RCH @ Home Manual: Continuous Positive Airway Pressure (CPAP) Ventilation

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This section covers the basic principles of CPAP. There are many different machines that are used to deliver CPAP. For information specific to the child’s own CPAP machine please see the relevant manual written by the manufacturers of the machine.

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<th>Version</th>
<th>5.0</th>
</tr>
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<tbody>
<tr>
<td>Date revised:</td>
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1. **What is Continuous Positive Airway Pressure (CPAP)?**

- CPAP describes the way we deliver continuous pressure to the child’s airways to make it easier for them to breathe.
- We give CPAP to children who have floppy airways or children who cannot breathe well enough on their own.
- The continuous pressure keeps the child’s air sacs in their lungs slightly open at the end of breathing out (expiration), which makes it easier for the child to take each breath.
- All children who have CPAP must to be able to breathe on their own. The machine makes it easier for the child to breathe, it doesn’t breathe for them if they stop breathing.

Imagine the lungs are like a balloon, you have to work quite hard when you start to blow up a brand new balloon, but it gets easier to blow up once there is some air in the balloon. It is the same with the lungs – if there is no air in the lungs the child has to work hard to get enough air into them, but if there is a little air (pressure) in the lungs then the child doesn’t have to work as hard to get enough air into them.

If we did not give them CPAP the child would have to work much harder to breathe. A child who has to work hard to breathe gets tired quickly will become very unwell and may stop breathing (become apnoeic) if they aren’t given help immediately.

CPAP can be delivered to the child via a tracheostomy tube, nasal mask or full face mask (see below).

2. **Important information for support worker**

The support worker will not be required to change any of the settings on the ventilator. This is only to be done by trained medical professionals or appropriately trained family members of the child and always in consultation with the child’s medical team.

3. **The breathing circuit**

Breathing circuits on different CPAP drivers can have slight differences between them, however all breathing circuits are generally made up of a:
3.1 CPAP driver

The CPAP driver is the machine that draws in room air through a filter(s) and then blows it out through a circuit to the patient to create a constant pressure in the child’s airways. This prescribed pressure is set on the CPAP driver. The driver has filters in it which need to be changed according to manufacturer’s recommendations or if they become dirty. There are usually two filters: the white one which needs to be changed monthly and the grey sponge which needs to be changed weekly (this can be washed and re-used).

3.2 Airway Pressure Monitor

Some CPAP drivers have an inbuilt pressure monitor; others require an external Airway Pressure Monitor, (see child specific care page). If the monitor is built into the driver, refer to the machines instructions of use (in the manual).

The airway pressure monitor measures the pressures that are being delivered by the CPAP driver. The monitor will alarm if the pressures are too high or too low. It will not tell you if the child stops breathing. A small tube connects the airway pressure monitor to the inspiratory limb at the end nearest to the child.

There is a delay control setting located on the lower right hand side of the front panel. The delay control sets how long the pressure in the breathing circuit can be below the Low Set control level before the Low Pressure alarm sounds. The delay control should be set as low as possible to detect disconnections quickly before the patient connector becomes blocked against the child’s skin or bedding. The alarm silence button is located next to this delay control.

This airway pressure monitor runs on a 9volt alkaline battery which must be changed as soon as the replace battery alarm activates. The battery lasts roughly 8-12 weeks if used continuously and with little alarm activation. A spare battery should always be available in the home and kept near the pressure monitor.

3.3 Inspiratory limb

This tubing delivers the pressure to the child from the CPAP driver. It is plugged into the CPAP driver and then connects to the child’s mask or tracheostomy. If the child has CPAP via a tracheostomy they will have a humidifier as part of the circuit (see below). In this case there will be two tubes – one that goes from the CPAP driver to the humidifier and then a tube that goes from the humidifier to the child (delivery tube). The inspiratory limb and all the connections that go with it can be very heavy. It is important to prevent all the tubing from pulling on the child’s tracheostomy.
3.4 **Humidifier**

![Image of humidifier and CPAP circuit connections](image)

Above picture shows the connections required when adding in a mechanical humidifier to the circuit (actual humidifier not in picture)

The heated humidifier warms and moistens the air the child breathes which helps to prevent thick secretions and damage to their lungs. The humidifier is added to the inspiratory limb of the CPAP circuit. It has a large heated plate which warms water in a chamber. The evaporation moistens the air which is delivered to the airways. The humidifier also connects to a heater wire that runs up the middle of the inspiratory limb and also a temperature probe to monitor the air temperature near the child’s airway. Some CPAP drivers have humidifiers built into them.

