# Oxygen Delivery Devices and Flow Rates

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Oxygen Delivery Devices and Flow Rates are important concepts to understand as a nurse. Oxygen is a **life-saving therapy** that nurses and respiratory therapists administer every day in the hospital.

Whether your patient is on chronic oxygen, or whether they are in **acute respiratory failure**, your patients will commonly have oxygen ordered and it will be **up to you as the nurse to administer it.**

Knowing the oxygen delivery devices and flow rates will tremendously help you take care of your patients who requires oxygen.


## The Role of Oxygen

Oxygen is used every day in and out of the hospital. In order to understand oxygen delivery devices and flow rates, we need to first understand a few basic principles and definitions.

Oxygen is the most important gas in our atmosphere that allows for humans and animals to live. **Our cells use oxygen to create energy** (Kreb's cycle anyone?). Our ability to create energy without oxygen is *very* limited.

Without oxygen, our cells will die within minutes.

Oxygen occurs naturally in our atmosphere, at a concentration of 21%. Another term for oxygen concentration is **FIO2**, or fraction of inspired oxygen.

When we breathe in air, the air (including oxygen) enters into our lungs and makes contact with all of the alveoli. Alveoli are small sac-like structures within the lungs.

The **oxygen diffuses across these alveoli into the bloodstream**, where it **attaches to hemoglobin** on our red blood cells. Our blood carries this oxygen throughout the body where it is absorbed by the tissue to give life and energy to our cells.

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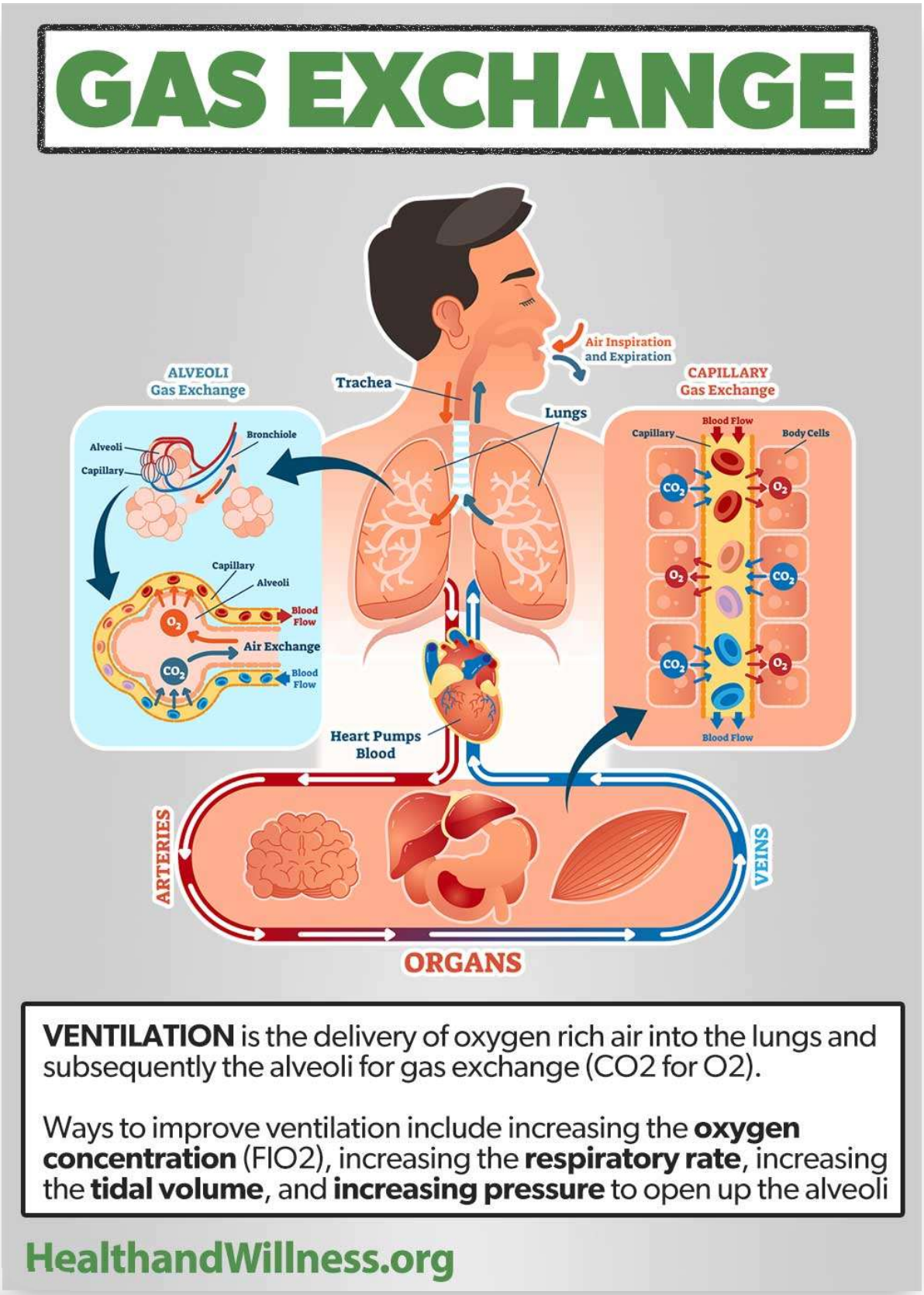


