PICU VENTILATION GUIDELINES

Introduction

These are clinical guidelines that illustrate typical ventilator settings for 3 different clinical settings i.e. normal lungs, sick lungs, and weaning options.

As we have a number of different ventilators the terminology can be confusing so for each situation I will outline initial settings for each of the ventilators.

A few general points:

1. The Bird Gold is a superior model of the Bird VIP that has some additional ventilation modes and can be used for all ages. It does true pressure control as well as TCPL.

2. The Bird ventilators and the Evita both have continuous flow so are the best for ventilating small infants.

3. The VIP should not be used for patients older than 12 kg. The flow rate is not high enough.

4. The VIP Bird has 2 unique modes of ventilation:
   - Time Cycled Pressure Limited (TCPL) – Similar to Pressure Control but uses a set flow rate.
   - Volume Assured Pressure Support (VAPS) – Supplements pressure support breaths with additional pressure if a preset Vt is not met.

5. The Servo 300 and the Drager EvitaXL are preferred for patients who have sick lungs. (However in neonates and infants the constant flow and sensitive triggering of the Bird may occasionally make this a better choice).

6. The Servo 300 has 2 unique modes of ventilation:
   - Pressure Regulated Volume Control (PRVC) – Ventilator delivers a set tidal volume at the lowest Peak Pressure it can achieve. Will alarm if it can NOT deliver set volume at 5cm H2O below the pressure limit.
   - Volume Support – Ventilator adjusts level of pressure support to deliver a set Vt and Mv.

   Triggering on the Servo is ONLY flow triggered if the trigger is set to the green or red zone.

7. The Drager has a number of unique modes plus some uniquely named modes which are similar to other ventilators.
- Mandatory Minute Volume Ventilation (MMV) – Adds to patients spontaneous breaths to deliver a set minute volume. Will deliver set volume breaths until patient creates MV over dialled. Then will reduce mandatory breaths accordingly.
- Airway Pressure Release Ventilation (APRV)– The ventilator fluctuates between 2 pressures with spontaneous breathing allowed at any time. APRV does use 2 pressures but uses very short Te to release CO2. APRV is end of line ventilation before considering oscillation. However PCV+ fluctuates between two pressures with spontaneous breathing allowed at any time.

8. Drager ATC (Automatic Tube Compensation) in a pressure control mode will increase the peak pressure 2-4cmH2O above the set pressure.

9. Our usual mode of ventilation is some form of Pressure Control for patients less than 12kg except for patients who require a tightly controlled minute ventilation eg head injuries where we use some form of Volume Control. Patients >12kg can be ventilated in a Volume Control Mode

10. Mode is also determined by whether the patient is making spontaneous breathing effort or not.

**Normal Lungs**

The aim is to ventilate to normocarbia, avoid ventilator induced lung injury, and maybe allow some patient effort.

Some patients will be need a Volume Control mode of ventilation to maintain P_aCO_2 within a narrow range.

Patients who are easy to ventilate will have the following initial settings

<table>
<thead>
<tr>
<th>Rate</th>
<th>Neonate</th>
<th>Infant/Small Child</th>
<th>Large Child</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20-25bpm</td>
<td>16-20</td>
<td>12-16</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Pressures</th>
<th>Peak</th>
<th>16-20cmH2O</th>
<th>5cmH2O</th>
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</thead>
<tbody>
<tr>
<td>PEEP</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tidal Volume</td>
<td></td>
<td>8mls/kg</td>
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<tr>
<td>FiO2</td>
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<td>0.6</td>
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**Ventilator Set Ups**

1. **Neonate/Infant/Child (<12kg)**

Bird VIP/Gold Mode Assist/Control
TCPL (Time Cycled Pressure Limited)
Inspiratory Time 1sec
Rate 20
Peak Insp Pressure 20 (adjust according to Vt)
Flow to 3x the patient weight in L/min
PEEP 5
Assist Sensitivity to 0.2L/min (max)
Termination Sensitivity Off if no Spont Vent
On 5% if Spont Vent

Alternatives would be:

i) Assist/Control Pressure Control **NB Peak insp press = Set Insp P + PEEP**

ii) SIMV +/- Pressure Support in TCPL or Pressure Control mode

**Servo 300**
- Mode
- SIMV(Press Control) + Pressure Support
- CMV rate 25  SIMV rate 20
- Insip time 1 sec
- Insip Pressure 15 (**this is above PEEP**)  
- PEEP 5
- Pressure Support 10
- Trigger Sens in the green or red as close to maximum without autotriggering

**EvitaXL**
- Mode
- PCV + PS
- Rate 20
- Insip Pressure 20
- PEEP 5
- Need to also set/check Flowtrigger @ 1
- ATC has correct #ETT
- Autoflow on
- Neoflow in circuit

2. **Older Child ( > 12kg)**

- Use adult tubing
- Ventilate in a Volume Control mode setting with an initial Vt of 8mls/kg and have a pressure limit set on the ventilator at 35cmH2O.
- Wide range of weight so need to individualise rate (12-20).
- For the Bird Volume or VAPS can be used in either SIMV or Assist.
- For the Servo either SIMV(Volume Control) + PS or PRVC can be used.
- For the Drager SIMV and MMV are volume control modes. Set PLV at an appropriate level.

