**Basic Principles of Ventilation**

There are two goals of ventilation:

* Appropriate oxygenation

2. Appropriate ventilation

Oxygenation is affected by several factors such as the inspired oxygen concentration (FiO2), mean airway pressure (MAP), the area of and diffusion across the gas exchange surface.

Ventilation refers primarily to the amount of carbon dioxide exchanging at the alveolar level. Factors which influence this include the gas exchange surface area and diffusion and the amount of gas able to be moved in and out of the lungs.

So, when you set about changing the settings, you need to think about what you are trying to achieve.

|  |  |
| --- | --- |
| **Change Oxygenation PaO2** | * Alter the FiO2 (turn the knob!) * Alter the mean airway pressure |
| **Change Ventilation PaCO2** | * Change the tidal volume (by changing the pressure, primarily) * Change the frequency of breaths |

**Target Blood Gas Values**

1-Ventilator settings in general should be set to achieve [target oxygen saturations](http://www.adhb.govt.nz/newborn/Guidelines/Respiratory/Oxygen/OxygenSaturationTargets.htm) as per unit policy.(88—93 )

2-Ventilation settings that determine pCO2 should be set with the following guidelines in mind:

|  |  |  |  |
| --- | --- | --- | --- |
| **pH** | **pCO2** | **Base Excess** | **Rationale** |
| 7.25 to 7.35 | 5.5 to 8.0kPa | 0 to -4 | We have a philosophy of relatively permissive hypercapnia. The rationale is to avoid overventilating lung and thereby inducing injury through volutrauma and barotrauma. At a pH above 7.25, metabolic function should be relatively preserved. If there is a significant metabolic component (that is, base excess <-4), then this may indicate that oxygenation at a tissue level is impaired. |
| Exceptions to this guideline include   * Infants with severe chronic lung disease where high pCO2 levels with a lower pH may be tolerated in order to further minimise ongoing lung injury. * Infants with [pulmonary hypertension](http://www.adhb.govt.nz/newborn/Guidelines/Cardiac/PPHNManagement.htm), where after discussion with a specialist a decision may be made to maintain the baby in an alkalotic state (pH >7.45). | | | |

**Before you touch the Ventilator.....**

|  |
| --- |
| **1. Look at the blood gas result.**   * Do you believe it? Does it fit with the clinical picture the baby is giving you? Does it fit with the expected course for the baby (e.g. improving compliance after surfactant for RDS)?   2. If it is vastly different than you expect, is there some reason for it?  A- Was there an air bubble in the specimen?  B- If a capillary gas, is the perfusion awful? Did the baby bleed easily?  3. Don't change anything on the basis of a venous gas. The only reliable information from a venous gas are the electrolytes and the glucose. |
| **2. Look at the baby.**   * Is the chest moving?   2. What's the air-entry like?  3. Is the baby struggling on the ventilator?  4. Is the baby very tachypnoeic or is the baby apnoeic? |
| **3. Look at the ventilator.**   * Is it cycling?   2. Are you giving the baby the ventilator settings you thought you were?  3. What tidal volume (VT) is the baby getting?  4. Is there a significant leak?  5. Is it set up properly with an appropriate inspiratory time and with appropriate pressures? LOOKS AT WAVES &LOOPS |
| **4. Look at the nursing flow chart.**   * How stable has the baby been over the past few hours or days?   2. Are there lots of secretions?  3. How is the baby handling? |

