CHEMICAL REGULATION OF PULMONARY VENTILATION

I. Chemical Factors Affecting Ventilation

A. Ventilatory drive
   1. Ventilatory drive may be chemical
   2. During conscious waking periods, ventilation is driven by a combination of factors -
   3. During MVV, ventilation may take on a negative chemical component -
   4. Chemical drive of ventilation
      a. CO2 -
      b. O2 -
      c. pH -

B. Carbon dioxide
   1. Most potent stimulus to ventilation -
      a. Response to CO2 rises to 8-10% then inc. linearly
      b. At 20% responses peaks and then falls -
   2. A 2 torr change in PaCO2 will alter ventilation

C. Central chemoreceptors
   1. Located on the ventrolateral surfaces of the medulla -
   2. Stimulation to central chemoreceptors increases ventilation -
      a. CO2 diffuses freely across membranes -
      b. (H+) stimulates centers -
      c. VT initially rises as CO2 increases -
      d. There are no buffers in CSF and solution remains acid until CO2 falls
   3. Prolonged hyperventilation -
      a. CSF becomes alkalotic -
      b. May explain the persistence of hyper or hypoventilation after blood gases return to normal
   4. CSF lack protein buffer - Small changes in PCO2 have greater effect in CSF than plasma
   5. Ventilation must be closely monitored and controlled to regulate pH in CSF
   6. Hypocapnia can cause vasoconstriction -
      a. PaCO2 20 torr -
      b. PaCO2 120 torr -
   7. Stimulus to change respiration -

D. Peripheral chemoreceptor responses to CO2
   1. Located at the bifurcation of common carotids and level of aortic arch -
   2. Respond to levels of PCO2 greater than 30 torr -
      a. As PCO2 rises, impulses increase -
   3. Minor role in regulation - 20 to 30% as opposed to central chemoreceptors -
   4. Sensitivity to PCO2 increases during hypoxemia -

E. Hydrogen ions
   1. I.V. injection of acid causes hyperventilation -
   2. Changes in (H+) has less effect than changes in PaCO2 -
   3. Acidosis causes stimulation when peripheral chemoreceptors
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are deinnervated

F. Lack of oxygen
   1. hypoxia stimulates ventilation -
   2. hypoxic levels -
   3. hyperventilation caused by hypoxia is more affected by low PO2 than low O2 saturation
      a. high altitude -
      b. CO intoxication -
   4. hypoxia stimulates breathing only through peripheral chemoreceptors
      a. hypoxia has central depressant effect
      b. hypoxia stimulates respiration only if peripheral chemoreceptors are intact

II. Hypoxia
   A. Definitions
      1. hypoxia -
      2. anoxia -
      3. hypoxemia -
      4. histohypoxia -
   B. Classification of hypoxia -
      1. circulatory hypoxia (stagnant hypoxia)
         a. reduced blood flow -
         b. caused by -
         c. may occur during severe muscular exercise -
         d. arterial blood may be normal, venous blood has low PO2 an O2 content
         e. capacity to carry oxygen is normal
      2. pulmonary hypoxia (hypoxic hypoxia)
         a. both arterial and venous PO2 and O2 are low
         b. blood oxygen capacity is normal -
         c. caused by -
         d. seen at high altitudes or asphyxia
      3. hematologic hypoxia (anemic hypoxia)
         a. PaO2 is high but O2 low
         b. arteriovenous PO2 difference is increased -
         c. causes of anemic hypoxia -
      4. dysmetabolic hypoxia (histotoxic hypoxia)
         a. cells are unable to use O2 due to metabolic derangement -
         b. PO2 and content are high in arterial and venous blood
         c. hypometabolism (hypoxidation) -
   C. Effects of hypoxia -
      1. fulminating hypoxia - sudden removal of O2 from inspired air
         a. explosive decompression -
         b. rapid loss of consciousness and collapse -
      2. acute hypoxia - relatively rapid loss of O2 -
         a. cortical depression may give false sense of well being -
         b. progression of acute hypoxia -
         c. usually there is an increase in ventilation, heart rate, and blood pressure
      3. chronic hypoxia - long term exposure
         a. loss of reserve
         b. polycythemia may result -
D. Cyanosis -
1. caused by an increase in the amount of reduced hemoglobin (Hb)-
2. 5 g of reduced Hb per 100 ml of blood causes cyanosis
3. suggests a high probability of tissue hypoxia -
4. may indirectly be the result of polycythemia -
5. cyanosis does not always mean tissue hypoxia -
6. central cyanosis -
7. peripheral cyanosis -