

# HYPERCAPNIC RESPIRATORY FAILURE

*(Last updated 07/23/2019; Reviewed by: Kang An, MD)*

**PRESENTING COMPLAINT:** Shortness of breath, difficulty breathing, altered consciousness

## FINDINGS

- **A** Check airway, suspect difficult airway
- **B** RR ↓ or ↑, use of accessory muscles of respiration
- **C** BP ↑, HR ↑
- **D** Variable altered (V,P,U,D)\* Coma if intoxication/overdose/medication
- **E** +/- Cyanosis, Dyspnea, Diaphoresis obesity, anasarca (if acute on chronic)
- **L<sub>PC</sub>** ABG- pH ↓, PaO<sub>2</sub> ↓, PCO<sub>2</sub> ↑
- **U<sub>PC</sub>** Lung US: effusions, diaphragmatic paralysis, normal if COPD

\***V** (verbal), **P** (pain), **U** (unconsciousness), **D** (delirious)

**U<sub>PC</sub>** (point of care ultrasound) **L<sub>PC</sub>** (point of care labs)

## OTHER HISTORY

- **Symptoms:** Anxiety, dyspnea, headaches, somnolence, delirium, paranoia, coma, diaphoresis, cyanosis, lethargy, restlessness, tremor, slurred speech, expiratory flow limitation, wheezing, decreased breath sounds, hyper resonance on percussion, paradoxical abdominal muscles during inspiration, clubbing, papilledema, tachycardia, signs of chest wall compression (obesity, abdominal distension, kyphosis), neuromuscular disease (weakness)
- **Predisposing Conditions:** Severe asthma/COPD, sedative use or drug overdose, central disorders (ex. sleep apnea), neuromuscular disorders (myasthenia gravis, ALS, cervical cord, brain stem injuries), thoracic cage disorders or kyphoscoliosis, effusions, obesity hypoventilation
- **Mechanisms:** Decreased central respiratory drive, abnormalities of the chest wall leading to excessive restriction, airways abnormalities leading to excessive dead space or increased work of breathing and fatigue, neuromuscular diseases (peripheral nervous system)

## DIFFERENTIAL DIAGNOSES

- Pulmonary embolus, heart failure, encephalopathy, sepsis

## OTHER INVESTIGATIONS

- **Labs:** ABG: pH, pCO<sub>2</sub>, and HCO<sub>3</sub> (to determine acute vs chronic hypercapnia), CBC: polycythemia (chronic hypoxemia), thyroid function tests to rule out hypothyroidism
- **Monitoring:** Periodic ABGs may be needed to assess clinical course
- **Imaging:** **Chest X-ray:** hyperinflation, diaphragm flattening (COPD), prominent pulmonary vasculature (pulmonary hypertension), bony abnormalities (kyphosis, scoliosis), elevated hemi-

diaphragm (neuromuscular disease); **consider CT** when additional information required regarding pulmonary process; **consider CT/ MRI brain** to detect brainstem stroke, tumor, or trauma

### **THERAPEUTIC INTERVENTIONS**

- **Medications:** Treat the underlying cause
- **Ventilation:** Noninvasive positive pressure ventilation (BIPAP), Invasive positive pressure ventilation, Reverse Trendelenburg position to minimize diaphragm compression
- **Oxygen:** Use cautiously for hypoxemia in patients who have hypercapnic respiratory failure, target SpO<sub>2</sub> of 88-94% to avoid worsening hypercapnia
- **Anxiolytic & Sedation:** Cautious use of medroxyprogesterone and acetazolamide as respiratory stimulants
- **Consider surgery:** Bariatric surgery in obesity hypoventilation syndrome, corrective surgery in cases of severe thoracic deformities (kypho-scoliosis)

### **ONGOING TREATMENT**

- **Level of care:** Depending on the severity and patient's initial response to treatment, patient may be managed on general medical floor or may need to monitor in ICU.
- **Further diagnostics:** Based on suspicion, consider: EMG, CK, and muscle biopsy for neuromuscular disease
  - Overnight oximetry and transcutaneous capnography for obesity hypoventilation syndrome
  - Transdiaphragmatic pressure measurement may be needed if the respiratory muscle or diaphragm weakness is unclear
  - Bedside spirometry can be used to diagnose obstructive disease (FEV1/FVC < 70%) and severity of obstruction (FEV1 % predicted) or restrictive disease in neuromuscular disease
- **Prophylaxis:** Home oxygen therapy assessment in patients who need outpatient oxygen therapy; chronic noninvasive positive pressure ventilation: encourage compliance; pneumococcal vaccines to patient with COPD or other chronic lung disease

### **CAUTIONS**

- **Complications:** Cor-pulmonale, pulmonary hypertension, significant increase in cardiovascular mortality

### **REFERENCES & ACKNOWLEDGMENTS**

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