**OBJECTIVE**

The administration of inhaled B-agonists is an established practice in the management of patients with acute hyperactive airway disease. In the Emergency Department and Critical Care setting asthmatics and patients with acute or impending respiratory failure may require repeated administration of small volume nebulizer treatments every 15-60 minutes, over a period of several hours. This frequent, intermittent nebulizer therapy produces variable drug administration, with peaks and troughs of aerosol drug delivery to the lung.

Continuous Nebulization therapy represents an alternative technique for administration of Bronchodilators. Continuous Nebulization allows for continuous, controlled drug delivery to the lung, avoiding the intermittent characteristics of small volume nebulizer therapy.

**STANDARDS OF CARE**

1. Continuous nebulizer therapy may be administered to patients in the following areas:
   a. ICUs
   b. TCNU
   c. PICU
   d. MSSU
   e. Emergency Department
2. Patients receiving continuous nebulizer therapy must be placed on a Cardiac Monitor and/or a Pulse Oximeter. For Pediatric/MSSU patients a continuous Pulse Oximeter is required.
3. Continuous nebulizer therapy may be delivered over one hour, 4 hours or 8 hours.
4. Therapy with a frequency of q2h or more may be delivered via Continuous Nebulizer therapy.
5. Initial Continuous Nebulizer protocol order for adult patients shall be valid for 24 hours. Pediatric patients will be ordered for a maximum of 4 hours per dose.
6. Beta-agonist of choice is Albuterol 0.5% solution, diluted with Normal Saline.
7. The Respiratory Care Practitioner shall verify that serum K+ levels are within normal range.
   a. If serum K+ levels are abnormal, notify physician for further instructions.
   b. For pediatric patients Serum K+ levels should be drawn every morning **IF** patients are receiving .5 mg/kg/hr or greater.

**INDICATIONS**

1. Non-ventilated Adult or Pediatric patients with acute bronchospasm
2. Patients requiring inhaled B-agonist at a frequency of q2 hour or more
3. Patients in respiratory failure.

**POTENTIAL COMPLICATIONS**

1. Tachycardia and palpitations.
2. Nervousness, tremors, dizziness, and nausea.
3. Increased blood pressure.
4. Worsening of V/Q Ratio; decreased PaO₂.
5. Decreases in serum K+. House staff should be advised of the potential for Albuterol to lower the Serum Potassium level.
6. High Serum Albuterol levels have been found in adult patients receiving .4mg/kg/hr or greater.
**ORDERING PROTOCOL**

1. Ipratropium Bromide (Atrovent) may be added to Continuous Nebulizer therapy but requires a physician order. The standard dose is ¼ - 2 Unit dose (250 mcg - 1000mcg) given over 4 hours. An alternate dose may be ordered by physician with a maximum dose of 1 Unit dose per hour.

2. Adult Medication Dosages
   a. Initially start Albuterol at 17.5 mg / hr x 4 hours.
   b. May increase to a maximum of 20mg/hr x 4 hours if there is no noted improvement.
   c. Standard Ipratropium Bromide (Atrovent) dose will be 1 UD q 4 hours.

3. Pediatric Medication Dosages
   a. Dosage range of Albuterol: 0.2 to 0.8mg/kg/hr
   b. Dosage not to exceed 20mg/hr
   c. Standard Ipratropium Bromide (Atrovent) dose will be ½ Unit Dose (250mcg in 1.25ml solution) for patients less than 30kg Q6–8-hours. Given ¼ UD every 4 hours; and 1 Unit Dose (500mcg in 2.5ml solution) q4 hours for patients weighing < 30 kg

4. Dosages over the maximum allowable, for both adults and pediatrics, must be cleared with attending physician.
   a. Respiratory Care Practitioner shall tag the Physician Order Sheet with a protocol sticker.

5. Medication will be delivered in 4-hour doses to allow for re-assessment.
   a. Pediatric floor patients requiring more than two (2) 4 hour doses of Continuous Nebulizer therapy will be considered for transfer to PICU for follow-up care.
   b. Respiratory Care Practitioner is to re-assess the patient every 2 hours. At the end of the first 4 hours, the Respiratory Care Practitioner will determine if the patient’s Continuous Nebulizer dosage needs to be decreased or increased.

