**Normal Levels of Substances in the Arterial Blood:**

|  |  |
| --- | --- |
| pH | 7.40 + 0.05 |
| pCO2 (partial pressure of carbon dioxide) | 40 mm Hg |
| pO2 (partial pressure of oxygen) | 90 - 100 mm Hg |
| Hemoglobin - O2 saturation | 94 - 100 % |
| [HCO3-] | 24 meq / liter |

**Case Study #1**

A 14-year-old girl with cystic fibrosis has complained of an increased cough productive of green sputum over the last week. She also complained of being increasingly short of breath, and she is noticeably wheezing on physical examination. Arterial blood was drawn and sampled, revealing the following values:

|  |  |
| --- | --- |
| pH | 7.30 |
| pCO2 | 50 mm Hg |
| pO2 | 55 mm Hg |
| Hemoglobin - O2 saturation | 45 % |
| [HCO3-] | 24 meq / liter |

1.What causes cystic fibrosis? Describe the pathophysiologic mechanisms of the disease.

Cystic fibrosis is the most common autosomal recessive disease in the United States. To have CF, an individual must inherit two defective genes, one from each parent. CF is caused by an abnormal mutation of the cystic fibrosis transmembrane conductance regulator. In individuals with cystic fibrosis, CFTC’s failure to function properly results in thick viscous secretions that eventually lead to obstruction of the glands and ducts in the affected organs (Nelm,s 663).

2. How would you classify this girl's acid-base status?

Based on her decreaed pH, elevated pCO2 and normal HCO3-, I would classify this girl with respiratory acidosis.

3. How does cystic fibrosis cause this acid-base imbalance?

Cystic fibrosis causes a build up of mucus in the airways. This would cause the girl to hypoventilate, increasing her pCO2 and decreasing her pH. There are a variety of ways to decrease this mucus accumulation and reduce infection. These include: inhaled bronchodilators, inhaled anti-inflammatory agents, inhaled mucolytics and inhaled antibiotics. The lungs are the most seriously involved organs in patients with cystic fibrosis (Nelms, 663).

4. How would the kidneys try to compensate for the girl's acid-base imbalance?

Respiratory compensatory mechanisms include increased excretion of H+ and resorption of HCO3-. Other renal buffer systems such as the use of ammonium will also provide compensation (Nelms, 143).

5. This girl has also had a long history of diarrhea and poor weight gain. Explain why.

Pancreatic insufficiency occurs in CF patients and prevents enzymes form reaching the small intestine. This would result in diarrhea and a poor growth pattern with decreased subcutaneous tissue and muscle mass despite a normal appetite. This explains her poor weight gain (Nelms, 663).

6. List some other causes of this type of acid-base disturbance.

Other causes of respiratory acidosis include: drugs, sleep apnea, excessive production of CO2, overfeeding, aspiration of foreign body of vomitus and acute pulmonary edema (Nelms, 143).

**Normal Levels of Substances in the Arterial Blood:**

|  |  |
| --- | --- |
| pH | 7.40 + 0.05 |
| pCO2 (partial pressure of carbon dioxide) | 40 mm Hg |
| pO2 (partial pressure of oxygen) | 90 - 100 mm Hg |
| Hemoglobin - O2 saturation | 94 - 100 % |
| [HCO3-] | 24 meq / liter |

**Case Study #2**

A 76-year-old man complained to his wife of severe sub-sternal chest pains that radiated down the inside of his left arm. Shortly afterward, he collapsed on the living room floor. Paramedics arriving at his house just minutes later found him unresponsive, not breathing, and without a pulse. CPR and electroconvulsive shock were required to start his heart beating again. Upon arrival at the Emergency Room, the man started to regain consciousness, complaining of severe shortness of breath (dyspnea) and continued chest pain. On physical examination, his vital signs were as follows:

|  |  |
| --- | --- |
| Systemic blood pressure | 85 mm Hg / 50 mm Hg |
| Heart rate | 175 beats / minute |
| Respiratory rate | 32 breaths / minute |
| Temperature | 99.2oF |

His breathing was labored, his pulses were rapid and weak everywhere, and his skin was cold and clammy. An ECG was done, revealing significant "Q" waves in most of the leads. Blood testing revealed markedly elevated creatine phosphokinase (CPK) levels of cardiac muscle origin. Arterial blood was sampled and revealed the following:

|  |  |
| --- | --- |
| pH | 7.22 |
| pCO2 | 30 mm Hg |
| pO2 | 70 mm Hg |
| Hemoglobin - O2 saturation | 88 % |
| [HCO3-] | 2 meq / liter |

1. What is the diagnosis? What evidence supports your diagnosis?

This patient is having a myocardial infarction. The evidence that supports this diagnosis is: chest pain, pain in the arm, unconsciousness, severe shortness of breath and continued chest pain.

