# Respiratory Acidosis Study Notes

- Acid-base disturbance characterized by reduced alveolar ventilation resulting in hypercapnia
- Verified by arterial blood gas analysis (partial pressure of arterial carbon dioxide [PaCO2] above 45 mm Hg and pH less than 7.35)
- Diagnosed when serum pH is reduced and serum bicarbonate concentration is abnormally low
- Prognosis varies depending on the severity of the underlying cause and the patient's general condition
- Can be acute or chronic

## Pathophysiology

- Inadequate ventilation causes carbon dioxide to be retained (hypercapnia). Carbon dioxide and water combine to make carbonic acid, leading to a decrease in the bicarbonate level and then in the hydrogen ion (pH) concentration.
- With chronic respiratory acidosis, PaCO2 is elevated but pH is normal or near-normal because of compensation by the kidneys.
- Cellular compensatory buffering (increase in bicarbonate) may occur over minutes to hours, with kidney compensation occurring over 3 to 5 days.

## Causes

- Elevated carbon dioxide levels resulting from respiratory depression or failure
- Compensatory mechanism for severe metabolic acidosis

## Risk Factors

- Airway obstruction
- Asthma
- Central nervous system (CNS) disorder or depression
- Chest wall disorders, such as flail chest or severe kyphoscoliosis
- Chronic bronchitis
- Chronic metabolic alkalosis
- Chronic obstructive pulmonary disease
- CNS-depressant drug use
- Extensive pneumonia
- Large pneumothorax
- Neuromuscular disease
- Obstructive sleep apnea
- Parenchymal lung disease
- Pulmonary edema
- Severe acute respiratory distress syndrome

- Obesity hypoventilation syndrome
- Laryngeal or tracheal stenosis
- Interstitial lung disease

## Incidence

- Respiratory acidosis affects males and females equally.

## Complications

- Metabolic alkalosis
- Cor pulmonale
- Carbon dioxide narcosis
- Papilledema
- Polycythemia
- Pulmonary hypertension
- Right ventricular failure
- Shock
- Respiratory arrest
- Cardiac arrest

