MICHIGAN MEDICINE
UNIVERSITY OF MICHIGAN

Home Respiratory Support Machines (Ventilators)

What is Ventilation?

The action of air moving in and out of the lungs is called **ventilation**. **Ventilators** are machines that facilitate this process. Ventilators help your child breathe by helping them inhale and exhale. The ventilator pushes air into the lungs, to help them inhale. The exhalation process can be passive, which means air would freely flow out of a specially designed port, or it could be controlled by the ventilator.

What should I know about my child's ventilator?

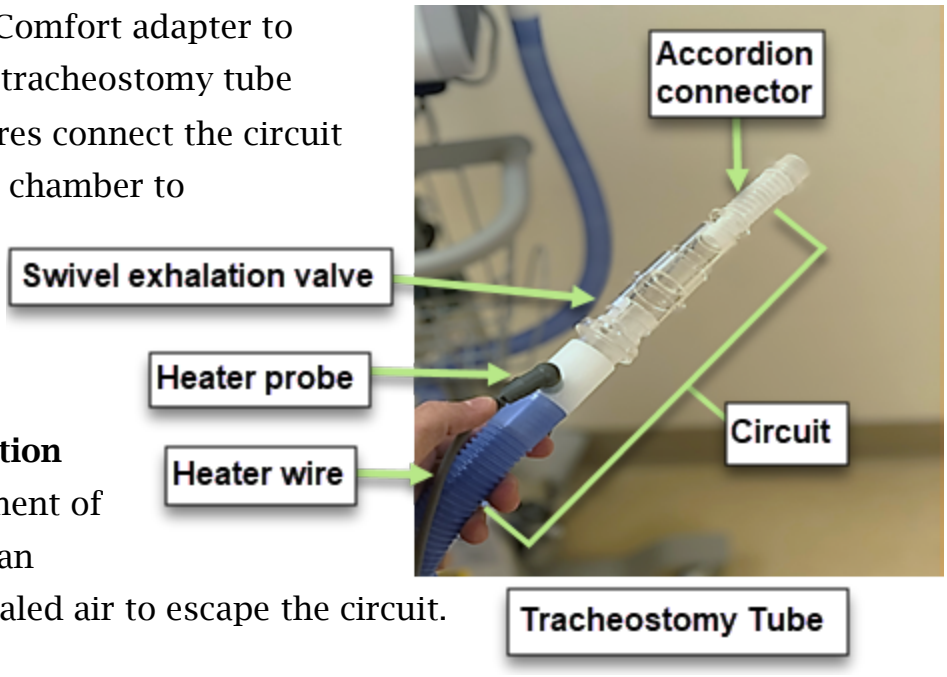
Each individual has a ventilator chosen specifically to meet the unique medical situation and specific support needed. Ventilators frequently change and improve, making it impossible to feature each and every difference between ventilators. Your respiratory therapist will go over the specifics of your child's home ventilator with you.

Some general concepts:

All ventilators deliver air to the individual through tubing attached to the machine and the individual's tracheostomy tube. A **tracheostomy tube** is a long, curved metal or plastic tube placed in a surgically-created opening in the windpipe (tracheostomy) to keep it open. Aside from the tracheostomy tube, the remaining tubing is considered the **circuit**. The circuit parts include:

- **Circuit:** the tubing that is connected from the ventilator to the individual. This tubing allows the air to inflate the lungs, while also providing a pathway for exhaled air to escape into the environment.

- **Accordion connector:** Comfort adapter to prevent tugging on the tracheostomy tube
- **Heater wires:** These wires connect the circuit to the heater and water chamber to maintain a constant temperature throughout the circuit.
- **Swivel-Whisper-Exhalation Valve:** This is a component of the circuit that creates an intentional leak for exhaled air to escape the circuit.



Notes about my specific ventilator:

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What is the difference between invasive ventilation and non-invasive ventilation?

When air is delivered to a person through a tracheostomy tube, it is called "**invasive ventilation**". Part 1 will explain invasive ventilation a bit more. Air can also be delivered to a person by using a mask. There are many different styles of masks that may be worn. This type of support is referred to as **"non-invasive ventilation**". Part 2 will explain Non-invasive ventilation (pg. 6).

