# Airway Pressure Release Ventilation:

## worth holding your breath for?

***Nepean WTET summary 5/5/20***

**Definition and Rationale**

- Spontaneous mode of ventilation where two PEEPs are set with more time (T) spent at $PEEP_{high}$
- Combines two key ideals;
    - Higher mean airway pressure to recruit and maintain open lung strategy (optimise gas exchange) without breaching safe plateau pressures
    - Low tidal volume strategy (no pressure support just automated tube compensation, ATC) that protect against volutrauma, atelectotrauma and unsafe driving pressures.
- Set by;
    - $P_{high}$ <30cmH2O (usually set as per Pplateau on initial mode), $P_{low}$ 0-5cmH2O, ATC 100%
    - $T_{high}$ usually 4.5-6s (depending on desired frequency)
    - $T_{low}$ based on flow-time curve, usually cease $T_{low}$ where flow rate dropped to approx. 40% of peak expiratory flow rate (NOT designed to target expiratory volumes)
    - Setting $P_{low}$ as 0cmH2O allows shorter $T_{low}$ time (higher $\Delta P$ increases flow rate) therefore increasing mean airway pressure -without dropping alveolar pressure to 0-5cmH2O ($T_{low}$ terminated well before flow ceases, which would otherwise lead to derecruitment)
    - Weaning; usually systematically reduce $P_{high}$ and increase $T_{high}$
- Appealing physiological concept for managing ARDS or hypoxic respiratory failure patients;
    - Minimise paralysis (critical illness myopathy) and heavy sedation (haemodynamic effects and may blunten hypoxic pulmonary vasoconstriction) both of which are associated with prolonged mechanical ventilation and associated complications
    - Ventilator dysynchrony not a problem as spontaneous mode without 'triggering'

**Advantages and Disadvantages**

- Advantages;
    - Physiologically attractive for above reasons
    - Cheap (all modern ventilators have this mode available)
    - Potentially avoids harm of deep sedation/paralysis, circumnavigates ventilator dysynchrony
    - As spontaneously breathing from the outset often fewer mechanically ventilated days than with mandatory modes
    - Higher mean airway pressures compared to other modes → reduced LV afterload
- Disadvantages;
    - Poor familiarity, documentation more difficult
    - Requires training on how to use (monitor $T_{low}$ with change in compliance) and then wean
    - Gets misused as a mode of delivering inverse ratio ventilation (IRV) as a mandatory pressure control ventilation (PCV) mode in heavily sedated +/- paralysed patients
    - Higher mean airway pressures compared to other modes → increased RV afterload

**Evidence**

- Varpula 2004 Helsinki
  - Single center; n=58 AECC ARDS criteria and P/F<200 (after period of stabilisation)
  - Randomised to APRV vs SIMV, excluded if >72h ventilation, chronic lung disease, contraindication to permissive hypercapnoea. PEEP in both arms titrate to pressure-volume curve. Driving pressure in both arms titrate to tidal volume (VT) 8-10ml/kg
  - No difference in ventilator-free days, ICU LOS, 28d and 1y mortality, or in oxygenation
  - Issues;
    - $T_{high}$ set to 4s $T_{low}$ to 1s; $T_{low}$ not based on expiratory flow, therefore more akin to PCV IRV? SIMV had IRV 2:1 → ?therefore not fair comparison of modes?
    - Pre lung protective ventilation (LPV); Large VT (8-10ml/kg actual body weight), Pinsp <35cmH2O, prone periods only 6h, used late steroids for ARDS
    - Power calculation n=80 based on 15% reduction in ventilator free days; stopped early due to lack of likelihood of significant difference (futility)
- Zhou 2017 China
  - Single center, n=138, ARDS P/F =/< 250, ventilated <48h. Randomised to LPV (ARDSnet) vs APRV. (NB 2/3 of patients in both arms had P/F <150 so sick cohort)
  - APRV; $P_{high}$ set as $P_{plat}$ of pre-randomised volume control (VC) mode setting, <30cmH2O. $P_{low}$ 5cmH2O, $T_{low}$ set based on termination expiratory flow peak of =/>50%, frequency 10-14 would determine $T_{high}$
  - Number of ventilator free days (to day 28) markedly better with APRV (19 vs 2, P<0.001), shorter ICU LOS and lower mortality (19.7% vs 34.3%), better oxygenation and compliance
- Hirshberg 2018 Utah
  - Four tertiary ICUs. Hypoxic respiratory failure (poorly defined) and ARDS ventilated <24h
  - n=52, stratified, block-randomsied to 3 groups; VC-LTV, APRV and APRV-LTV (latter expiratory time targeted at volume 6ml/kg, rather than expiratory flow), excluded chronic respiratory disease, acute coronary syndromes, severe traumatic brain injury, pregnancy
  - No difference in P/F at day 3, ICU or hospital LOS despite adjustment for severity of illness
  - Issues;
    - Stopped early due to poor recruitment (power calculation n=246) and inability to consistently achieve VT<6.5ml/kg in low VT APRV group despite titration $P_{high}$ and $P_{low}$
- Meta-analysis 2019 Ann Intensive Care
  - APRV in hypoxaemic respiratory failure. 5 RCTs (including above 3), n=330
  - Higher ventilator free days at day 28 with APRV and lower hospital mortality, without negative haemodynamic impact or risk of barotrauma
  - BUT low quality evidence and moderate heterogeneity. Further high quality RCTs needed

**Summary (my practice)**

- APRV is extremely physiologically attractive, in particular in those patients whom have marked hypoxia with atelectasis or shunt and would benefit from high mean airway pressures, but whom due to ventilator dysynchrony would otherwise require deep sedation +/- paralysis (and drawbacks associated with this) in order to facilitate safe conventional LPV strategies
- Importance of release volumes unclear (not measured in Zhou et al), ? is APRV less safe in highly lung compliant conditions?
- I will continue to trial APRV in selected patients with moderate-severe hypoxic respiratory failure (to include ARDS) who have passed their initial phase of optimisation of respiratory mechanics. However individual response (safety profile to include VT, as well as patient comfort /respiratory pattern; relative to other modalities) will determine my chosen duration and ongoing use
- I am inexperienced in using APRV as a weaning mode (to extubation) once respiratory failure resolved
- I eagerly await more research in this promising area – in particular to define patient selection