Mechanical ventilation-911

SCOPE:

This protocol is intended to provide general guidance on ventilator use with the focus on 911 response. For additional information on ventilator use during inter-facility transport see Mechanical Ventilation-Adult-InterFacility or Mechanical Ventilation-Pediatric-InterFacility

Patient care goals

1. Maintain adequate oxygenation.
2. Maintain adequate minute ventilation and capnography targets based on patient pathophysiology.
3. Prevent or limit risk of short- and long-term invasive airway and ventilator- associated complications including barotrauma, pneumothorax, aspiration, over-ventilation.

Patient presentation

Inclusion criteria

Adult patients with invasive airway requiring mechanical ventilation.

Exclusion criteria

1. Interfacility transfer patients with established vent settings.
2. Patients with suspected untreated pneumothorax or large airway injury.
3. Patients in cardiac arrest.

Patient management

Assessment

1. Confirm airway placement with ventilation and auscultation over epigastrium and assess for symmetric bilateral lung sounds.
2. Verify that airway (ETT, SGA) is securely held in place (by holder or other method).
3. Assess oxygen delivery and confirm that FiO2 meets patients' needs and maintains desired oxygen saturation (SpO2).
    a. If oxygen will be needed during transport calculate the duration of supply needed (O2 tank time (min) = tank pressure (psi) x tank conversion factor/flow rate (L/min).
4. Assess blood pressure to assure SBP greater than 90 mmHg or resuscitate to SBP >=90 mmHg or MAP >=60 mmHg.
5. Assess mental status, level of consciousness, Richmond Agitation Sedation Scale (RASS) or similar sedation score.

Treatment and interventions

1. Set up ventilator and circuit, program initial ventilator settings as below. Suggested general guidelines for adults with EMS initiation of mechanical ventilation: **[Automated vent: EMT-O; Variable settings: PARA-O]**
    a. Consider and modify based on any underlying acute or chronic lung pathology (COPD, asthma, CHF) [PARA-O].
    b. Volume mode is generally preferred initially in adults.
    c. Select an appropriate ventilator mode: Assist Control (AC) is acceptable for most patients.
        i. Initial settings:

Tidal volume	6–8 mL/kg ideal body weight	Go to ARDSNET table of height and Predicted Body Weight and Tidal volumes. Use 6–8 mL/kg as a starting point. Patients with known acidosis should start with 9 mL/kg
Respiratory rate (f)	12–14 (or 8–12) breaths/min	Adjust for target minute ventilation based on EtCO2

Inspiratory time	1 second	Adjust 0.7–1.2 seconds to maintain desired I:E ratio (inspiration-expiration) ratio of 1:2 and patient comfort
PEEP	5 cmH20	
FiO2	60%	Titrate to achieve target O2 saturation (94–98%)

ii. Set the heat moisture exchange (HME) at circuit Y.
iii. Plateau pressure (PPlat) goal is less than 30 cmH20.

Patient safety considerations

1. Ensure that all vent alarms are set appropriately, and patient is continually monitored with pulse oximetry and waveform capnography.
    a. Set all alarms that involve high pressure, low pressure, minute volume, and apnea
    b. Plateau pressure (PPlat) goal is less than 30 cmH20.
    c. Set high pressure alarm 10 cmH2O above resting PIP.
    d. Set low pressure alarm 5 cmH2O below resting PIP.
    e. Set low minute volume alarm 25% below resting minute volume.
2. During transport of a critically ill patient only necessary adjustments should be made to the ventilator. Focus on maintaining adequate oxygenation, minute volume and patient comfort.
3. An increase in the respiratory rate shortens the expiratory time. If changing rate, also check the I:E ratio (the proportions of each breath cycle devoted to the inspiratory and expiratory phases) and adjust the inspiratory time if necessary.
4. The inspiratory time can be adjusted slightly to ensure greater patient comfort, however any change in inspiratory time will affect the I:E ratio. Rarely should an inspiratory time be less than 0.7 for an adult.
5. Assure proper sedation level for patient to tolerate ventilator.
6. Assure patient does not have auto-PEEP.
7. Asthmatics and patients with severe bronchoconstriction require different initial settings: for example, PEEP of 0, FiO2 100%, tidal volume 5 mL/kg, rate 10, I:E of 1:4 – 1:6 to allow full exhalation and limit breath stacking/auto-PEEP. Hemodynamic instability may indicate increased intrathoracic pressure and require either manual chest wall compression to promote full exhalation or possibly needle chest decompression for pneumothorax.

