Mechanical Ventilation-Pediatric

PURPOSE:

- This policy is primarily intended to address ventilator use during inter-facility transports. See Mechanical ventilation-911 for additional information on initial settings for prehospital mechanical ventilationthe current oxygen supply in transport vehicles should be calculated based on
- To determine the appropriate ventilator settings for pediatric patients
- Consideration of current oxygen supply in transport vehicle should be calculated based upon mission requirements (see attachment).

HIGHLIGHTS:

- Efforts should be taken to minimize use of bag-valve ventilation of the patient and maximize mechanical ventilation to provide consistent tidal volumes and respiratory rates.
- Clamping of endotracheal tubes are strongly encouraged with patients who have PEEP >5mmHg to maintain alveolar recruitment and to minimize the loss of that recruitment.
- A new ventilator circuit shall be used with each new patient with calibrations already performed prior to assuming of care.

COMPLICATIONS

- Hemodynamic compromise from reduced venous return
- Bronchospasm
- Accidental extubation
- Bronchial intubation
- ET tube cuff leak/air leak
- Endotracheal tube obstruction- from sputum, kinking, biting
- Auto-PEEP
- Barotrauma - lung injury from alveolar over distention, alveolar hypoperfusion, and repetitive shear stress across alveolar walls, which leads to an inflammatory response; from volutrauma (excess volume of air delivered to lungs that cannot accept that much volume)
- Pneumothorax
- Ventilator associated pneumonia
- Ventilator malfunction
    - NOTE: If at any time acute respiratory deterioration occurs and obvious cause not immediately determined (tube disconnected, tube kinked, etc), disconnect the patient from the ventilator and initiate manual ventilation with 100% oxygen. Then perform a rapid physical exam and assess the ventilator circuit and settings. Consider assessing the patency of the airway by passing a suction catheter through the airway.

SCOPE:Paramedic / Critical Care Paramedic / RN Provider

NOTE: If the patient is being mechanically ventilated prior to transfer, use pre-transport ventilator settings initially and then adjust as needed to optimally ventilate and oxygenate the patient.

General Initial Ventilator Settings

A. Modes: SIMV[i]; Assist Control (AC); or Adaptive Support Ventilation (ASV)
B. Pressure cycled ventilation mode is the preferred method to mechanically ventilate the pediatric patient.
C. Start with an initial Peak Inspiratory Pressure (PIP) of 20 cm H_20.
D. Tidal Volume (Vt) (if using volume cycled ventilation): 6-10 ml/kg (if no lung injury) of ideal body weight. 6ml/kg and more rapid rates in diseases with DECREASED compliance (i.e., ARDS, pneumonia, pulmonary edema) 10ml/kg and slower rates in patients with INCREASED airway

resistance (i.e., asthma, bronchiolitis).

E. Permissive hypercapnia (mildly higher pCO_2) is preferred over high inflation pressures (15-25 cm H_2O) to avoid ventilator induced lung injury from high pressures.
F. Rate[ii]: Infants/Small Child – 20-30 breaths/min to attain desired minute ventilation.
G. Adolescent/Child – 15-20 breaths/min to attain desired minute ventilation.
H. Modify to keep $ETCO_2$ 35-45 mmHg[iii]
I. FiO_2: 1.0 and titrate down to keep Pulse Ox > 90%. Goal $FiO_2 \leq 0.42$ 2PEEP[iv]: 0-5 cmH_20 titrate to keep Pulse Ox > 90% and FiO
J. Peak Pressure goal < 35 $cmH_20 \leq 0.4$
K. These settings should be adjusted to meet the patient's requirements to keep $SpO_2 \geq 90\%$ and $ETCO_2$ 35-40 mmHg.
L. Contact the receiving Pediatric Intensivist if unsure of appropriate ventilator settings

NON-INVASIVE MECHANICAL VENTILATION (Bi-PAP)

- **Objective**: To establish guidelines for the selection of patients appropriate to receive non-invasive positive pressure ventilation (NPPV) and define procedures for the administration of NPPV with ventilators in current use. **Note:** Fine tune adjustments of ventilator settings may be required based upon which brand of ventilator used and/or comfort level of patient.
- **Indications**: Pediatric patients with respiratory compromise of sufficient severity who warrant ventilatory support but in whom it is desirable to avoid intubation.
- **Contraindications**: Apnea, recent surgery or trauma to the face, upper airway or upper GI tract, fixed upper airway obstruction, absent or insufficient ability to protect airway, life threatening hypoxemia, hemodynamic instability, impaired consciousness, confusion / agitation, vomiting, bowel obstruction, copious respiratory secretions, high risk for aspiration.
- **Equipment Needed**: Current issued ventilator, patient appropriate ventilator tubing, patient, and device appropriate mask with system for securing it to the patient's face.

A. Prepare ventilator and tubing as directed.
B. Tape holes in mask (if applicable) to minimize air leaks.
C. Put ventilator into non-invasive mode (NPPV)
D. Settings for NPPV
    i. Inspiratory Pressure is represented as the pressure support value. Start at 8-10 cmH_2O and titrate upward to correct ventilation problems (typical 8-16) (i.e. High PCO_2). To avoid gastric insufflation, the inspiratory pressure should not exceed 20 cmH_2O.
    Note: Some ventilators do not compensate for PEEP. If for example you need an inspiratory pressure of 20, you need to set an inspiratory pressure of 20.
    ii. Expiratory pressure is represented as PEEP. Start at 2-4 cmH_2O (typical is 4-8) and titrate upward to correct problems with hypoxemia. Expiratory pressure should not exceed 10 cmH_2O.
    iii. Maintain a 5 – 8 point difference between inspiratory and expiratory pressures.
    iv. Set inspiratory time to 0.8 – 1.0 second.
    v. Set breath rate to 0[v].
    vi. Adjust FIO_2 to maintain $SPO_2 \geq 92\%$.
E. All patients receiving NPPV should have an AMBU bag and mask of appropriate size accompany them throughout the transfer process.
F. Monitor SPO_2 continuously.

Notes

i. SIMV-Synchronized Intermittent Mandatory Ventilation
ii. Ventilatory rate and tidal volume make up minute ventilation(VE).
iii. Unless increased ICP with signs of brain herniation-then mild hyperventilation with goal $ETCO_2$ 30-35mmHg

iv. PEEP(Positive End Expiratory Pressure) increases intrathoracic pressure which decreases venous return. If patient develops hypotension not easily responsive to fluid therapy, reduce or turn off PEEP. PEEP with high airway pressures increases the risk of pneumothorax. If possible, reduce PEEP to keep peak airway pressures <35cm H_20, as long as maintaining Pulse Ox ≥88-92%.

v. In the event of apnea, the ventilator with alarm and initiate a back-up ventilatory rate of 12 breaths/min. Particularly at lower pressure settings, this will probably not generate a sufficient tidal volume to support the patient. Remember apnea is a contraindication of NPPV. If this occurs, the patient will need to be intubated and ventilated.