Part 1– Invasive Ventilation

Ventilators have a variety of settings which are used to optimize your child's comfort as it breathes with/for them. There are many different modes, and settings that you can adjust to make this possible.

What are the types of invasive ventilation?

There are two types of invasive ventilation:

Pressure ventilation: Pressure refers to the flow of air into the lungs. In pressure ventilation, the ventilator will use as much flow as it needs to inflate the lungs to the prescribed pressure setting.

Volume ventilation: Volume refers to a set amount of air being delivered to the lungs. Lung volume is related to age and body weight, making each individual's volume needs different. When volume ventilation is used, the ventilator uses pressure to inflate the lungs with the amount of volume that is prescribed to the machine. In other words, the volume is set and the pressure required to obtain that set volume is variable.

What features do invasive ventilators have?

Modes: A mode of ventilation refers to the specific way in which the machine delivers breaths. There are several modes that can be used to best fit the needs of the individual.

Settings on the ventilator:

- **Pressure control (PIP / IPAP)** the amount of pressure the ventilator is set to deliver. In pressure ventilation, we set this value to ensure the same amount of pressure on each breath.
- **Positive End Expiratory Pressure (PEEP / EPAP**) the level of pressure that exists in the lungs at the end of a breath. Even when you breathe all of the air out of your lungs, there is still a level of PEEP that exists.
- **Pressure Support (PS)** an additional pressure setting that is offered during each spontaneous breath (without support) the individual takes in certain

modes of ventilation. Pressure support helps to reduce the individual's breathing work. This value is not always used, and is mode-dependent.

- **Rate (Breath Rate / RR)** the number of breaths the machine is preset to give an individual per minute. The rate is the minimum number of breaths the machine will deliver. The individual on the ventilator can always take breaths over the set rate if they choose.
- **Tidal Volume (Vte)** the volume or amount of air that the machine is set to deliver on each breath. In volume ventilation, we set the tidal volume so that on each breath, the same volume is delivered.
- **Average Volume, Assured Pressure Support (AVAPS)** an additional setting that can be turned on in many modes of ventilation. AVAPS allows advantages of both volume ventilator and pressure ventilation to be used in mechanical ventilation.
- **Sensitivity/Trigger Type (AutoTrak Sensitive/AutoTrak /Flow** how easy or difficult it is for the individual to take a spontaneous breath (without support) on the ventilator. The machine will sense effort and deliver a breath.
- **Inspiratory Time** the amount of time that the machine has to deliver the breath.
- **Rise** similar to the inspiratory time, and refers to the amount of time the breath has to reach its full set pressure **or** tidal volume based on which mode of ventilation is being used.

Alarms

Ventilators have alarms that are built-in, and cannot be adjusted. There are also many alarms that can be used based on different modes and settings on the ventilator:

- **Circuit Disconnect** is used in all modes of ventilation, and causes the ventilator to alarm if the individual is removed from the machine, or if the circuit is broken anywhere along its connections.

- **Apnea** means a period of about 20 seconds in which there is no initiation of a breath. The apnea alarm is only on ventilator modes that do not include a set respiratory rate. If there is a set breath rate, this will never alarm.
- **Low Minute Ventilation** alarm is used often as a "safety backup" to circuit disconnect. Minute ventilation is a calculation based on an individual's respiratory rate, multiplied by their tidal volume. If one of these parameters is low, this alarm will sound.
- **Low Respiratory Rate** is an alarm parameter that is used in modes of ventilation without a set respiratory rate. It alerts us to potential issues if the individual on the ventilator is not taking enough spontaneous breaths (without support).
- **High Respiratory Rate** is an alarm that is set in all modes of ventilation. This alarm will sound if the individual is breathing too quickly. Fast breathing can be a sign of respiratory distress. By hearing this alarm, one can begin to troubleshoot further if needed.