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A healthy patient has a **respiratory rate** of 12-20 respirations per minute (rpm). Lower than 12 is usually from medications like opioids or benzos, and higher is usually from anxiety, asthma, COPD, CHF, a PE, pneumonia, or some other type of respiratory failure.

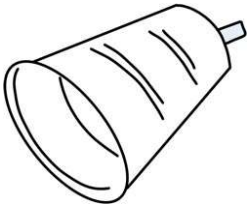
The **tidal volume** is the amount of air breathed into the lungs with each breath. The tidal volume will depend on the patient's physical size of their lungs and their respiratory effort, but is generally around **400-500ml in a healthy adult.**

The **FIO2** or the **fraction of inspired oxygen** is the percentage or concentration of oxygen that a person inhales. Remember **room air is always at 21%** FIO2 on earth.

# Oxygen Delivery Devices and Flow Rates

There are different oxygen delivery devices and flow rates to know, with each device allowing for certain flow rates of oxygen (L/min), as well as different concentrations of oxygen (FIO2).

## Blow-by Oxygen



Blow-by oxygen is just that – it's oxygen that blows by. This does not not apply oxygen directly, but rather **indirectly by "blowing" on the patient's face.**

This is usually only used in infants and young toddlers who become agitated when masks or tubing is applied.

**Less than 30% FIO2** can be provided with this, which is not much greater than room air of 21%.

If used, the oxygen rate should be at least 10 L/min through a simple mask or even a tubing sticking through a styrofoam cup, which infants and toddlers may be less scared of.

## Nasal Cannula

**Nasal cannula** is tubing that runs from the oxygen source to the patient's bilateral nares or nostrils.

This is **the most common use of oxygen** within the hospital, especially for non-critical patients and those who need chronic oxygen delivery like with COPD.

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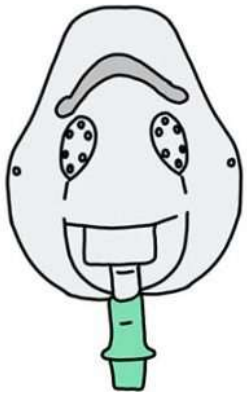
Nasal Cannula is typically **started at 2L/min** and then titrated upwards to as high as 6L/min, although **2-4L/min is ideal.** This delivers **25-40% FIO2,** depending upon their respiratory rate, tidal volume, and amount of mouth breathing.

The nasal cannula is good for most patient needs with lower levels of oxygen requirements.

Nasal cannula can be very irritating and cause dry nares at rates >2L/min, so the oxygen **should be heated and humidified if possible at higher flow rates.**

## Simple Face Mask

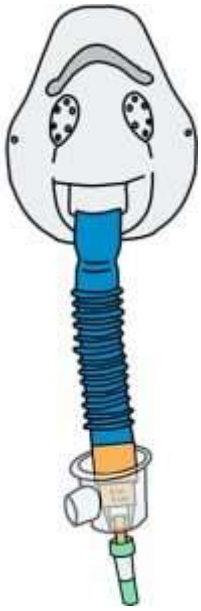


**Simple face masks** are a mask with tubing that is hooked up directly to an oxygen source. This is similar to Nasal Cannula, except it is delivered in a mask format over the mouth and the nose, instead of just the nose.

Simple face masks allow for **flow rates between 6-10L/min**, with an **FIO2 of 35-50%.**

Simple face masks tend to be a **temporary solution**, used when titrating your oxygen delivery devices and flow rates.

