

Knowledge Domain: Mechanical
Unit: Calibration
Skill: Ventilator

Tools and Parts Required:

- | | |
|--|-----------------------------|
| 1) Large jug | 7) Tape measure or ruler |
| 2) Transparent rubber tube, at least 40 cm in length | 8) Marker |
| 3) Rubber or latex glove | 9) Watch |
| 4) Balloon | 10) Pen or pencil |
| 5) Syringe, largest available | 11) Graduated cylinder (1L) |
| 6) String, at least 1 m | 12) Large tub |

Introduction

A ventilator is a machine used to assist patients in breathing. A ventilator can breathe for patients entirely. A ventilator may include a pump or compressed gases to provide gas to the patient. There are three basic modes of ventilation: volume limited, pressure limited, and timed cycle.

- Volume limited ventilation delivers a predetermined volume of gas to the patient.
- Pressure limited ventilation delivers gas until a predetermined pressure is reached in the lungs.
- Timed cycle ventilation delivers gas based on a predetermined volume, pressure, respiration rate, and inspiratory/expiratory ratio. In timed cycle ventilation, the predetermined volume is delivered at the respiration rate as long as the predetermined pressure is not exceeded.

A ventilator uses a non-rebreathing valve to prevent the patient from breathing his own expired gas. This valve opens when the patient expires gas.

Example

Ventilators are complicated machines. They may include computer screens. You usually need the manual to operate the ventilator, even for calibration. Below are two different ventilators.



Identification and Diagnosis

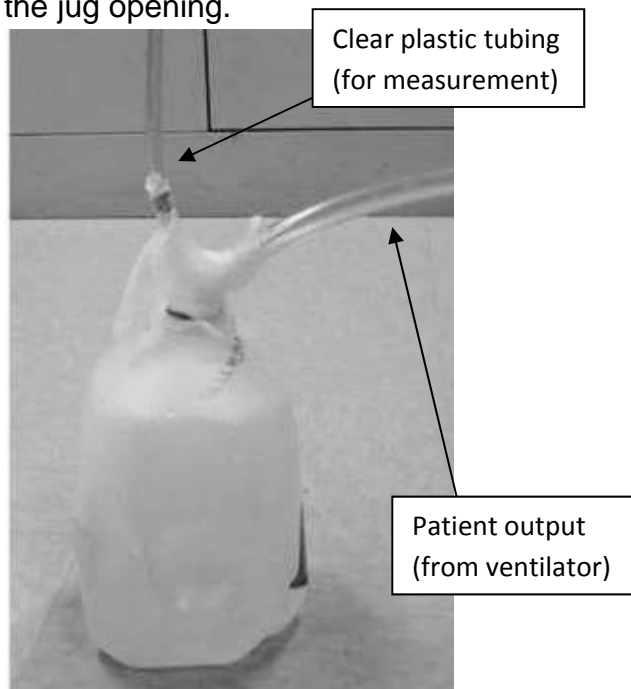
Calibration of ventilators does not require diagnosis. Calibrate each ventilator every 6 months as part of your planned preventative maintenance.

Procedure

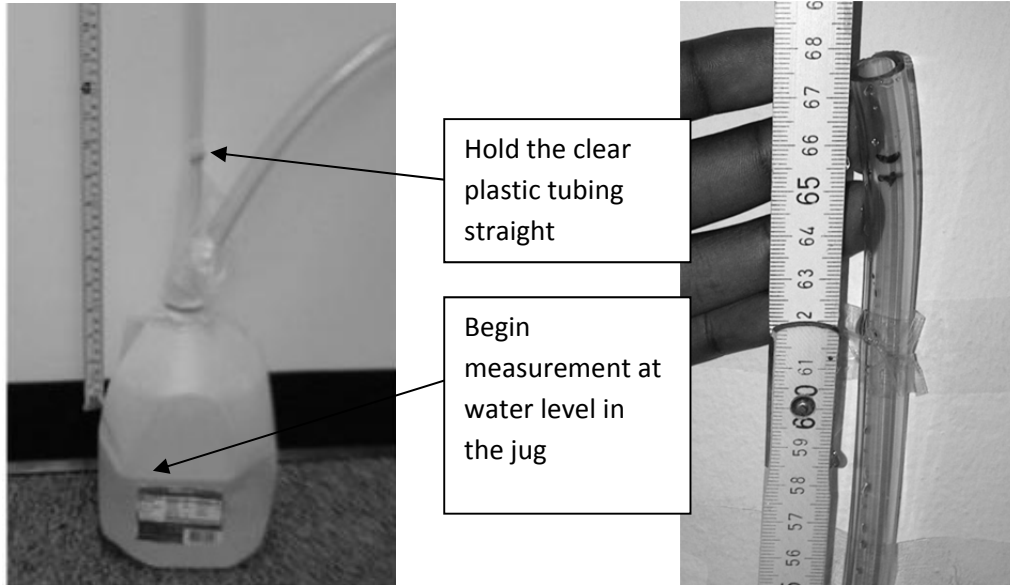
Before a ventilator is placed into service, it should be calibrated to insure patient safety. Three outputs must be calibrated: pressure, volume, and flow.

