Guidelines for the use of airway pressure release ventilation (APRV) using Drager ventilators at Wishaw General Hospital.

BACKGROUND

APRV is a form of inverse ratio, pressure controlled, time cycled ventilation. APRV applies a continuous airway pressure (P_{high}) identical to CPAP to maintain adequate lung volume and promote alveolar recruitment. However, APRV adds a brief time-cycled release phase to a lower set pressure (P_{low}). CO2 removal occurs mainly during the release phase. The duration of the cycle spent at P_{high} is T_{high} and the release phase represents T_{low}. Spontaneous breathing is integrated and is independent of the ventilator cycle. APRV is designed to be used with reduced levels of sedation. Spontaneous ventilation promotes CO2 clearance in APRV, and as such it is less likely to be successful in those patients with no respiratory effort or receiving neuromuscular blocking drugs.

USES

APRV is generally used as an alternative for difficult-to-oxygenate patients usually (although not exclusively) in the context of acute lung injury/ acute respiratory distress syndrome (ALI/ARDS). It may also confer significant advantages in morbid obesity.

PATIENT SELECTION

APRV should be considered in patients who have a FiO2 > 0.5.

INITIAL SETTINGS ON COMMENCING APRV

Frequency	Related to T_{high}/ $T_{low.}$ Usually 10 – 12	T_{high}	4 - 6 seconds
P_{high}	See below	T_{low}	Turn auto release on. Set T_{low} max to 1 sec.
P_{low}	Zero at all times	Pressure support	Zero. See below

- Initially, T_{high} should be set to the lower end of the range. This should be increased over time depending on response.
- The default pressure support is set to zero. Spontaneous breaths however should be tube compensated (ATC). On the APRV screen select additional settings tab. Select the ATC tab. Turn ATC on at 100% and key in tube type/size.

SETTING P_{high}

- Newly intubated patient - set P_{high} at desired plateau pressure (typically 20–30 cmH2O).
- Transition from conventional ventilation – set P_{high} as the plateau pressure in volume-cycled mode or peak airway pressure in pressure-cycled mode.
- P_{high} >30 cmH2O may be necessary in patients with decreased thoracic/abdominal compliance (e.g. ascites/obesity).

LINK BETWEEN T_{low} AND EXPIRATORY FLOW RATE

Appropriate T_{low} settings are essential to the success of APRV and they are linked to the expiratory flow waveform. T_{low} commences on P_{high} release. At this point, expiratory flow is at its highest (100%) which is equivalent to PEFR. T_{low} should terminate at the time taken for PEFR to reduce to between 50 – 75% of its peak. Patients with obstructive lung disease have altered expiratory flow waveforms, and require appropriate adjustment of T_{low} (i.e. increased).

The Drager Infinity has the ability to automatically terminate T_{low} based on PEFR and we recommend its use. On the APRV screen select additional settings tab. Select auto release tab. Turn auto release on. The default setting for expiratory termination (exp. term.) is 60% of PEFR and generally this should be used initially. The T_{low} max also needs to be set on this tab and an initial time of 1 second is appropriate. T_{low} needs to be evaluated regularly (see common pitfalls). With this technique, T_{low} can altered by changing the exp. term. (an increase above 60% will reduce T_{low} and vice versa).

Alternatively, T_{low} can be set manually with auto release turned off. An initial setting of 1 second is appropriate.

TECHNIQUES TO IMPROVE CO2 CLEARANCE

- Assess for over sedation (inadequate spontaneous ventilation).
- Increase alveolar ventilation (*preferred method*) - increase P_{high} or P_{high} and T_{high} simultaneously.
- Increase minute ventilation - decrease T_{high} and increase P_{high} simultaneously. In some cases however, this may paradoxically increase PaCO2 as mean P_{aw} and gas exchange surface may reduce (especially if P_{high} is not simultaneously raised).
- Optimise T_{low}

TECHNIQUES TO IMPROVE OXYGENATION

- Increase FiO2.
- Increase P_{high} in 2 cm H_2O increments to a maximum of 30 cm H_2O.
- Increase T_{high} in 0.5-1 second increments to a maximum of 10 seconds.
- Reduce T_{low} by increase the auto release to nearer 70%
- Optimise haemodynamic status to ensure optimum pulmonary perfusion.

USE OF APRV IN OBSTRUCTIVE LUNG DISEASE (OLD)

APRV can be used in OLD, although caution should be exercised. Because the expiratory flow slope is altered, and there is a variable level of intrinsic PEEP, T_{low} is set at a value of 25 – 50% PEFR, thus T_{low} should be prolonged (0.8 – 1.5 seconds).

APRV IN SPECIAL CIRCUMSTANCES

- Inhalational anaesthesia – patients can receive inhalational anaesthesia during APRV. Inspired and expired agent monitoring is mandatory.
- Proning – patients on APRV can be proned.

WEANING

Patients with improved oxygenation on APRV (e.g., FiO2 0.4 with SpO2 > 95%) can be progressively weaned by lowering the P_{high} and extending the T_{high}. The minute volume generated by release volumes decreases and is gradually supplemented by increased spontaneous minute volume, until the patient has essentially been weaned to pure CPAP. Alternatively, patients can be converted from APRV to a standard weaning mode.

COMMON PITFALLS

- APRV is most successful with a limited number of releases. Thus, ventilator frequency should remain around the 10-12 range. Increases outwith this range promotes derecruitment, and risks a return to refractory hypoxaemia.
- Plow must be set to zero. Because T_{low} transits to T_{high} at 50 - 75% of PEFR, end-expiratory lung volume remains high, thus "intrinsic PEEP" is applied which should not be added to by setting $P_{low} > 0$. Similarly, setting a $P_{low} > 0$, will alter the PEFR waveform (decelerates flow) which will impact on $T_{low.}$
- Pressure support must be set to zero although 100% tube compensation should be used for spontaneous breaths. Adding pressure support above $P_{high,}$ can result in unacceptably high peak airway pressures and barotrauma.
- As the lung is progressively recruited release volumes will increase. T_{low} should be re-evaluated at least every 1-2 hours in the first six hours after initiation of APRV to ensure release volumes do not exceed 6-8 ml/Kg IBW. T_{low} settings should also be re-evaluated after a change in pressure settings.
- If appropriate shortening of the T_{low} still results in excessive release volumes (> 8ml/Kg IBW), then the patient does not have poor compliance and the rationale for the use of APRV should be reviewed and alternative ventilation options considered.
- Haemodynamic compromise - APRV can be associated with reductions in blood pressure. Often, this represents the unmasking of relative hypovolaemia, and fluid administration should be viewed as first line treatment.
- Secretion load – APRV can dramatically increase secretion load as newly recruited alveoli discharge their contents.
- Significant and unanticipated increase in PaCO2 – Exclude obstruction to circuit/ETT/tracheostomy tube.

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