

CRITICAL CARE CLINICAL PRACTICE GUIDELINE

Practice Guideline:

Acute Respiratory Distress Syndrome Ventilation in Critical Care (Adult)

Approval Date:

December 3rd, 2020

Pages:

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Approved By:

Critical Care Program Leadership
Professional Advisory Committee

Supercedes:

New

I. PURPOSE AND INTENT

I.A To ensure a standard of care is provided to all patients with acute respiratory distress syndrome within the Winnipeg Regional Health Authority.

I.B To aide in the practical application of the Moderate / Severe Hypoxemic Respiratory Failure Order set.

II. DEFINITIONS

II.A Acute Respiratory Distress Syndrome (ARDS): a term used to describe the pathophysiological events that occur in the lungs as a result of direct or indirect injury of the lungs. It can be described as mild, moderate, or severe based on PaO₂/FiO₂ ratio. Recommended treatment algorithm shown in Appendix A.

II.B PaO₂/FiO₂ ratio : is calculated by dividing PaO₂ found on the arterial blood gas by the fractional inspired oxygen values given to the patient by the ventilator (0.21 to 1.0). The PaO₂/FiO₂ ratio is used to define the severity of ARDS (Mild is 200 < PaO₂/FiO₂ ≤ 300, Moderate 100 < PaO₂/FiO₂ ≤ 200, Severe PaO₂/FiO₂ ≤ 100) The PaO₂/FiO₂ ratio can be estimated from measured Oxygen Saturation and delivered FiO₂ and positive end expiratory pressure (PEEP) using the below table.

PaO ₂ /FiO ₂ Ratio	Oxygen Saturation / FiO ₂		
	PEEP < 8	PEEP 8-12	PEEP >12
<400	<502	<515	<425
<300	<370	<387	<332
<200	<240	<259	<234
<100	<115	<130	<129

Critical Care Med, 37(4):1317-1321

*Use table to estimate PaO₂/FiO₂ ratio only measured oxygenation saturation is less than 98%

II.C Lung Protective Ventilation Settings: Ventilator strategies used to minimize lung barotrauma, volutrauma, and atelectrauma.

III. GUIDELINES

III.A Sedation and analgesia shall be ordered with direction to titrate to targeted sedation scales (such as Richmond agitation sedation scale). This is achieved using the WRHA Critical Care Continuous Sedation and Analgesia order set.

III.B Neuromuscular blockade agents may be ordered. Ensure administration of adequate analgesia and sedation **prior** to the use of neuromuscular blocking agents. If continuous neuromuscular blocker is ordered then dosage should be titrated using peripheral nerve stimulator (train of four) monitoring. Refer to CPG Peripheral Nerve Stimulator: Train of Four Monitoring (Adult) located at <https://www.wrha.mb.ca/extranet/eipt/files/EIPT040.001.pdf> Neuromuscular blocker infusions should be titrated to a goal of 2 out of 4 twitches. Ulnar location is preferred.

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III.C Consider Prone Positioning if inclusion criteria are met. (Refer to CPG: Prone positioning for severe hypoxic respiratory failure in critical care located at

<https://professionals.wrha.mb.ca/old/extranet/eipt/files/EIPT-070.pdf>

III.D Establishing lung protective ventilator settings requires a physician's order. Determining subsequent ventilator settings may be altered by the Respiratory Therapist according the protocol outlined below or by physician's written order.

IV. PROCEDURES

Equipment

- "Lung Protective Ventilation Strategy for ARDS Worksheet" (See Appendix B)

IV.A Determination of Initial Ventilator Settings for Lung Protective Strategies by the Respiratory Therapist

