Operational Manual

If not done, set up the machine as shown on the Assembly Protocol. To activate the ventilator, you can plug the dc power supply in the arduino/PCB.

Ventilators and Pressure

Air flows in and out of the lungs because of the pressure difference between the atmosphere and the gases in the lungs. The 2 lungs pressure involved in the mechanics of breathing are: interalveolar pressure and intrapleural pressure (pressure: -4 to -10 mmHg).

When the net lungs pressure is equal to the atmospheric pressure (760 mmHg), airflow is absent. Upon inspiration, the lung pressure becomes less than the atmospheric pressure. Due to the increase in volume, the lung pressure decreases. When expiring, the lung pressure becomes greater than atmospheric pressure. Since the lung recoil and decrease in volume, the pressure in the lungs increase

Ventilators regulate this sequence in people whose physiologic function does not allow them to do so naturally through a process called compliance (Δ Volume / Δ Pressure). Compliance is defined as the pressure required to change the volume. This amount is naturally very low. However, in a patient who cannot expel air on their own, the machine works by positive pressure balance. Since naturally the lungs have a negative pressure, the ventilator works to equilibrate this value by expelling the correct amount of CO_2 from the lungs.

Intubation

How to Intubate

1. Hyperextend the patient's neck and support the back of the patient's head with your left hand

2. Open the patient's mouth with your right hand, placing your thumb and the lower jaw and middle finger on the upper jaw. Keep your finger as far to the right as possible so your fingers do not touch the blade

    a. Rationale: by pushing on the patient's jaw rather than manually spreading, the mouth can be opened wider

3. Pick up the blade with your left. Hold it with the blade down and pointing away from yourself

4. Insert the blade in the patient's mouth, slightly to the right of the tongue. Keep advancing the blade until you see the tip of the epiglottis. As you are advancing, sweep the patient's tongue to the left

      a. Do not hit the patient's teeth

      b. Avoid catching the lips between the blade

      c. Macintosh Blade (curved): needs to be angled once past the teeth

      d. Miller blade (straight): can be inserted directly

5. Adjust your stance: lift your left arm upwards and away from yourself, keep your elbows in, keep your back straight

      a. Rationale: poor posture put the health care professional at risk for injury, eyes too close to the patients results in stereoscopic vision, intubation arm relying of wrist strength results in loss of maneuverability

6. View the larynx. If the patient's head is properly tilted backwards, there should be a clear view of the larynx

      a. Macintosh Blade (curved): put pressure on the vallecula to pull the epiglottis forwards

      b. Miller blade (straight): epiglottis lifts itself

      c. Tongue must be swept to the left and blade slightly to the right of the tongue for larynx to be visible

      d. If you cannot see the larynx, use cricoid pressure

7. Pass the tube through the cords into the trachea. Stop advancing the cords when you see the cuff pass the cord (~21-22 cm)

      a. Proper placement: can see arytenoid cartilage behind the tube

8. Hold the tube with your right hand and carefully remove the blade with your left hand

9. Inflate the cuff by slowly injecting air through the tube until the balloon just starts getting tense

10. Auscultate the patient's lungs to make sure the tube was in fact places in the trachea

User Interface

There are 3 pages: General Settings, Patient Settings, and Monitor.

On General Settings (the gear icon), you can modify settings that will persist between sessions. Click on a textbox to modify its values. A dialog will open and you can use the slider to select a new value. We've chosen this method of interaction because we feel it goes well with a touch screen.

On Patient Settings (the avatar icon), you can modify settings which pertain to the particular patient currently using the ventilator. Modifying settings works as with General Settings.

On Monitor, you can observe the operation of the ventilator and the breathing of the patient. Important "quick settings," such as tidal volume and respiration rate, can be changed easily - simply click on the button, and adjust the value using the same slider dialog system.

In the top bar, to the left of the date and time, there is a bell-shaped icon. This icon is part of the alarm system. It contains a list of all active alerts and information on possible repercussions and solutions. When no warnings or errors are active, the bell is white; when at least one is active, it is red. Whenever a warning or error is triggered, two things will happen:
   a) A dialog box will open, front and centre, notifying the user that so-and-so has happened and recommending they open the notifications menu for more information. This dialog box can be immediately dismissed so as not to impede the physician from viewing charts and data or modifying settings.
   b) The warning/error will then be added to the alarm list, which can be opened by touching the aforementioned bell icon. When the issue causing the warning/error is solved, its notification will automatically disappear.

At the top of the screen, next to the title, is a ? icon. Clicking on this icon will bring up the Help dialog, which instructs the user in using the app. All instructions found here are also in that dialog, in some form or another. Note that the Help dialog will automatically open every time the ventilator is turned on.

References

Kozier, B., Erb, G., Bermna, A., Buck, M., Yiu, L., & Stamler, L. L. (Eds.) (2018). *Fundamentals of Canadian Nursing*. Canadian 4th ed. Toronto: Pearson Education Canada

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