Ventilation Strategy (Adults)

Mechanical ventilation serves **two** functions: Oxygenation (↑O_2) & Ventilation↓(CO_2).
Each can be aided by **two** ventilator setting changes…

↑O_2	↓CO_2
↑FiO_2	↑RR
↑PEEP	↑VT

VT = tidal volume

Initial Settings (post intubation)

FiO_2 : 100%	RR : 15
PEEP : 5	VT : ~6 mL/Kg*

ideal body weight

***Ideal body weight** ≃ **Height (cms) – 100 - 10%**
e.g. height = 180 → 180 – 100 = 80 → 80 – 10% ≃ 72 Kg
⇒ Initial VT = 72 × 6 ≃ 430 mLs

Targets (O_2 sats first, then $ETCO_2$)

O_2 Sats : ≥92%	$ETCO_2$: 40*

*tolerate higher $ETCO_2$ to achieve O_2 Sats ≥92%

Basic Initial Strategy

1. **Set VT** to ~6 mL/Kg with **FiO_2** set to 1.0 (100%)
2. **Raise PEEP** from 5 cmH_2O until you achieve O_2 Sats ≥92%
   Unlikely to need >10 cmH_2O initially but be comfortable with 10 cmH_2O
   At >15 cmH_2O PEEP, vasopressor requirement likely
3. **Wean FiO_2** – the patient won't benefit from hyperoxia and we will run out of O_2 faster

P_{MAX} : 30 cmH_2O

ARDS Strategy *– if sudden ↓O_2 Sats*

1. **Increase FiO_2** to 1.0 (100%)
2. **Decrease VT** to 4 mL/Kg
3. **Increase PEEP** ≥10 → may require 15-18 cmH_2O ⇒ likely will need vasopressors
4. **I:E Ratio** 1:2-2.5
5. **Respiratory Rate** 18
6. **Tolerate** ↑$ETCO_2$
7. **Wean FiO_2** if/when possible
8. **Escalate to ICU team**

Make sure P_{MAX} is not >30 cmH_2O
Avoid disconnecting patient from ventilator without clamping the tube – loss of PEEP recruitment (see video) will occur

ARDS diagnosis

Early indication: ↓O_2 Sats
Simple definition: PaO_2/FiO_2 ratio ≤200 mmHg
Severe ARDS: PaO_2/FiO_2 ratio ≤100 mmHg
(PaO_2/FiO_2 also known as P/F ratio or P:F ratio)

Actual Calculation of P/F Ratio

1. Take an arterial blood gas sample and note the PaO_2 and FiO_2 at the time of sampling.
2. Divide PaO_2 by FiO_2 (as a number NOT a percentage)

e.g. PaO_2 80 mmHg and FiO_2 0.6 ⇒ P/F ratio = 133 ⇒ moderate ARDS

Troubleshooting

1. Hypoxia alarm on monitor
2. Low tidal volumes
3. High pressure alarm

Hypoxia Alarm (on sats monitor)

1. **raise FiO_2**
2. **check sats probe** is on patient's finger
3. **check oxygen supply**
4. **check no issues with circuit**
   e.g. disconnection → see separately
5. **raise PEEP** (e.g. 10 cmH_2O but may need 15-18)
6. **wean FiO_2** if/when possible
7. consider ARDS (see above)

Low Tidal Volumes

Likely due to high pressures. SIMV or volume control ventilation is actually "pressure regulated" volume control, meaning it will deliver the chosen volume if the maximum set pressure (P_{MAX}) is not breached. If P_{MAX} is breached, the ventilator will stop pushing more air in to avoid barotrauma.

Remember that the ventilator attempts to give the desired volume over the available time for inspiration. The inspiratory time is dependent on the respiratory rate and I:E ratio. If the RR is 15 breaths per minute then there are 4 seconds for the respiratory cycle. If the I:E ratio is set at 1:3 then there will be 1 second to deliver the full tidal volume (e.g. 500 mL). 500 mL over 1 second equates to 30 L per minute. Normal lungs can handle this but lungs with ARDS (as well as bronchospastic airways) may not be able to handle that rate of flow without breaching P_{MAX}.