A child receiving CPAP may be able to do without heated humidification for periods of up to 8 hours. Children receiving CPAP via a tracheostomy require more constant humidification. A heat and moisture exchanger (HME) should be used when a mechanical humidifier is not able to be used.

Due to the temperature difference between the air inside the inspiratory limb and the air outside, the water vapour cools and condensation collects in the inspiratory limb. This water needs to be emptied regularly as it can run into the patient’s mask or tracheostomy which could cause them to breathe in the water (aspirate). Water in the inspiratory limb can also cause the monitor to alarm.

When draining water out of the circuit, always keep the circuit lower than the child (so water doesn’t enter the tracheostomy/mask). You may need to disconnect the circuit from the child to do this and they may need manual bagging while you drain the water out.

Not all patients require humidification. Always check the specific needs of the child by checking the patient’s current ventilator order and child specific care page.

3.5 **Oxygen inlet**

If the child requires oxygen while on CPAP an additional tube carrying the oxygen from either an oxygen concentrator or oxygen cylinder is attached to the CPAP circuit via a connector. The connector is normally attached to the outlet of the CPAP driver, before the filter (if present) and inspiratory limb.

3.6 **Whisper swivel/exhalation port or device**

The exhalation port allows the carbon dioxide (CO2) that the child breathes out to be released from the circuit. It is important that there is an exhalation point in the circuit so the child does not rebreathe carbon dioxide as CO2 is toxic to the body in high levels. The exhalation port must always be in the circuit as close as possible to the mask or tracheostomy. Some masks have the port built into them while others will need it added. When using a tracheostomy the exhalation port must be added into the circuit, this will be
provided by RCH Clinical Technology Service. The child may suffocate if there isn't an appropriate exhalation port or if the port is blocked.

### 3.7 Tracheostomy connector

Children who have a tracheostomy must have a connector added which has holes drilled into it that allow carbon dioxide to be breathed out of the circuit. This should be placed near where the connector attaches to the tracheostomy tube. It is essential to always ensure that the leak holes are not blocked and to only use connectors that have these holes present.

The above picture shows the part of the circuit that connects to the tracheostomy. It includes the tracheostomy connector with the inbuilt leak (holes drilled into connector), Airway pressure monitor connector, temperature probe connector, top end of inspiratory limb

### 3.8 Battery Pack

The CPAP driver is supplied with a battery pack that can be used to provide power to the CPAP driver when there is no other source of power (e.g. electrical fault, going for a walk outside, driving in the car). The battery pack should be left charging on mains power at all times. A fully charged battery lasts for approximately 4-6 hours when in use.

3.8.1 Travelling in the car

The CPAP driver can be connected to run through the car when you are driving. The connection plugs into the cigarette lighter in the car. It is very important to disconnect the battery and CPAP driver from the car when the car is turned off otherwise the battery continues to charge itself using the car battery, which can cause the car battery to go flat.

### 4. CPAP Masks

There are three different kinds of masks that can be used to give CPAP to a child:

#### 4.1 Nasal mask

The nasal mask only covers the nose. Some nasal masks contain a leak. If the mask does not have a leak then an exhalation port must be added to the circuit. A foam rest is added to the top of the mask to help protect the bridge of the nose and position the mask. Straps are used to secure the mask to the patients face.
4.2 Full face mask

This covers the nose and mouth. One side of the mask is fitted with a quick release clasp so it can be taken off quickly if patient vomits or stops breathing. Some masks contain an hole for the leak, if the mask does not have this then an exhalation port must be added to the circuit. Full face masks also have an anti-asphyxiation valve (AAV) that opens to room air if pressure is lost from the cpap machine and is closed when pressure is present (see below). A foam rest is added to the top of the mask to help protect the bridge of the nose and position the mask. Straps are used to secure the mask to the patients face.

4.3 Total face mask

Covers the whole face. One side of the mask is fitted with a quick release headgear so it can be taken off quickly if patient vomits or stops breathing. There are two exhalation points (holes in the mask) which allow carbon dioxide (CO₂) to flow out and an anti-asphyxiation valve to allow room air into the circuit in case of mechanical failure.

