Departmental Policy	Dept.: Intensive Care Services	Policy No: 1-2-9451-03-020 Version No: 02		
Title: Airway Pressure Release Ventilation (APRV)		**JCI Code:** COP		
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1. PURPOSE

1.1 APRV is used to improve oxygenation in Acute Respiratory Distress Syndrome (ARDS) by improving Ventilation/Oxygenation (V/Q) matching, as intrapulmonary shunt in collapse/consolidated lung is the major cause of hypoxemia in ARDS.

1.2 APRV is used for CO2 clearance with a lower MV by the following Mechanisms:

1.2.1 Unventilated alveoli are recruited, and ventilation to previously well-perfused alveoli is improved.

1.2.2 As lungs volume increases, pulmonary vascular resistance decreases and blood flow to previously hypo-perfused alveoli increases, reducing physiological dead space.

1.2.3 Unsupported spontaneous breathing increases cardiac output, which will also improve V/Q matching and reduce physiological dead space.

2. POLICY

2.1 APRV mode is initiated by physician order only.

2.2 Minimize number of releases to supplement ventilation from spontaneous breathing.

2.3 Ensure Automatic Tube Compensation (ATC) is set at 100% to maximally compensate for artificial airway resistance and decrease resistive Work of Breathing (WOB) imposed by the artificial airways.

2.4 Allow spontaneous breathing within 24 hrs of APRV application.There is little advantage in using APRV in patients who do not breathe spontaneously or who are paralyzed.

2.5 Reduce sedation and paralysis requirements to allow for spontaneous breathing.

2.6 Limit derecruitment; **Tlow** set to ensure **T-PEFR** is between 50% and 75%.

2.7 Use APRV with caution in patients with TBI, bronchopleurafistula and severe Chronic Obstructive Pulmonary Disease (COPD).

2.8 Arterial Blood Gases (ABG) must be done 30 minutes after initiation of APRV.

2.9 For the first twelve hours, ABG must be done every 3 hours, and 30- 45 minutes after any change in the APRV settings.

2.10 Chest X- ray must be done 2 hours after initiation of APRV mode.

2.11 Patient Monitoring must include the following:

2.11.1 Patient Oxygen Saturation (Spo2) needs to be at least ≥92% or per physician order.

2.11.2 Exhaled Tidal Volume (Vt_{ex}) must be at least 6ml/kg.

2.11.3 Minute Ventilation may be 5- 10 liters per minutes.

2.11.4 Respiratory Rate (RR) must be ≤ 30 breaths per minute.

2.11.5 Hemodynamics must be monitored and reported for any changes ≥ 20% from baseline.

2.11.6 Mean Airway Pressure

3. DEFINITION OF TERMS

3.1 Airway Pressure Release Ventilation (APRV) - A ventilation mode that:

3.1.1 Uses two levels of Continuous Positive Airway Pressure (CPAP) in an intermittent mandatory ventilation-breathing pattern with unrestricted spontaneous respiration.

3.1.2 Has a brief release in CPAP for a short time. The short release along with spontaneous breathing promotes CO_2 elimination.

3.1.3 Is based on the open lung concept that facilitates recruitment of collapsed and poorly ventilated alveoli, and where inverse inspiratory-expiratory (I: E) ratio is typically applied.

3.1.4 Is associated with an increase in mean airway pressure and a tendency to stack breaths (increased intrinsic Positive Expiratory Pressure (PEEP). Increased intrinsic PEEP is the likely mechanism by which APRV improves arterial.

3.2 Spontaneous breaths during APRV mode

Breaths is patient-triggered and patient-cycled. They can occur both during and between mandatory breaths.

3.3 **Mandatory Breaths during APRV -** Are machine-triggered and machine-cycled.

3.4 **Pressure High (P high) -The** upper CPAP

3.5 **Pressure low (P low)**

*ΔP =Phigh –Plow

3.6 **T High**-is the Inspiratory Time (IT) phase for the high CPAP level (P High).

3.7 **T low-** is the expiratory time phase for Plow, or their release time that allow Carbon Dioxide (CO_2) elimination.

* T High + T low is the set cycle time

3.8 PEFR- Peak Expiratory Flow Rate:

It is the maximum expiratory flow rate in liters per second (L/sec)

4. PROCEDURES

4.1 Initial Settings of APRV

4.1.1 Newly intubated

Phigh- High pressure level

4.1.1.1 Set at desired plateau pressure (typically 20–30 cm H2O). Titrate to deliver Tidal Volume (TV) 6-8ml/kg.

4.1.1.2 Avoid Phigh ≥ 30 cm H2O

4.1.1.2.1 Phigh of 35 cm H2O may be necessary in patients with decreased thoracic/abdominal compliance or morbid obesity.

