cardiopulmonary status at least q 2-4 hours or prn
    - Assess VS and auscultate breath sounds
    - Monitor pulse ox or ETCO2 levels and hemodynamic parameters as ordered
    - Monitor I&O, being mindful of fluid volume excess or dehydration

- Suction prn
- Oral care (exquisite)
- Positioning
  - Turn pt side to side q 1-2 hours to aid lung expansion and removal of secretions
  - Perform active or passive ROM to reduce hazards of immobility
- Nutritional support
- Medications
  - The pt receiving a NMB agent requires close observation, b/c he cannot breathe or communicate. Make sure the pt also receives a sedative with a NMB!
- Routine eye care and lubrication b/c patient cannot blink

If there is a problem with the vent!
Disconnect the pt from the ventilator and manually ventilate with 100% oxygen. You may reset an alarm, but NEVER turn it off! Some patients may alarm frequently...this needs to be thoroughly investigated. Contact RT if necessary.

Suctioning
There are two types of suction devices...a Ballard and the traditional type. With the Ballard, the pt stays on the vent and the line stays sterile in a plastic sheath. To suction the traditional way, take the patient off the vent, bag with 100% FiO2, and suction using sterile technique. COMPLICATIONS: decreased HR, decreased O2 sats, tracheal trauma, anxiety. NOTE THAT SUCTIONING CAN CAUSE A VAGAL RESPONSE!!!!!!

Criteria for Weaning
- Minute ventilation close to 10L/min
- pO2 > 60 mm Hg
- PCO2 < 45
- pH 7.35 to 7.45
- Adequate hematocrit
- Have any renal failure, arrhythmias, and fever under control
- Ability to cough or mobilize secretions
- Withdrawal of NMB or sedatives
- Clear or clearing CXR

During weaning, continue to observe for respiratory distress, fatigue, hypoxemia or arrhythmias. Schedule weaning to comfortably and realistically fit into the patient's daily regimen...avoid weaning during baths, meals or lengthy therapeutic procedures. Document the length of the weaning trial and the patient's tolerance to the procedure.

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