2. How would you classify his acid-base status? What specifically caused this acid-base disturbance?

This patient currently is experiencing metabolic acidosis. This is evidenced by his decreased pH, plasma HCO3-, and pCO2. When this man experience a heart attack, his body stopped delivering oxygen to his organs. This resulted in an increase of lactic acid in the body, which can cause metabolic acidosis (Nelms, 145).

3. How has his body started to compensate for this acid-base disturbance?

His body has started to compensate by increasing ventilation, hyperventilation. This occurs because the high levels of H+ stimulate respiratory centers in the brain (Nelms, 146). Additionally, renal compensation will occur when the kidneys increase their excretion of H+ and retaining HCO3-.

4. What would his blood pH be if his body had not started compensating for the acid-base disturbance? Show your work.

pH=pka + log (conjugate base/conjugate acid)

pH= 7.3 + log (40/70)=7.1

His blood pH would be approximately 7.1

5. List some other causes of this type of acid-base disturbance.

The other major cause of this type of acid-base disturbance is diarrhea. Other causes include losses from an ileostomy or from pancreatic, biliary or intestinal fistulas (Nelms, 144).

**Normal Levels of Substances in the Arterial Blood:**

|  |  |
| --- | --- |
| pH | 7.40 + 0.05 |
| pCO2 (partial pressure of carbon dioxide) | 40 mm Hg |
| pO2 (partial pressure of oxygen) | 90 - 100 mm Hg |
| Hemoglobin - O2 saturation | 94 - 100 % |
| [HCO3-] | 24 meq / liter |

**Case Study #3**

An elderly gentleman is in a coma after suffering a severe stroke. He is in the intensive care unit and has been placed on a ventilator. Arterial blood gas measurements from the patient reveal the following:

|  |  |
| --- | --- |
| pH | 7.50 |
| pCO2 | 30 mm Hg |
| pO2 | 100 mm Hg |
| Hemoglobin - O2 saturation | 98% |
| [HCO3-] | 24 meq / liter |

1. How would you classify this patient's acid-base status?

I would classify this man as having respiratory alkalosis based on his decreased pCO2, elevated pH and normal HCO3- level.

2. How does this patient's hyperventilation pattern raise the pH of the blood?

Rapid breathing results in decreased PCO2, and increased HCO3-. This would result in an increased H+ concentration and an increase in pH. Direct stimulation of the respiratory center in the brain can also cause hyperventilation (Nelms, 144).

3. How might the kidneys respond to this acid-base disturbance?

The kidneys reduce their secretion of H+ (which reduces the HCO3- amount) and increase their excretion of bicarbonate (Nelms, 144).

4. List some other causes of this type of acid-base disturbance.

Other causes of respiratory alkalosis include hypermetabolic states, emotional distress and an adaptation to high oxygen demands during strenuous physical activity (Nelms, 144).

**Normal Levels of Substances in the Arterial Blood:**

|  |  |
| --- | --- |
| pH | 7.40 + 0.05 |
| pCO2 (partial pressure of carbon dioxide) | 40 mm Hg |
| pO2 (partial pressure of oxygen) | 90 - 100 mm Hg |
| Hemoglobin - O2 saturation | 94 - 100 % |
| [HCO3-] | 24 meq / liter |

**Case Study #4**

A 28-year-old woman has been sick with the flu for the past week, vomiting several times every day. She is having a difficult time keeping solids and liquids down, and has become severely dehydrated. After fainting at work, she was taken to a walk-in clinic, where an IV was placed to help rehydrate her. Arterial blood was drawn first, revealing the following:

|  |  |
| --- | --- |
| pH | 7.50 |
| pCO2 | 40 mm Hg |
| pO2 | 95 mm Hg |
| Hemoglobin - O2 saturation | 97% |
| [HCO3-] | 32 meq / liter |

1. How would you classify her acid-base disturbance?

I would classify this patient as having metabolic alkalosis based on her elevated pH, HCO3- and normal pCO2.

2. Why might excessive vomiting cause her particular acid-base disturbance?

Metabolic alkalosis often occurs during fluid imbalances. Excessive vomiting would result in fluid imbalances in the body (Nelms, 146).

3. How would the kidneys compensate for this acid-base disturbance?

The kidney will excrete H+ in exchange for K+ (Nelms, 146).

4. List some other causes of this type of acid-base disturbance.

Other causes of this type of disturbance include blood transfusions, antacids, and corticosteroids.