Ventilation for Inpatient Nursing

Created by BC Children's Medicine Inpatient CNE's & Critical Care RRT's November 2022

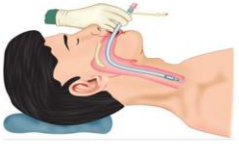
Ventilation

- We can ventilate non-invasively or invasively

Non-Invasive Ventilation:
Mask

Pillows

Invasive Ventilation:
Endotracheal Tube (short-term)



Tracheostomy Tube (long-term)

Today we will review some basic concepts of ventilation - these concepts will lay the foundation of your understanding of how and why we ventilate patients. Don't hesitate to speak up with questions as we go along!

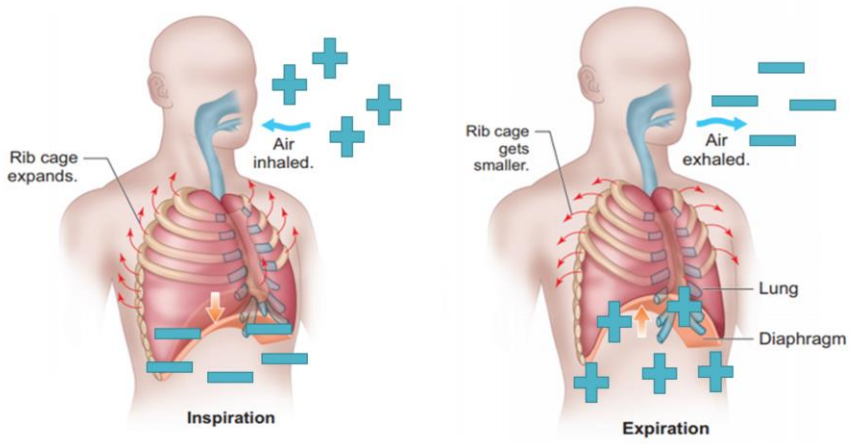
Review difference between Invasive and Non-invasive ventilation

- Non-invasive: via facemask, nasal mask or cannula
- Invasive: via artificial airway (i.e. endotracheal tube or tracheostomy)

Nasal Pillows: Specially designed masks that deliver continuous positive airway pressure (CPAP) through the nostrils.

Ventilation Review

- Controlled by pressure gradients between atmospheric air & thorax
- Air travels from an area of high pressure to low pressure



Ventilation is controlled by pressure differences between the atmosphere and the gases inside the lungs.

These pressure differences are created by contraction and relaxation of the diaphragm and chest muscles.

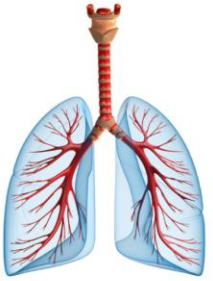
What are the two phases of ventilation?
- Inspiration and expiration

Inspiration:
- The diaphragm and intercostal muscles contract (and pull down) → Enlarging the thoracic cavity. This increase in capacity decreases the pressure in the lungs to below atmospheric pressure, creating a negative pressure gradient. Air will move into the lungs (like a vacuum). Pressure from the atmosphere is higher so air travels from an area of high pressure (the atmosphere) to an area of lower pressure (the thorax)

Expiration:
- Diaphragm and intercostal muscles relax. Thoracic cavity gets smaller, returning it its original size. Thoracic pressure is now higher than atmospheric pressure, so air will travel out of the lungs to the atmosphere.

Negative Pressure Ventilation

- This is the way we naturally breathe
- Air gets pulled into our lungs as we inhale



Positive Pressure Ventilation

- A constant pressure is being applied to the person's airway. The pressure increases on inspiration and is decreased on expiration to the lower level that is constantly maintained
- Maintains a pressure in the alveoli at all times to avoid collapse to provide improved gas exchange

As was just mentioned in the previous slide, spontaneous breathing create negative pressure ventilation (i.e. moving diaphragm down → more space → sucks in air)

Positive pressure ventilation is when air is "pushed" into the lungs, despite the thoracic pressure. Some pressure is constantly applied.

Is expiration active or passive?

- Passive: in both negative pressure ventilation and positive pressure ventilation
    - Negative pressure (spontaneous breathing) – diaphragm relaxes → less thoracic space → air pushed out
    - Positive pressure (assisted ventilation) – pressure gradient results in air leaving positive pressure thoracic space to negative space (environment)

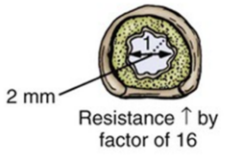
Lung Compliance and Airway Resistance

Lung Compliance: Measure of the lungs ability to stretch and expand

- Increased Compliance: lungs expand easily
- Decreased Compliance: lungs are difficult to expand
- ↓ Compliance = ↑ Work of Breathing

Airway Resistance : Dependent on the diameter of the airway

- This is important is infants and children who have small airways *(Secretions in airway, airway swelling)*
- ↑ Resistance = ↑ Work of Breathing



The amount of air that can move into and out of the lungs during respiration is affected by the lung compliance and airway resistance

Compliance: measure of the lungs ability to stretch and expand – more stretchy = more compliant and easier to ventilate; more stiff = less compliant and more difficult to ventilate

Common causes of decreased lung compliance:
- Pulmonary fibrosis (lung disease that occurs when lung tissue becomes damaged and scarred)
- Pneumonia
- Pulmonary edema

Airway resistance: Ex. Imagine drinking a milkshake with a bubble tea straw vs. a normal/smaller straw. It's much easier to drink a milkshake with a bubble tea straw because it has a larger diameter.

Common causes of increased airway resistance:
- Secretions
- Edema
- Obstructive lung disease (asthma)

True or False?

If the patient's lung compliance decreases, their work of breathing will increase.

True or False?

If the patient's lung compliance decreases, their work of breathing will increase.

True

Correct! If the patient's lung compliance decreases, that means their lungs are more stiff and harder to stretch out.

Respiratory muscles and/or ventilator have to work harder to expand the lungs.

True or False?

During ventilation, pressure and volume will fluctuate depending on the patient's compliance and resistance.

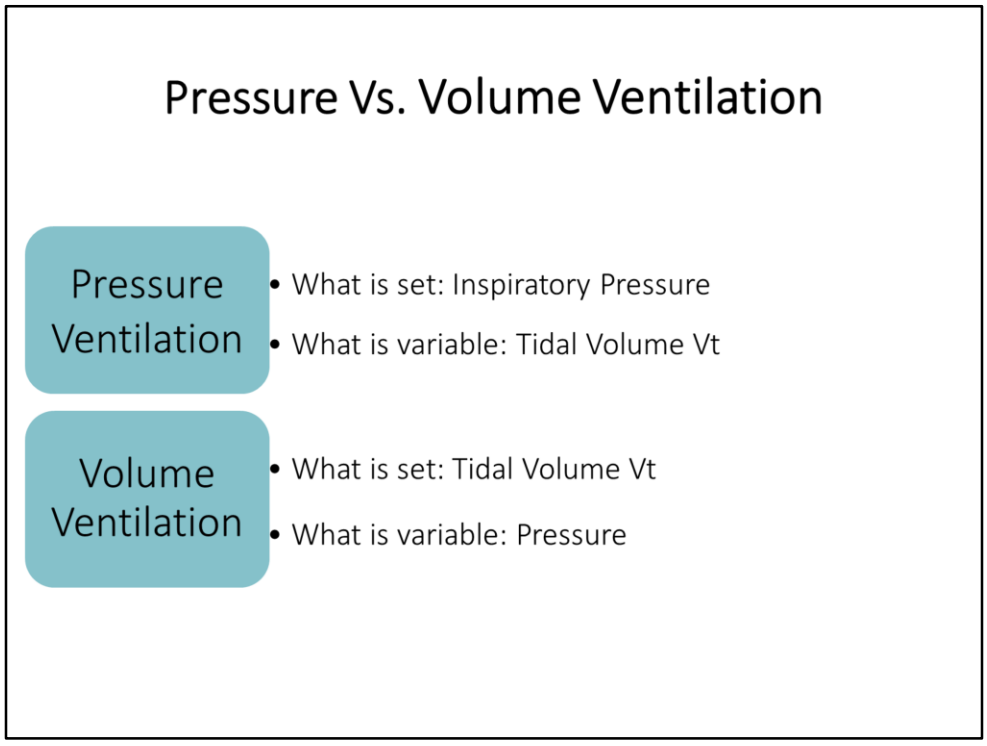
True or False?

