[redacted]

Subject:	Adult Mechanical Ventilation Protocol	Effective Date:	3/2004
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Section:	Respiratory Care	SL:	
Primary Responsibility:	Associate Administrator	Revised:	9/15/2017
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Approved by: [redacted]

I. **Policy:**

The Respiratory Care department has established guidelines within this policy for the management of mechanical ventilation. Ventilator care will be performed according to the assessment of appropriate respiratory parameters, and in compliance with the established criteria within this policy.

[redacted]

II. **PURPOSE**:

To provide consistent clinical practice and timely interventions in the management and weaning of the adult patients requiring mechanical ventilation.

III. **PROVIDER**:

Must be a Licensed Respiratory Care Practitioner meeting the competencies stated in the Genesis Medical Center Policy/Procedure manual for ICU Primary Respiratory Care Practitioner's.

IV. **PROTOCOL INITIATION**:

A. The Adult Mechanical Ventilation Protocol will be initiated as indicated, and preferably no later than 24 hrs post intubation. (Currently – when ordered by physician)

B. Once the Ventilator Weaning Protocol has been initiated, the respiratory care practitioner will:

1. Determine the patient's need for either Total or Partial Mechanical Ventilatory Support using the clinical indications defined by the protocol.
2. Determine initial ventilator settings and initiate mechanical ventilation.
3. Assess the patient's response to the level of mechanical ventilation support provided.
4. Communicate the initial mechanical ventilation settings and all subsequent changes to other members of the patient care team. (Ordering physician, primary nurse, primary RCP.)
5. Document all interventions in the medical record.

C. Subsequent adjustments

1. Subsequent adjustments will be made according to protocol guidelines and based upon the patient's response to the level of ventilation provided (see Section V. *Goals* and Appendix 1, *Tolerance Criteria*).
    a) An arterial blood gas sample should be obtained within 60 minutes following the initiation of mechanical ventilation.
    b) Subsequent arterial blood gas samples should be obtained…
        i Upon receipt of a physician's order
        ii Following a ventilator setting change that is intended to stabilize or achieve ventilation and/or acid-base goals (see Section IV. *Goals*) for the patient receiving total mechanical ventilation support.
        iii Following a ventilator change that is intended to stabilize or achieve oxygenation goals (see Section V. *Goals*) for the patient receiving total mechanical ventilation support (when non-invasive monitoring is unavailable or insufficient to provide reliable data).
        iv To assess the oxygenation, ventilation, and acid-base effects resulting from the changeover to partial mechanical ventilation support from total mechanical ventilation support.
        v To assess the oxygenation, ventilation, and acid-base effects resulting from a ventilator setting change that leads to a significant change in respiratory rate, tidal volume and/or minute volume for patient's in either total or partial mechanical ventilation support.
        vi To assess Vd/Vt when changes are indicated by SBCO2.

V. **GOALS**: The goals of the Adult Mechanical Ventilation Protocol include all of the following:

a. To maintain the patient's arterial pH between 7.30 and 7.45
b. To maintain the patient's PaO_2 between 55 and 80 mmHg
c. To maintain the patient's SpO_2 between 88-95%
d. To provide an inspiratory pressure plateau of no greater than 30 cmH_2O

*VI. **ADULT MECHANICAL VENTILATION PROTOCOL***

a. **TOTAL MECHANICAL VENTILATION SUPPORT** – The total mechanical ventilation support protocol will be initiated when it is desirable to stabilize the patient's clinical condition by adjusting the mechanical ventilator to perform virtually all of the ventilatory work.

i. **INDICATIONS FOR TOTAL MECHANICAL VENTILATION SUPPORT** – A patient should be placed on total mechanical ventilator support if any one of the following is present…

1. Hypercapnia with respiratory acidosis.
2. Severe hypoxemia as evidenced by…
    a. $PaO_2/FiO_2 < 200$
    b. PEEP > 10
    c. $FiO_2 > 0.6$
3. Intolerance of less than total support (see Appendix 1)
4. Apnea, bradypnea, or an unreliable respiratory drive.