4.4 Safety Valve (anti asphyxiation valve)

The anti asphyxiation valve is built into any mask that covers the nose and mouth i.e. Full Face mask and Total Face Masks. The valve works if there is not enough pressure in the circuit usually because of a problem with the CPAP driver or circuit. This valve allows the child to breathe room air when the CPAP driver isn't working correctly.

If the CPAP driver isn’t delivering enough breathing air to the child and they are breathing from room air they will not be getting any pressure support for their breathing and the amount of oxygen they are breathing may not be enough. In this situation it is important that the child is monitored and the support worker notifies the family immediately so they can provide another way of helping the child to breathe while the driver is fixed.
5. Putting on a mask

It is important that the mask is not too tight and not too loose.

The masks should be put on as loose as possible while still allowing the machine to create the prescribed pressure. Masks that are too loose can cause a large leak of air which can mean that not enough pressure will be delivered to the child.

We expect there to be some leak of air from around the mask - the CPAP machine is designed to deal with a small intentional leak.

Masks that are too tight can cause skin damage and other complications which can stop the child from wearing a mask. Over time a mask that is on too tight can also lead to dental problems or changes in normal bone growth (of the facial bones). You will need to report any areas of redness or skin breakdown to the child’s family.

6. Cleaning a mask

All masks should be wiped over daily with a soft damp cloth and left to dry. Once weekly (or more frequently if required) the mask and head harness should be washed in warm water, using a mild shampoo or dish detergent, rinsed well and allowed to dry completely in air. Do not dry the head harness in a clothes dryer as this can lead to shrinkage or damage to the material and Velcro straps.

After the head harness and mask are completely dry, reassemble and store in a clean, dry pillow case with a spare, clean circuit.

Caution: Do not clean any parts of the circuit with alcohol, cleaning solutions containing alcohol, any strong household cleaners or bleach. Do not use cleaners containing conditioners or moisturizers. These could damage the circuit and/or leave residues.

7. Troubleshooting airway pressure monitor alarms

The airway pressure monitor has alarms that are set to alert you that there is a problem. **When an alarm goes off you must always check the child before you take any further action, including silencing the alarm.**

<table>
<thead>
<tr>
<th>Alarm</th>
<th>What caused it</th>
<th>How to fix the problem</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Inadvertent Off alarm</td>
<td>The airway pressure monitor is switched off but it detects that the CPAP driver is on</td>
<td>Turn on the CPAP driver</td>
</tr>
<tr>
<td>High Pressure Alarm</td>
<td>Kink in tubing</td>
<td>Check tubing for kinks and remove (may need to replace circuit)</td>
</tr>
<tr>
<td></td>
<td>Child is crying, laughing, moving</td>
<td>Comfort child if upset.</td>
</tr>
<tr>
<td></td>
<td>If the child has a tracheostomy tube then this may have secretions in it and need suctioning</td>
<td>Suction the tracheostomy to remove secretions</td>
</tr>
<tr>
<td></td>
<td>Water in tubing (if using mechanical humidifier)</td>
<td>Remove any water that may be in tubing</td>
</tr>
</tbody>
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Low Pressure Alarm
The pressure in the circuit is lower than the low pressure alarm setting.
A connection along the tubing has come apart (circuit disconnection)
Leak in circuit
Check child and circuit and reconnect
Check circuit for leaks and replace if required

Replace Battery Warning
You will hear an intermittent alarm tone and see the alarm light
Battery is running out on the pressure monitor. You have approximately 6 hours to replace the battery.
For safety, replace the battery as soon as the alarm sounds. Use a new alkaline 9volt battery

8. Care of the ventilated child

8.1 Start of shift equipment checks

8.1.1 CPAP driver
- Make sure the driver is plugged into the mains AC power and the power point switch is on
- Starting from the CPAP driver check the circuit for leaks and ensure connections are tight
- Check for water (from excess condensation) in the circuit and remove water
- Using the ventilation order make sure that the settings and alarm limits are correct

8.1.2 Airway Pressure Monitor
- Check that the monitor is connected to the inspiratory limb near the mask via a small pressure monitoring tube
- Check that the monitor alarms are set correctly
- Check that the delay setting is as low as possible (0.5sec)
- Make sure the monitor is on
- Check a spare battery is available

8.1.3 Oxygen Saturations monitor (if required) refer to oxygen saturations manual
- Monitor plugged into mains AC power and the power point switch is on
- Check that saturation sensor probe ("Sats-Probe") has been repositioned on the child in the last four hours.
- Check that the monitor is displaying the heart rate and oxygen saturation. Some monitors may also have a trace of saturation over time.
- Make sure the alarm limits are set according to the limits on the sats monitor child specific care page.