During ventilation, pressure and volume will fluctuate depending on the patient's compliance and resistance.

True

If the patient's compliance is decreased (lungs are stiffer) or their airway resistance is increased, you will need a higher pressure gradient to inflate the lungs with the same volume of gas

In healthy people, compliance and resistance are constantly changing breath to breath

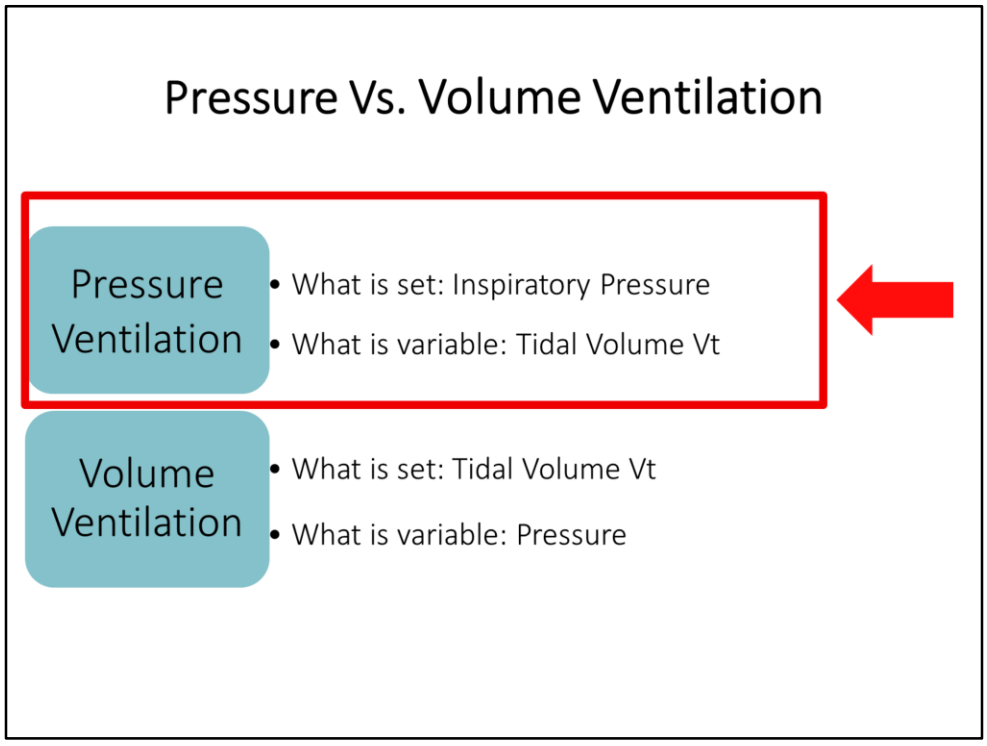


With pressure ventilation:

- The RT will set an inspiratory pressure that will be delivered with every breath. Both a maximum pressure and a minimum pressure will be set.
- With BiPAP (which has a PIP and a PEEP) the Delta P (difference between the two pressures) will determine how much volume is delivered.
- The amount of volume the patient receives will change from breath to breath

With volume ventilation:

- The RT will set specific amount of volume of gas (ml) that will be delivered with every breath
- Because this volume will be delivered despite the compliance and resistance of the lungs, there is a risk of barotrauma and volutrauma in stiff, non-compliant lungs



The patients who are sent home on non-invasive ventilation will be on pressure ventilation settings, because it is a safer mode of ventilation

Ventilation Terminology

- Peak Inspiratory Pressure (PIP/IPAP)
- Positive End Expiratory Pressure (PEEP/EPAP)
- Respiratory Rate (RR)
- Inspiratory Time (Ti)
- Tidal Volume (Vte)
- Minute Ventilation (MinVent/VE)

updated

Peak Inspiratory Pressure (PIP)

- PIP is the pressure that pushes the air into the lungs during inspiration
- It's the highest level of pressure that will be applied to the lungs during inspiration (measured in cm H_2O)
- It helps to augment the child's own breathing effort in order to deliver an adequate tidal volume.
- The amount of PIP prescribed will depend upon the compliance of the child's lungs and the desired tidal volume for the child.

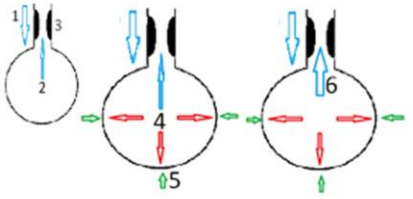
PIP:

- Inspiratory gas flow pressure that is delivered with each breath
- As we discussed in the previous slide, in pressure ventilation this value is set by the RT

Higher PIP means a higher volume of gas is being delivered → therefore it is considered a higher level of ventilator support

Positive End Expiratory Pressure (PEEP)

- PEEP is the pressure that is applied to the lungs at the end of expiration (cmH_2O) and continued through until the next inspiration.
- PEEP keeps the alveoli from collapsing on exhalation and prevents atelectasis.
- PEEP also helps to prevent upper/lower airway collapse by stenting the airways open, especially in children who have soft airways e.g. tracheobronchial malacia.



PEEP:

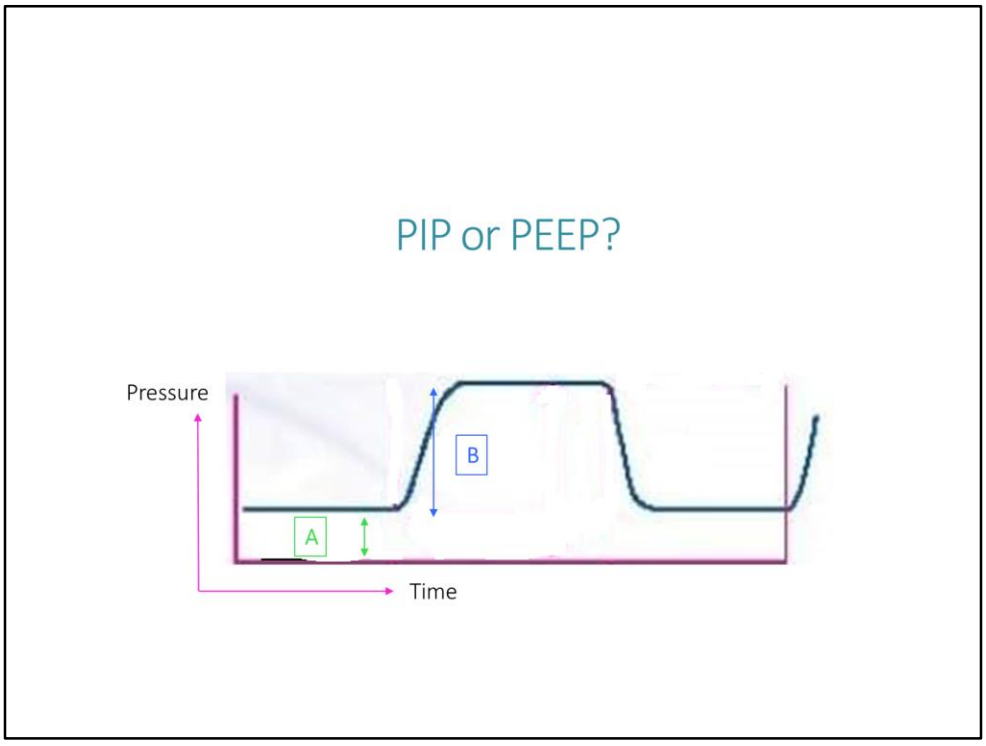
- The amount of pressure that remains in the lungs at the end of expiration *keeps alveoli open*