<u>PROCEDURE</u>	<u>SPECIAL CONSIDERATION</u>
1. Measure and document patient's height.	
2. Using the patient's height, determine their predicted ideal body weight (IBW). See Appendix A - Table 1.	<p>Circle the tidal volumes for 8, 6, & 4 mL / kg for the appropriate IBW on the "Lung Protective Ventilation Strategy for ARDS Worksheet". (Appendix A)</p> <p>For patients outside of the Predicted Ideal Body Weight table, calculate using the following equation:</p> <p>Male: IBW (kg) = 50 + 2.3 x (height in inches - 60) OR IBW (kg) = 48 + 1.1 x (height in cm - 150)</p> <p>Female: IBW (kg) = 45.5 + 2.3 x (height in inches - 60) OR IBW (kg) = 45 + 0.9 x (height in cm - 150)</p>
3. Establish initial ventilator settings:	
<p>a) Mode: Assist Control</p> <p>b) Initial Tidal volume shall be based on 6 mL / kg IBW.</p>	Decrease tidal volumes in 25-50 mL increments to achieve targeted tidal volume over up to 2 hours.
c) Rate: Set the breaths per minute (up to 35) based on patient's current minute ventilation.	Respiratory rate may be limited by autoPEEP. Do not increase rate higher if encountering autoPEEP issues.

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IV.A Determination of Initial Ventilator Settings for Lung Protective Strategies by the Respiratory Therapist

<u>PROCEDURE</u>		<u>SPECIAL CONSIDERATION</u>													
Adjustments may be required depending on pH and blood gas results.															
d) Measure plateau pressure.		Notify attending physician if plateau pressures are greater than 30 cm H ₂ O, or if the patient is not tolerating the above settings.													
e) Oxygenation goals: PaO ₂ 55 – 80 or SaO ₂ greater than 88% using choice of following methods as ordered on physician orders:															
i. The physician will direct all changes if PEEP is above 12.		Physician directed PEEP orders documented in physician orders.													
ii. Use the PEEP / FiO ₂ ladder protocol as noted below		Check with physician prior to increasing the PEEP if: <ul style="list-style-type: none"> - Systolic blood pressure is less than 90. - Increasing the PEEP above 12. 													
PEEP/FiO₂ Ladder Protocol															
FiO ₂	0.3	0.4	0.4	0.5	0.5	0.6	0.7	0.7	0.7	0.8	0.9	0.9	1.0		
PEEP	5	5	8	8	10	10	10	12	14	14	14	16	20-24		
For PaO ₂ less than 55 or sustained SaO ₂ less than 88%, move one column to the right.															
For PaO ₂ greater than 80 or sustained SaO ₂ greater than 96%, move one column to the left.															
iii. Perform a “Best PEEP Study” according to an acceptable method and discussion with the attending physician.		Choosing an acceptable Best PEEP Study method is based on: <ul style="list-style-type: none"> • Disease pathology • Compliance • Changes in oxygenation • Physician preference 													

IV.B: Monitoring, Ventilator Settings and Goals

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<u>PROCEDURE</u>	<u>SPECIAL CONSIDERATION</u>
<p>1) Ventilation goals based on pH. Goal pH 7.30 – 7.45</p>	Check arterial blood gas within 2 hours of initiation of lung protective ventilation
<p>a) <i>For pH 7.15 – 7.29:</i> increase respiratory rate to a maximum of 35.</p>	
<p>b) <i>For pH less than 7.15 that does not respond to respiratory rate of 35:</i> notify the attending physician. <i>Consideration can be made for either bicarbonate or increasing the tidal volume by 50 mL every 30 minutes until pH is greater than 7.15.</i></p>	Plateau pressure may exceed 30 if needed to control pH less than 7.15. Physician order is required to accept the new plateau goal.
<p>c) <i>For pH greater than 7.45:</i> If the patient is NOT breathing over the set rate, decrease the respiratory rate to maintain a pH 7.35 – 7.40.</p>	
<p>2) Tidal volume and plateau pressure goals: Tidal volume of 6 mL / kg IBW & plateau pressure less than or equal to 30 cm H20.</p>	
<p>a) Measure and document plateau pressure on the ventilator flow sheet daily and after every tidal volume or PEEP change.</p>	
<p>b) If plateau pressure is greater than 30 cm H20 for two consecutive ventilator checks, decrease the tidal volume by 50 mL every 60 minutes until plateau pressure is less than or equal to 30 cm H20, but do not decrease less than 4 mL / kg IBW.</p>	Notify attending physician prior to reducing the tidal volume if pH less than 7.25 or PaO2 less than or equal to 70 mmHg on current ventilator settings. Change in pH or oxygen saturation goals should be written in physician orders.
<p>c) If tidal volume is less than 6 mL / kg and plateau pressure is less than 25 cmH20 for two consecutive ventilator checks, then increase the tidal volume by 50 mL every 60 minutes until tidal volume is 6 mL / kg IBW, provided the plateau pressure remains less than or equal to 30 cm H20.</p>	