1. No improvement in patient status:
   a. Respiratory Care Practitioner will increase the Continuous Nebulizer dose, for adult patients in, 2.5 - 5.0mg/hr increments, up to the allowable maximum dose, and for pediatric patients in 0.1 –0.2mg/kg/hr increments, up to the allowable maximum dose.
   b. If patient is already at the maximum dose, Respiratory Care Practitioner will contact attending physician for further orders.

2. Improvement in patient status:
   a. Respiratory Care Practitioner will decrease the Continuous Nebulizer dose, for adult patients in, 2.5 - 5.0mg/hr increments, if appropriate from their assessment of patient status, and for pediatric patients in 0.1 – 0.2mg/kg/hr increments, if appropriate from their assessment of patient status.

3. Each time there is a change in medication dosage, the new Continuous Nebulizer dose will be set up for 4 hours only.
Continuous Nebulized Albuterol Protocol for Non-Ventilated Patients

Documentation of Continuous Nebulizer changes

1. All dose, frequency and mode changes will be documented in MediLinks.

1. Respiratory Care Practitioner shall verbally notify the patient’s RN of all dose, frequency and mode changes. The RN will be responsible for writing the changes on the nursing flowsheet.

9. Medication concentration of Albuterol in mg/hr: 2.5mg/hr = 0.5cc/hr.

A. 4 Hour medication dosages. Total volume needed for Continuous Nebulizer therapy:

output for the HEART Nebulizer is ± 30 ml/hour, therefore, total volume for 4 hours of Continuous Nebulizer therapy will be 120 cc

1. 2.5 mg/hour - 2cc Albuterol (10 mg) / 118cc NS
2. 5 mg/hour - 4cc Albuterol (20 mg) / 116cc NS
3. 7.5 mg/hour - 6cc Albuterol (30 mg) / 114cc NS
4. 10 mg/hour - 8cc Albuterol (40 mg) / 112cc NS
5. 12.5 mg/hour - 10cc Albuterol (50 mg) / 110cc NS
6. 15 mg/hour - 12cc Albuterol (60 mg) / 108cc NS
7. 17.5 mg/hour - 14cc Albuterol (70 mg) / 106cc NS
8. 20 mg/hour - 16cc Albuterol (80 mg) / 104cc NS

10. Pulse limits:

A. Adult patients: Discontinue for pulse >140 BPM or increase of 20 BPM from baseline. Physician order may increase or decrease the limit.

B. Pediatric patients: Discontinue for pulse >160 BPM or increase of 20 BPM from baseline. Physician order may increase or decrease the limit.

11. Oxygen Saturation:

A. Adult patients: Keep SaO2 ≥ 92%. Alternate Sat limits may be set by the physician.

B. Pediatric patients: Keep SaO2 ≥ 93%. Alternate Sat limits may be set by the physician.

12. Use worksheet (Attachment A) for medication calculations.

13. ADULT SAMPLE ORDER: Continuous Nebulizer with Albuterol and 2 Unit Dose Atrovent. Hold for pulse >140 BPM, keep SaO2 > 92%.

14. PEDIATRIC SAMPLE ORDER: Continuous Neb with Albuterol 0.5mg/kg/hr add ¼ Unit Dose Atrovent over 4 hours. Hold for HR > 160 BPM, keep SaO2 > 93%.

CONTINUENCE OF CONTINUOUS NEBULIZER THERAPY

1. Continuous Nebulizer therapy must be re-ordered q24 hours.

2. If there is no re-order, the Respiratory Care Practitioner must contact physician for DC or re-order instructions.

CHANGES IN CONTINUOUS NEBULIZER THERAPY

1. Changes in mode of therapy are to be documented by placing the protocol sticker on the doctors order form section of the patient’s chart, and marking the appropriate box on the sticker.
DISCONTINUENCE OF CONTINUOUS NEBULIZER THERAPY