Notes and educational pearls Key considerations

Pertinent assessment findings

1. Perform a pre-ventilator use inspection including a circuit check on the ventilator prior to placing it on a patient.
2. Assess values during transport, including:
    a. Peak inspiratory pressure (PIP) Compare against baseline value to monitor for compliance changes or obstruction in the circuit.
    b. Respiratory rate. Compare with baseline value, rapid increases could indicate leaks. Over breathing may require vent setting adjustment.
    c. Exhaled tidal volume. Compare against baseline, if extreme fluctuations, check for leaks in circuit and in ET tube.
    d. Monitor the I:E ratio. 1:2 or 1:3 for normal lungs, longer E times may be needed for patients with obstructive or restrictive lung disease.

Adult Male Patients

Height IBW kg Lung-Protective Resuscitative Metabolic

		6 ml/kg		10 ml/kg		8 ml/kg	
		Vt	Initial f	Vt	Initial f	Vt	Initial f
5'0"	50	300	12	500	12	400	20
5'1"	52	314	12	523	12	418	20
5'2"	55	328	12	546	12	437	20
5'3"	57	341	12	569	12	455	20
5'4"	59	355	12	592	12	474	20
5'5"	62	369	12	615	12	492	20
5'6"	64	383	12	638	12	510	20
5'7"	66	397	12	661	12	529	20
5'8"	68	410	12	684	12	547	20
5'9"	71	424	12	707	12	566	20
5'10"	73	438	12	730	12	584	20
5'11"	75	452	12	753	12	602	20
6'0"	78	466	12	776	12	621	20
6'1"	80	479	12	799	12	639	20
6'2"	82	493	12	822	12	658	20
6'3"	85	507	12	845	12	676	20
6'4"	87	521	12	868	12	694	20
6'5"	89	535	12	891	12	713	20
6'6"	91	548	12	914	12	731	20

Source: NIH-NHLBI ARDS Network

Adult Female Patients

		Lung-Protective		**Resuscitative**		**Metabolic**	
Height	**IBW kg**						
		6		10 ml/kg		8	

		ml/kg				ml/kg	
		Vt	Initial f	Vt	Initial f	Vt	Initial f
5'0"	46	273	12	455	12	364	20
5'1"	48	287	12	478	12	382	20
5'2"	50	301	12	501	12	401	20
5'3"	52	314	12	524	12	419	20
5'4"	55	328	12	547	12	438	20
5'5"	57	342	12	570	12	456	20
5'6"	59	356	12	593	12	474	20
5'7"	62	370	12	616	12	493	20
5'8"	64	383	12	639	12	511	20
5'9"	66	397	12	662	12	530	20
5'10"	69	411	12	685	12	548	20
5'11"	71	425	12	708	12	566	20
6'0"	73	439	12	731	12	585	20
6'1"	75	452	12	754	12	603	20
6'2"	78	466	12	777	12	622	20
6'3"	80	480	12	800	12	640	20
6'4"	82	494	12	823	12	658	20
6'5"	85	508	12	846	12	677	20
6'6"	87	521	12	869	12	695	20

Source: NIH-NHLBI ARDS Network

Oxygen Consumption

Minute Volume (VE) x FIO2 (0.21 to 1.0) = L/min

Oxygen Tank Duration

$$\frac{\text{PSI in tank} - 200^* \times \text{Constant}}{\text{L/min}} = \text{duration in minutes}$$

200* = safe residual pressure

Tank Constants

D cylinder = 0.16 (cot)

E cylinder = 0.28

H(K) cylinder = 3.14 (ambulance)

Consider mask leak as displayed on Hamilton T1, incorporate into VE