Atelectasis: the partial collapse of an area of the lung

Tracheobroncial malacia:

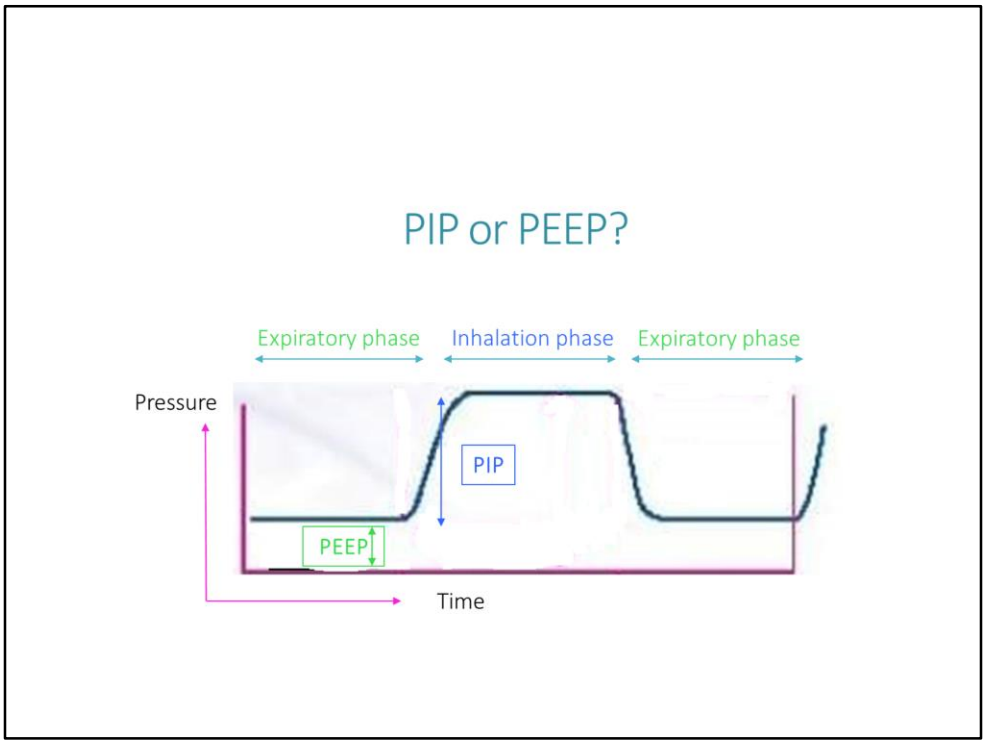
- When your trachea and the airways leading to your lungs (bronchial tubes) are floppy or collapse

Ex. If the patient is on ventilator settings of 10/5 → PIP = 10; PEEP = 5



If the y axis is pressure and the x axis is time… Where do you think PIP and PEEP sit on the curve?

A= PEEP
B= PIP



As you can see, constant end expiratory pressure is being maintained (PEEP), PIP is what is delivered by the ventilator- what makes ventilation positive pressure (as opposed to spontaneous breathing which is negative)

Respiratory Rate (RR)

There will be a total RR displayed on the monitoring screen of the ventilator which includes the set RR + spontaneous RR

There are 2 types of breaths that are supported by the ventilator:

Spontaneous breaths:
the breaths that are started and ended by the child.

Mandatory breaths:
the breaths that are fully controlled by the ventilator.

Spontaneous breaths:
- The patient's respiratory effort "triggers" the ventilator to deliver a breath
- Trigger can be set based on pressure or volume

Mandatory breaths:
- Set breaths that are delivered by the ventilator

Patient may need mandatory breaths delivered because
- Their respiratory rate is too slow to provide adequate ventilation
- They have a poor respiratory drive

Inspiratory Time (Ti)

- This is the length of time that the upper pressure (PIP) will be maintained during inspiration on all mandatory (set) breaths
- Inspiratory time allows the pressure to inflate the lung to allow for improved gas exchange in the alveoli.

  (The more restrictive or stiff the lungs are the longer it will take to inflate.)
- Normal ranges vary with age:

  neonates 0.5 seconds

  older children to a max of 1.2 seconds

How long can you hold your breath?

We briefly talking about inspiratory time when we reviewed bagging. How long do we want to give a breath over when bagging? 1 second

Any time an RT sets a respiratory rate, they have to set an inspiratory time

Inspiratory time is the only time that is set because expiration is passive.

Tidal Volume (Vt)

Vt is the volume of air that a person typically breathes in and out during a normal breath. An average target Vt is 6-8ml/kg

The tidal volume that a person generates is dependent upon a number of factors:

1. The person's own ability to breathe

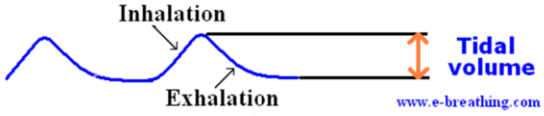
   Muscle strength/function.

2. Lung compliance

   The lower the lung compliance (i.e. the stiffer the lungs/secretions) the smaller the Vt

3. Airway resistance

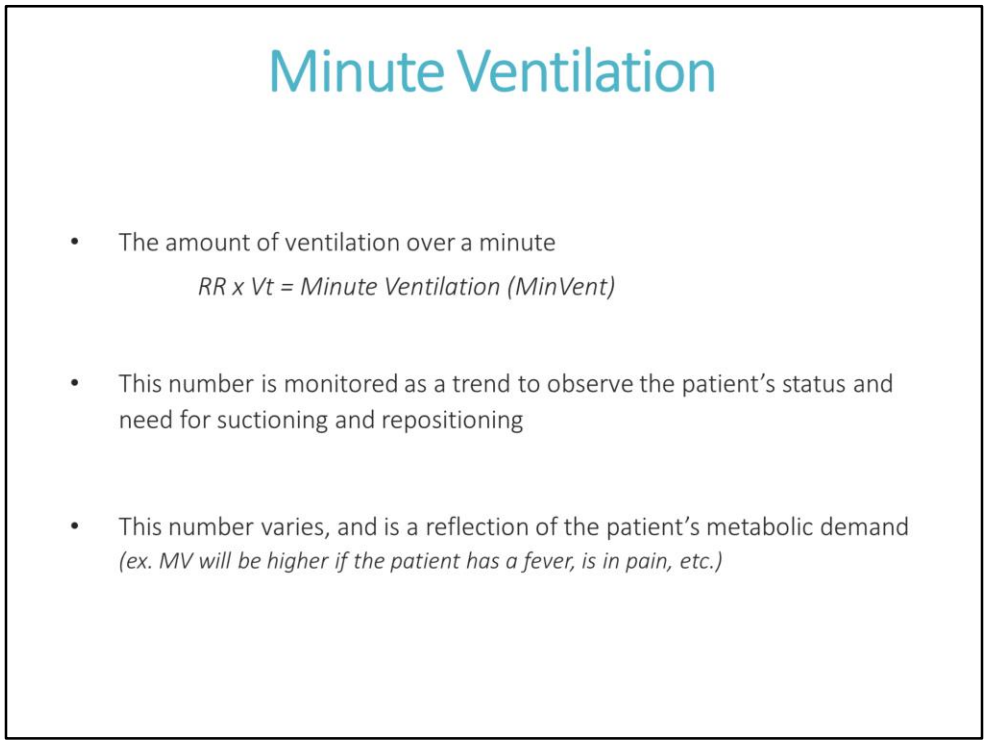
   The higher the airway resistance, the smaller the Vt



Tidal volume:

- The volume of air inhaled or exhaled with each breath (measured in ml's)

- Important to keep an eye on tidal volume – if trending down, may indicate need for increased pressures
- Could be decreasing because of increased resistance/decreased compliance



Minute ventilation:

- The total volume of gas that is delivered to the patient each minute
- Respiratory rate and tidal volume will compensate for each other to maintain the same minute ventilation
- Ex. patients who have a resp illness and are full of secretions often tachypneic (can't maintain normal volume)

Metabolic demand:
Minute ventilation increases with increased metabolic demand

- Ex. When we exercise we're only able to take small breaths, so our respiratory rate will increase to maintain the same minute ventilation, same with when patients have fevers

RR and VT will compensate for each other to maintain the same minute ventilation

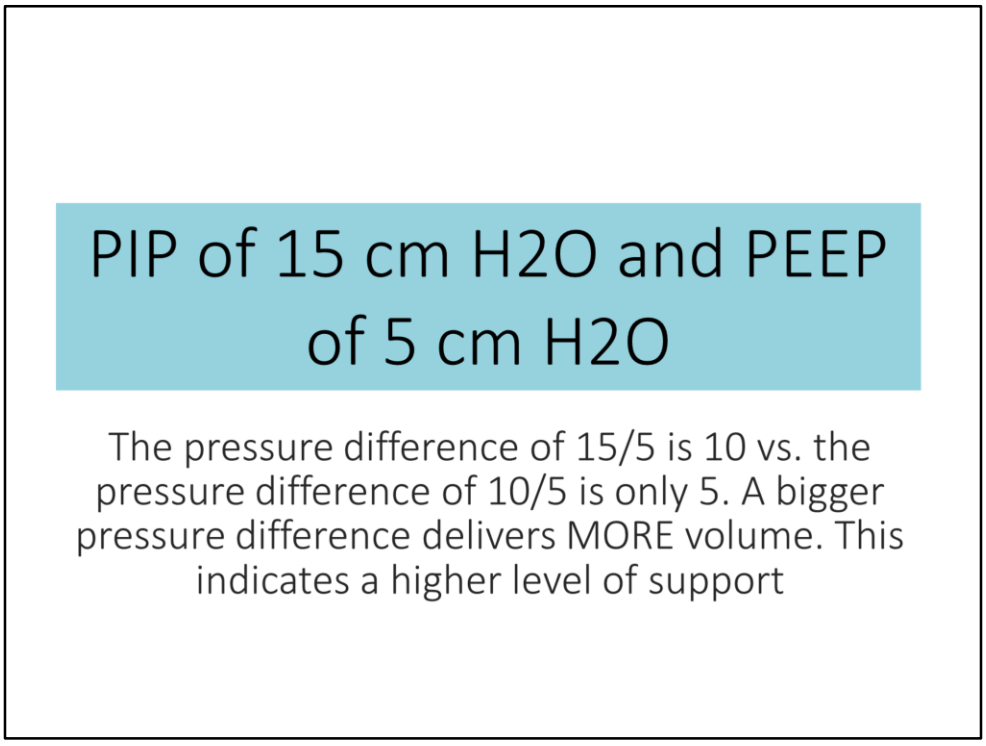
Question!

In which example will a patient receive more **volume** with each breath:

PIP of 15 cm H2O and PEEP of 5 cm H2O

OR

PIP of 10 cm H2O and PEEP of 5 cm H20



Demonstrate the different settings on the ventilator. Show the group how decreasing the PIP or increasing the PEEP can affect the volume delivered.

Modes of Ventilation

(CPAP) Continuous Positive Airway Pressure

(S) Spontaneous

(S/T) Spontaneous/Timed

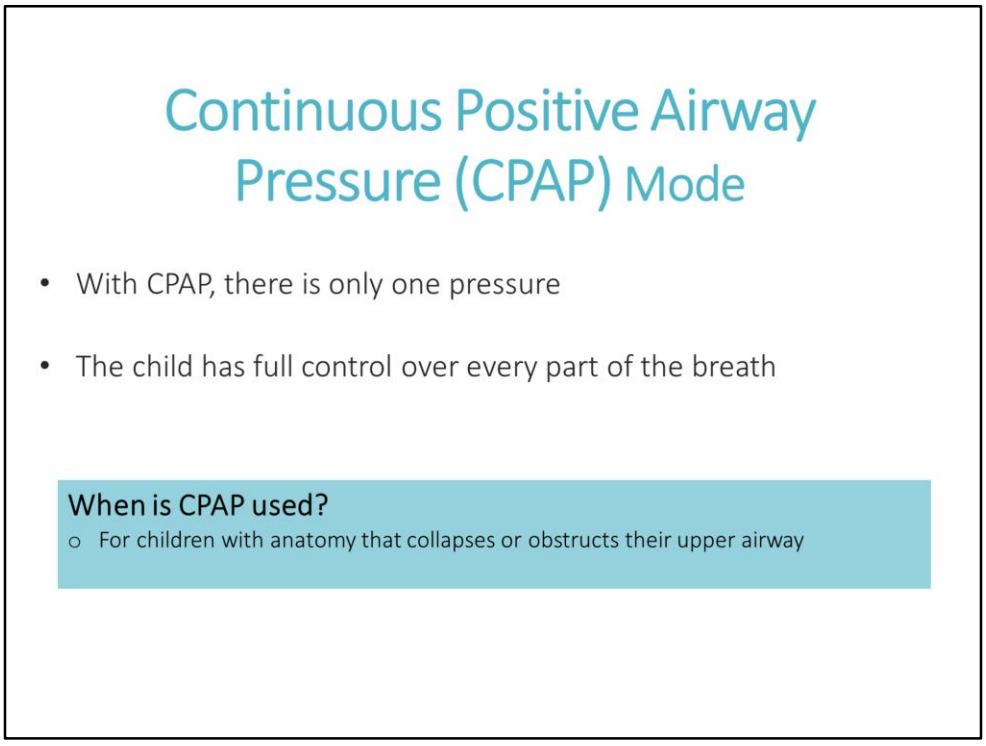
(PC-SIMV) Pressure Control – Synchronized Intermittent Mandatory Ventilation

(PC) Pressure Control

The type of support will depend on the patient and their underlying disease process.

Any mode with 1 pressure setting = CPAP
Any mode has two different pressure settings = BiPAP

- S, ST, PC-SIMV, PC are technically Bipap (have settings for PIP and PEEP)



Constant pressure throughout the respiratory cycle (inspiration and expiration)

If asked… difference between PEEP and CPAP?

- PEEP is maintained at the end of expiration only and CPAP is maintained throughout the ventilator cycle

With CPAP, there is only one pressure. With the modes we're going to cover next there will be two pressures (ex. 12/6)

Example: OSA, big tonsils, abnormal upper airway

Spontaneous (S) Mode

- Patient initiated breaths are supported by a set pressure → helps with inspiration
- No set respiratory rate

When is S mode used?

- For children with neuromuscular weakness who have difficulty taking deeper breaths because of their weak respiratory muscles but have a good respiratory drive

The patient NEEDS to have a respiratory drive….WHY?

- Patient initiated breaths are supported by a present pressure limit
- Benefit is to reduce work of breathing → the ventilator support decreases the inspiratory muscle requirement
- Patient must have the ability to spontaneously breathe because the ventilator doesn't have a set respiratory rate
- The rate and inspiratory time are controlled by the patient (not set)
- Drive is good but muscles are weak

Why does the patient need to have a strong respiratory drive?

- They need to be strong enough to tell "trigger" the ventilator when they need a breath. If they go apneic, the ventilator doesn't know when to give a breath.

Example: child with SMA

Spontaneous/Timed (S/T) Mode

- With ST mode, the ventilator would provide spontaneous support while the child is breathing above the set RR.
- If the child breathes below the set RR, the child will get mandatory breaths at the set RR until they breathe above it.
- This is similar to Spontaneous mode with a back up rate built in

When is ST mode used?