## Ventimask

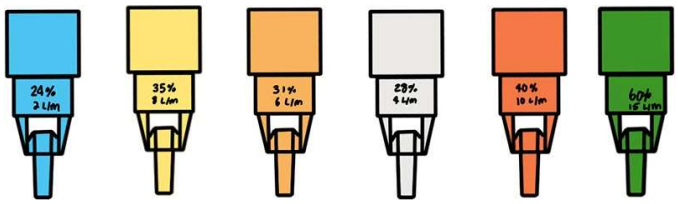


**Ventimask** or a **Venturi mask** is a face mask that is connected to corrugated tubing with a venturi valve on the end.

This piece connects to the oxygen tubing, which mixes oxygen with room air to provide a **consistent high flow of oxygen** even with irregular respiratory rates or tidal volumes.

Depending on the oxygen flow rate, there are different colored venturi pieces that are used, with **FIO2 of 24-60%** FIO2 depending on which venturi valve is used. Levels >40% are generally not used and likely don't offer more benefit.

The oxygen flow rate will be indicated on the specific venturi valve used, but generally is from **3-10L/min.**




Some Ventimasks come in an all-in-one rotational setup, where the FIO2 can be adjusted on a single venturi valve.

Ventimasks are usually **used with COPD patients** when they require high levels of oxygen, but there is concern for CO2 retention. It can also be helpful for asthma exacerbations and general respiratory distress.

This is typically not used long-term.

## Non-Rebreather

A **Non-rebreather** is typically what is initially used when the patient is requiring a high flow of oxygen and nasal cannula's are not cutting it.

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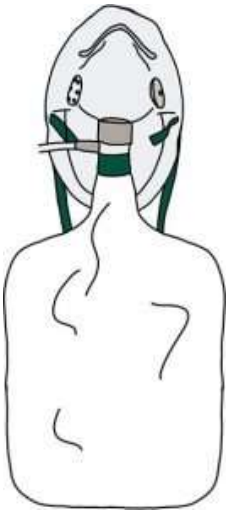
A non-rebreather provides **the highest concentration of oxygen** that can be provided to a patient who is breathing on their own, **up to 95% FIO2**, without any additional machines.

However, **this is NOT a long-term solution**, and unless they can be titrated down, patients will need to be transitioned to a BIPAP, HFNC, or intubation, unless they can

be titrated down.



In a non-rebreather, there is a reservoir bag attached to the mask, with a one-way valve separating the two. This **prevents exhaled CO2 from entering the reservoir, and only allows oxygen.**

There are holes or "exhalation ports" in the sides of the mask that allow expired are out also do not allow room air back in (usually only one of these is "blocked" to prevent suffocation if the oxygen turns off).

Oxygen **flow rates of 10-15L/min** can deliver **FIO2 of up to 95%** in these individuals. However, there is a small amount of room air which "gets in" the system, so the FIO2 is invariably lower, **more like 80-90%.**

Remember **over-oxygenation can also be dangerous termed "oxygen toxicity".** This can cause vasoconstriction, worsen outcomes, and even cause seizures.

This means you want to keep the patient's **SPO2 at 94-99%**, as a pulse ox does not measure above 100%.

If a patient is still struggling to breathe with SPO2 of 88-94% or lower on a NRB, then they probably need intubated.

## High-Flow Nasal Cannula

**High-Flow Nasal Cannula** (HFNC) is a **newer** method of delivering a high flow and FIO2 of oxygen in patients who have higher oxygen requirements. COVID patients tend to do well on these devices, but it can be used for all sorts of respiratory distress.

High-flow Nasal cannula consists of a **specific machine and tubing** used to deliver a very high flow of oxygen that is heated and humidified.

HFNC can be delivered from 8-60L/min (**30-60 L/min in adults**), and an **FIO2 of 100%.**

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**HFNC is more comfortable** and studies have shown that using HFNC may be a better alternative than using a face mask.

HFNC also **adds PEEP-like pressure** equivalent to about 3-4 cm H2O, similar to a CPAP, helping to keep the alveoli open and **increase ventilation** (gas exchange).

It is also an alternative to BIPAP other than those patients who are hypercarbic (high CO2 levels like in COPD).

Knowing the difference between the oxygen delivery devices and flow rates, HFNC is not a good option for those who are CO2 retainers for very long .

