

VENTILATION: SYNCHRONOUS POSITIVE PRESSURE VENTILATION (SIPPV)

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

DEFINITION

A form of synchronous ventilation in which baby triggers/initiates the breath while ventilator does the work of breathing. In other words, rate of ventilation is determined by baby while pressures are determined by operator via ventilator

SETTING UP TRIGGER VENTILATION

- Set humidifier temperature at 39°C (negative 2) to achieve airway temperature of 37°C

Set up Babylog® (Drager)

- Flow 6–10 L/min
- Select SIPPV mode
- Select highest trigger sensitivity (1: bar is all unshaded)
- Select T_{insp} (inspiratory time) between 0.3–0.4 sec
- Adjust T_{exp} (expiratory time) to achieve back-up rate of 35–40/min
- Peak inspiratory pressure (PIP) 16–18 cm H₂O
- Peak end expiratory pressure (PEEP) 5 cm H₂O
- FiO₂ to achieve target SpO₂ for gestation (see **Oxygen saturation targets** guideline)

Set up SLE 5000/6000

- Select patient triggered ventilation (PTV) mode
- Select highest trigger sensitivity (0.2 L/min for ≤28 weeks' gestation, 0.4–0.6 L/min for >28 weeks' gestation). Look at baby to confirm triggering adequately by observing baby generated breaths are triggering ventilator support
- Select T_{insp} for back-up breaths between 0.3–0.4 sec
- Set back-up rate of 35–40/min
- PIP 16–18 cm H₂O
- PEEP 5 cm H₂O
- FiO₂ to achieve target SpO₂ for gestation (see **Oxygen saturation targets** guideline)
- Software allows compensation for a leak of 10–60%
- Observe tidal volume (Vt) settings to confirm between 4–6 mL/kg

Baby

- If gestation <34 weeks, consider loading baby with IV caffeine citrate (20 mg/kg)
- Discontinue sedation

INITIATING TRIGGER VENTILATION

- Once baby connected to ventilator:
 - check SpO₂ (see **Oxygen saturation targets** guideline) and adjust FiO₂ accordingly
 - check baby's chest moving adequately, and measured Vt. Chest expansion should be just visible, and Vt should be between 4–6 mL/kg. If not, adjust PIP/PEEP to maintain adequate oxygenation and ventilation
 - check ventilator triggering in synchrony with baby. Assess by **listening** to ventilator while **watching** baby's respiratory effort

Most likely cause of baby 'fighting' ventilator is ASYNCHRONY (see Management of asynchrony)

SUBSEQUENT ADJUSTMENTS ON SIPPV

- Check blood gas within 30 min of initiation of SIPPV
- Aim for:
 - PaO₂: 6–10 kPa or target appropriate SpO₂ level (see **Oxygen saturation** guideline)
 - PaCO₂: 4.5–8.5 kPa day 1–3, 4.5–10 kPa day 4 onwards
 - pH >7.25

To improve oxygenation

- Increase FiO₂
- Rule out pneumothorax
- Increase PIP and/or PEEP
- Increase T_{insp} (not more than 0.4 sec)

To decrease PaCO₂

- Rule out pneumothorax
- Increase PIP
- Check if baby triggering adequately. If not, try shortening T_{insp}, or increasing back-up rate

Low PaCO₂

- Decrease PIP
- Decrease back-up rate if >35/min (if baby not breathing above this rate)
- In a vigorous hypocapnic baby, transfer to synchronised intermittent mandatory ventilation (SIMV) at a rate of at least 20/min

GENERAL SUPPORT

- Monitor SpO₂ continuously
- Check arterial blood gases at least 4–6 hrly depending on stage of disease
- In babies successfully ventilated in SIPPV mode, sedation is unnecessary
- Remember, most common cause of baby fighting ventilator is ASYNCHRONY. Always carry out checks and adjustments (see **Management of asynchrony**)
- If baby still 'fights' ventilator, consider morphine bolus (50–100 microgram/kg)
- If baby continues to 'fight' ventilator, use continuous sedation and change to other conventional ventilation (SIMV) mode (see **Ventilation: conventional** guideline)

Do not use muscle relaxants unless, despite carrying out above checks, baby cannot be ventilated.

If muscle relaxants necessary, revert to conventional ventilation (see Ventilation: conventional guideline)

NURSING OBSERVATIONS

While baby on SIPPV, hourly observations

- Back-up rate set
- Baby's own respiratory rate
- Vt (in mL)
- Minute ventilation [MV (in l/min)]

If alarm goes off, check

- Synchrony between baby and ventilator
- Excessive water droplets in ventilator tubing
- Flow graph for evidence of blocked tube or excessive T_{insp}
- Disconnection

MANAGEMENT OF ASYNCHRONY

Checklist

- Is endotracheal tube (ETT) patent (look at flow graph and Vt)
- Is T_{insp} too long? (is baby exhaling against ventilator?), if so shorten T_{insp} to 0.3 sec
- Is back-up rate too high? If so, consider dropping to 30–35 breaths/min

- Is there water condensation in ventilator tubing?
- If all above fails, consider morphine bolus (100 microgram/kg) over 3–5 min
- If baby still continues to 'fight' ventilator, use continuous sedation and revert to SIMV

AUTOCYCLING (FALSE TRIGGERING)

- False triggering occurs when ventilator delivers a mechanical breath artefactually when baby not actually initiating a spontaneous respiration
- Usually results from presence of water droplets in ventilatory circuit, or an excessive ETT leak
- If baby's trigger rate appears to be in excess of 80/min, ensure this is actual rate by observing baby's own respiratory movements. If not:
 - check ventilatory circuit for excessive water condensation and empty if necessary
 - decrease trigger sensitivity by increasing trigger threshold e.g. from 0.4 to 0.6 L/min
 - Look for amount of ETT leak on Babylog display. If in excess of 50%, consider changing to slightly wider ETT

WEANING FROM SIPPV

- Once baby stable (triggering above set rate, saturating in $\text{FiO}_2 < 0.3$), wean by:
 - decreasing PIP by 1–2 cm H_2O each time (in SIPPV/PTV mode, weaning rate in a baby who is already triggering above it is useless)
 - check baby breathing regularly and effortlessly (no chest recessions), and blood gases and oximetry are acceptable
 - once PIP between 14–16 cm H_2O (depending on size of baby), consider extubation
 - assess need for nasal CPAP/high-flow by checking for chest recessions, spontaneous minute ventilation, and regularity of breathing
- During weaning PaCO_2 can rise above 7 kPa and V_t may fall below 4 mL/kg
 - provided baby triggering well, is not visibly tired, and $\text{pH} > 7.25$, no action required
 - if poor triggering, visibly tired or abnormal pH, increase PIP, and later back-up rate