Targeted Tidal Volume (TTV)

Background

A major contributor to ventilation induced lung injury is excess end-inspiratory lung volume-overdistension. A keyway to minimise this is to avoid excess tidal volume. The SLE 5/6000 can target volumes to avoid this, and this mode is called Targeted Tidal Volume (TTV).

Targeted Tidal Volume enables the user to select a target volume that they wish to achieve, allowing the ventilator to adjust PIP and Ti to achieve and maintain the selected tidal volume.

Potential benefits of Targeted Tidal Volume include:

- Reduced bronchopulmonary dysplasia
- Reduced intraventricular haemorrhage
- Reduced periventricular leukomalacia
- Reduced pneumothoraces
- Reduced hypocarbia (low PCO_2)
- Reduced duration of oxygen dependency

Indication

- Any ventilated baby on SIMV or CMV who does not have a big leak (>50%) around their endotracheal tube

How does it work?

Basic principle

- CO_2 elimination is determined by minute ventilation (rate time tidal volume)
- When you are using TTV the tidal volume is held constant and therefore the usual way to control PCO_2 is to adjust the ventilator rate
- The clinician sets the desired tidal volume and a maximum pressure and inspiratory time that the ventilator is allowed to deliver
- The ventilator measures the inspired volume delivered with each breath and terminates inflation when the target tidal volume has been delivered
- The ventilator will use the lowest pressure and inspiration time needed to deliver the set tidal volume
- If the lungs are improving the delivered pressure will diminish
- The ventilator will still be able to deliver the set pressure if for any reason the tidal volume goes down, such as when the baby splints his/her chest

What about leak around the tube?

- Preterm infants are ventilated with uncuffed tubes and there is usually some leak around the tube
- This means that there is a difference between the tidal volume that is measured to go in to the baby (inspired tidal volume) and the tidal volume that comes back out (expired tidal volume)
- This difference is the leak.
- The expired tidal volume tells you what really went into the baby's lungs.
- The ventilator measures the leak of every breath and displays a percentage value based on the last 5 breaths
- With TTV, the ventilator adjusts the inspired tidal volume breath by breath
- The ventilator automatically compensates for leaks up to 50%. This means that the ventilator will deliver the set inspired tidal volume plus the percentage leak averaged over the last 5 breaths, up to a maximum of 50%
- Leak >50% is not compensated so then the actual tidal volume delivered to the baby will be lower than you intend and may make using this mode unhelpful.

Turning on TTV on SLE 5/6000

- First note current average TV's, leak, Ti, Pressure and Rate.
- Turn on TTV by pressing the button and confirm
- Set TV to desired TV (see notes below)
- Set Max PIP to the previous PIP plus 2cmH_2O
- Leave the rate and Ti unchanged unless clinically indicated.

Turning TTV off

- Turn off TTV by pressing the button and confirm
- Reset the PIP because the ventilator will default to the set PEEP plus 5cmH_2O
- Check that all the ventilation parameters are satisfactory

Tidal volumes to use:

- 5 mL/kg or current Vt is a reasonable starting volume
- Vt values outside the range 4–6 mL/kg are not recommended without consultant discussion
- Tidal volume is not usually adjusted, weaning will be on rate
- Adjustments can be made in steps of 0.5 mL/kg
- Consider a lower VT if there is possible pulmonary hypoplasia

Ventilator Rate

- In baby with poor respiratory drive, use rates of 40–60 bpm initially (usually start at 40).
- Adjust rate to obtain the desired PCO_2
- Use Ti (inspiratory time) of 0.3–0.4 sec initially

Weaning

- Inspiratory pressure weans automatically as lung compliance improves
- Generally wean rate rather than VT to control PCO_2
- There is no need to turn of TTV before extubation
- If baby has good respiratory drive and satisfactory gases and delivered mean airway pressure is not high (<8cmH_2O) consider extubation

Documentation

The set Maximum PIP will not reflect the average delivered PIP as this will be adjusted to meet the baby's needs.
The average delivered PIP should be documented in the Badger nursing chart on an hourly basis. The set maximum PIP should be documented in the nursing summary on each shift