## Assessment

## History

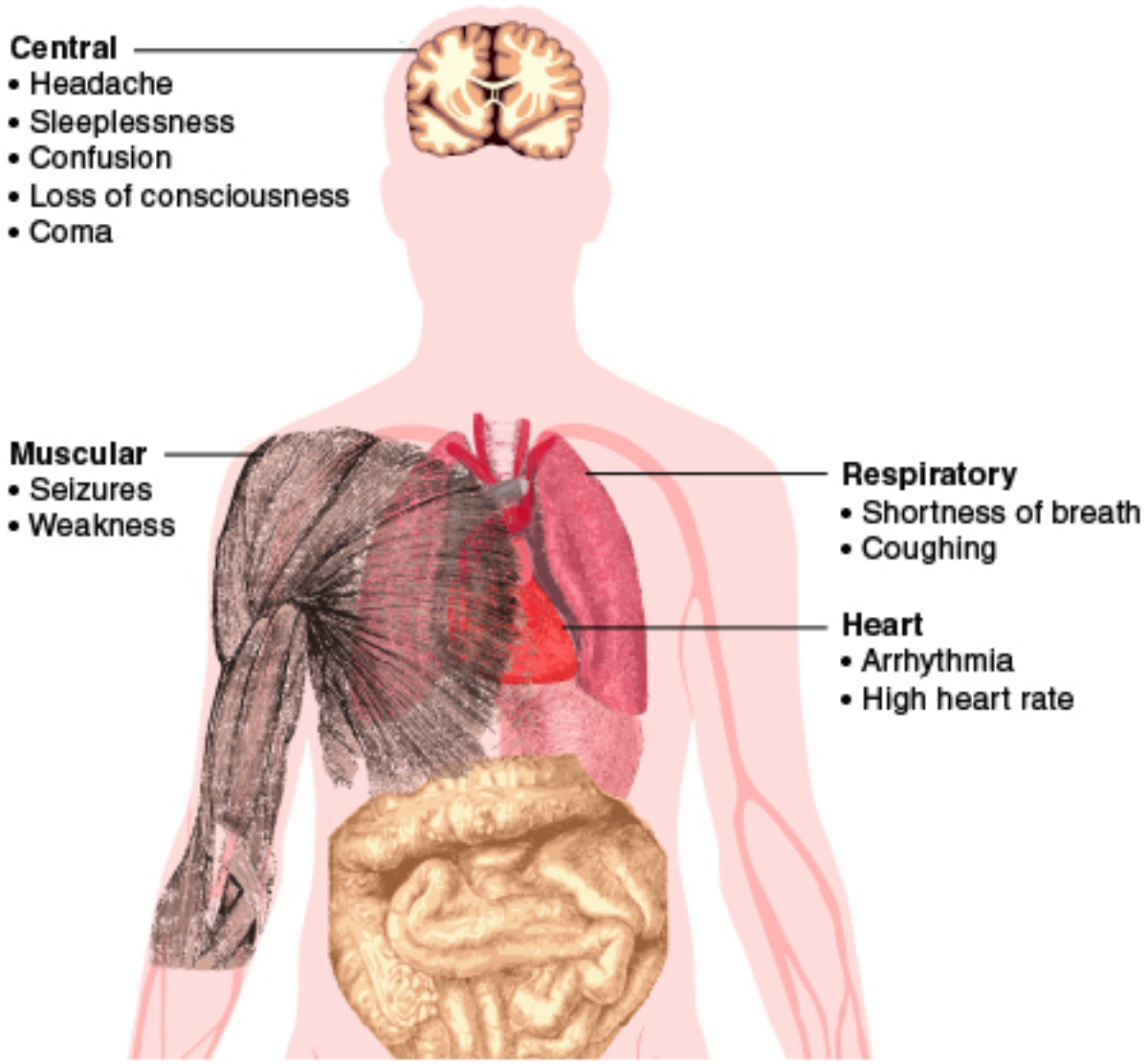
- History of underlying condition or disorder
- Headache
- Shortness of breath
- Nausea and vomiting
- Daytime sleepiness
- Anxiety that progresses to confusion, somnolence, and possible delirium
- Disturbed sleep
- Illicit drug use

## Physical Findings

- May be related to underlying cause
- Diaphoresis
- Bounding pulses
- Rapid, shallow respirations
- Tachycardia and other arrhythmias
- Hypotension
- Papilledema
- Mental status changes
- Asterixis (tremor)
- Seizures
- Depressed deep tendon reflexes

- Wheezing, barrel chest, decreased breath sounds, hyperresonance on percussion, and prolonged expiration (patients with chronic obstructive lung disease)
- Clubbing (with chronic respiratory disease)
- Cyanosis (if hypoxemia is present)
- Somnolence (See Signs and symptoms of respiratory acidosis.)

Signs and symptoms of respiratory acidosis
Respiratory acidosis occurs when the lungs can't remove enough carbon dioxide ($CO_2$) produced by the body. Excess $CO_2$ lowers the pH of the blood, making it too acidic, which in turn affects a number of body systems.




## Diagnostic Test Results

## Laboratory

- Arterial blood gas analysis shows PaCO2 above 45 mm Hg (hypercapnia); pH level 7.35 with acute occurrence may be normal with chronic respiratory acidosis secondary to compensation.
- Serum bicarbonate levels may be increased (in the chronic form).
- Drug screen may confirm the cause of respiratory depression.
- Thyroid-stimulating hormone level (serum) and thyroxine level (serum) may identify thyroid disease as the cause.
- Hemoglobin level test and hematocrit test results may be elevated with chronic hypoxemia that occurs with the chronic form of respiratory acidosis.