**Injured Lungs**

These patients often require modes of ventilation that are not well tolerated necessitating sedation and paralysis. Our mainstay ventilator for these patients has been the Servo 300 although the Bird Gold or Evita XL can also be used. Our general philosophy is to use a Pressure Control mode, long inspiratory times, adequate PEEP, and limit rate and tidal volume. Start with an FiO₂ of 1.0.
NB This does not apply to patients with gas trapping eg asthma, bronchiolitis where the aim is to avoid excessive PEEP and prolong expiratory time.

Ventilator Set ups

All patients (Rate will be slightly faster for neonate vs older child but the rest of the settings are similar)

Servo 300 Mode SIMV(Pressure Control) + PS
Pressure Control(above PEEP) 15-20
PEEP 8-10
Insp Time 1sec
Rate 12-20 (CMV rate MUST be > SIMV rate)

If patient requires high pressures (>35cmH2O) to achieve an acceptable tidal volume can try PRVC.

In a paralysed patient can use Pressure Control (NB CMV dial determines the rate AND affects the Insp Time).

EvitaXL Mode PCV+
Insp Pressure 28-30
PEEP 8-10
Insp Time 1sec
Rate 12-20

Make sure ATC, Autoflow, and Flowtrigger are set correctly.
Alternative would be SIMV or MMV as both of these modes have an “inbuilt” form of PRVC which will seek out the lowest Insp Pressure to deliver a set Vt at.
As a safety feature in these volume control modes always turn the PLV on.

Bird Gold Mode Pressure Control in either SIMV or Assist Settings
Insp Pressure(above PEEP) 20
PEEP 8-10
Insp Time 1sec
Rate 12-20

If poor oxygenation with high ventilator settings use adjuncts such as prone position, permissive hypercapnia, accept lower PaO2 etc.
Wean FiO2 to <0.5 if possible.
PEEP may need to be increased to > 10cmH2O.
Pressure may have to be increased to achieve a reasonable Vt (6ml/kg).
If the lungs are compliant decrease Insp Pressure if Vt > 8ml/kg.

These are ventilation guidelines only.
Once connected to the ventilator YOU need to ensure that the patient is being adequately ventilated ie adequate tidal volumes at an acceptable pressure, adequate synchronisation between the patient and the ventilator, and adequate gas exchange.

Weaning Ventilation

See weaning section

Patients with normal lungs do not need weaning from the ventilator. They need to extubated once they are awake and on low level support.

Patients with abnormal lungs especially if they have had a prolonged period of mechanical ventilation may require weaning from the ventilator over a number of days.

There is little evidence for using 1 form of weaning over another but there is good evidence that

1. if the patients work of breathing is excessive then this may prolong weaning.
2. complicated ventilation modes may PROLONG weaning.
3. an individualised weaning protocol is advantageous.

Most studies have shown T piece weaning to be at least as effective and often more rapid than any other method.

1. Neonates/Infants/Small Children (<12kg)

   Bird VIP/Gold Mode TCPL Assist
   Wean Insp Pressure
   Set rate no effect if below Spont Rate
   Use Termination Sensitivity to limit Insp Time

   Alternatives:
   i) SIMV(Pressure Control) / Pressure Support and wean rate
   ii) SIMV / Pressure Support TCPL and wean rate
   iii) VAPS in either Assist or SIMV mode

   Servo 300 Mode SIMV(PC) + Pressure Support
   Wean SIMV rate to zero
   May then switch to Pressure Support/CPAP mode
   Start with PS 10-15cmH₂O then wean

   Lack of constant flow makes the servo less ideal for weaning small infants. May choose to switch them to a different ventilator for weaning.
EvitaXL Mode PCV + PS
Wean Insp Pressure
Has built in termination sensitivity
Ensure trigger and ATC set correctly
Constant flow present

Alternatives:

i) PS/CPAP

2. Patients > 12kg

Bird Gold Mode SIMV(Volume Control) / PS
Wean Rate then Pressure Support

Alternatives:

i) VAPS in Assist/Control or SIMV/CPAP/PS.

Servo 300 Mode SIMV (Vol Control) Pressure Support
Wean rate then PS

Alternatives:

ii) SIMV (Press Control) Pressure Support
iii) PS/CPAP

EvitaXL Mode MMV + Pressure Support
Self Weaning
Once all M, Spontaneous wean PS

Alternatives:

i) SIMV + PS
ii) PCV + PS
iii) PCV + Assist – Wean insp pressure
iv) PS/CPAP – can have apnoea back up on