- Who have episodes of apnea or periodic breathing with long pauses between in breaths

Similar to the spontaneous mode we were just talking about, but in this mode the RT will set a back up rate.

If the patient is breathing above the backup respiratory rate, the ventilator will support each spontaneous breath.

If the patient has a decreased respiratory rate, or goes apneic, the ventilator will deliver mandatory breaths to the patient.

Example:

- The patient's backup respiratory rate is set to 10 bpm. If the patients respiratory rate is 12-16, they will be able to breathe as quickly or as slowly as they would like (can determine their own inspiratory time)
- If the patient's respiratory rate falls to 10 or less, the ventilator will take over breathing and will delivery 10 breaths per minute with a set inspiratory time for every breath
- Once the patient "triggers" the ventilator and starts breathing faster than 10 breaths per minute, the ventilator will stop delivering breaths and the patient can resume breathing spontaneously

Example: child with central sleep apnea, periodic breathing while asleep

Pressure Control (PC) Mode

- This is a controlled mode in which every breath is a set length.
- When/if the child triggers a breath, it will be held for the set Ti.

When is PC mode used?

- For children who require full ventilator support
- For children who have no central control of breathing (i.e. high Spinal Cord injury, brain stem tumour)
- If the child is not able to ventilate well enough with PC-SIMV mode (which we will talk about next)

Note: This mode may feel uncomfortable for some children as the ventilator controls the length of every breath

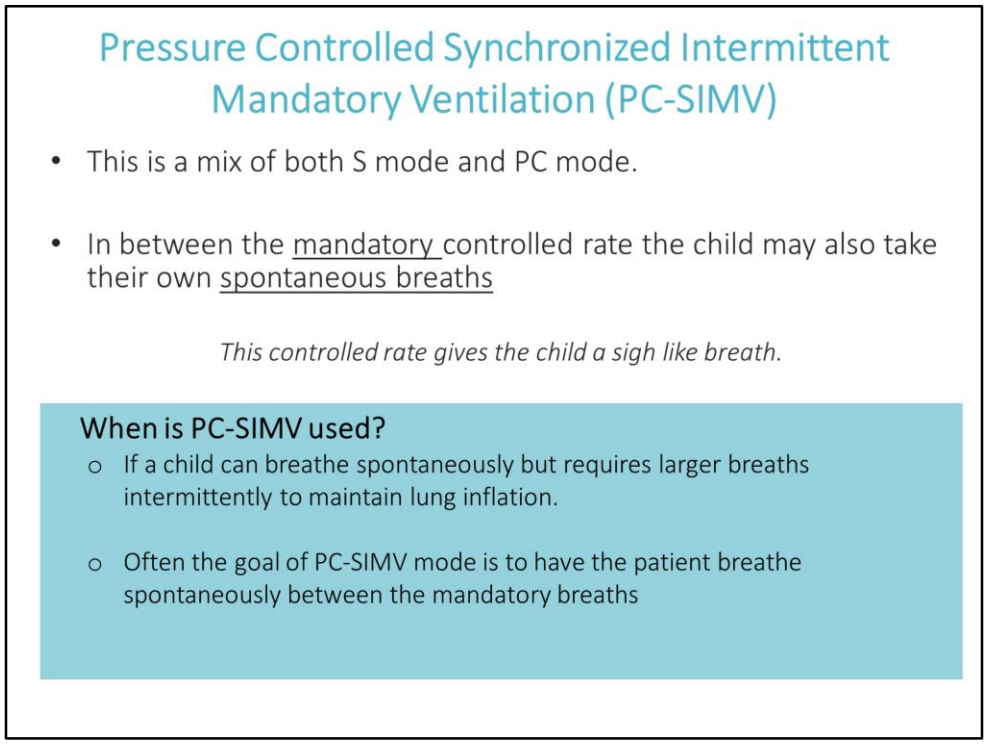
The ventilator will control every breath: the RT will set the respiratory rate, inspiratory time, and peak inspiratory pressure

The patient can still trigger a breath, but every breath will be held for a set inspiratory time (ex. 1.0 seconds), unlike in spontaneous/timed mode

If the patient still has the drive to breath, and is triggering their own breaths, this mode can be very uncomfortable and dis-synchronous → so the patient would instead be on PC-SIMV mode which we will talk about next

Examples:

- In our HTV patient population, PC mode is used for patients with congenital central hypoventilation syndrome (CCHS). CCHS is a neurological disorder that causes inadequate breathing (decreased respiratory rate or shallow breathing) when patients are asleep
- Used for patients who are paralyzed/cannot initiate breaths on their own

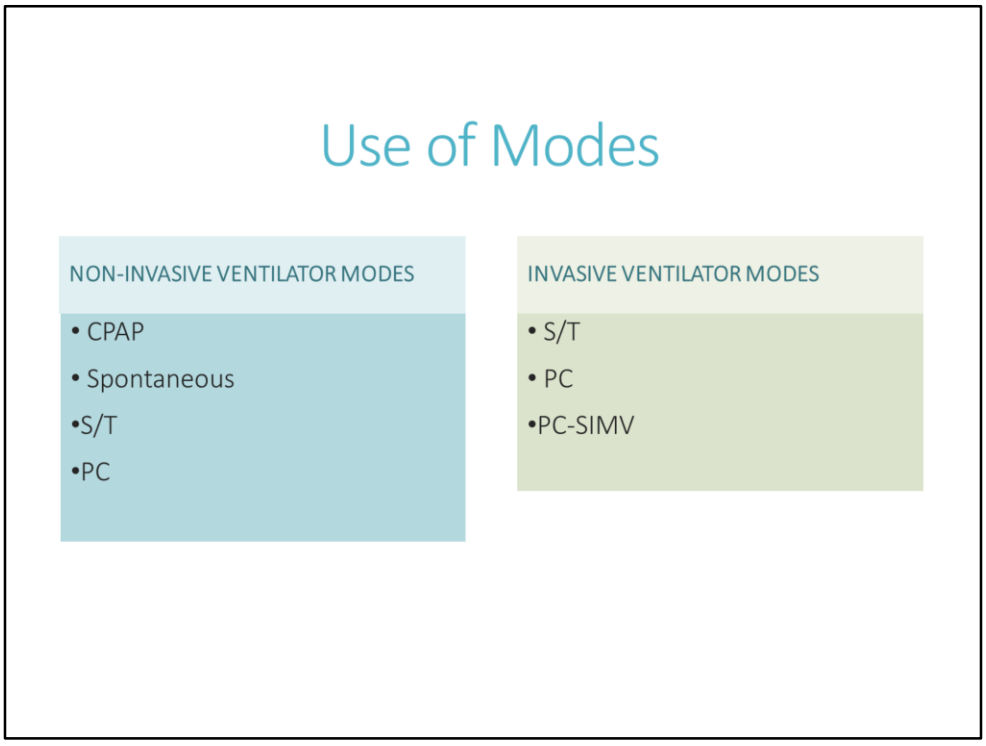


This is an invasive mode of ventilation. It is a mix of both spontaneous and pressure control mode.

In this mode, the ventilator will deliver a set number of mandatory breaths per minute. The ventilator will also allow the patient to breath spontaneously in between these mandatory breaths. It then registers the spontaneous breaths and synchronizes the mandatory breaths (the set respiratory rate) with the patients spontaneous breaths.

