

Mechanical Ventilation in Chronic Lung Disease

1. You are ventilating a patient on the Servo ventilator with a minute ventilation of 10 L/min. The pH is 7.26, PaCO₂ 70 mm Hg, HCO₃ 30 mEq/L, PaO₂ 62 mm Hg. The doctor asks you to correct the pH. What is the desired level of PaCO₂? How would you change the ventilator settings to correct to the new PaCO₂ level?

THE DESIRE IS TO RETURN pH TO 7.40. CORRECTING THE PaCO₂ TO NORMAL WILL OVER-CORRECT pH.

DESIRED RATIO IS 20 : 1

$$\frac{1.2 \text{ mEq/L}}{24 \text{ mEq/L}} \times 30 \text{ mEq/L} = 1.5 \text{ mEq/L} \quad \text{PaCO}_2 \text{ NEEDS TO BE CORRECTED TO 50.0 mm Hg}$$

$$\frac{1.5}{0.03} = 50.0 \text{ mm Hg}$$

$$\text{ACTUAL PaCO}_2 \times \text{ACTUAL } \dot{V}_E = \text{DESIRED PaCO}_2 \times \text{DESIRED } \dot{V}_E$$

$$70 \text{ mm Hg} \times 10 \text{ L/min} = 50 \text{ mm Hg} \times \text{DESIRED } \dot{V}_E \text{ (we will designate as } \chi \text{)}$$

$$700 \text{ mm Hg} \cdot \text{L/min} = 50 \text{ mm Hg} \times \chi$$

$$\frac{700 \text{ mm Hg} \cdot \text{L/min}}{50 \text{ mm Hg}} = 14 \text{ L/min Minute Volume}$$

2. You are called to the Emergency Department to care for a closed head injured patient who is being intubated. He is placed on mechanical ventilation with the following settings: V_t: 600 mL, Mode: A/C, f: 12/min, FIO₂: .60, PEEP: 5 cm H₂O.

An arterial blood gas shows the following results: pH: 7.38, PaCO₂: 42 torr, PaO₂: 80 torr, and HCO₃⁻: 24 mEq/L. The physician wishes to hyperventilate the patient to a PaCO₂ of 30 torr. What changes would you make to accomplish this goal?

$$\text{ACTUAL PaCO}_2 \times \text{ACTUAL } f = \text{DESIRED PaCO}_2 \times \text{DESIRED } f$$

$$42 \text{ mm Hg} \times 12 = 30 \text{ mm Hg} \times \text{DESIRED } f \text{ (we will designate as } \chi \text{)}$$

$$504 \text{ mm Hg} = 30 \text{ mm Hg} \times \chi$$

$$\frac{504 \text{ mm Hg}}{30 \text{ mm Hg}} = 16.8 \text{ breaths/minute} = 17 \text{ breaths/minute}$$

3. You are called to the ICU to help with the management of a patient with long standing COPD (FEV_{1.0} of 0.7 L one month ago) who was intubated one hour ago. Arterial blood analysis demonstrates a pH: of 7.23, PaCO₂: 88 torr, PaO₂: 55 torr, and a HCO₃⁻ of 36 mEq/L. These values were obtained on the following ventilator settings: V_t: 500 mL, Mode: A/C, f: 14/min, FiO₂: .50, PEEP: 0 cm H₂O.

What is the desired PaCO₂ level? How would you change the ventilator settings to correct to the new PaCO₂ level?

DESIRED RATIO IS 20 : 1

$$\frac{1.2 \text{ mEq/L}}{24 \text{ mEq/L}} \times 36 \text{ mEq/L} = 1.8 \text{ PaCO}_2 \text{ NEEDS TO BE CORRECTED TO 60 mm Hg}$$

$$\frac{1.8}{0.03} = 60 \text{ mm Hg}$$

ACTUAL PaCO₂ × ACTUAL f = DESIRED PaCO₂ × DESIRED f

$$88 \text{ mm Hg} \times 14 = 60 \text{ mm Hg} \times \text{DESIRED f (we will designate as } \chi \text{)}$$

$$1232 \text{ mm Hg} = 60 \text{ mm Hg} \times \chi$$

$$\frac{1232 \text{ mm Hg}}{60 \text{ mm Hg}} = 20.53 \text{ breaths/minute} = 20 \text{ breaths/minute}$$

4. You are caring for a 75-year-old female with a long history of diabetic ketoacidosis. She is on a ventilator with the following settings: V_t: 550 mL, Mode: A/C, f: 16/min, FiO₂: .40, PEEP: 5 cm H₂O. An arterial blood gas on these settings shows the following: pH: of 7.08, PaCO₂: 42 torr, PaO₂: 55 torr, and a HCO₃⁻ of 12 mEq/L. While attempts are being made to correct the patient's blood sugar (550 mg/dL) there is signs of cardiac decompensation with frequent PVCs and hypotensive episodes. What changes can you make to the ventilator to return the pH to near 7.4?

DESIRED RATIO IS 20 : 1

$$\frac{1.2 \text{ mEq/L}}{24 \text{ mEq/L}} \times 12 \text{ mEq/L} = 0.6$$

$$\frac{0.6}{0.03} = 20 \text{ mm Hg}$$

ACTUAL PaCO₂ × ACTUAL f = DESIRED PaCO₂ × DESIRED f

$$42 \text{ mm Hg} \times 16 = 20 \text{ mm Hg} \times \text{DESIRED f (we will designate as } \chi \text{)}$$

$$672 \text{ mm Hg} = 20 \text{ mm Hg} \times \chi$$

$$\frac{672 \text{ mm Hg}}{20 \text{ mm Hg}} = 33.6 \text{ breaths/minute} = 34 \text{ breaths/minute}$$