VENTILATION: VOLUME-TARGETED (VOLUME GUARANTEE/TARGETED TIDAL VOLUME)

NICE QS193 recommends that preterm babies having invasive ventilation are given volume targeted ventilation in combination with synchronised ventilation

DEFINITION

In volume-targeted ventilation (VTV) gas delivery is targeted to deliver a pre-set tidal volume. Inspiratory pressure varies with each breath, depending on resistance and underlying lung compliance. The ventilator measures expired tidal volume (Vte) and calculates the pressure required to deliver this volume for the next breath. Available as volume guarantee (VG) on Draeger Babylog®, targeted tidal volume (TTV) on SLE 5000 and VTV on SLE 600

Benefits

- Compared with pressure-controlled ventilation, VTV can reduce:
- mortality
- bronchopulmonary dysplasia
- pneumothorax
- hypocarbia
- severe intraventricular haemorrhage and periventricular leukomalacia

INDICATION

- Primarily used in preterm babies with surfactant-deficient lung disease requiring ventilation
- May be useful in other situations requiring ventilation

CONTRAINDICATION

- ETT leak >50%
- Caution to be used in situations such as pneumothorax, tracheo-oesophageal /bronchopleural fistula; leak may be increased and affect ventilation

TIDAL VOLUMES TO USE

- Vte used as less influenced by ETT leaks
- Vt 4–6 mL/kg
- 5 mL/kg reasonable starting volume
- Acute respiratory distress syndrome (RDS) 4–6 mL/kg
- baby <750 g: 5–6 mL/kg (minimum starting volume 3 mL if 6 mL/kg is <3 mL)
- baby 750–999 g: 4.5–5 mL/kg
- baby ≥1000 g: 4–4.5 mL/kg
- Chronic lung disease: 5–8 mL/kg
- Avoid Vte >8 mL/kg (associated with volutrauma)
- Avoid Vte <3.5 mL/kg (associated with atelectotrauma)
- Change Vte in 0.5 mL/kg increments

MODE

- VG/TTV combined with SIMV, SIPPV, assist control (PTV) or pressure-support ventilation (PSV)
- VG also available for PC-CMV and HFO modes on Draeger VN-500 ventilator
- In SIMV mode, set rate of ≥40/min (baby breaths are unsupported)
- PSV has additional advantage of synchronising inspiration termination.

PEAK PRESSURES

- Start PIP limit (Pmax) of ~25–30 cm H_2O
- Once baby stable and gases satisfactory adjust Pmax to 5–6 cm H_2O above average PIP needed to deliver set tidal volume
- usually set ≤30 cm H_2O in preterm babies

- If PIP progressively increases or is persistently high, or if set Vt not delivered, reassess baby
- PEEP set at 4–6 cm H_2O

VENTILATOR RATE

- In baby with poor respiratory drive, use rates of 50–60 bpm
- Lower rates of 30–40 bpm can be used with good respiratory drive
- Use T_{insp} (inspiratory time) of 0.3–0.4 sec; in PSV mode, set maximum T_{insp} at 0.5–0.6 sec – actual T_{insp} is adjusted by the ventilator
- Set flow trigger sensitivity at 0.2–0.4 L/min

WEANING

- Pressure weans automatically as lung compliance improves
- Avoid tidal volumes <3.5 mL/kg as increases work of breathing in small babies
- In SIMV, rate reduced to 40 breaths/min. VG/TTV is unhelpful with SIMV rates <40/min as baby breaths are unsupported. Attempt extubation when:
- FiO_2 <0.3
- MAP falls consistently <8 cm H_2O
- baby has good respiratory drive and satisfactory gases

TROUBLESHOOTING AND PREVENTING PROBLEMS

High CO_2 (blood gases)

- Review baby
- Is set Vte being delivered?
- Is chest expansion adequate?
- Has leak increased? Change baby's position before increasing Pmax
- If ETT displaced/obstructed, or pneumothorax suspected, perform chest X-ray

Low CO_2 (blood gases)

- Decrease Vte by 0.5 mL/kg but maintain ≥4 mL/kg (≥2.5 mL total volume)
- Change to SIMV
- Lower trigger sensitivity
- Check for water in circuit (auto-triggering)
- Decrease rate by 5–10 bpm (in SIMV mode only)
- Increase PEEP (maximum 8 cm H_2O)

Low SpO_2

- Review baby
- Exclude air leaks
- Worsening RDS: may require additional surfactant dose
- Evidence of PPHN (see **Pulmonary hypertension** guideline)
- Increase FiO_2
- If Vte not delivered, increase Pmax
- Baby may benefit from change to high frequency [see **Ventilation: high frequency oscillatory ventilation (HFOV)** guideline]
- Exclude congenital heart disease

Low Vte alarm

- ETT leak >50%
- Pneumothorax
- Poor compliance/high resistance: increase Pmax

Baby persistently tachypnoeic

- Increase Vte by 0.5–1.0 mL/kg even if gases normal
- Review sedation