II. **TOTAL MECHANICAL VENTILATION SUPPORT PROTOCOL**

1. **MODE SELECTION**: The initial mode of mechanical ventilation will be either Pressure Regulated Volume Control (PRVC) or Pressure Control (PC).
    a. Pressure Regulated Volume Control guarantees the delivery of a preset tidal volume as well as minimum minute ventilation when a respiratory rate is set. With the advantage of a decelerating flow characteristic that may improve gas mixing as well as facilitate flow synchrony for the patients who have the ability to trigger breaths.
    b. Pressure Assist-Control limits the amount of pressure applied to the airway during each positive pressure breath and, because of the decelerating inspiratory flow waveform, may improve gas mixing as well as facilitate flow synchrony for patients who have the ability to trigger breaths.
2. **TIDAL VOLUME SELECTION**: The initial tidal volume will be set within the range of 5-7 mL/kg of the patient's Ideal Body Weight (IBW). IBW in kilograms (Kg) will be calculated by one of the following formulas:

    IBW (males) = 50 + 2.3 (height inches – 60)

    IBW (females) = 45.5 + 2.3 (height inches - 60)

    The practitioner may adjust the tidal volume setting up to 10 mL/kg to achieve the arterial pH goal or improve patient comfort as long as the inspiratory plateau pressure goal is not violated (section V:D).

3. **RESPIRATORY RATE (f) SELECTION**: The initial respiratory rate will set between 10 and 30 breaths per minute and will subsequently be

adjusted to achieve the arterial pH goal (see Section V:A). The respiratory rate will be set to avoid air trapping whenever possible.

4. The combination of **FiO_2 AND PEEP** will be used to help achieve an oxygenation level within the target range (Section V;B and C). If a PEEP level is required that exceeds 10 cmH2O a verbal or written order from the physician must be obtained. Adjustments to FiO_2 and PEEP must follow the steps outlined in FiO_2/PEEP table (see Appendix 2). (During the first two hours of mechanical ventilation support, however, the FiO_2 may exceed 0.5 without setting PEEP at the prescribed target.)
5. When Pressure Control or Pressure Regulated Volume Control is selected the initial **INSPIRATORY TIME** will be set to optimize patient comfort (Flow time graphics), avoid or minimize air trapping, and produce an **I:E RATIO** of less than 1:1.
6. A physician's written order is required whenever an I:E of greater than 1:1 is deemed necessary.

b. **PARTIAL MECHANICAL VENTILATION SUPPORT** – The partial mechanical ventilation support protocol will be initiated when the patient is determined to be ready to assume a greater proportion of his/her ventilatory work. A partial mechanical ventilation support mode is used to facilitate weaning from mechanical ventilation.

i. **INDICATIONS FOR PARTIAL VENTILATION SUPPORT** – A partial ventilation support mode may be initiated when all of the following are present…

1. PEEP has been reduced to $\leq$ 10, and FiO_2 reduced to $\leq$ 0.6 (see Appendix 2)
2. pH ≥ 7.30
3. The patient is able to initiate an inspiratory effort and demonstrates a reliable, regular respiratory drive.
4. The patient's chest radiograph is stable or improving
5. Improvements as indicated by Vd/Vt, PeCO2, and SBCO2.
6. The patient is able to tolerate pressure support (PSV), pressure assist, Pressure Control set at minimum rate with appropriate I: time (PA) or unassisted spontaneous breathing (see Appendix 1)
7. The patient's hemodynamic status is stable as evidenced by need for Dopamine of < 10 μg/kg/min with no other ionotropes or vasopressors are being administered.
8. Vd/Vt $\leq$ .50, if Vd/Vt > .50 PeCO2 needs to be $\geq$ 18mmHg.

ii. PARTIAL MECHANICAL VENTILATION SUPPORT PROTOCOL

1. **MODE SELECTION** - The respiratory care practitioner may initiate partial ventilation support by one of the following modes or methods…
    a. Pressure Support Ventilation (PSV)

b. Pressure Assist (PA)

c. Volume Support (VS)

d. Trach collar or t-piece trials followed by total or partial mechanical ventilation support.

e. BIPAP

2. **PRESSURE SUPPORT VENTILATION OR PRESSURE ASSIST** – The respiratory care practitioner will select either Pressure Support Volume Support or Pressure Assist as the primary partial mechanical ventilation support modes. Practitioner choice of mode will be based upon by patient tolerance, comfort and synchrony.

    a. The initial inspiratory pressure will be set to achieve an exhaled V_T of 5-10 mL/kg. Inspiratory pressure will not exceed 25 cmH_2O.

    b. Inspiratory pressure will be titrated to patient comfort using RSBI levels between 40 to 100 patient dependent and Malv/VCO2.

    c. Setting enough support to keep RSBI between 40 and 60 initially.

    d. Malv/VCO2 is monitored to assure patient tolerance.

