Complex Care Hub Manual: Biphasic Positive Airway Pressure (BiPAP) Ventilation

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

<table>
<thead>
<tr>
<th>Version</th>
<th>4.0</th>
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<tbody>
<tr>
<td>Date revised: 2017</td>
<td>Next due: 2019</td>
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</table>
1. **Important information for support worker**

The support worker will not be required to change any of the settings on the BiPAP machine. 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.

2. **Commonly used terms**

2.1 **Inspiration**

Describes the act of breathing in or taking a breath.

2.2 **Expiration**

Describes the act of breathing out. When combined with inspiration this forms the basis of ventilation (breathing).

2.3 **Breath rate (bpm)**

The amount of breaths given in one minute, as measured on the ventilator.

2.4 **Ventilation**

In this section ventilation describes mechanical ways of breathing for someone who can’t breathe well enough on their own.

2.5 **Biphasic Positive Airway Pressure (BiPAP)**

BiPAP is a type of ventilation where the ventilator delivers two levels of pressure to the child to mimic regular breathing patterns (breathing in and out).

2.6 **Positive inspiratory pressure (PIP)**

PIP is the pressure delivered during inspiration. The pressure helps the child to breathe in so that the child does not have to work as hard to take a good breath. Another term you may hear used to describe PIP is Inspiratory positive airway pressure (IPAP).

2.7 **Positive end expiratory pressure (PEEP)**

PEEP is a lower pressure maintained in the airways at the end of expiration. The BIPAP ventilator (machine) decreases the pressure from PIP (breath in) to PEEP (end of breathing out) with the lower pressure (PEEP) keeping the lungs open a bit (inflated) at the end of the breath. Keeping some pressure (PEEP) in the airways makes it easier for the child to take their next breath in.

For example: Imagine the lungs are like a balloon, it is harder to blow up a brand new balloon but it gets easier 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 in the lungs then the child doesn’t have to work as hard to get enough air into them.

Another term you may hear used to describe PEEP is expiratory positive airway pressure (EPAP).
3. The breathing circuit

Circuits on different BiPAP drivers can have slight differences between them, however all breathing circuits are generally made up of a:

3.1 BIPAP driver or ventilator

The driver draws in room air using an enclosed high speed fan. The pressurised air is then delivered to the patient via the inspiratory limb. The driver is set to deliver Peep and PIP. It can also be set to deliver a minimum number of breaths and to alarm if there are any problems with the child.

The driver is usually set to work with the child to help them breathe. The driver detects when the child is starting to take a breath and it helps to support the child when they do this. When the machine works with the child it is called a synchronised breath.

3.2 Inspiratory limb

The inspiratory limb is tubing that delivers the air pressure from the BiPAP driver to the child. The tube is connected to the BiPAP driver and then onto the child’s mask.

When the child has mechanical humidification there are two sections to the inspiratory limb. The first (shorter of the two) goes from the BiPAP driver to the humidifier. The second (longer) limb goes from the humidifier to the child’s mask.

3.3 Humidifier

The mechanical humidifier acts to warm and moisten the air. Some BiPAP drivers have an inbuilt humidifier (see specific driver manual section) whilst others require an external humidifier added to the circuit (see Fisher and Paykel Humidifier manual section).

A child receiving BiPAP may be able to do without the mechanical humidifier for periods of up to 8 hours. This can be done provided extra care is taken with moistening secretions; more frequent suctioning may also be required.

Not all patients require humidification. Please check ventilator order in the child specific care pages to confirm.

3.4 Oxygen inlet

If the child requires oxygen while on BiPAP an additional tube carrying the oxygen from either an oxygen concentrator or oxygen cylinder is attached to the BiPAP circuit.

3.5 Whisper swivel/port/exhalation device

This device must always be in the circuit. Some masks have it inbuilt while others will need this device added to the circuit. It is placed as close as possible to the mask (or in the mask) to allow carbon dioxide (CO₂) to flow out of the mask/circuit. The BiPAP driver is designed to cope with this “intentional leak”.

4. BiPAP masks

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

4.1 Nasal Mask

The nasal mask only covers the nose. There is an attachment which allows carbon dioxide (CO₂) to flow out. 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 a 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 BiPAP machine and is closed when pressure is present. 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 patient's face.

4.3 Total Face Mask

This 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-asphyxia valve to allow room air into the circuit in case of mechanical failure.

4.4 Safety Valve (anti-asphyxiation valve)

The safety 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 BiPAP driver or circuit. This valve allows the child to breathe room air when the BiPAP driver isn't working correctly.