## Imaging

- Chest radiography may identify a pulmonary cause, such as obstructive pulmonary disease, pneumonia, pneumothorax, or atelectasis.
- Computed tomography scanning (thorax) or magnetic resonance imaging may identify abnormalities not identified by chest radiography or a central nervous system cause, such as stroke, tumor, or trauma.

## Diagnostic Procedures

- Pulmonary function tests may help diagnose underlying respiratory disease; the ratio of forced expiratory volume in 1 second to forced vital capacity is decreased.
- Electromyography and nerve conduction velocity tests may reveal a neuromuscular disorder as an underlying condition, such as Guillain-Barré syndrome or amyotrophic lateral sclerosis.
- Transesophageal pressure measurement helps confirm diaphragmatic dysfunction and paralysis.

## Treatment

## General

- Correction of the underlying condition causing alveolar hypoventilation
- Mechanical ventilation, noninvasive positive-pressure ventilation, or noninvasive external negative-pressure ventilation
- Smoking cessation
- Chest tube insertion for pneumothorax
- Venous thromboembolism (VTE) prophylaxis while hospitalized

## Diet

- Small, frequent meals
- Enteral feedings if intubated
- Parenteral nutrition if indicated

## Activity

- As tolerated

## Medications

- Oxygen therapy
- Bronchodilators, such as albuterol sulfate, ipratropium bromide, theophylline, or tiotropium bromide
- Inhaled corticosteroids, such as budesonide (inhalation, intranasal) or fluticasone propionate
- medroxyPROGESTERone acetate to increase respiratory drive
- acetaZOLAMIDE to increase bicarbonate excretion
- Antidotes for respiratory depression caused by drug therapy, such as flumazenil for benzodiazepine overdose and naloxone hydrochloride for opioid overdose
- Sodium bicarbonate (based on cause of hypercapnia)

## Surgery

- Surgery to treat underlying cause, if indicated
- Spinal fusion to treat severe kyphoscoliosis
- Bariatric surgery for obesity-associated hypoventilation

## Nursing Considerations

## Nursing Interventions

- Give prescribed drugs; administer bronchodilators via inhalation; give IV fluids as ordered; ensure patent IV access.
- Provide supplemental oxygen based on oxygen saturation levels as determined by pulse oximetry or arterial blood gas (ABG) results.
- Elevate the head of the bed to maximize lung expansion; encourage the patient to take slow, deep breaths; assist with relaxation and stress management techniques.
- Ensure a patent airway; suction secretions as indicated; assist with respiratory support; and assist with insertion of an endotracheal tube and mechanical ventilation as indicated.
- Provide adequate fluids orally if possible.
- Encourage the patient to verbalize feelings and concerns related to the condition; provide emotional support and an explanation of all treatments and care.
- Provide small, frequent meals to minimize energy expenditure; allow for frequent rest periods, and cluster care to ensure adequate rest. If the patient is intubated, provide enteral feedings as ordered and assess for tolerance.
- Obtain a swallowing evaluation when the patient is extubated.
- Apply antiembolism stockings or sequential compression stockings to prevent VTE.
- Auscultate heart and lung sounds for changes; check the patient's level of consciousness for changes.
- Obtain specimens for laboratory testing, such as ABG and serum electrolyte levels, as indicated.
- Obtain daily weight and check skin turgor.
- Turn and reposition the patient regularly and frequently, unless contraindicated. Base the

frequency of repositioning on the patient's tissue tolerance, skin condition, mobility, medical condition, and treatment goals.
- Perform a skin assessment and provide skin care to prevent pressure injury formation.