Example:
- The respiratory rate will be set to 10 breaths per minute, meaning the ventilator is delivering a breath every 6 seconds (and hold those mandatory breaths for a set inspiratory time) .
- If the patient wants to breath between that 6 seconds, they can breathe however they would like (determine their own inspiratory time).
- If the patient went apneic, the ventilator would continue to deliver a breath every 6 seconds and hold it for a set inspiratory time (ex. 1.0 seconds)
- If the patient takes a spontaneous breath at 5 seconds, the ventilator will synchronize to the patient and not deliver an extra breath at 6 seconds → this prevents 2 breaths from being delivered back-to-back (breath stacking)

Example:
- This mode is useful for patients who still have a drive to breathe, but their inspirations are weak and shallow. This mode allows for a few large breaths to achieve adequate minute ventilation but still allows the patient to spontaneously breath and “exercise” their diaphragm
- Patients with spinal cord injuries, SMA



Most patients who are on non-invasive ventilation at home have a drive to breathe and can tolerate long periods of time off the ventilator.

The order of these modes in each column is from least to most supportive

Test Your Knowledge…

Nadia is a 3 month old infant who has a history of a stroke post-meningitis and was recently diagnosed with central sleep apnea. Her medical team has decided to initiate positive pressure ventilation for nights/naps.

- What type of ventilation mode would they likely choose and why?

ST mode – has back up mandatory breaths if Nadia doesn't meet minimum RR spontaneously

Test Your Knowledge…

Noah is a 2 year old with a progressive neuromuscular disease. Up until now, Noah has never required any respiratory support other than suctioning as needed. Recent sleep studies show Noah is experiencing decreased oxygenation at night. Noah's medical team has decided to start him on positive pressure ventilation for nights/naps.

- What type of ventilation mode would they likely choose and why?

Come up with a few case study examples that ties in modes and ventilation basics

1. S mode – to help with inspiration, Noah's initiated breaths are supported by set pressures

Bonus question:
Does this form of positive pressure ventilation have a PIP and a PEEP prescribed?

Test Your Knowledge…

Throughout the night you notice Noah's tidal volumes are decreasing. If Noah weighs 20 kg, what should his tidal volumes be?

If Noah's tidal volumes overnight were 80-100 ml, what might be going on? And what would your next steps be?

- 120-160 ml

What might be going on?!
- Progression of his disease (muscle weakness)
- Requires more support (increased PIP)
- Developing a respiratory illness → effects compliance and/or resistance
- Site to source check, is something going on with the circuit? What is Noah's leak?

Next steps:
- Site to source
- Call RT
- Make MRP aware

Measured or Set?

1. PIP
2. PEEP
3. Tidal Volume
4. Respiratory Rate
5. Inspiratory Time
6. Expiratory Time
7. Minute Ventilation
8. Leak

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1. PIP
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1. SET

When you are monitoring your patient's ventilator settings, which of these settings is set by the RT and which is measured (can change)? (referring to pressure ventilation)

Measured or Set?

1. PIP
2. PEEP
3. Tidal Volume
4. Respiratory Rate
5. Inspiratory Time
6. Expiratory Time
7. Minute Ventilation
8. Leak

1. SET
2. SET

Measured or Set?

1. PIP
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3. Tidal Volume
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1. SET
2. SET
3. MEASURED

Measured or Set?

1. PIP
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1. SET
2. SET
3. MEASURED
4. SET and/or MEASURED

Measured or Set?

1. PIP	1. SET
2. PEEP	2. SET
3. Tidal Volume	3. MEASURED
4. Respiratory Rate	4. SET and/or MEASURED
5. Inspiratory Time	5. SET
6. Expiratory Time	
7. Minute Ventilation	
8. Leak	

Any time an RT sets a respiratory rate, they have to set an inspiratory time.

Measured or Set?

1. PIP	1. SET
2. PEEP	2. SET
3. Tidal Volume	3. MEASURED
4. Respiratory Rate	4. SET and/or MEASURED
5. Inspiratory Time	5. SET
6. Expiratory Time	6. NOT SET or MEASURED
7. Minute Ventilation	
8. Leak	

Trick question! Not set or measured, but something the RTs keep in mind when they set the inspiratory time.

The set inspiratory time will determine the expiratory time, because expiration is passive.

Measured or Set?

1. PIP
2. PEEP
3. Tidal Volume
4. Respiratory Rate
5. Inspiratory Time
6. Expiratory Time
7. Minute Ventilation
8. Leak

1. SET
2. SET
3. MEASURED
4. SET and/or MEASURED
5. SET
6. NOT SET or MEASURED
7. MEASURED

Measured or Set?

1. PIP	1. SET
2. PEEP	2. SET
3. Tidal Volume	3. MEASURED
4. Respiratory Rate	4. SET and/or MEASURED
5. Inspiratory Time	5. SET
6. Expiratory Time	6. NOT SET or MEASURED
7. Minute Ventilation	7. MEASURED
8. Leak	8. MEASURED

Now that you know ALL of the Terminology….

Let's move on to the Ventilators

**See cheat sheet in "Respiratory Care & Non-Invasive Ventilation" shared folder*

Have stations set up with three ventilators, high flow machines (AirVo and Optiflo), and non-invasive masks (with mannequins). After reviewing each of the ventilators, split the group into pairs and allow them time for hands on practice with the ventilators and masks.

At the mask station review:
- *Where the exhalation valve is*
- *How to put on and take off each of the masks*
- *Different type of masks (nasal pillows, nasal mask, full face mask, total face mask (scuba mask))*
- *Why patients with full face or total face masks are often not seen on the inpatient units*
- *Discuss the importance of assessing skin integrity and face care: we don't apply creams to patients faces below masks because it can effect the seal and integrity of the mask, if concerned about skin integrity apply duoderm*

Ask if anyone has cared for a patient who uses one of these ventilators? There used to be a long A-40 ventilator, but it was recalled last year. Now all patients are who require home NIV are on the Aircurve or Stellar ventilators

Start by demonstrating safety checks on the ventilators

Before putting the mask on the patient the ventilator must be turned on and have air flow → otherwise you're putting a mask on the patient's face without any air delivery, making it difficult for them to breathe

The mask also must be taken off the patient's face before stopping turning the ventilator off/putting it on standby

1. Blocked Tube/ Obstruction/ Low Leak Alarm Check
    - Turn on ventilator, start therapy, with a gloved hand block end of circuit tubing for up to 60 seconds until the alarm is set off
    - Checking to make sure the ventilator will alarm if the circuit becomes blocked
2. Circuit Disconnect/High Leak Alarm Check
    - Take gloved hand off of circuit tubing, point circuit away from face, allow air to flow freely for up to 60 seconds until you get the alarm
    - Checking to make sure the ventilator will alarm if the circuit becomes disconnected

Trilogy 202

- Trilogy 202 is a hospital provided ventilator

Parts from back to front:
- Power cord
- Has 4 hours of battery life
- It can be attached to a wall oxygen source using a high pressure oxygen hose. If connected to the wall oxygen source there is a button on the bottom left that can be used to deliver 100% oxygen for "rescue" over 2 minutes
- It can be hooked up to a wall oxygen source and has a 100 % oxygen button for "rescue" that will give 100% oxygen for 1 minute
- External humidifier pot
  - Set to 31 to 34 degrees
  - Must be plugged in (no battery)
  - Gravity fed inhalation bag
- Heated circuit
- Buttons
  - Power (does not function as a standby so ventilation starts immediately after powering on)
  - Menu toggle arrows
  - Menu select buttons
  - Alarm Silence (can be turned on and off)

Monitoring:
- Pressure monitoring and bar graph
- Expiratory Tidal Volume (Vte)
- Minute Ventilation
- Leak
  - Important to check if the patient has a leak
  - There is an exhalation valve on every mask, this will create a leak. If there is no leak/the leak is low, the exhalation valve may be obstructed
  - Trend the leak (doesn't have to be a specific number, will differ with each patient)
- Respiratory rate

Checking Mode and Settings:
- Use the arrow button to open the menu
- Scroll down to settings and alarms page
- Use arrows to scroll through mode and settings