**Changing the Ventilation Settings**

|  |  |  |
| --- | --- | --- |
| **Problem** | **Possible solutions** | **Comment** |
| **Low Oxygenation**  **Low PaO2 or Saturations** | **Increase the FiO2** | * The easiest solution. * Remember that babies whose oxygen requirements are changing significantly need to be clinically reassessed and you should consider a radiograph if the FiO2 increases by more than 10%. |
| **Increase the Mean Airway Pressure (MAP)** | * Increase the PIP (but this may also affect ventilation) * Increase the [inspiratory time](http://www.adhb.govt.nz/newborn/teachingresources/ventilation/RespiratoryFunctionMonitoringAndGraphics.htm#Short iT) (but this may just hold the lungs fully inflated at a high pressure). You need to watch that the inspiratory time is shorter than the expiratory time. * Increase the PEEP (we don't do this often, except for pulmonary haemorrhage) |
| **High Oxygenation**  **High PaO2 or Saturations** | **Decrease the FiO2** | * The easiest solution (unless the baby is already in room air - if in room air, then we generally accept high saturations or PaO2) |
| **Decrease the MAP** | * If the PEEP is higher than 5, then you can drop this down (if the reason for the high PEEP - e.g. pulmonary haemorrhage - has resolved)   2. Decrease the PIP (but this may adversely affect ventilation)  3…Decrease the [inspiratory time if it is too long](http://www.adhb.govt.nz/newborn/teachingresources/ventilation/RespiratoryFunctionMonitoringAndGraphics.htm#Long iT) |
| **Over-ventilation**  **High pH with a Low PaCO2** | **Decrease the tidal volume**   * Do this first if the baby has good chest movement and/or high tidal volumes | * Decrease the difference between the PIP and PEEP (usually by decreasing the PIP) * **Note** that there are no rules on how much to drop the PIP by - you need to look at the chest movement and look at the delivered tidal volume on the ventilator. In general, dropping the PIP by 2mbar (or more if significantly overventilated) is about the right amount. But look at the tidal volume! * If the baby is on [Volume Guarantee](http://www.adhb.govt.nz/newborn/teachingresources/ventilation/VGSetUp.htm#Setting up the ventilator), drop down the set tidal volume. |
| **Decrease the frequency** | * Drop the rate. If the gas is just a bit alkalotic, drop by 5. If really alkalotic, you might want to drop it by 10 or more. * **Note** that for modes where every breath is assisted (e.g. PSV, SIPPV), it is **futile** to reduce the rate if the baby is breathing above the back up rate. So wean the pressure (or VT) instead. |
| **Under-ventilation**  **Low pH with a High PaCO2** | **Increase the tidal volume**   * Do this first if the baby has no chest movement and/or low tidal volumes | * Increase the PIP till you get some chest movement but look at the tidal volume too. * In general, you should not increase the PIP too high as you may find that the tidal volume increases significantly. But you need to give enough pressure to get chest movement. * **Remember** that if you are having to put the PIP up a lot to get the same tidal volume in that you were giving previously, [compliance](http://www.adhb.govt.nz/newborn/teachingresources/ventilation/RespiratoryFunctionMonitoringAndGraphics.htm#Loops) is going down. Ask yourself "Why?". Look at the baby, listen to the air entry, and think about a radiograph, particularly if the FiO2 is going up. * If the baby is on [Volume Guarantee](http://www.adhb.govt.nz/newborn/teachingresources/ventilation/VGSetUp.htm), increase the set VT. But you may have to increase the PIP as well. |
| **Increase the frequency** | * Increase the rate. If a bit acidotic, increase by 5. If really acidotic, you may need to increase it by 10 or more. * For fast rates, it is really important that the expiratory time is longer than the inspiratory time. The Babylog will let you know if you get it the wrong way around. You may need to decrease the inspiratory time accordingly. * If you find you need to give more than 70 breaths per minute, think about [HFOV](http://www.adhb.govt.nz/newborn/Guidelines/Respiratory/HFOV/HFOV.htm) as a ventilation mode. Speak to the specialist on duty. |

**Balance is Important**

* Don't forget to balance your ventilator settings. For example, if a baby is in 100% oxygen but with low pressures settings, it may be preferable to reduce the FiO2 but increase the pressures.

2. Similarly, if the baby is on high pressure settings but a low rate, it may be better to give a faster rate and lower pressures.

**When Do I Do the Next Blood Gas?**

|  |  |
| --- | --- |
| **How abnormal the gas is** | * If it is really outside the normal range you are targeting, you probably want to check it quite soon to see whether your changes have had the effect you thought they would (that is, in 15-30 minutes). |
| **How stable the baby is** | * The specialist on duty should be able to give you some guidance on how often gases need to be done. * If the baby is stable and you're not doing too much with the ventilation, you don't need to check it too soon after the change. Some babies who are chronically ventilated may only need a gas once a day. * You can look at other things like the new tidal volume to see whether you think your changes have had any sort of effect. * But if the baby is really unstable, you may wish to do gases often to see where they are heading. * If you have given surfactant, you might want to check a gas within an hour to see what effect any change in [compliance](http://www.adhb.govt.nz/newborn/teachingresources/ventilation/RespiratoryFunctionMonitoringAndGraphics.htm#Loops) is having on gas exchange. |
| **How confident you are** | * If you are new to ventilation, you may need reassurance with a gas soon after you make your change. * However, try to avoid too many tests just to reassure yourself (particularly if the nursing staff need to take a capillary sample). * Blood letting is the most common reason for babies needing transfusions in the first week or two of life. |
| **When the nurses tell you** | * If they are worried, they will tell you (...and you should listen). |
| **I'm really worried that I will be told off on the ward round if I get it all wrong .....** | * There are many ways to ventilate babies. All the consultants have different styles and experiences, and have their "favourite" modes. No single mode has been shown to be significantly better than another (other than synchronised modes are probably better than untriggered modes). * Some babies do well on one mode and settings one minute, then they may seem to need something else. * Believe it or not, all the consultants had to learn by trial and error, and they don't always get it "right". * What is most important is that you understand what happens when you make a change to a ventilator setting. No one can necessarily predict what will exactly happen to a blood gas as a result of that change. |

***DR YASIR I ALSAADI***

**Pediatric specialist-email-yasseralsadi@yahoo.com**

**welfare teaching hospital-medical city complex.**