Adult patients:
1. When appropriate, based on patient assessment, medication dose will be decreased by 2.5 – 5.0 mg/hr every four hours until the patient reaches a dose of 7.5mg/hr (equivalent to q20” therapy).
   A. Patient will be switched to Small Volume Nebulizer therapy at a frequency of q2 hours x 2.
      1. If initial Continuous Nebulizer was Albuterol only, the Small Volume Nebulizer will be Unit Dose (2.5mg in 2.5ml solution) Albuterol.
      2. If the Initial Continuous Nebulizer was Albuterol with Ipratropium Bromide (Atrovent), the Small Volume Nebulizer will be Unit Dose (2.5mg in 2.5ml solution) Albuterol with Unit Dose (500mcg in 3ml solution) Ipratropium Bromide (Atrovent).
      3. At the end of the 24-hour reorder period the physician must rewrite a new Small Volume Nebulizer order.
   B. If after the q2h x 2, the patient’s respiratory status continues to improve, the Respiratory Care Practitioner will decrease the frequency to q4h and q2h prn.
   C. If after q2h x 2, the patient has not improved or has worsened, Respiratory Care Practitioner will continue q2h or consider restarting Continuous Nebulizer therapy at most recent Continuous Nebulizer dose.
      1. If Continuous Nebulizer therapy is restarted, Respiratory Care Practitioner must contact ordering physician.
   D. Follow-up, frequency changes and prn assessment will continue per Respiratory Care Bronchodilator Protocol guidelines, B7180-50.

Pediatric patients:
1. When appropriate, based on patient assessment, medication dose will be decreased by 0.1 – 0.2 mg/kg/hr every four hours until the patient reaches a dose of 0.2mg/kg/hr.
   A. Patient will be switched to Small Volume Nebulizer therapy at a frequency of q2h hours x2.
      1. If initial Continuous Nebulizer was Albuterol only the Small Volume Nebulizer will be Albuterol only. For patients <15 kg the dose is .05 -.15mg/kg of Albuterol, and for patients ≥15 kg the dose is 1 Unit Dose (2.5mg in 2.5ml solution) Albuterol.
      2. If the Initial Continuous Nebulizer was Albuterol with Ipratropium Bromide (Atrovent), the Small Volume Nebulizer will be Albuterol with Ipratropium Bromide (Atrovent). For patients <15 kg the dose is .05 -.15 mg/kg of Albuterol with ½ Unit Dose Ipratropium Bromide (Atrovent) Q8 hours, and for patients ≥15 and <30 kg the dose is 1 Unit Dose (2.5mg in 2.5ml solution) Albuterol with ½ Unit Dose (500mcg in 3ml solution) Ipratropium Bromide (Atrovent) Q8 hours.
      3. At the end of the 24-hour reorder period the physician must rewrite a new Small Volume Nebulizer order.
   B. If after the q2h x 2, the patient’s respiratory status continues to improve, the Respiratory Care Practitioner will decrease the frequency to q4h and q2h prn.
   C. If after q2h x 2, the patient has not improved or has worsened, Respiratory Care Practitioner will continue q2h or consider restarting Continuous Nebulizer therapy at most recent Continuous Nebulizer dose.
      1. If Continuous Nebulizer therapy is restarted, Respiratory Care Practitioner must contact ordering physician.
D. Follow-up frequency changes and prn assessment will continue per Respiratory Care Protocols guidelines, B7180-50.

**AMBIENT ADMINISTRATION**

1. Medication will be administered via a HEART nebulizer with an aerosol mask or face tent for adult patients, (infants and pediatric patients may use head hood, face tents or aerosol masks) @ 10 Lpm Air/O₂. If SaO₂ falls below the ordered limit, O₂ may be increased by the blender or a nasal cannula will be added with a maximum flow of 6 Lpm to maintain ordered SaO₂ limits and the physician will be notified.

2. Respiratory Care staff will complete a physical assessment of the patient obtaining baseline measurements of vital signs, SaO₂, and assessment of breath sounds.

3. Respiratory Care Practitioner will return and reassess the patient at least q2h hours.

4. All patient and therapy monitoring will be documented per existing departmental procedures.

5. All patient billing information will be documented in MediLinks

**REFERENCES**


SCVMC RESPIRATORY CARE PROCEDURE
Continuous Nebulized Albuterol Protocol for Non-Ventilated Patients

Worksheet for Continuous Nebulization Therapy For all NON-Ventilated Patients
Using the HEART Nebulizer
for 4 HOURS*

Patient Name _____________________________________________________ Patient weight (Pedi only)_______ Room #__________
Date and Time______________________________________ Dr. Order____________________________________________________

**PEDIATRIC** Dosage range for CN: 0.2 mg/kg/hr to 0.8 mg/kg/hr

or **ADULT** equivalents

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Notify physician if hourly dose is greater than 20 mg/hr. May give greater than 20 mg/hr with physician order.