3. **TRACH COLLAR OR T- PIECE TRIALS** - Trach collar or t-piece trails are spontaneous breathing trials employed in combination with a partial mechanical ventilation support mode to facilitate weaning in prolonged (i.e. greater than 21 days) ventilator-dependant patients. Trach collar or t-piece trials combine periods of spontaneous breathing, generally of increasing duration, with periods of mechanical ventilation support or non-invasive support (Bi-pap).

    a. The patient will be removed from total or partial mechanical ventilation support and placed on a continuous, cool-mist aerosol. Flow and FiO_2 will be adjusted to meet SpO_2 goal.

    b. Patient tolerance will be assessed (see Appendix 1).

    c. The respiratory care practitioner will return the patient to total, partial mechanical ventilation or non-invasive support…

        i. If the patient fails to meet tolerance criteria (see Appendix 1), or

        ii. To 'rest' the patient overnight with the intention of continuing weaning by trach collar or t-piece the following morning.

The level of ventilation support should be set to produce a ventilatory pattern is stable, non-fatiguing and comfortable for the patient.

iii. **PATIENT ASSESSMENT AND VENTILATOR MONITORING** – Patient assessment and ventilator monitoring will be performed to determine the patient's clinical status and progress toward goals.

1. The RCP will assess the patient and monitor the ventilator…

    a. Immediately after initiating mechanical ventilation

b. At 4-hour intervals (approximately) thereafter

c. Whenever there is a change in the level of support (mode) provided or a change in settings that effects minute ventilation or mean airway pressure.

d. Whenever there is an acute change in the patient's condition signaled by a rapid deterioration in vital signs or oxygenation (see Section VI.4. below) or a change in ventilation.

2. Patient assessment and ventilator monitoring will consist of…

   a. An evaluation of the performance of the mechanical ventilator to include:

      i. Settings and monitored data

      ii. Graphics – waveforms and loops (if available)

   b. An evaluation of the patient's response to ventilation support (to include but not limited to):

      i. Breath sounds, vital signs, and physical appearance

      ii. Arterial blood gases (if available; see Section IV, C above)

      iii. Data from non-invasive monitors, e.g. SpO_2, ETCO2, SBCO2, RSBI, AND MALV/VCO2.

      iv. Chest radiograph (if available) and SBCO2

iv. DAILY PATIENT ASSESSMENT: SPONTANEOUS BREATHING TRIAL (SBT)

The respiratory care practitioner will conduct a spontaneous breathing trial each day for the patient receiving partial mechanical ventilation support. The spontaneous breathing trial will help determine the patient's readiness for extubation or discontinuation of mechanical ventilation support. RCP will request minimum sedation before proceeding with a SBT.

1. The SBT will be performed with low level of CPAP (5-8 cmH_2O) while maintaining the ventilator's FiO_2.

2. The practitioner will monitor the patient closely for the initial few minutes (e.g. 5 minutes) of the SBT.

3. If the patient tolerates the SBT for 5-minutes the trial will continue for at least 30 minutes but not greater than 120 minutes. Patients who tolerate the SBT will be considered for extubation (see Appendix 3).

4. Patients who fail the SBT trial will be returned to partial mechanical ventilation at previously tolerated settings.

v. EXTUBATION

1. The respiratory care practitioner will recommend extubation or discontinuing mechanical ventilation support when the patient meets the extubation criteria listed in Appendix 3.

2. The respiratory care practitioners will extubate the patient upon communication with the physicians.

3. Once extubated, if the patient is currently ordered on meter dose inhaler (MDI) you may write an order to convert the MDI to a nebulizer using the same medication and frequency.

INSERT RE-INTUBATION PROTOCOL

c. ACTION TO BE TAKEN IN THE EVENT OF AN ACUTE DETERIORATION IN THE PATIENT'S CLINICAL CONDITION.

i. In the event of an acute deterioration in the patient's condition during the course of mechanically ventilation as evidenced by acute oxygen desaturation (SpO_2 < 80%), acute hypotension (mean BP drop of > 20 mmHg), an acute increase in airway pressure or an acute decrease in tidal volume the respiratory care practitioner will…

1. Immediately notify the nurse and physician.
2. Assess the patient to rule out one of the following conditions:
    a. Acute airway obstruction
    b. Bronchospasm
    c. Pneumothorax
    d. Airway misplacement – e.g. accidental extubation or decannulation, intubation of the right-mainstem bronchus.
    e. Equipment failure
3. Recommend to the physician that an arterial blood gas sample be obtained if the acute decompensation has resulted in profound hypoxemia or acute hypotension.
4. Recommend to the physician that a "stat" chest radiograph be obtained.

