How to use Ventilation, Bipap and Bag Valve Mask in the Emergency Department (and how to stop your patients Sats plummeting when you do RSI!)

How to use this package and a list of learning resources.

So, this document is the first part of the learning package to help doctors and nurses understand how to:
1. Maximise success using a **BVM**
2. Use **CPAP and BiPAP**
3. Use a **ventilator**.
4. **Prevent desaturation** during **RSI**.
5. **Reoxygenate** someone during **RSI**.

Read this document first and then listen to the following podcasts and videos:

1. http://emcrit.org/podcasts/niv/
2. http://emcrit.org/lectures/vent-part-1/
3. http://emcrit.org/podcasts/vent-part-2/
4. http://emcrit.org/podcasts/bvm-ventilation/
5. http://emcrit.org/preoxygenation/

And then come to the simulation day……and then about a month later go though all this again, and you will be a VENTILATION LEGEND!

The doctors should then read the following documents that take things into a bit more detail:

1. http://www.annemergmed.com/article/S0196-0644%2811%2901667-2/fulltext

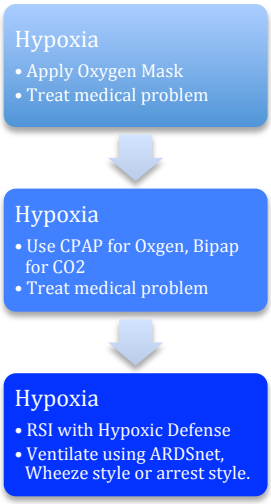
2. **Weingart SD. Preoxygenation, Reoxygenation, and Delayed Sequence Intubation in the Emergency Department. J Emerg Med. 2010 Apr 7. [Epub ahead of print]**

3. 1. ARDSNet. **Ventilation** with lower tidal volumes as compared with **...**

Learning Objectives and Summary:

Your objectives are to learn the following list and understand what each point means. That's it. You will have learned all you need to know about bipap and ventilation in the ED.

1. Hypoxia is initally corrected by increasing the amount of oxygen we inhale.
2. If that doesn't work we splint open the alveoli with peep or CPAP. Peep or CPAP and EPAP are essentially the same thing.
3. You can only give extra whole breaths with a BVM or ventilator.
4. Increasing the air that goes in and out of the lungs lowers CO2.
5. When a patient becomes tired we increase a patients tidal volume (and so decrease CO2) by giving extra pressure when the patient breaths in – this is called Bipap. This is commonly used in COPD.
6. Hiflo nasal cannulae and a BVM give you 6 of peep, 100% O2 and the ability to give extra breaths and help when the patient breaths in! This is great in someone with a low sats and low GCS or if you are reoxygenating someone during RSI.
7. Sats probes can have a delay of 2 minutes in the really sick - Use EtCO2 and SpO2 to know you are bagging someone well, not just SaO2.
8. When we use CPAP/Bipap there are two main strategies:
a. In CHF when the alveoli need recruiting with CPAP – start with 5 cmH20 of CPAP. Increase the CPAP until Sats are greater than 95%.
b. In COPD when the patient is tired and needs inspiratory support – start with 12 over 2 of Bipap. The difference between the EPAP and IPAP is what helps the person breath in. We need a difference of at least 10 cmH20 to reduce CO2, often more.
9. When we use a ventilator there are 3 different strategies:
a. ARDSnet strategy with balanced peep/FiO2 and limits lung injury for all patients excluding those with wheeze (ie asthma and COPD).
b. Wheeze strategy with slow resp rates and minimal peep and limits gas trapping or stacked breaths
c. Arrest style, which is slow, low and no peep which reduces pressure in the chest and so maximises venous return to the heart.
8. We could start with supplemental oxygen, then progress to CPAP, and then to ventilation via an ET tube. The algorithm for treating hypoxia is:


Hypoxia
• Apply Oxygen Mask
• Treat medical problem
Hypoxia
• Use CPAP for Oxgen, Bipap for CO2
• Treat medical problem
Hypoxia
• RSI with Hypoxic Defense
• Ventilate using ARDSnet, Wheeze style or arrest style.

Ventilators are not complicated!

Using ventilators and Bipap machine is something that people feel nervous about. Any ventilator is just a pump with a computer on it! That's it!

To be able to use these devises you need to know some basic physiology (strategy) and the machine specific "nobology" (tactics)…..

We only actually ventilate people using three different setups in the ED, which if I can do anyone can! First however we need to understand a few basic principles……

The following principles will help you fix your patients. Knowing this stuff literally saves lives so stick with it!

How to Treat Hypoxia

So one the first things we will do in a hypoxic patient that is breathing is put on an oxygen mask which relieves the hypoxia in the majority of patients. Pretty obvious! The amount of oxygen a patient gets is called the "*Fraction of Inspired Oxygen*" and abbreviated to *FiO2*. We already give carefully monitored Oxygen therapy using the colour-coded oxygen masks.