* Adult patients receiving ≥4mg/kg/hr may have increased Serum Albuterol levels and Tachycardia. (Lin RY, Chest 1993; 103:221-225)

**MEDICATION CALCULATION**

0. _____ mg x _____ kg x 4 hr's = _____ Total mg

_____ Total mg / 5 = _____ cc's Albuterol

_____ cc's Albuterol

+ _____ cc's Atrovent (1/2 UD = 1.25 cc's: 1 UD = 2.5 cc's: 2 UD = 5 cc's: *(Atrovent Requires a MD/PA order)*

= _____ total cc's medication.

120 cc's (total amount of solution)

- _____ cc's total medication

= _____ cc's NS added to Albuterol (& Atrovent if applicable)

_____ cc's medication + _____ cc's NS = 120 cc's Total solution run over 4 hours

1. Place Medication and Normal Saline in HEART Nebulizer. The HEART Nebulizer can be placed in-line with a Head Hood, Face Tent, or Aerosol Mask. (Refer to procedures B7180-51 and B7180-51.1). Run HEART nebulizer at 10 Lpm.

2. Assess patient 15 minutes after initial set up, and at least every two hours there after. Record assessment on the charting and billing form. Assess volume remaining in HEART Nebulizer every two hours.

RCP Signature________________________________________________Co-Signature____________________________________
VARIATION: Administration of CN for all Non-Ventilated patients via Head-Hood, Face Tent, or Aerosol Mask.

Equipment needed:
- HEART nebulizer
- HEART flowmeter adapter
- Corragated tubing
- Appropriate delivery device (HH, FT, Aerosol mask, etc.)
- 250 cc bottle of NS (at least)
- Undiluted Albuterol
- Air/O₂ Blender with flowmeter, and nipple adapter OR
- Air or Oxygen flowmeter depending on patient condition

1. Assemble HEART Nebulizer.
2. Connect to wall flowmeter or blender flowmeter utilizing the HEART nebulizer flowmeter adapter.
3. Fill HEART nebulizer with appropriate medication. Use worksheet for HEART nebulizer for either 4 or 8 hours to verify appropriate dosage given (Attachment B or C).
4. Adjust blender to achieve the FIO₂ desired, if appropriate.
5. Set blender flowmeter to 10 liters per minute.
6. Attach aerosol mask, head hood, or face tent to the patient, and to outlet of HEART nebulizer.
7. Assess patient q2 hours and prn for any changes in patients condition.
Physicians write 24 hour order for Continuous Nebulizer (CN) Therapy

RCP checks patient medical record for correct order. RCP checks K+ now and q am

RCP obtains patient ideal body weight (IBW) and brief patient history and physical

RCP starts CN therapy based on patient’s IBW (see suggested starting doses below). Doses above maximum dose need to be approved by an attending physician. All doses are for 4 hours.

- Adult pt. >50 kg suggested initial dose of 17.5 mg/hr (maximum dose of 20 mg/hr.)
- Adult pt. 40-50 kg suggested initial dose of 15 mg/hr (maximum dose of 17.5 mg/hr.)
- Adult pt. <40 kg suggested initial dose of 7.5 mg/hr (maximum dose of 10 mg/hr.)
- Pediatric patient dosage range 0.2 – 0.8 mg/kg/hr (maximum dose of 20 mg/hr.)

RCP to make patient assessment checks q2 hours to include but not limited to:
- Time of assessment check, current dose, pt. HR, RR, and breath sounds.

Make changes in CN dosage based on patient assessment.

Patient improvement based on patient assessment

If patient improvement is:

- YES
  - Decrease CN dose by 2.5 – 5.0 mg/hr, for adults, and 0.1 – 0.2 mg/kg/hr for pediatrics, q4 hr based on q2 hr pt. assessment until patient dose is 7.5 mg/hr for adults and 0.2 mg/kg/hr for pediatrics.
  - Is patient stable on minimum dose?
    - YES
      - Change pt. to SVN q2h x 2 w/ Albuterol (and Atrovent if appropriate). If after x 2 Tx, pt. is stable change to SVN q4h.
    - NO
      - Increase CN dose and reassess pt.
  - NO
    - Increase dose 2.5 – 5.0 mg/hr for adults, and 0.1 – 0.2 mg/kg/hr for pediatrics, q4 hr based on q2 hr pt. assessment until patient dose is up to maximum dose, if indicated. Continue q2h checks on patient and notify MD if patient doesn’t improve or patient worsens.