chloride depends on the timing of the measurement. The metabolic alkalosis from diuretics is clearly chloride responsive; it corrects only after adequate volume repletion. This is the rationale for including it among the chloride-responsive causes of a metabolic alkalosis.

The **chloride-resistant** causes of metabolic alkalosis can be subdivided based on blood pressure. Patients with the rare disorders that cause a metabolic alkalosis and hypertension either have increased aldosterone or act as if they have increased aldosterone. Patients with Bartter syndrome or Gitelman syndrome (Chapter 36) have metabolic alkalosis, hypokalemia, and normal blood pressure secondary to renal tubular defects that cause continuous urinary losses of chloride.

Clinical Manifestations

The symptoms in patients with a metabolic alkalosis often are related to the underlying disease and associated electrolyte disturbances. Hypokalemia is often present, and occasionally severe, in the diseases that cause a metabolic alkalosis (see Chapter 36). Children with chloride-responsive causes of metabolic alkalosis often have symptoms related to volume depletion (see Chapter 33). In contrast, children with chloride-unresponsive causes may have symptoms related to hypertension. Severe alkalemia may cause arrhythmias, hypoxia secondary to hypoventilation, or decreased cardiac output.

Table 37-3 Causes of Metabolic Alkalosis

CHLORIDE RESPONSIVE (URINARY CHLORIDE <15 Meq/L)
Gastric losses (emesis or nasogastric suction)
Pyloric stenosis
Diuretics (loop or thiazide)
Chloride-losing diarrhea
Chloride-deficient formula
Cystic fibrosis (sweat losses of chloride)
Posthypercapnia (chloride loss during respiratory acidosis)
CHLORIDE RESISTANT (URINARY CHLORIDE >20 Meq/L)
High Blood Pressure
Adrenal adenoma or hyperplasia
Glucocorticoid-remediable aldosteronism
Renovascular disease
Renin-secreting tumor
17α-Hydroxylase deficiency
11β-Hydroxylase deficiency
Cushing syndrome
11 β-Hydroxysteroid dehydrogenase deficiency
Licorice ingestion
Liddle syndrome
Normal Blood Pressure
Gitelman syndrome
Bartter syndrome
Base administration

Diagnosis

Measurement of the urinary chloride concentration is the most helpful test in differentiating among the causes of a metabolic alkalosis. The history usually suggests a diagnosis, although no obvious explanation may be present in the patient with bulimia, surreptitious diuretic use, or an undiagnosed genetic disorder, such as Bartter syndrome or Gitelman syndrome.

Treatment

The approach to therapy of metabolic alkalosis depends on the severity of the alkalosis and the underlying etiology. In children with a mild metabolic alkalosis ($[HCO_3^-] < 32$ mEq/L), intervention is often unnecessary. Patients with chloride-responsive metabolic alkalosis respond to correction of hypokalemia and volume repletion with sodium and potassium chloride, but aggressive volume repletion may be contraindicated if mild volume depletion is medically necessary in the child receiving diuretic therapy. In children with chloride-resistant causes of a metabolic alkalosis that are associated with hypertension, volume repletion is contraindicated because it exacerbates the hypertension and does not repair the metabolic alkalosis. Treatment focuses on eliminating or blocking the action of the excess mineralocorticoid. In children with Bartter syndrome or Gitelman syndrome, therapy includes oral potassium supplementation and potassium-sparing diuretics.

RESPIRATORY ACID-BASE DISTURBANCES

During a respiratory acidosis, there is a decrease in the effectiveness of CO_2 removal by the lungs. The causes of a respiratory acidosis are either pulmonary or nonpulmonary (Table 37-4). A respiratory alkalosis is an inappropriate reduction in the blood CO_2 concentration. A variety of stimuli can increase the ventilatory drive and cause a respiratory alkalosis (Table 37-5). Treatment of respiratory acid-base disorders focuses on correction of the underlying disorder. Mechanical ventilation may be necessary in a child with a refractory respiratory acidosis.

Table 37-4 Causes of Respiratory Acidosis

Central nervous system depression (encephalitis or narcotic overdose)
Disorders of the spinal cord, peripheral nerves, or neuromuscular junction (botulism or Guillain-Barré syndrome)
Respiratory muscle weakness (muscular dystrophy)
Pulmonary disease (pneumonia or asthma)
Upper airway disease (laryngospasm)

Table 37-5 Causes of Respiratory Alkalosis

Hypoxemia or tissue hypoxia (carbon monoxide poisoning or cyanotic heart disease)
Lung receptor stimulation (pneumonia or pulmonary embolism)
Central stimulation (anxiety or brain tumor)
Mechanical ventilation
Hyperammonemias