8.1.4 External Battery Pack
- Make sure Battery is charging on mains power and that all connections are available
8.1.5 **Mechanical Humidifier** (if used) refer to humidifier section of manual
- Check that humidifier is on the right setting (is it mask or tube ventilation?)
- Check the water level and add cooled boiled water if needed.
- Check that the humidifier is displaying an appropriate temperature (if temperature display is available).
- Make sure the humidifier is lower than the child (so water can’t drain into the circuit)
- Make sure the temp probe is connected to the circuit and that it is in a position that will prevent it getting wet.

8.1.6 **Oxygen**
- If oxygen is required check if there is enough oxygen equipment (O2 cylinders, concentrators, tubing, connectors) for your shift and the next shift

8.1.7 **Suction**
- Check that suction is available, working and is fully charged or charging. Check that the canister and the suction catheter are clean and the right size for the child.

8.1.8 **Resuscitation equipment**
- Make sure the resuscitation bag or mask is available and working
- Make sure the emergency tracheostomy kit is available and fully stocked (if child has a tracheostomy)
- If any of the equipment used for ventilating the child needs servicing or repairs, please inform the parents. The parents will need to arrange to return the equipment to the RCH Clinical Technologists.

8.2 **Standard checks of a ventilated child**
At the beginning of the shift the support worker should get a handover from the family. Together you should check:
- Is the child breathing normally (for them)?
  - Is the breathing faster or slower than normal?
  - Are they working harder to breathe than normal?
  - Is the breathing softer or shallower than normal
  - Does their breathing sound normal for them?
- Does the child need suctioning?
- Do the settings on the ventilator match the settings prescribed in the child’s ventilation order
- Is the ventilator properly connected to the child—not too loose, not too tight?
- Is the CPAP machine plugged into mains power?
- Is there enough water in the mechanical humidifier?
- Is there too much water in the ventilation tubing?
- Are the anti-asphyxiation valves clean, free of blockage and working properly?
- Are the carbon dioxide ports/holes clean and free of blockage?
- How has the child been? Are they well at the moment? Has there been any change in the child’s condition since the support worker last cared for them?
If there are any equipment problems fix them while you complete your checks. If you have any concerns about the child speak to the child's primary caregiver immediately.

### 8.3 Hourly checks

The support worker needs to complete standard checks of the child every hour or as directed by the child specific care pages (more frequent checks may be needed).

- Check the child looks/acts like their usual self
- Does the child need suctioning?
- Is the CPAP circuit properly connected to the tracheostomy?
- Check the pressures on the ventilator – are they reaching the pressures prescribed on the ventilation order?
- Is there enough water in the humidifier?
- Is the ventilation tubing free of water (condensation)?
- Provide 4 hourly pressure area care (or more frequently if any pressure areas present)

Read the child specific care pages for any other checks required. During the support workers shift they may be required to record information from the ventilator as directed by the child specific care page/nurse or family.

The following signs and symptoms should be reported to the child’s primary caregiver and the child’s Doctor:

- Blocked nasal airways and sinusitis due to infection or allergy
- Ear infections
- Pressure areas from the mask or head harness
- Nose bleeds
- Headaches on waking
- Asthma or wheezing
- Larger than normal mouth leak

### 9. Changing and cleaning the circuit

A home use circuit can be cleaned and reused; this should be done by the family. Some of the equipment may be disposable; check with the nurse or child’s family if you are unsure. A home use circuit needs to be changed and washed weekly (or more frequently if it becomes dirty or there is a breakage in the circuit).

To clean the home use circuit (once it is removed from the ventilator)

- Remove the heater wire from the inspiratory limb.
- Wash the inspiratory limb in warm soapy water, then rinse well and allow it to dry completely in room air
- Wipe temp probe with a dry cloth
- If there is a heater wire put it back into the inspiratory limb when the inspiratory limb is dry. You will need to use a special hook to pull the heater wire through the limb.
- Change the filter in the back of the CPAP driver
- Once the circuit has been cleaned and dried it should be set up for use and packed away – a clean dry pillowcase can be used to store the circuit.