If the BiPAP driver isn’t working and the patient is 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 BIPAP machine is designed to deal with a small 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 always on too tight can 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.

5.1 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, rinse well and allowed to dry completely in air. Do not dry the head harness in a clothes drier as this can lead to shrinkage or damage to the material and Velcro straps.

After the head harness and mask are completely dry, put them back together 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 harmful residues.

6. Delivering BiPAP

There are four different ways BiPAP can be given. See the child specific care page and ventilation order to check which type the child you care for uses:

6.1 Spontaneous Timed mode

The BIPAP driver recognises that the child is trying to take a breath and helps them, but if the child does not try to breathe on their own in the time allowed the driver will give them a breath.

6.2 Timed mode

The child gets a set rate of breaths every minute.

6.3 Spontaneous mode

The child must start (initiate) their own breaths. The BIPAP driver will recognise when the child tries to take a breath and will help them.

6.4 Continuous Positive Airway Pressure (CPAP)

The child must initiate their own breaths. The BiPAP driver provides only one level of pressure support which remains constant during both inspiration and expiration.

In each mode there are various other settings that impact patient comfort and safety. These will be covered in the specific ventilator section.
7. Troubleshooting alarms

Alarms are set to alert the support worker 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.

Each different type of BiPAP machine will have a different way of displaying alarm messages. Please see the attachment about the child’s own BiPAP driver which will explain the specific alarms for the machine.

There are common reasons for an alarm to go off, they are outlined below

<table>
<thead>
<tr>
<th>Common types of alarms</th>
<th>What caused the alarm?</th>
<th>How to fix the problem</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High Pressure Alarm</strong></td>
<td>Child is crying, laughing, coughing or moving</td>
<td>Comfort child if upset.</td>
</tr>
<tr>
<td></td>
<td>Kink in tubing</td>
<td>Suction if required</td>
</tr>
<tr>
<td></td>
<td>Water in tubing (if using mechanical humidifier)</td>
<td>Remove kinks (may need to replace circuit).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Remove any water that may be in tubing</td>
</tr>
<tr>
<td><strong>Low Pressure Alarm</strong></td>
<td>A connection along the tubing has come apart (circuit disconnection)</td>
<td>Check child and circuit and reconnect</td>
</tr>
<tr>
<td></td>
<td>Leak in circuit</td>
<td>Check circuit for leaks and replace if required</td>
</tr>
<tr>
<td><strong>Low Minute Volume Alarm</strong></td>
<td>The child has not had enough oxygen/air in the last minute</td>
<td>Check that the child’s chest is rising and falling equally on the left and right side</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Keep airway clear with suctioning</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Inform the child’s parents if alarm continues despite troubleshooting measures.</td>
</tr>
<tr>
<td><strong>High Leak alarm</strong></td>
<td>Large leak of air from around the mask</td>
<td>Feel around the mask for a leak. Adjust the straps</td>
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</tbody>
</table>

8. Care of the ventilated child

8.1 Start of shift equipment checks

8.1.1 BiPAP driver and inspiratory limb
- Make sure the BiPAP driver is plugged into the mains power
- Starting from the BiPAP driver check the inspiratory limb for leaks and ensure connections are tight
- Check for water in the circuit and remove water
- Check that the settings and alarm limits are correct

8.1.2 Airway Pressure Monitor (if required)
- Check that the monitor alarms are set correctly
- Check that the delay setting is as low as possible (0.5sec)
- Check the monitor is connected to the inspiratory limb
• Make sure the monitor is on
• Check a spare battery is available

8.1.3 Oxygen Saturations monitor (if required – check child’s manual)
• Monitor plugged into mains power
• When was measuring probe position last changed (needs to change position every four hours)?
• Is the monitor showing the heart rate and oxygen saturation?
• Are the alarm limits set according to the child specific care page?

8.1.4 Heated Humidifier (if used) refer to humidifier section of manual
• Check that humidifier is on the right setting (mask 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.

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

8.1.6 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.

8.1.7 Resuscitation equipment
• Make sure the resuscitation bag is available and working
• 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. Together you should check:
• Is the child breathing normally (for them)?
  o Is the breathing faster or slower than normal?
  o Are they working harder to breathe than normal?
  o Is the breathing softer or shallower than normal
  o Can you hear normal breath sounds?
• Does the child need suctioning?
• Is the ventilator properly connected to the child—not too loose, not too tight?
• Is the BiPAP 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?

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 BiPAP circuit properly connected to the mask?
• 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 as per child specific care page)

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