4.1.1.2.2 Set at 30 cm H_2O if Pplat is greater than this on conventional ventilation.

4.1.1.2.3 Plow- Low pressure level - 0 cm H2O.

4.1.1.3 Lung collapse is avoided by manipulation Tlow rather than Plow

Thigh - Time spent at pressure high

4.1.1.4 Initial Setting 4-6 seconds (s)

4.1.1.5 Progressively increase to 10-15s

4.1.1.6 Target is oxygenation.

Tlow - Time spent at low pressure

4.1.1.7 Initial settings at 0.6s

4.1.1.8 Restrictive lung disease(RLD): 0.2–0.8 s

4.1.1.9 Obstructive lung disease(OLD): 8–1.5 s

4.1.2 Transition from conventional ventilation

4.1.2.1 **P_{high}** - Set at plateau pressure in volume-cycled mode or peak airway pressure in pressure-cycled mode

4.1.2.2 **P_{low}** - Set at 0 cm H2O

4.1.2.3 **T_{high}** - Set at 4–6 s

4.1.2.4 **T_{low}** - Set at 0.2–0.8 s (Restrictive Lung Disease)

4.1.3 The two most common methods described for setting Tlow

4.1.3.1 Using the PEFR

4.1.3.1.1 Refer to the flow waveform (Fig1).

4.1.3.1.2 T_{low} should end when expiratory flow falls to 50-75% of Peak Expiratory Flow Rate (PEFR).

4.1.3.1.3 Ensure T_{low} ends earlier than the expiratory cycle ~(75% of PEFR), during poor lung compliance, because emptying occurs more quickly.

4.1.3.1.4 In Obstructive Lung Disease the opposite occurs, so ensure Tlow ends at ~50% of PEFR.

4.1.3.1.5 Ensure the expiratory flow curve is displayed at all times to allow adjustment of Tlow as lung compliance changes.

4.1.3.1.6 Tlow can be increased in 0.1s increments, as the lung recovers and compliance improves.

4.1.3.2 Using optimal Positive End Expiratory Pressure (PEEP)

4.1.3.2.1 Use Pressure/Volume curve to determine optimal PEEP.

4.1.3.2.2 Optimal PEEP maintains sufficient volume (FRC) to prevent derecruitment.

4.1.3.2.3 Note the Tidal Volume Exhaled (TVE) generated by moving from optimal PEEP to Thigh, and manipulate Tlow to deliver an equivalent TVE.

4.2 Titrating settings in APRV:

4.2.1 *Hypoxia*

4.2.1.1 Increase Fio2

4.2.1.2 Increase Phigh

4.2.1.3 Increase Thigh (watch CO2)

4.2.1.4 Consider reducing Tlow (effects on PEEP, but watch CO2).

4.2.2 *Hypercapnia*

4.2.2.1 Increase Alveolar ventilation ('Increase APRV)—increase Phigh or increase Phigh and Thigh together.

4.2.2.2 Increase minute ventilation—decrease Thigh and increase Phigh

4.2.2.3 Check Tlow. (See if you can lengthen it?)

4.2.3 ***Hypocapnia***

4.2.3.1 Increase Thigh

4.2.3.2 Decrease Phigh (play-off against oxygenation).

4.2.3.3 Weaning:

4.2.3.3.1 No requirement to change any other mode of ventilation; weaning may be achieved by the 'Drop and stretch" method.

4.2.3.3.2 FiO_2 should be 40% before attempting any reduction in airway pressure.

4.2.3.3.3 Keep Plow at 0 for as long as the patient remains on APRV.

4.2.3.3.4 Only adjust Tlow in response to change in lung compliance.

4.2.3.3.5 Reduce Phigh in 2 cm H_2O increments, guided by oxygenation. Eventual target 8-10 cmH2O.

4.2.3.4 In tandem, increase Thigh in 2s increments. Monitor $PaCO_2$.

4.2.3.4.1 This effectively reduces the release rate and CO_2 clearance is achieved by spontaneous ventilation.

4.2.3.5 At CPAP 8-10 cm H_2O, an assessment of suitability for tracheal extubation or shifting to trach collar, if patient is tracheostomized, may be appropriate.

4.2.3.6 Should the patient condition deteriorate at any stage during this process, increase Phigh (for deterioration of oxygenation) or reduce Thigh (for unacceptable rise in CO2). This avoids switching from one mode to another with potentially deleterious effects.

5. REFERENCES

5.1 Oxford Specialist Handbook in Critical Care "Advanced Respiratory Critical Care" 2011 3rd. Edition. Edited by Martin Hughes and Ronald Black.

5.2 Other approaches to open-lung ventilation: Airway pressure release Ventilation Nader M. Habashi, MD, FACP, FCCP.

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