Counterintuitively, increasing the tidal volume and/or the respiratory rate of a patient with low tidal volumes or low minute ventilation will usually fail. The ventilator will attempt to deliver more volume over a shorter amount of time and will breach P_{MAX} sooner and so the tidal volume and minute ventilation will DECREASE not increase.

1. **Drop the tidal volume** to 4 mL/Kg (ideal body weight - see above)
2. **Increase the RR** <u>ONLY</u> if this reduced tidal volume achieves better ventilation → 18 breaths per minute
3. **Target O_2 Sats** first <u>THEN</u> $ETCO_2$

High Pressure Alarm

This is the other alarm you'll get when peak pressures are breached. This is what the P_{MAX} setting if for. **DO NOT INCREASE P_{MAX} above 30 cmH_2O** in a patient with ARDS as this will lead to barotrauma. Instead, follow the advice above in the "Low Tidal Volumes".

Additional explanation

Oxygenation

Oxygen is "**diffusion limited**" which means the greater surface area available for diffusion, the more oxygen can enter the blood stream. PEEP leads to expansion of the lung and opening of the alveoli and, thence, more oxygenation.

https://youtu.be/oKH7CtsEgHw (1m 2s)

Watch this IMMEDIATELY to understand forever why PEEP leads to better oxygenation

A greater FiO_2 increases the partial pressure of O_2 in the alveoli, increasing the concentration gradient and also leading to better diffusion. Aim to find the right PEEP to obtain **O_2 Sats ≥92%** then wean FiO_2 to minimum required.

PEEP is the same as CPAP and EPAP (lower pressure in BiPAP)
PEEP ≤10 is **very unlikely** to require vasopressors
PEEP >15 is **likely** to require vasopressors

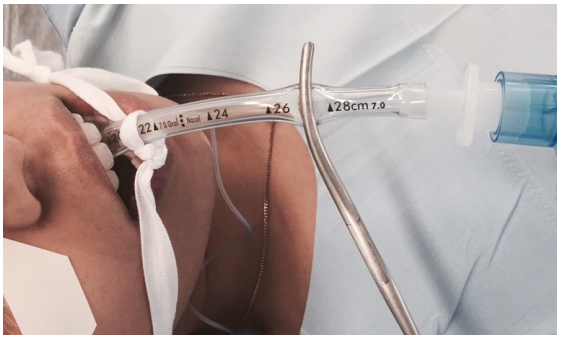
Disconnection of patient and ventilator

TWO IMPORTANT ISSUES…

1. The intubated patient will have a viral filter attached, something like this…

NEVER disconnect the viral filter from the patient without full PPE in a negative pressure room. With the viral filter in place, viral particles will not enter the ventilator circuit nor the air that you breath.

2. If you have to disconnect the patient's ETT (WITH filter still attached) from the ventilator to troubleshoot, clamp the tube first (e.g. "locking" needle holders). If you don't, the patient will lose PEEP recruitment and become more hypoxic…



e.g. Oxylog 3000

Tidal Volume (VT)
→ 6 mL/Kg initially
→ 4 mL/Kg in ARDS

Resp Rate (RR)
→ 12 initially
→ 18 in ARDS

P_{MAX}
≤30 cmH_2O

FiO_2

SIMV
is the ventilation mode of choice
set and forget

***Ideal body weight** ≃ **Height (cms) – 100 - 10%**

e.g. height = 180 → 180 – 100 = 80 → 80 – 10% ≃ 72 Kg
⇒ Initial VT = 72 × 6 ≃ 430 mL

e.g. height 160 → 160 – 100 = 60 → 60 – 10% = 54 Kg
⇒ Initial VT = 54 × 6 = 320 mL

Caveat: these ideal weight estimations are slightly less for females, slightly more for males. They are only an approximate starting point and should be subsequently titrated to $ETCO_2$ if O_2 sats allow.

Finally

There is so much more to say about ventilation that I didn’t feel was helpful to put in this "brief" guide. Please don’t be afraid to speak to any of the SMS about ventilation. We are all here to help demystify these concepts, it’s our job.

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