APPENDIX 32

APPENDIX: 32

TITLE: Mechanical Ventilator Use

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Mechanical Ventilator Use

I. Introduction:

Mechanical Ventilation is the use of an automated device to deliver positive pressure ventilation to a patient. Proper use of a mechanical ventilator has shown improved oxygenation, ventilation, and patient comfort compared to a BVM. Mechanical ventilation has an increased complexity and risk, and should only be used by paramedics familiar with both the general concepts of mechanical ventilation and the specific ventilator in use.

II. Mechanism of Action:

Mechanical Ventilation works by providing increased positive pressure ventilation at the level of the lower airway structures, improving gas exchange in the alveoli.

III. Indications:

Due to the complexities of patient management and dynamics of each individual call, there are no *absolute* indications for mechanical ventilation. A provider may choose to continue to use a bag-valve-mask (BVM) or other device as the clinical and practical situation dictates.

NOTE: If not used, provider must document reason(s) for deferring mechanical ventilation in a patient with an advanced airway

Mechanical ventilation **should be considered** for patients who have an advanced airway (ETT or SGA) *and*:

- Suffer from apnea or agonal respiratory effort during cardiac or respiratory arrest.
- Are at risk of hyperventilation during cardiac arrest resuscitation

Mechanical ventilation **may be considered** for:

- Patients who are intubated or have an advanced airway placed for other etiologies, particularly those who are likely to be in the providers care in for prolonged periods of time (excess of 15 minutes).
- Face Mask /Nu-Mask Ventilation
    - Should only be considered when manpower is limited.
    - Oral or nasal adjuncts, as well as proper positioning of the patient are essential.
- Patients who are already in the community (i.e. at home or in a nursing home) on a vent.
- Administration of Continuous Positive Airway Pressure (See *appendix 6*) if the mechanical ventilator has that capability.

APPENDIX 32

Mehchanical Ventilator Use

IV. Contraindications:

- Suspected Pneumothorax (untreated/developing)
- Pulmonary Over pressurization/barotrauma (Blast Injuries, rapid ascent dive injury)

IV. Cautions

- Patients who are being ventilated should be attended by **at least two providers at all times**, one of whom should be an ACCESS Agency Paramedic.
- Use of positive pressure ventilation, including mechanical ventilation, increases the risk of pneumothorax.
- Increased intrathoracic pressure from positive pressure ventilation, PEEP, and overventilation may have severe hemodynamic effects.
- All patients who are being mechanically ventilated should be monitored closely with frequent auscultation, vital signs, SPO2, and waveform ETCO2.

V. Procedure:

General

1. Treat the *patient*.
2. Asses for indications and contraindications (especially suspected pneumothorax)
3. Inspect and prepare ventilator for use prior to application to the patient.
    i. Ensure proper functioning by inspecting settings and cycling a few breaths with the “test lung”.
    ii. Insure adequate oxygen supply, and location of back up oxygen supply if needed.
4. Select proper patient type and mode for the patient. Double check settings visually. Default for prehospital use is AC/V. Other settings to be adjusted as needed.
    i. I:E ratio
    ii. Tidal Volume (6-8 mL/kg ideal or predicted body weight)
    iii. Respiratory Rate.
    iv. FiO2 (Target patient saturation 94-99%)
    v. PEEP (MAX 10 cm H2O)

    NOTE: SIM/V may be used on spontaneously breathing patients who are already on a ventilator of some type in the community or in interfacility settings and are already in this or similar mode of operation.

5. Pre-oxygenate the patient as needed.
6. Transition the patient from manual ventilation to mechanical ventilation.
7. Assess breath sounds and reconfirm airway placement.

8. Adjust respirator settings as clinically indicated.
    i. It is required that patients on a transport ventilator should be monitored continuously through Capnography and Pulse Oximetry.
    ii. The ventilator rate should adjusted to maintain a pulse oximetry of 94-99 (or as high as possible up to 99%) while maintaining an ETCO2 of 35-45.
9. If any worsening of patient condition, decrease in oxygen saturation, or any question regarding the function of the respirator, remove the respirator and resume bag-valve mask ventilations until situation is resolved.
10. Document time, complications, and patient response on the patient care report (PCR).
11. An in line nebulizer may be run simultaneously with the CPAP.
12. Treatment should be given continuously throughout transport to ED.

VI. Documentation:

Documentation on the patient care record should include:

- Tube depth (CM at teeth/gums) during intubation and on transfer of care.
- Tube confirmation (be specific)
- CPAP/PEEP level →(0-10cmH2O)
- F_iO_2 →(60-100%)
- Vent settings (I:E, Tidal volume, RR)
- Vital Sign q5 minutes, including ETCO2 and SPO2
- Tolerance of Ventilation
- Any adverse reactions
- Justification for sedation, paralysis, etc. Be specific.

VII. Special Notes

The following are special considerations and noted when using a mechanical ventilator.