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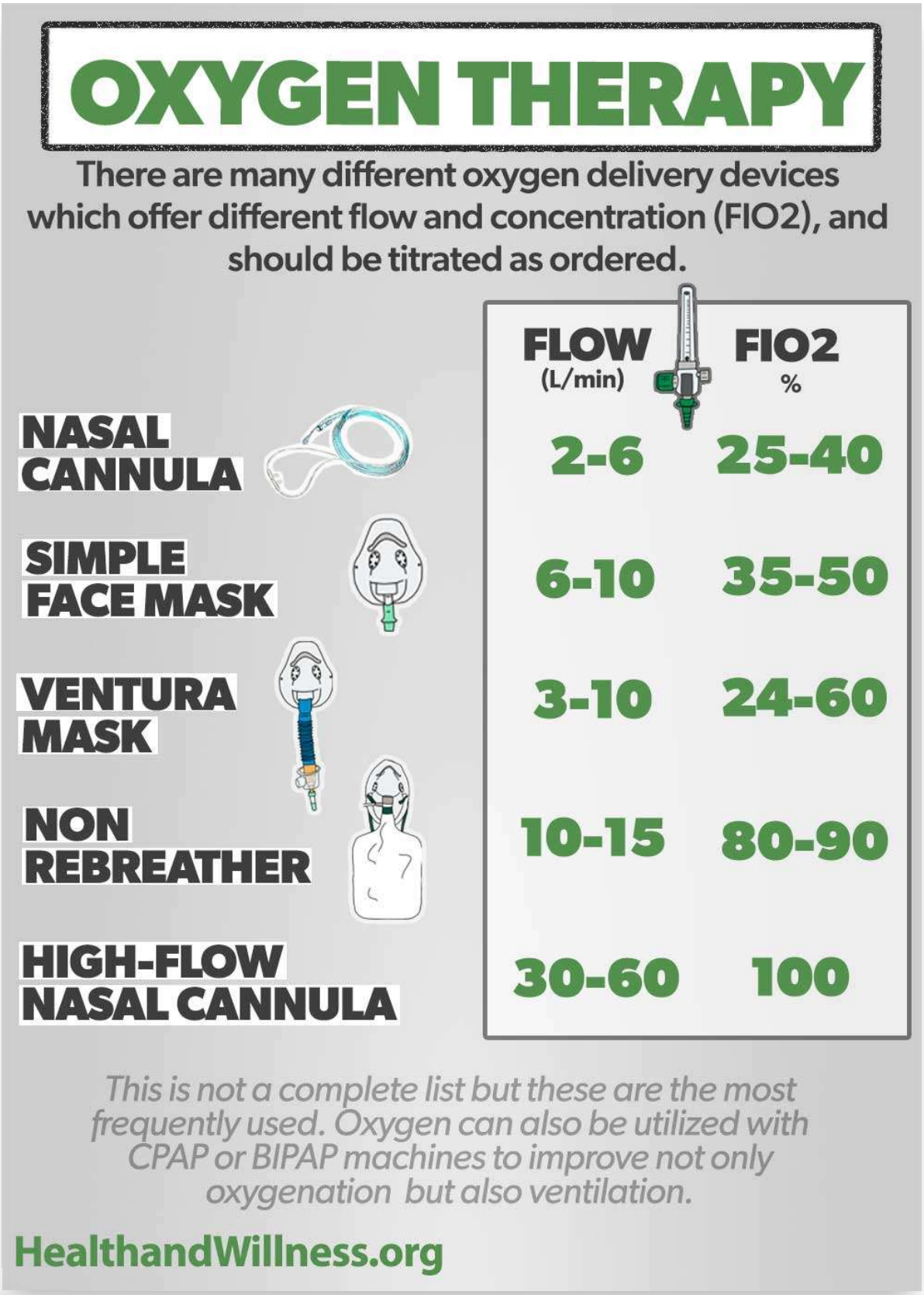


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## CPAP

**CPAP** or **Continuous Positive Airway Pressure** is a method of non-invasive ventilation. This helps **open up the alveoli** allowing for better gas exchange.

This can be useful in acute pulmonary edema like in CHF, because it **reduces intrathoracic pressure** and can **reduce preload** and **increase cardiac output**, as well as **decrease alveolar congestion**.

It is also used for **obstructive sleep apnea (OSA)** to keep the airway open.

Oxygen is not always added (especially if the patient is just using it for OSA). The pressure is set at 5-20 cm H2O, usually beginning at **5-8 cm H2O**.

Increased pressures will increase intrathoracic pressures.