Alarms

Set as usual in other modes
Top and bottom alarms are set automatically on the SLE 5000
Upper pressure alarm should be 4-5 cmH_2O above maximum set PIP
Lower pressure alarm should be 3-4 cmH_2O below the current PEEP (but not negative or zero)

Pitfalls

- When TTV is turned off, PIP will drop to the set PEEP plus 5cmH_2O. PIP readjustment will be necessary
- If the infant appears less stable on this form of ventilation it may be discontinued
- If leak is higher than 50% the mode may not deliver adequate VT and may need to be discontinued
- This form of ventilation requires a flow sensor lead to be attached as it requires Vte measurements

Refs

1) Volume-targeted ventilation is more suitable than pressure-limited ventilation for preterm infants: a systematic review and meta-analysis, W Peng, et al. Arch Dis Child Fetal Neonatal Ed 2013;0:F1–F8. doi:10.1136/archdischild-2013-304613
2) http://www.networks.nhs.uk/nhs-networks/staffordshire-shropshire-and-black-country-newborn/neonatal-guidelines/respiratory-1/Volume%20guarantee%202013201315.pdf/file_popview

Main author: Dr David Quine, main reviewer: Dr Ben Stenson

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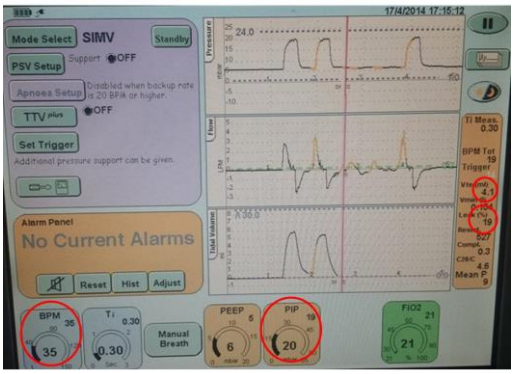
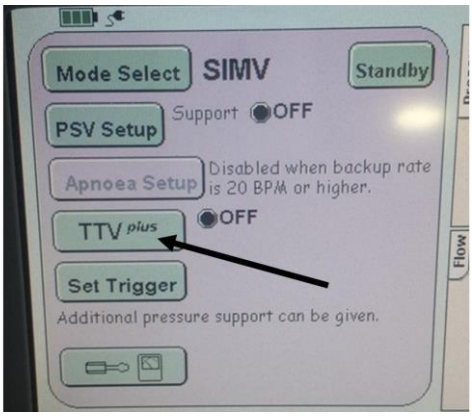
Step by step guide to turning on TTV on SLE 5000

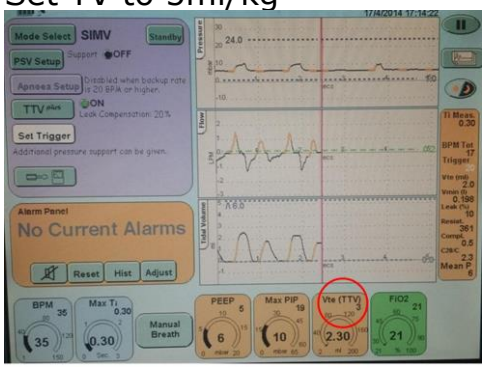
1. First note current average TV's, leak, Ti, Pressure and Rate.



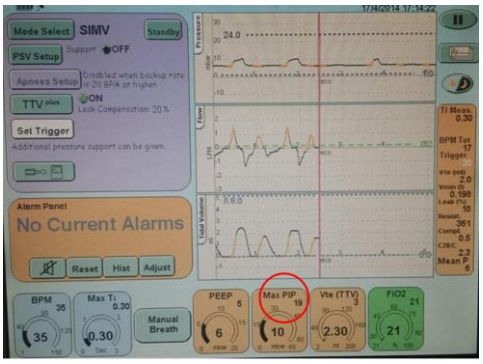
2. Turn on TTV by pressing the button and confirm



3. Set TV to 5ml/kg



4. Set Max PIP to previous PIP plus 2cmH_2O



5. Leave rate and Ti unchanged unless clinically indicated.
6. Monitor blood gases and control PCO_2 by adjusting the set breath rate.

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