Changing Mode and Settings:
- In the settings and alarms page, scroll to the mode or setting that needs adjusting, select it using the menu select button, adjust the parameter with the arrow button, the select finish using the menu select buttons
- Settings should only be changed by an RT, we are simply showing you how so you are aware of what the RT is doing to change the settings
- Monitor: pressure settings, tidal volume, leak, FiO2, set RR and measured RR

Resmed Aircurve

Aircurve Ventilator: This is a home ventilator

For facilitator: please review Learning Hub course #26797

Parts from back to front:
- Power cord → does not have a battery. Needs to be plugged in
- Heated circuit
- If the patient is on home oxygen, the circuit will have an oxygen nipple located at the back where the circuit connects to the ventilator
- Air intake and filter are located on the side → do not block this area (pillows, blankets, etc.)
    - Cleaning: Parents are instructed ot rinse with water and air dry as part of cleaning schedule and/or it is visibly dirty/dusty etc.
    - If parents have questions about cleaning, please contact the HTV RT (Karen and Laureen) or the floor RT

- Integrated humidifier chamber:
    - Fill with sterile water to the line
    - Use a two pot system to fill the chamber
    - Air-flow is interrupted when the chamber is removed, so it must be changed in less than 4 seconds or the mask must be removed from the patient

Buttons:
- Start/standby (used to power on machine, start therapy, pause therapy, and power off machine)
- Home button
- Control/click dial

Monitoring:
- When ventilator is active, there is the "monitoring" menu and "my options" menu
- Monitoring: will display pressure bar graph and when you turn the control dial, you can find the tidal volume, minute ventilation, respiratory rate, leak, etc on the bottom of the screen
- My options: controls basic comfort settings (ramp, humidification)
- RAMP time: is the set amount of time the ventilator will take to slowly reach the ordered settings. It is for the comfort of the patient, so we're not putting the mask on and then immediately starting full ventilation
- The screen will go dark after a few seconds, press any button to brighten
- When there is an alarm, it will display on screen and give the option to mute (for 2 minutes). Alarm will stop and notification will disappear automatically when the issue is resolved

Checking Mode and Settings:
- Must use the secret handshake to unlock the ventilator and access clinical mode (to change settings)
    - Press and hold the home button and control dial button simultaneously
- Navigate to "my options" menu
- Scroll through to view mode and settings
- Repeat the secret handshake to re-lock the machine

Changing Mode and Settings:
- Must use secret handshake to unlock the ventilator and access clinical mode
    - Press and hold the home button and control dial button simultaneously
- Navigate to "my options" menu
- Scroll through to view mode and settings
- Select the parameter that needs adjusting by clicking control dial and rotate dial for desired setting
- Repeat secret handshake to relock the ventilator

Resmed Stellar

For facilitator: please review Learning Hub course # 26796

This is also a home ventilator.

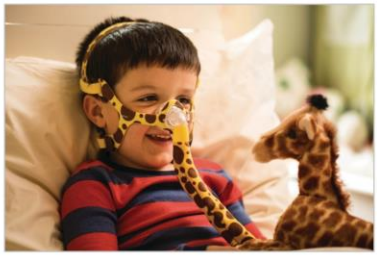
Parts from back to front:
- Power cord. This ventilator can operate on batter for about 2 hours
- Power switch is at the back (not the circular button in the middle on the front)
- There is an oxygen nipple attachment at the back
- The air intake filter is at the back- do not block this area (pillows, blankets, etc)
- Filter at the back
    - Cleaning: parents are instructed to rinse with water and air dry as part of cleaning schedule and/or if its visibly dirty/dusty etc.
- Detachable humidifier chamber:
    - Dial for humidity level
    - Use 2-pot system to fill chamber
    - Air flow is interrupted when chamber is removed so much change chamber in less than 4 seconds or remove mask from the patient
    - Detach humidifier chamber when patient is being transported to prevent back-flow of water
    - Fill with sterile water to the line
- The circuit is NOT heated. Option to use blue sleeve
    - What do we monitor for more closely if the circuit is not heated?
- Buttons
    - Alarm silence
    - Start/stop therapy → this ventilator has the option to put the ventilator on standby
    - Control click dial
    - Monitor menu
    - Set up menu
    - Info menu

Monitoring:
- Use the start/standby button to start therapy
- Click the monitor menu and scroll through the pages (RNs only need to use page 1/8: treatment and 2/8: monitor) to find pressure bar graph, expiratory tidal volume, minute ventilation, respiratory rate, and leak (also displayed on bottom of screen)

Checking Mode and Settings:
- Click set up menu and scroll through the pages (RNs only need to use page 1/3: clinical settings)

Changing Mode and Settings:
- Use the secret handshake to unlock the machine and access clinical mode
    - Press and hold the control dial and set up button simultaneously
- Navigate to page 1/3 and scroll through the settings. Click the parameter that needs adjusting and use the dial to adjust the setting
- Repeat the secret handshake to re-lock the machine

Mask Station



While staff are practicing with the ventilators, have a table set up with different masks that they might see on the inpatient units. Have participants practice applying and removing the masks from the mannequins.

Review: where the exhalation valve is, how to easily remove the mask (without undoing all the Velcro), why patients may have a nasal mask vs full face mass vs total face mask (scuba mask)

Lotions are not to be applied underneath the mask. This can break down the plastic of the mask and negatively effect the seal. If you are worried about your patient's skin integrity duoderm can be used.

Most patients have nasal masks. Patients may require full face or total face masks because they have a large leak from their mouth or because they require higher pressures. Some patients may have more than one type of mask.

Ask participants what they should monitor for if their patient is on a full or total face mask?

- Aspiration

Review that the ventilator needs to be turned on before applying the mask and the mask needs to be removed before turning off the ventilator.

HTV Team

Home Tracheostomy Ventilation Program

Supports children in BC who have tracheostomies and/or home ventilation.

HTV Team Members:

- 3 physicians
- Nurse
- 2 Respiratory Therapist
- Physiotherapist
- Occupational Therapist

**Not all patients will require these services*

The Home Tracheotomy and Ventilation team is a team of 3 physicians, 1 nurse, 2 RTs, 1 PT, and 1 OT who support ~ 150 children throughout BC who require home ventilation (ex. BiPAP, CPAP, patients with tracheostomies)

They see their patients in outpatient clinic every 6-12 months. They also follow all of their patients if they are admitted to hospital, usually as a consulting service or, when appropriate, the primary service.

If families or team members have any questions about equipment ordering, ventilator settings, at home nursing support, etc please direct them to the HTV team. They are available during the day throughout the week. They can be paged. Parents and caregivers also have their email and clinical phone number

Physical therapists may be involved with some of these patients for respiratory support and secretion management. These patients will have care plans that have been developed by PT (that include breathing exercises and secretion management guidelines). These care plans be found in CST under “documentation” and may be titled “Chest Health Action Plan” or may be included in the last PT note

If you are concerned about your patients secretion management or feel that your patient may benefit from breathing exercises, feel free to reach out to PT to see if they are an appropriate consult! *RT should be called for acute needs, but physio can help with longer term needs*

Test Your Knowledge…

Josie is a 6 year old girl with Spinal Muscular Atrophy. She requires BiPAP 16/8 for most of the day, with breaks in the morning and evening. You notice that her monitor is alarming because her heart rate is 130… you go in to assess.

Assessment:

Vital signs: HR 135, BP 120/90, RR 30, SpO2 94%, Temp 36.8

CNS: Quiet, Josie talks at baseline

Resp: Mild subcostal indrawing, shallow breathing

What are signs/symptoms of a patient with neuromuscular disease in respiratory distress?

How may signs and symptoms of a patient with neuromuscular disease (ex. SMA) in respiratory distress differ?