The only thing that is a bit odd is that FiO2 is sometimes not expressed as a percentage, but as the percentage divided by 100, so…..

a. 100% Oxygen is the same as an FiO2 of 1.0.
b. 50% Oxygen is the same as an FiO2 of 0.5

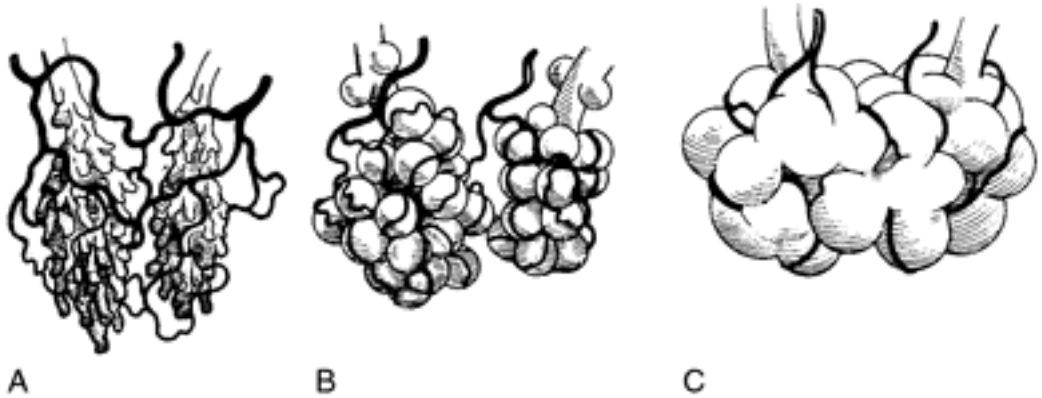
c. 40% Oxygen is the same as an FiO2 of 0.4
d. No oxygen, 0%, would be an FiO2 of 0.0 (probably not advisable!)

Ive put the Oxygen mask on and they are still hypoxic! What do I do now!?

If you cannot raise the saturations with a non-rebreather mask on 15 litres the patient is likely to have sick lungs (assuming that hypotension and shock are not the cause of the patients impaired oxygen delivery to their finger!). The next thing we would do is treat the medical problem. For example we would give nebulisers to the sick asthmatic or nitrates to the sick patient with congestive heart failure. But what do we do if that doesn't work? If a patient is failing medical therapy then would consider given some sort of ventilatory support. To understand what sort of ventilatory support we need depends on us knowing some very basic respiratory physiology……

The gases we rely on are exchanged in the lung alveoli. Sick lungs may have collapsed alveoli or from fluid in the alveoli. If we apply pressure to the lungs this will open up the alveoli and push the fluid out of them. This pressure we use is called peep or cpap.

The alveoli are essentially tiny balloons. If they are collapsed then they have a small area to exchange gas. If they are held open just enough, oxygen can exchange more readily. The pressure that keeps the alveoli open is called PEEP, or "Positive End Expiratory Pressure". We can also splint open the alveoli using CPAP which stands for Continuous Positive Airway Pressure. You can think of CPAP and Peep as being the same thing in that they both splint alveoli and improve oxygenation however peep is usually given through and ET tube and a ventilator and CPAP is usually given with a mask in an awake patient. Essentially it is the pressure that remains in the patient's chest at the end of expiration. We actually walk around with peep, due the resistance in our upper airways. You can feel the lung expanding effects of PEEP if you try and breath though pursed lips. You've probably seen patients with COPD doing this already (these patients lower airways and alveoli collapse because their lung tissue is damaged).



The picture above illustrates this. Picture A the alveoli are collapsed and will not absorb oxygen well. In Picture B you can see that the air sacs are held open just enough. However giving too much peep however is bad, and can damage the lung. You can see this in picture C; you can just imagine the air sacs popping under the stress! We actually walk around with about 3 cmH2O of Peep, and generally we would give no more than 12 cmH2O to sick people.

The hard bit isn't the decision making with CPAP though, it's the machine, the finicky mask and the hospital politics that often accompanies putting patients on Bipap. In terms of the machine they are all very simple once you have used them once, there is a just a slider or a digitial selector that usally goes from 0 to 20cmH2O.

So generally we'd start with 5, quickly work up to about 10 whilst checking the blood pressure as we increase the pressure.

When to Give CPAP.

We see sick patients every shift that have disease that cause hypoxia. Essentially if you're maxed out with the oxygen and the patient is still hypoxic, give CPAP. Its really that simple. The table below list the diseases where this might help. The most common reason for starting CPAP in the ED is pulmonary oedema.