APPENDIX 1

TOLERANCE CRITERIA

Patient will be considered intolerant of the partial support settings or a SBT if <u>any</u> of the following exists:

1. Development of rapid, shallow breathing: f ≥ 35 or an increase of ≥ 10 breaths per minute over previous respiratory rate or RSBI > 100.

2. Intolerable dyspnea, diaphoresis, excessive use of accessory muscles, or development of paradoxical respirations.

3. Heart rate > 120 or a change in heart rate of ≥ 20 that cannot be attributed to another cause.

4. Diastolic blood pressure change of 20 mmHg that cannot be attributed to another cause.

5. Development of cardiac arrhythmia, deterioration of mental status, or deterioration of arterial blood gases.

APPENDIX 2

FiO_2/PEEP TABLE

GOAL: $55 \leq PaO_2 \leq 80$

GOAL: $88 \leq SpO_2 \leq 95$

CLINICAL APPLICATION OF STANDARD: If below goal(s), move up one step, if above goal(s) move down one step – PEEP adjustments within each step are based on clinical assessment.

FiO_2	PEEP
.30	5 – 14
.40	5 – 16
.50	8 – 18
.60	10 – 20
.70	12 – 20
.80	14 – 22
.90	16 – 22
1.0	18 – 24

APPENDIX 3

EXTUBATION CRITERIA

A patient should be considered for extubation if all of the following criteria are met:

1. A rapid shallow breathing index (RBSI or f/V_T) < 100 after a 30-120 minute Spontaneous Breathing Trial (CPAP or PSV 5 H_2O)
2. PaO_2/FiO_2 >180 and PEEP ≤ 5 (CPAP) and FiO_2 ≤ 0.4
3. Adequate airway protection, a reliable respiratory drive, and airway suctioning no more than every two hours.
4. Successful 'cuff leak test' in patients suspected of possible upper airway abnormalities.
5. Arterial Blood Gases are recommended 30 minutes post extubation.

REFERENCES:

1. Acute Respiratory Distress Syndrome Network. Ventilation with lower tidal volumes as compared with traditional tidal volumes for acute lung injury and the acute respiratory distress syndrome. N Engl J Med 2000;342(18):1301-1308.
2. Duke Medical Center Respiratory Care Department.

Evidenced-Based Guidelines for Weaning and Discontinuing Ventilatory Support. Chest 2001; 120(6) 375-395.

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ADDENDUM:

THERAPEUTIC GOAL FOR VENTILATION OF PEDIACTRIC PATIENTS

To stabilize patients' respiratory status and maintain pH, p02, pCO2, and HCO3 within a normal physiologic range appropriate for the patients' conditions.

Indications for Mechanical Ventilation

1. Clinically significant periods of apnea.
2. Arterial blood gas criteria of the following:
    a. Low PA02 < 60 mmHg on Fio2 of 80% or greater
    b. High PaCo2 > 55-65 mmHg.

c. Low pH, < 7.25 or as clinical condition dictated (ie: closed head injury requiring alkalotic state)

Initial Parameter Setting of the Ventilator

The primary goal is adequate chest expansion with bilaterally equal breath sounds while maintaining Pa02 and PaC02 within normal limits.

Vt……infant (7 – 10 cc/kg)……child (10 – 15 cc/kg)
Ventilator Rate…..infant (20 – 45 BPM)……child (12 – 25 BPM)
Pip……infant (< 35 cmH20)……child (< 35 cmH20)
Insp. Time…….infant (0.25 – 1.0 sec)……child (0.5 – 1.0 sec)
Fi02 ……infant to maintain adequate level of 02 saturation.

Administration of Ventilatory Support

1. Obtain order from physician and initial ventilatory settings.
2. Adjust ventilator settings to correspond with order and check pop off valve and/or working pressure for patient safety.
3. Double check that settings are correct and test ventilator while still disconnected from patient.
4. Place patient on ventilator and auscultate for adequate air exchange and chest excursion bilaterally.
5. Assure that patient is being monitored with continuous ECG and Sa02 readings and document all information on flowsheet.
6. Wean patient from ventilator as clinical condition improves with proper physician notification.

Hazards of Ventilator Therapy

1. Barotrauma including: pulmonary interstitial emphysema, pneumomediastinum, pneumopericardium, pneumoperitoneum, tension pneumothorax, venous and arterial embolism.

   Cardiovascular complications (ie: decreased cardiac output and decreased venous return).