**Oxygen is added to keep SPO2 >90%.**

## BIPAP

**BIPAP** or **Bilevel Positive Airway Pressure** is the "better" version of CPAP. This can often be used as an **alternative to intubation**, and is great for **hypercapnic** respiratory failure *(think COPD)*.

This uses a **higher pressure during inspiration** and a **lower pressure during expiration.**

BIPAP uses 3 settings:

- **Rate:** The respiratory rate is usually set to a backup or spontaneous rate, as these patients are awake and breathing spontaneously. This is usually 8-12 rpm. Most patients on a BIPAP will be breathing much faster than this.
- **IPAP:** The inspiratory positive airway pressure is how much pressure is given during inspiration. This is anywhere from 5-30 cm H2O, but usually started at 8-12 cm H2O. A higher level will increase tidal volume.
- **EPAP:** The expiratory positive airway pressure is the pressure during expiration, which is typically 3-5 cm H2O.

Oxygen delivery is then used as well to ensure SPO2 >90%. FIO2 is started at 100% and titrated down.

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**Clinical Note:** Settings are usually given as IPAP/EPAP, Rate, and FIO2. This means you would relay the settings as 10/5, backup rate of 10, and an FIO2 of

> 30%. The RT should tell you the settings and they should be the ones to titrate the FIO2.

This is used for **Acute COPD exacerbations**, and **acute respiratory failures like in CHF or ARDS**. It can work great for reducing CO2 retention in hypercarbia subsequent and respiratory acidosis.

This is not good for those who are nauseous or have thick secretions, as this may be a **risk for aspiration**. This can be dangerous for those who are altered for the same reason, although is sometimes still used.

## Ventilator

Mechanical Ventilation is the best way of controlling a patient's oxygenation (oxygen delivery) **and** ventilation (gas exchange).

**Mechanical ventilation is used as a last resort** when a patient is in severe respiratory distress and cannot tolerate non-invasive ventilation.

These patients are in respiratory failure and may be altered, cannot protect their airways, are throwing up, or just **continue to be hypoxic despite alternative oxygenation.**

To be put on a ventilator, a patient will need intubated, likely sedated, and hooked up to a ventilator.

Ventilators have various settings which control the respiratory rate, the IPAP, the EPAP, the inspiratory flow rate, and the FIO2%.

If ventilation can be avoided, it should be. Some patients are difficult to wean off the vent (like in severe COPD or ARDS).

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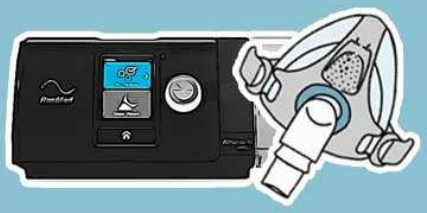
And that is an overview of oxygen delivery devices and flow rates. Hopefully you have a solid understanding of each device and when it is appropriate to use each one.

# CPAP VS BIPAP

CPAP and BIPAP are two different methods of **non-invasive ventilation**, and can be used before intubation in some scenarios.

## CPAP

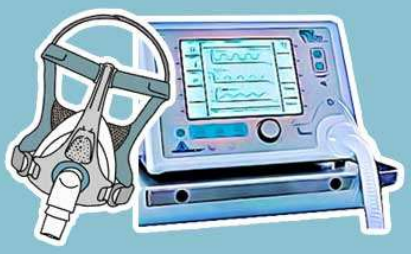


Continuous Positive Airway Pressure (CPAP) provides a constant increased pressure to the airway

**SETTINGS:** Start @ **5-8 cm H2O**, can titrate up to 20 cm H2O

**USE:** CHF / Pulmonary Edema, Obstructive Sleep Apnea (OSA)

## BIPAP



Bilevel Positive Airway Pressure (BIPAP) provides two pressures, one while breathing in (termed IPAP), and a lower one while breathing out (EPAP).