- cardiogenic pulmonary oedema
- patient not candidates for intubation
- chronic hypoventilation syndromes
- Pneumonia.

So what is Bipap?
Right. So CPAP is just one continuous blow of pressure that doesn't change throughout the respiratory cycle. Its like holding your head out of the window of a car doing a constant speed and breathing in and out. Bipap is just CPAP that increases the pressure when you breath in. Hence its full name is Bi-Level Positive Airway Pressure or BiPAP. The upper pressure when the person breaths in and is called the inspiratory positive airway pressure or iPAP. With BiPAP when you exhale, the machine senses and reduces the pressure to provide an expiratory positive airway pressure, or ePAP (which is the same as CPAP). You could imagine BiPAP then as putting your head out of the window of car and the driver going faster when you breath in and going slower when you exhale.

The extra pressure when you breath in increases your tidal volume (or breath size), which increases how much atmospheric air washes in and out of the alveoli. This in turn washes more CO2 out of the alveoli. The amount of air that goes in and out of the alveoli is called alveolar ventilation…which makes sense…..so to go heavy on the jargon, providing an iPAP (as part of BiPAP) increases alveolar ventilation by increasing tidal volume which will reduce CO2 measured as PaCO2. Cool!

So BiPAP is useful if you want to reduce CO2, say for example in someone that has COPD, and is tiring. The BiPAP reduces the patient's work of breathing by giving them ventilatory support and improving gas exchange. It gives the breathless patient a "breather"! However you still have to provide medical care. The machine wont fix their wheeze, only reduce the impact of how tiring it is! This is a potential major pitfall of Bipap – once the mask is on patients tend not to get the oral or inhaled medications that will fix them. Patients can still get nebulisers or inhalers if they are on BiPAP or a ventilator!

What Are Bipap typical settings?
So most patients with COPD that require BiPAP have a high CO2 as their dominant problem. So starting with something like 12 of iPAP over 4 of ePAP would be fine, but remember it is the difference between the ePAP and the iPAP that increases the tidal volume and you need at least a difference of 8-10 cmH20 to get someone's CO2 down and reduce their work of breathing. If Oxygenation is a real problem then you have two choices up their epap or entrain some O2 into the circuit. I often start on 12 over 4 and entrain O2 to get sats between 90-92%. Then after 1 hour repeat an arterial blood gas.

What are the complications of CPAP AND BiPAP?
CPAP and BiPAP can drop blood pressure. Increasing the pressure in the chest makes it harder for blood to return to the heart and so blood pressure can fall. For this reason we use no peep when ventilating patients in cardiac arrest and are very cautious when giving peep or CPAP to hypotensive patients…..so keep checking the BP!

When shouldn't I use CPAP or BiPAP?
We shouldn't leave someone on BiPAP who can aspirate, ie has a reduced level of consciousness.
We also shouldn't put someone on BiPAP that has a pneumothorax as it can turn a simple pneumothorax into a tension pneumothorax…..

So I'm about to Intubate someone and their SPO2 is low – what do I do?
There's loads you can do! It depends a little if they are breathing too slowly or too fast…..too slowly they need extra breaths with a BVM too fast you could just use use BiPAP with an FIO2 of 1…….or you could just use the method below with actually bagging them…..

1. My patient is hypoxic has a respiratory rate of 6 and low sats!

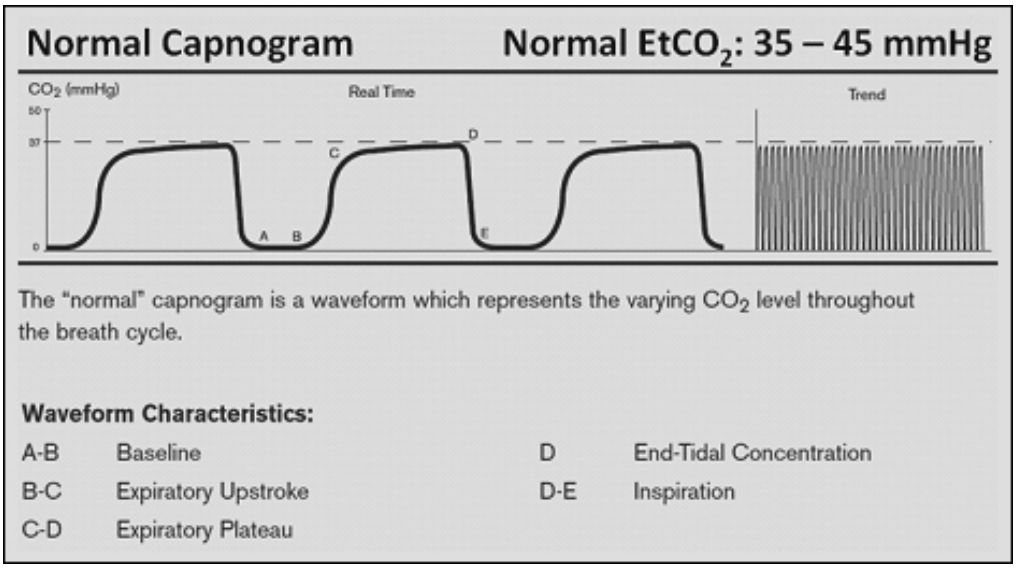
People that are hypoxic and breathing too slowly (arbitrarily a respiratory rate of 8 or less) are often exhausted and comatose. These patients are moments away from respiratory arrest. They therefore need resuscitating under direct supervision as they could easily arrest, vomit and aspirate. The patient needs bagging with a system that is most likely to produce rapid reoxygenation. The best way to do this is using to following:

1. Manipulate the person's head and neck to achieve Levitan's Line (horizontal line between tragus and suprasternal notch. You may need pillows to do this or raise the head of the bed a little…

2. Then apply normal nasal cannula at 15 litres per minute. This provides you 6 of peep when the BVM is applied and dramatically slows desaturation during intubation attempts.

3. Apply a BVM and bag the patient using 2-person technique. The evidence is this will work better than single person bagging.

4. Make sure there is waveform EtCO2 between the bag and the mask The reason to use this is to not get caught out by "Sats Probe Lag". Sats probe lag is essentially when the Sats probe measurement at the finger lags behind what is actually happening inside the patient, unsurprisingly! However using EtCO2 will tell you very quickly if you are bagging the patient effectively because you should see the waveform below:



5. If they will tolerate an OPA use one!

This is also the most effective way to reoxygenate people who are getting RSId…..hence including all the stuff you need to do this in your RSI checklist!

So the patient is intubated - How do I use the Ventilator?
Now you understand how to use Bipap and CPAP, using a ventilator is a piece of cake! Seriously! And there are only 3 ways we use a ventilator in the ED…..

1. **ARDSnet strategy: ie less volume, faster rate.** Nearly Everyone (except those in cardiac arrest and with wheeze) gets an ARDSnet strategy Ventilation. ARDSnet was a large study that showed that if we ventilate people being careful not to cause to much pressure of volume damage to the lungs then less people die as a result of ARDS which is acute respiratory distress syndrome……although few of our patients actually have ARDS, most of our ventilated patients are at risk of it, so it is worthwhile using ARDSnet ventilation in everyone other than those with wheeze or those in full cardiac arrest…..To do this you give 6-8 mls per kilo of tidal volume but a faster rate typically 25-30 breaths per minute. Giving less volume causes the lungs to be less expanded or stretched and so causes less barotrauma. We also use balanced amounts of peep and oxygen as too much peep or oxygen can be harmful. Nearly all ventilators have a dial that you can adjust to give different concentrations. The more basic ventilators like the Oxylog 1000 , have a switch that allows the selection of "no air mix" or 100% Oxygen (or an FiO2 of 1.0) and "air mix" which delivers 40% oxygen (or an FiO2 of 0.4) - see picture 2. So why don't we give 100% O2 to everyone? Well, believe it or not, too much oxygen can actually make your lungs sick, so we need to give just enough, like any other drug.

OXYGENATION GOAL: PaO_2 55-80 mmHg or SpO_2 88-95%
Use a minimum PEEP of 5 cm H_2O. Consider use of incremental FiO_2/PEEP combinations such as shown below (not required) to achieve goal.

Lower PEEP/higher FiO2

FiO_2	0.3	0.4	0.4	0.5	0.5	0.6	0.7	0.7
PEEP	5	5	8	8	10	10	10	12

FiO_2	0.7	0.8	0.9	0.9	0.9	1.0
PEEP	14	14	14	16	18	18-24

2. COPD/Asthma Strategy: The second strategy is almost opposite to the one above. The problem with asthma or COPD is that cannot breath out quickly – expiratory wheeze is literally outflow obstruction. What can happen if the patient is breathing out too quickly they actually not completely exhale which means over time they can "stack breaths". This leads eventually to cardiorespiratory arrest! Not completely exhaling because of wheeze, leaves some volume and therefore pressure in the chest and so it can be called auto peep…..So we would generally start somebody off with, 8mls per kilo, no faster than 10 breaths per minute, with a longer expiratory time, by setting the I:E ration to 1:4 or 1:5…We would also use no peep and so just assist oxygenation by changing the FiO2…..

3. Cardiac Arrest Strategy. The enemy in cardiac arrest is extra intrathoracic pressure, other than that generated by CPR. The reason being is that raising the average intrathoracic pressure with positive pressure ventilation can reduce venous return to the heart. We therefore set the vent rate to 10, 6mls per kil tidal volume, no peep and an FiO2 of 1.