- Respiratory distress may be less obvious. May not display increased work of breathing, depending on how weak the patient is and the severity of their disease

Signs to look for instead/in addition to increased work of breathing:
-Oxygen desaturation is a late sign
-Increased heart rate
-Increased blood pressure
-If they are able to make noise/speak they will become quiet (short of breath)
-Increased respiratory rate
-Decreased tidal volumes (shallowly breathing)
-May deteriorate more quickly (has less reserve)
-Change in voice, activity, energy levels

Intervene early! These patients may deteriorate quickly, because they have less reserve. Intervene before their oxygen saturation begins to drop.

Interventions:
-Be proactive!
-Utilize positioning: place the patient in a prone or semi prone position to promote oxygenation and upper airway drainage; reposition Q2H
-Suctioning: consult family to see what the patient requires at baselines; suction before repositioning
-Consult RT for acute deterioration (if tidal volumes have been trending down, may require more support)
-Consult PT for longer term management (secretion management plan, chest health action plan)
-Chest physio and airway clearance are essential!

Nursing Considerations

Know your patient's underlying disease!

Feeding:

Some patients are fully orally fed while others require tube feeds

Followed routinely by HTV OT

Mobility:

May have lower exercise tolerance

Developmental Impact:

Development may improve with a trach

May be working towards having their ventilation decreased or learning to live with a trach and/or ventilator for their entire life

Include your patient in their care!

<u>Mobility:</u>

Children who require a wheelchair will have a special bracket mounted to their chair to accommodate their ventilator and other respiratory equipment

The trilogy ventilation has a carry bag that can be used by caregivers when their child is ambulating

<u>Development:</u>

For some children their quality of life and development improve once they receive a tracheostomy tube

Depending on the underlying disease process, some children will be working towards decreasing their ventilator support. While others with permanent/progressive conditions will be learning to live with ventilator support for the rest of their life.

Documentation

Hourly:

Site to Source

FiO2

Q4H and PRN:

Type of ventilation

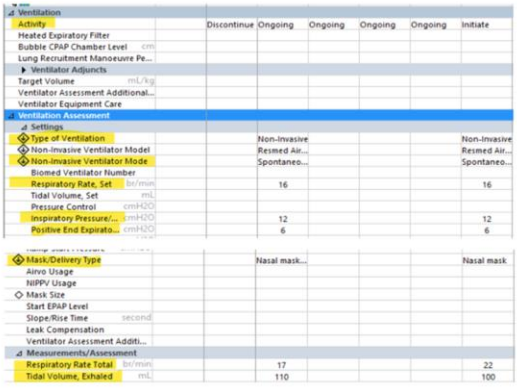
Non-Invasive Ventilator Mode

Settings (Set RR, PIP, PEEP)

Mask

Measured RR

Tidal Volume



* Follow documentation guidelines as per your health authority
Q1H: Site-to-source, monitoring as ordered
If applicable:
Oxygenation → Oxygen Activity, Oxygen Therapy, Oxygen Flow Rate – should be completed if patient on oxygen
Ventilation → Activity – should be completed when initiating, maintaining, or discontinuing ventilation

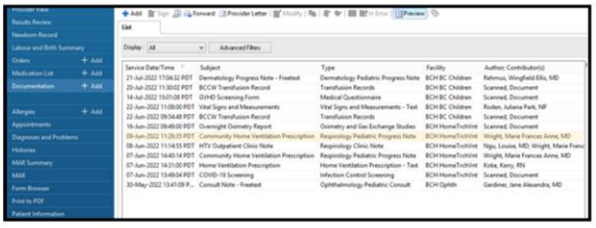
Q4H and PRN:
Ventilation Assessment →
Type of Ventilation
Non-Invasive Ventilator Mode
Settings (Respiratory Rate, Set (if applicable), Inspiratory Pressure (if applicable), Positive End Expiratory Pressure)
Mask/Delivery Type,
Measurements (Respiratory Rate Total, Tidal Volume, Exhaled)

Prescription

1. Found in Documentation

2. Navigate document titled “Home Ventilation Prescription”

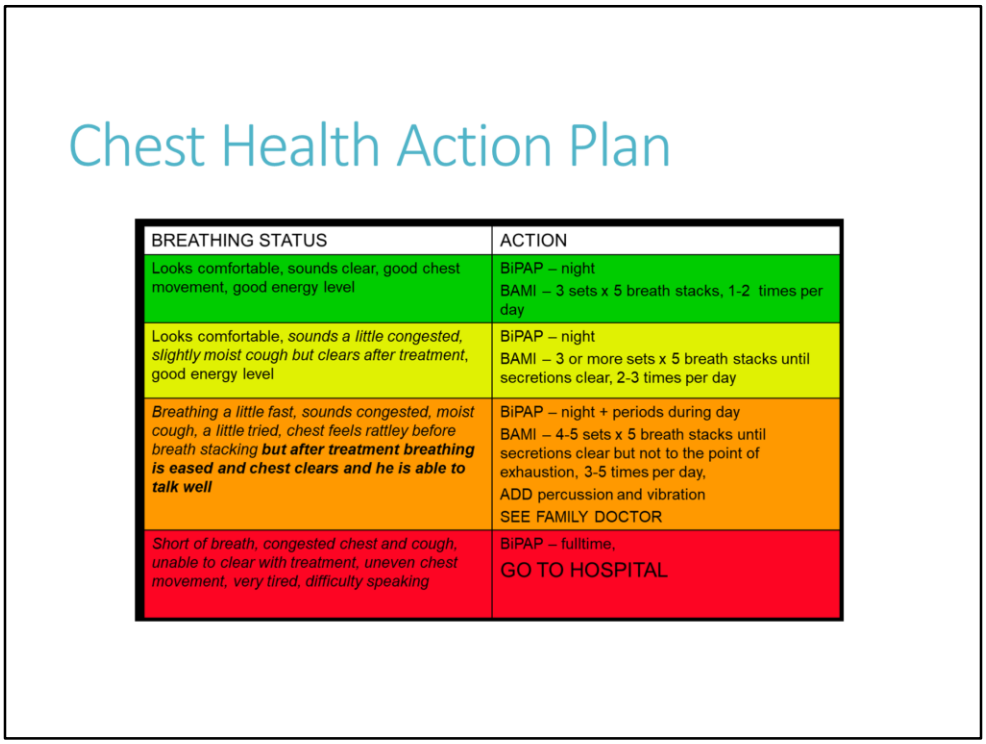
Respirology Pediatric Clinic Note
HTV Outpatient Clinic Note
Home Ventilation Prescription - Text
Home Ventilation Prescription
Nursing Assessment



Prescription

CPAP / NIPPV / Humidification Settings
HTV NIPPV Reason for Treatment : Skeletal anomalies
HTV NIPPV Mode : S/T
HTV NIPPV IPAP : 12 cmH2O
HTV NIPPV EPAP : 6 cmH2O
HTV NIPPV Inspiratory Time (Ti) : 0.6/1.2
HTV NIPPV Respiratory Rate : 20 br/min
HTV NIPPV Alarm Settings : Other: High Leak Alarm-On; Non Vented Mask Alarm-on
HTV NIPPV Titrate Oxygen to Keep SpO2 : >88
HTV NIPPV Oxygen Flow Rate : None
HTV NIPPV Frequency of Use : Nights
HTV NIPPV Special Instructions : Ramp-10 mins/ 4 cmH2O
Rise time-200 ms
Trigger-Very High
Cycle-med
mask setting-Pediatric

Oximetry Monitoring
HTV Oximetry Low Sat Alarm : 88
HTV Oximetry High Sat Alarm : Off
HTV Oximetry Low HR Alarm : 70
HTV Oximetry High HR Alarm : 200



If the HTV physiotherapist is involved in your patients care, they will have a Chest Health Action Plan. These plans are mainly used for patients with neuromuscular disease. The HTV physiotherapist is uploading all of these plans to CST and they can be found if you filter your documentation searches to “Special Care Plan”

These action plans can be helpful to have a better understanding of the breathing exercises and suctioning plans your patients are on at home. PT should be involved in your patient’s care if they are in hospital and have one of these plans.