**SETTINGS:**

**RATE:** 10-12 rpm (usually set to spontaneous)
**IPAP:** usually 8-12 cm H2O, but anywhere from 5-30 cm H2O
**EPAP:** usually 3-5 cm H2O
**FIO2:** Start @ 100% and titrate down once stable

**USE:** CO2 Retention *(Hypercarbia)*, **Respiratory Failure** *(CHF, COPD, etc)* OSA

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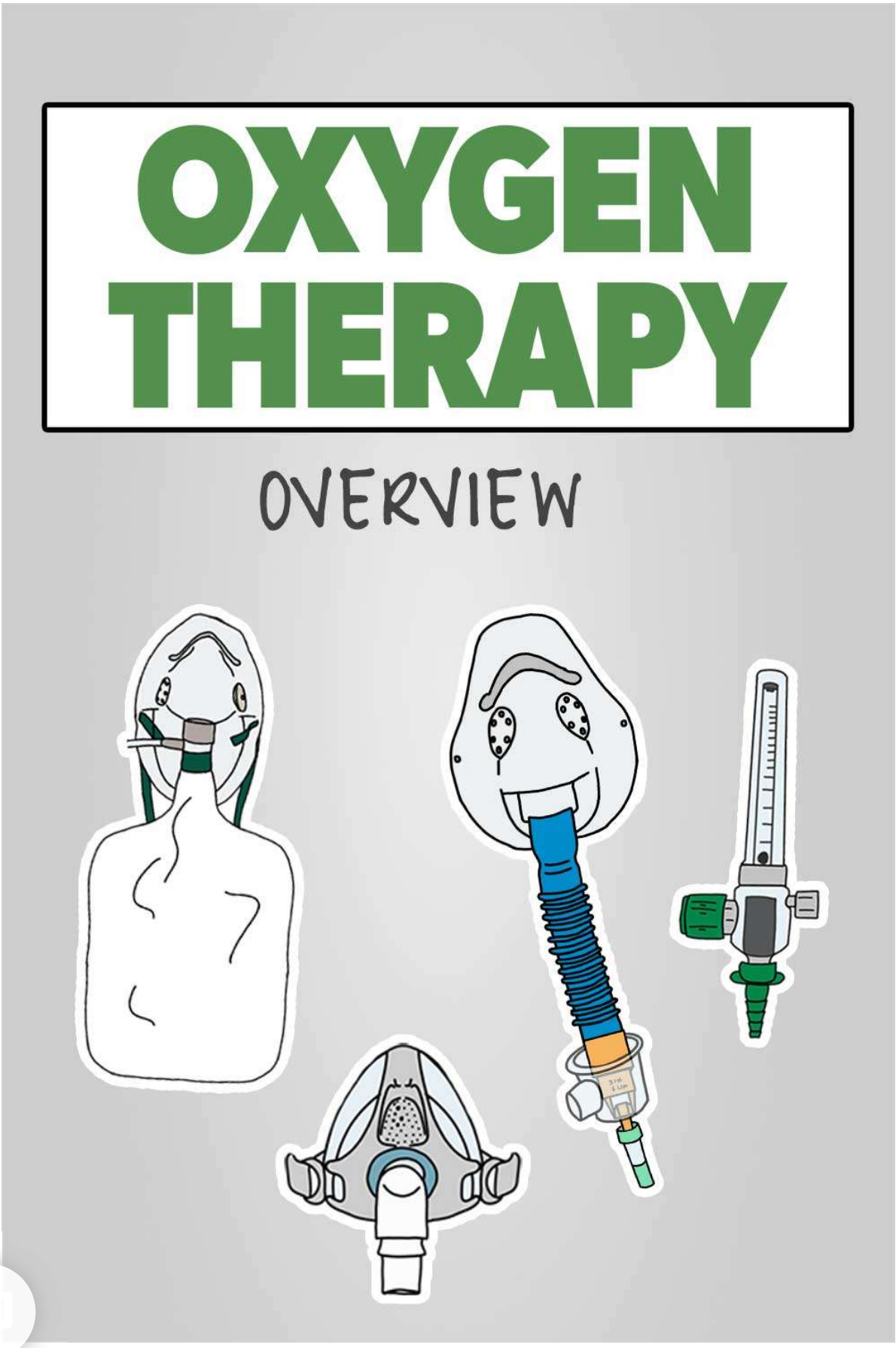
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**Krista** 10 months ago

Great update and outstanding article. Easy to comprehend and not too long.

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**Jeff** 7 months ago

Trying to find info on maximum safe level of O2 bleed in with a home CPAP or Bipap machine. I have been unable to find any document that gives that info. Have you seen anything in writing that supports high liter flow (10-15 lpm or more) with a home PAP unit?

0 Reply

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**James** 5 months ago

Usually at steady rate of 4L via cannula, but my nose is revolting after years of this. I have just tried a Bi-Flow mask, and it seems great. Hopefully I can sleep with it on.

0 Reply

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