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V. DOCUMENTATION

V.A Nursing Documentation:

Nurse shall document ventilator FiO₂, tidal volume, respiratory rate and oxygen saturation (ventilator settings and patient response) on the Adult Intensive Care Flow Sheet.

V.B Respiratory Therapist Documentation:

Respiratory Therapist shall document the following on the ventilator flow sheet a minimum of daily and after any significant ventilator parameter change:

- Resistance / compliance
- Tidal volume (mL / kg IBW)
- PaO₂:FiO₂ ratio
- Plateau pressure
- Evidence or amount of auto-PEEP

V.C Physician Documentation:

Any ventilation parameters and/or goals outside those stated in this clinical practice guideline needs to be ordered in the physician orders.

VI. REFERENCES

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Pandharipande P, Shintani A, Hagerman H, Jacques P, Rice T, Sanders, Wares L, Bernard G, and Ely W. (2009) Derivation and validation of SpO₂/FiO₂ ratio to impute for PaO₂/FiO₂ ratio in the respiratory component of Sequential Organ Failure Assessment (SOFA) Score. *Critical Care Med*, 37(4):1317-1321.

“Lung Protective Ventilation Strategy for ARDS Worksheet” (See Appendix A)

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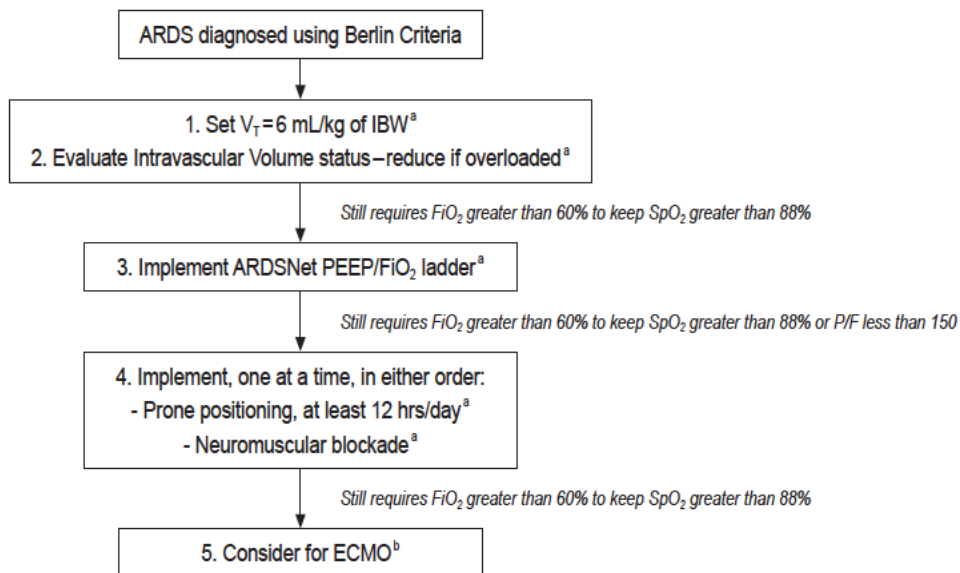
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Appendix A:

ARDS Management Algorithm



NOTES:

- Re-evaluate each step daily
- ^a Good evidence for improvement in at least one clinically relevant endpoint
- ^b Only weak evidence for improvement in any clinically relevant outcomes
- No current evidence for efficacy of: inhaled nitric oxide, high-frequency ventilation

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Appendix B

Lung Protective Ventilation Strategy for Acute Respiratory Distress Syndrome (ARDS) Worksheet

1. **Measure and document** patient's height on table. It is recommended that height is measured by 2 people separately to ensure accuracy.
2. **Circle the 3 tidal volumes in cells for 8, 6, 4 mL/kg** predicted ideal body weight (IBW) that corresponds to the height and appropriate sex. If exact height is not available, round up to the next higher number.