## Monitoring

- Airway patency
- Vital signs
- Intake and output and fluid balance
- Neurologic status
- Cardiopulmonary status
- Oxygen saturation level
- End tidal carbon dioxide levels if monitoring available
- ABG values
- Serum electrolyte levels
- Mechanical ventilator settings
- Enteral feeding tolerance
- Skin integrity
- Coping status

WARNING!
**Be aware that pulse oximetry, which is used to monitor oxygen saturation, won't reveal increasing carbon dioxide levels.**

## Associated Nursing Procedures

- Antiembolism stocking application, knee-length
- Antiembolism stocking application, thigh-length
- Arterial puncture for blood gas analysis
- Coughing and diaphragmatic breathing exercises
- Endotracheal tube removal
- Endotracheal tube repositioning
- Enteral feeding tube insertion, gastric and duodenal
- Enteral tube feeding, gastric
- Handheld resuscitation bag and mask use
- Intubation with direct visualization
- IV bolus injection
- IV pump use
- IV secondary line drug infusion
- Mechanical ventilation, positive pressure
- Nasogastric or orogastric tube irrigation
- Neurologic assessment
- Oral care for an intubated patient
- Oxygen administration
- Pressure injury prevention

- Relaxation and stress management techniques
- Safe medication administration practices, general
- Sequential compression therapy
- Swallowing assessment
- Weaning a patient from a ventilator

# Patient Teaching

## General

Include the patient's family or caregiver in your teaching, when appropriate. Provide information according to their individual communication and learning needs. Be sure to cover:

- disorder, diagnostic testing, and treatment, including possible underlying causes
- rationale for the use of supplemental oxygen and associated care measures, emphasizing the appropriate safety measures for oxygen use
- prescribed drugs, including the drug name, dosage, route of administration, frequency of administration, expected results, and duration of therapy
- how to use a nebulizer or metered-dose inhaler, as appropriate
- possible adverse effects of medications, such as shakiness, palpitations, restlessness, sweating, flushing, and CNS stimulation with bronchodilators
- how to perform coughing and diaphragmatic breathing exercises
- how to perform pursed-lip breathing to help expel trapped carbon dioxide
- relaxation and stress management techniques and positive coping strategies
- energy-conservation techniques
- signs and symptoms of acid-base imbalance and when to notify the practitioner
- home oxygen therapy, if indicated.

# Discharge Planning

- Participate as part of a multidisciplinary team to coordinate discharge planning efforts. This team may include a bedside nurse, care manager, respiratory therapist, nutritionist, physical therapist, pulmonologist, and primary care practitioner.
- Assess the patient's and family's understanding of the diagnosis, treatment, follow-up, and warning signs for which to seek medical attention.
- Assess the patient's level of independence before admission.
- Evaluate how the current illness will impact the patient's independence.
- Identify the patient's formal and informal supports.
- Identify the patient's and family's goals, preferences, comprehension, and concerns about discharge.
- Confirm arrangements for transportation to initial follow-ups.
- Provide a list of prescribed drugs, including the dosage, prescribed time schedule, and adverse reactions to report to the practitioner. Provide the patient (and family or caregiver, as needed) with written information on the medications that the patient should take after discharge.
- Assess the patient's and family's understanding of prescribed medication, including dosage, administration, expected results, duration, and possible adverse effects.
- Assess the patient's ability to obtain medications; identify the party responsible for

obtaining medications.
- Instruct the patient to provide a list of medications to the practitioner who will be caring for the patient after discharge; to update the information when the practitioner discontinues medications, changes doses, or adds new medications (including over-the-counter products); and to carry a medication list that contains all of this information at all times in the event of an emergency.
- Assist with arrangement of home health care, if needed.
- Provide information on smoking cessation, if appropriate.
- Ensure that the patient and caregivers receive medical contact information.
- Ensure that the patient or caregiver receives a copy of the discharge instructions and that a copy is placed in the patient's medical record.
- Assess the patient's and family's understanding of teaching by using the teach-back method when possible.
- Document the discharge planning evaluation in the patient's clinical record, including who was involved in discharge planning and teaching, their understanding of teaching provided, and any need for follow-up teaching.