Volume Targeted Ventilation Bedside Troubleshooting Guide

Ventilator Alarming 'Volume not Reached' regularly, eg enough to affect MV (MV = vT x Rate)

No → Ensure settings are correct for age, expected volumes and alarm limit settings are correct. If these are set correctly the ventilator should provide the necessary ventilation and prompt with an alarm if problems occur.

Yes ↓

Is the baby unstable? Are they desaturating? Is there acute change in condition?

Yes →

Dislodged ET	Can baby manage off ventilation? If not replace ETT
Obstruction	Suction of ETT; if blocked or coated replace ETT
Pneumothorax	Cold light / CXR; needle / drain
Equipment	Check ventilator functioning / circuit correct. Often helpful to 'neo-puff' and assess response; if baby responds then likely issue is with ventilator

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After the above actions check ventilator settings are appropriate; alarm limit settings, appropriate P-Max. Requirements are likely to change following any DOPE

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Is the baby still unstable?

Yes → Is 'Volume not Reached' Alarm still sounding?

Yes → **Check ETT Specifics** (Refer to main guideline for full details)
1. Excessive 'dead space'
2. High 'leak': >50% in Phabian & Drager / >30% in SLE
3. ETT too small
4. Not enough support through narrow ETT

No → Routine Monitoring

No → Ask: Do you need senior assistance / advice?

Minimise ETT dead-space	Ensure ETT 'dead-space' is not excessive; >2cm outside the lips
Minimise ETT Leak	Positionaling of baby's head and ariway will often reduce ETT leak, this is does not help consider the aspect below
'Up-size' ETT	If the ETT has a high leak which is not improved with positioning, consider up-sizing the ETT if possible; this will lower the required pressure to deliver the set volume
Consider Pressure Support Ventilation	If 'up-sizing' the ETT is not possible consider pressure support ventilation; this will help increase minute volume and decrease baby fatigue

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After the above actions check ventilator settings are appropriate; alarm limit settings, appropriate P-Max. Requirements are likely to change following the above

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Is the baby still unstable?

Yes → Seak senior advice / assistance, re-check DOPE

No → Is 'volume not reached' alarm still sounding?

Yes → **Check volume settings:** Is the volume target set to the appropriate amount? The 'set / target volume' should be entered as the actual volume to be delivered, not the mL/kg value. It should be adjusted weekly with weight gain.

No → Routine Monitoring

Baby Weight / Condition	Volume Setting; Rationale
Preterm RDS	4.5mL/kg (starting)
<700g Weight	5-6mL/kg; increased equipment 'dead-space' to lung ratio requires more volume. If needed increase to 7mL/kg NOT BEYOND
MAS / Air-trapping	5-6mL/kg; increased alveolar 'dead-space'
> 2 weeks of age / CLD	6mL/kg; increased anatomical and alveolar 'dead-space'. May require longer inspiratory time (iT)
Pulmonary Hypoplasia	Max 5mL/kg; small lung volume. Require low tidal volumes, high respiratory rates, lower PEEP (3-4 cmH2O). P-Max should not exceed 25 cmH20, after this HFOV should be considered
BPD	May need 7-8mL/kg; Abnormal airways, increased physiological dead space
Term	5-6mL/kg

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After the above actions check ventilator settings are appropriate; alarm limit settings, appropriate P-Max. Requirements are likely to change following the above

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Is the baby still unstable?

Yes → Seak senior advice / assistance re-check DOPE

No → Is the 'volume not reached' alarm still sounding?

Yes → **Check Pressure and InspiratoryTime Settings:** Is the P-max (PIP) adequate? Is PEEP appropriate? Adequate PEEP essential to maintain FRC as VTV uses lowest possible PIP. Is the inspiratory time appropriate for the underlying condition?

No → Routine Monitoring

Parameter	Setting / Value
P-Max	25 cmH20 for Preterm 30 cmH20 in Term Once 'required' PIP to achieve target volume has been established, set the P-max 5 cmH20 above this required PIP
PEEP	Commence 5 cmH20 (can be adjusted to 7-8cmH2O to maximise lung recruitment; too low PEEP and lung will not be compliant enough to reach target volume. Too high PEEP and lung will be overdistended and not able to expand to set volume) Helpful to observe hysteresis curves **Pulmonary Hypoplasia** 3-4 cmH20 Higher PEEP 6-8cmH20 maybe needed in pulmonary haemorrhage, abdominal distension,
Inspiratory Time	Inspiratory time needs to be long enough to ahieve the target volume: Initial settings 0.32 - 0.38 (seconds) iT. In RDS use short inspiratory times; lungs inflate quickly In BPD lungs as long as 0.5 maybe needed; lungs take longer to inflate. Checking 'Time Constant' is helpful to determine the necessary individual iT. Observing flow graphs is helpful to visualise if iT is long enough to fill the lungs; if so there is a pause at the end of inspiration before expiration begins

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After the above actions check ventilator settings are appropriate; alarm limit settings, appropriate P-Max. Requirements are likely to change following the above

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Is the baby still unstable?

Yes → Seak senior advice / assistance re-check DOPE

No → Is the 'volume not reached' alarm still sounding?

Yes → **Check the Baby:** Is there asynchrony between the ventilator and the baby's own breaths? Is the baby aggitated? Does the baby have increase work of breathing (tachapnoea / recession)?

No → Routine Monitoring

Splinting / 'Expiratory Breaking'	This suggests inadequate support from current PEEP setting; the baby is trying to increase lung volume / recruitment by pausing / 'breath-holding' prior to expiration. - Increase PEEP within safe levels according to underlying lung disease: see PEEP settings above.
Increased work of breathing	This suggests inadequate support from current ventilation; the baby is having to work harder to maintain minute volume. - Provide PSV for unsupported breaths especially in the presence of very small diameter ET tubes <3.0 and / or ELBW babies; this will lessen the work of breathing. - Increase target volume within safe limits: if the target volume is below the baby's physiological need, the ventilator lowers PIP and the baby has to work harder.
'Auto-triggering'	This occurs when external stimulus (water in tubing / movement of the tubing / other artifacts), triggers the ventilator to deliver a breath to the baby, when in fact the baby has not initiated this breath and will often be in the resting or expiratory phase when this auto-triggered breath is delivered. The baby may become aggitated in response. Some ventilators will alarm with minute volume high in response. Resolve the cause of the auto-triggering.
Changes in lung compliance	This may occur as lung disease progresses. In the RDS lung, compliance may decrease as a result of surfactant deficiency; a dose or further doses of surfactant may be necessary to increase compliance and achieve adequate ventilation and target volume. Consequently settings should be checked as the rapid change in compliance associated with surfactant administration may result in over-ventilation and set target volume may need to be reduced.
Aggitation of the baby	If the other above aspects which can cause aggitation have been assessed and resolved then the baby may need sedation or an increase in dose, but only after exclusion of other factors. Once adequate sedation is provided synchrony between baby and ventilator should return.