Patient Height: _____ Male Female

Determine Predicted Ideal Body Weight (IBW):								
Height			Male			Female		
cm	inches	feet	8 mL/kg IBW	6 mL/kg IBW	4 mL/kg IBW	8 mL/kg IBW	6 mL/kg IBW	4 mL/kg IBW
157.5	62	5'2"	440	330	220	400	300	200
162.5	64	5'4"	480	360	240	440	330	220
167.6	66	5'6"	510	390	260	480	360	240
172.7	68	5'8"	550	410	280	510	390	260
177.8	70	5'10"	620	440	290	550	410	280
182.9	72	6'0"	640	470	310	590	440	290
188	74	6'2"	660	500	330	620	470	310

3. Initial Ventilator Settings:

Mode: Volume Assist Control Mode (AC)

Initial Tidal Volume: _____ (Target: 6 mL/kg IBW)

Respiratory Rate (RR): Increase breaths per minute (up to 35) based on tidal volume to maintain current ventilation.

Decrease tidal volumes in 25-50 mL increments to achieve targeted tidal volume over up to 2 hours.

FiO2 and PEEP: Goals of PaO₂ 55 – 80 or SaO₂ greater than 88% using one of the three below methods as ordered:

Use the PEEP/FiO₂ ladder protocol as noted below.

FiO ₂	0.3	0.4	0.4	0.5	0.5	0.6	0.7	0.7	0.7	0.8	0.9	0.9	0.9	1.0	1.0
PEEP	5	5	8	8	10	10	10	12	14	14	14	16	18	18	20-24

For PaO₂ less than 55 or sustained SaO₂ less than 88%, move one column to the right.

For PaO₂ greater than 80 or sustained SaO₂ greater than 96%, move one column to the left.

Notify the physician prior to increasing PEEP if PEEP will be above 12 or the systolic blood pressure is less than 90.

Physician directed PEEP titration if PEEP is over 12

PEEP to be determined by performing a "Best PEEP study" according to an acceptable method after discussion with the attending physician

4. Monitoring, Ventilator Settings, and Goals:

Check arterial blood gas within 2 hours of initiation of lung protective ventilation.

Ventilation Goals based on pH: Lung protective ventilation aims for patients to have arterial pH 7.30-7.45

- If pH 7.15-7.29: Increase RR to maximum of 35 breaths per minute.
- If pH less than 7.15 does not respond to RR of 35: Notify the attending physician. Consider intravenous bicarbonate or increase the tidal volume by 50 mL every 30 minutes until pH is greater than 7.15.
- If pH greater than 7.45 and patient is NOT breathing over set RR, decrease the RR to maintain pH 7.35 – 7.40.

Volume and Pressure Goals: Tidal volume of 6 mL/kg IBW and plateau pressure of less than or equal to 30 cm H₂O

- Measure and document plateau pressure on the ventilator flow sheet daily and after every tidal volume or PEEP change.
- If plateau pressure is greater than 30 cm H₂O for two consecutive ventilator checks, decrease the tidal volume by 50 mL every 60 minutes until plateau pressure is less than or equal to 30 cm H₂O, but do not decrease less than 4 mL/kg IBW. Notify attending physician prior to reducing the tidal volume if pH less than 7.25 or PaO₂ less than or equal to 70 mmHg on current ventilator settings. Change in pH or oxygen saturation goals should be written in physician orders.
- If tidal volume is less than 6 mL/kg and plateau pressure is less than 25 cmH₂O for two consecutive ventilator checks, then increase the tidal volume by 50 mL every 60 minutes until tidal volume is 6 mL/kg IBW, provided the plateau pressure remains less than or equal to 30 cm H₂O.