- Tidal volume should be based on ideal body weight. To do this we use the NIH estimate for predicted body weight (PBW) by gender. The morbidly obese do not have substantially larger lungs compared to patients of more normal mass.
- The provider must be familiar with the ventilator at hand. If in doubt, the provider should secure expertise from other personnel or facility staff prior to taking responsibility for the patient.
- An in line nebulizer may be run simultaneously with the CPAP and mechanical ventilation. **Monitor airway pressures closely**.
- When transitioning to Mechanical ventilation, discontinue all unnecessary oxygen consumption off of the same line or tank. Multiple drains of oxygen will shorten oxygen supply, and will lower “line pressures” required to operate the mechanical ventilator.
- Persistent alarms, particularly **pressure alarms** should never be discounted.

APPENDIX

32

Mehchanical Ventilator Use

- **Proper paralysis and sedation is essential to good ventilator management**, balanced against the patient's hemodynamic status. Indicators of poor sedation or paralysis include:
    i. Tachycardia
    ii. ETCO2 for the "Curare Cleft" and other signs of spontaneous breathing
    iii. Tears, grimacing, coughing, or other motor movements.
- The first step of troubleshooting a ventilator is to place the patient back on the BVM and conduct a modified *DOPES* check. Therefore all ventilated patients should have a complete BVM (with mask) at bedside at all times.

    D - Displacement of tube: Attach end-tidal CO2 to verify and check depth (cm at lip)

    O - Obstruction of tube/circuit : Use suction catheter to remove mucus plug, or make sure patient not biting down, Insure that in line suction catheter is not partially blocking ETT tube.

    P – Pneumothorax : Auscultate, assess, visualize chest wall, and perform needle decompression if needed.

    E - Equipment failure :Connect to BVM to buy time to evaluate your patient and the ventilator

    S - Stacked breaths - Auto-PEEP especially in COPD/Asthma: Disconnect from ventilator and allow open circuit exhalation. Increase I:E ratio (1:4 or 1:6), Decrease Respiratory rate or Tidal volume (or both) if tolerated. Consider bronchodilators and/or ETT suctioning.

Monitor closely for:

- Stacked Breaths (Auto Peep). Especially in COPD and Asthma.
- Pneumothorax
- Hypotension
- Decompensation

Tidal Volume Chart

Pediatrics (6-8 ml/kg Tidal Volume) **Age 1-5:** PBW = (Age x 2)+8 ***Age 6-12:*** PBW (age x3)+7					
Age	IBW (KG)	Est. Tidal Volume	**Age**	IBW (KG)	Est. Tidal Volume
1	10	60-80 ml	**7**	28	168-216 ml
2	12	72- 96 ml	**8**	31	186-248 ml
3	14	84-112 ml	**9**	34	204-272 ml
4	16	96- 128 ml	**10**	37	222-296 ml
5	18	108-144 ml	**11**	40	240-320 ml
6	25	150-200 ml	**12**	43	285-344 ml
NOTE: **e600 preset Tidal Volume is 100 ml for infant and 250 ml for child settings**					

Adult **Male :** PBW= 50 + 2.3 (height in inches - 60) (6-8 ml/kg Tidal Volume)					
Height (Feet)	PBW (KG)	Est. Tidal Volume	**Height**	PBW (KG)	Est. Tidal Volume
5'0	50	300-400 ml	**6'0**	78	460-620
5'1	52	310-420 ml	**6'1**	80	480-640
5'2	55	330-440 ml	**6'2**	82	490-660
5'3	57	340-460 ml	**6'3**	85	500-680
5'4	59	350-480 ml	**6'4**	87	520-700
5'5	62	370-490 ml	**6'5**	89	530-710
5'6	64	380-510 ml	**6'6**	91	550-730
5'7	66	400-530 ml	**6'7**	94	560-750
5'8	68	410-550 ml	**6'8**	96	570-770
5'9	71	420-570 ml	NOTE:		
5'10	73	440-590 ml	e600 preset Tidal Volume is 500 ml for Adult		
5'11	75	450-600 ml			

Adult **Female:** PBW = 45.5 + 2.3(height in inches - 60) (6-8 ml/kg Tidal Volume)					
Height (Feet)	PBW (KG)	Est. Tidal Volume	**Height**	PBW (KG)	Est. Tidal Volume
5'0	46	270-370	**6'0**	73	440-590
5'1	48	290-380	**6'1**	75	450-600
5'2	50	300-400	**6'2**	78	470-620
5'3	52	310-420	**6'3**	80	480-640
5'4	55	330-440	**6'4**	82	500-660
5'5	57	340-460	**6'5**	85	510-680
5'6	59	360-480	**6'6**	87	520-700
5'7	62	370-490	**6'7**	89	540-720
5'8	64	380-510	**6'8**	92	550-730
5'9	66	400-530	NOTE:		
5'10	63	410-550	e600 preset Tidal Volume is 500 ml for Adult		
5'11	71	430-570			

APPENDIX

32

Mehchanical Ventilator Use