Table 1 Quick guide to understanding the modes of ventilation

Mode	How it works in Pressure Ventilation:	How it works in Volume Ventilation:
Assist Control – All breaths are machine assisted	Every breath delivered gets a set pressure	Every breath delivered gets a set tidal volume.
Synchronized Intermittent Mandatory Ventilation (SIMV)– Breaths given at the set rate are assisted by full support. Spontaneous breaths above the set rate are slightly less supported by the machine.	Machine breaths (those that are part of the set rate) will provide a set pressure. On patient-initiated breaths, the ventilator will deliver a slightly lower pressure.	Machine breaths (those that are part of the set rate) will provide a set volume. On patient-initiated breaths, the ventilator will deliver a slightly lower volume.
Spontaneous (S mode / PS) – There is no set rate on the machine. The individual is responsible for taking all of their own breaths as needed.	There is no set respiratory rate. Every breath will be initiated by the individual, and a set inhale pressure will be delivered.	There is no set respiratory rate. Every breath will be initiated by the individual, and a set tidal volume will be delivered.

Please Remember: Settings on the ventilator are specifically set for your child by your pulmonary doctor and respiratory therapist based on your child's medical condition. **Ventilator settings should never to be changed by you, family members, or home care staff for any reason without specific orders from your pulmonary doctor.**

Part 2 – Non-Invasive Positive Pressure Ventilation

Non-invasive positive pressure ventilation (NPPV) means that the air is delivered to your child with a device that fits on the face. There are many types of face devices. As a group, these devices are called "**interfaces**". The air enters the nose or mouth through this device, which is also connected to an NPPV machine.

Types of NPPV:

- **Continuous Positive Airway Pressure: (CPAP)**: Provides one constant pressure to the interface.
- **Spontaneous/Timed- S/T mode (also referred to as BIPAP)**: Provides two different pressure levels to the interface.
- **Inspiratory Positive Airway Pressure (IPAP):** Controls the peak inspiratory pressure during inspiration.
- **End Positive Airway Pressure (EPAP):** The pressure or PEEP left when the individual exhales.
- **Average Volume Assured Pressure Support (AVAPS):** This setting can be used as supplemental support in non-invasive modes of ventilation. This option allows the advantages of both volume ventilation and pressure ventilation to be used in mechanical ventilation.
- **Rate**: Is as optional value that can be set. The rate is the minimum number of breaths the individual can receive from the device.

Interfaces (facial devices) for Non-invasive positive pressure ventilation (NPPV) Machines:

Nasal Masks: Nasal masks fit over the nose of the individual only. They are secured with headgear.	
Full Face Masks: Full face masks fit over both the nose and the mouth. They are also secured by headgear.	
Nasal Pillows: Nasal pillows are soft pieces of silicon that look like little funnels that fit into each nostril and are held in place by headgear.	

Helpful hints for using NPPV at home

Here are some of the common complaints that your child may have, as well as some tips on how to fix them:

Complaint: Air is leaking out of the mask.
Cause: Poorly fitting mask.
What to do:

1. Adjust the mask with the child lying down.
    - Make sure that the mask is centered on the child's face.
    - Turn the machine on and check for leaks at the top of the mask toward the eyes. It is **ok** if the mask leaks slightly at the bottom.
2. Adjust the headgear. It should keep the mask in place without being too tight on the child's face. The skin should not appear reddened or blanched. These are signs of a poor-fitting mask.

Complaint: Skin redness and breakdown.
Cause: Headgear is too tight **or** the mask is oily/dirty.
What to do:

1. Check the headgear fit as stated above.
2. Wash the mask daily with mild soap and water. Allow the mask to dry completely before placing it on the child.
3. Utilize mask liners or skin barriers when needed. These include products like Duoderm, Pad-a-cheek, and RemsZzz's. These mask liners are specific to each different mask on the market. You can order them online.

Complaint: Nasal discomfort and dryness.
Cause: Excessive drying of nasal tissues from airflow of NPPV.
What to do:

1. Speak to your child's pulmonary doctor about getting a humidifier that attaches to the machine.
2. You may use over the counter nasal saline spray as needed for nasal discomfort.

Additional Notes:

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