Pressure Calibration

1. Construct a manometer to measure pressure in centimeters of H_2O .
 - a. Use a large non-inflatable jug as the reservoir. Most water jugs will work.
 - b. Fill the jug half-full with water.
 - c. Insert the patient output from the ventilator into the plastic jug. Also insert one end of the clear plastic tubing into the plastic jug. The end of the plastic tube should be near the bottom.
 - d. Seal the tubes with latex gloves and tape. Insure that no air can escape from the jug opening.



2. Set the pressure limit on the ventilator. Record this pressure in Table 1 below.
3. Hold the clear plastic tubing straight up. Use a tape measure to measure the peak height of the water in cm H_2O . Measure from the water level in the jug to the maximum height reached in the clear plastic tubing. Record this measurement in Table 1 below. The height of the water is the pressure.



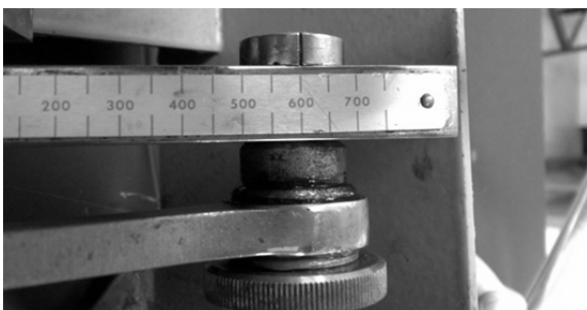
4. Repeat Steps 2-3 for four settings of pressure.
5. To determine if the ventilator is accurate enough, show your table to the physician that uses the ventilator.

Set Pressure (Step 2)	Measured Pressure (Step 3)

Table 1: Pressure Calibration

Volume Calibration

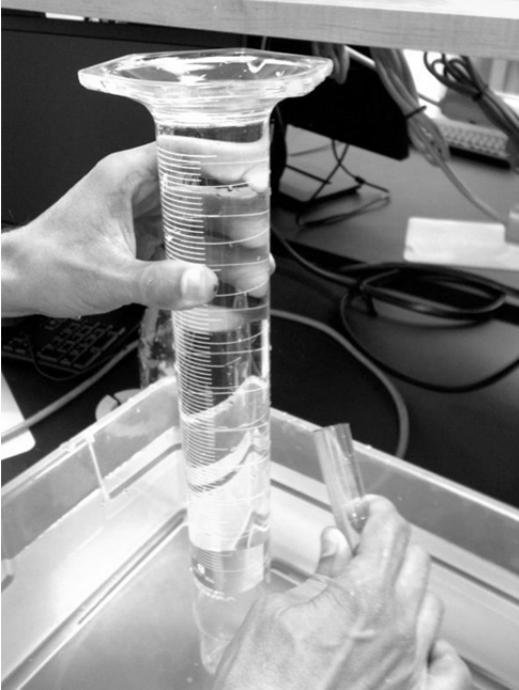
1. Insure that the ventilator's patient output tube is at least 80cm long. If the output tube is too short, change the tube to a longer one.
2. Set the ventilator to 500 mL. 500 mL is the average volume of a breath in adults.



3. Fill a plastic tube with water. The tub should be big enough to comfortably fit a 1 liter graduated cylinder
4. Fill a 1 liter graduated cylinder entirely with water. Insure there are no air bubbles. Set the graduated cylinder upside down in the container.



5. Place the patient output tube inside the graduated cylinder.



6. Turn on the ventilator. Allow the ventilator to deliver one breath. The top of the graduated cylinder should fill with air. Turn off the ventilator. Read the water level on the graduated cylinder. Record this value in Table 2 below.



7. Repeat Steps 1-6 to complete the table. You should measure three trials for three different volumes.
8. To determine if the ventilator is sufficiently accurate and precise, show your table to the physician that uses the ventilator.

Set Volume (Step 1)	Measured Volume (Step 6)
400 ml	
400 ml	
400 ml	
500 ml	
500 ml	
500 ml	
600 ml	
600 ml	
600 ml	

Table 2: Volume Calibration

Flow Calibration

1. Set the ventilator to deliver a constant volume per breath. Set the ventilator to deliver the number of breaths per minute you wish to test. Record the number of breaths in Table 3 below.
2. Attach a latex glove to the output of the ventilator so each breath is visible. Measure the number of breaths that occur in one minute using a watch. Record the number of breaths that occur in one minute in Table 3 below.
3. Repeat Steps 1-2 for four total settings of breaths per minute.
4. To determine if the ventilator is accurate enough, show your table to the physician that uses the ventilator.

Desired Breaths Per Minute (Step 1)	Measured Breaths Per Minute (Step 2)

Table 3: Flow Calibration

Exercise

Your instructor will give you a ventilator. Calibrate the ventilator in all available modes of ventilation. Your instructor must verify your work before you continue.

Proper calibration of ventilators is crucial. Proper calibration involves repeated measurements. Ventilators are critical pieces of medical equipment. The wrong pressure, volume or flow could result in death.

Preventative Maintenance and Calibration

Do not use a ventilator if it does not pass the calibration procedure. Common problems are caused by cracks or leaks in the tubing. The non-rebreathing valve can also be a source of failure. Check for cracks, leaks, or a loose connection of the non-rebreathing valve.