PH - Lecture notes
02/03/11

ACIDOSIS – production of H+

- TISSUE METABOLISM...12 500meq/d CO_2
- LIVER utilization of AMA for gluconeogenesis H_2SO_4, H_3PO_4 a major H^+ load ..... 50 meq/day
- STRENUOUS EXERCISE .....lactic acid
- DIABETES MELLITUS ..... ketoacidosis
- INGESTION OF ACIDS, DIARRHOEA
- FAUILURE OF KIDNEY

ALKALOSIS

- Vomit
- Fruits, vegetables

Consequence of pH disturbances

- Change of tertiary and quaternary structure of proteins
- ↓ of activity of enzymes
- changes in permeability of membranes
- changes in distribution of electrolytes

Regulation of pH of body fluids

- Buffer systems... immediately, small capacity
- Lungs... co_2 ...quickly, limited capacity
- Kidney... H^+, HCO_3^- .slowly, high capacity

BUFFERS – BUFFER CAPACITY OF BLOOD

- BUFFER- weak acid
- The Henderson-Hasselbalch equation

HA <=> H^+ + A^-

<= + H^+ added strong acid

=> + OH^- added strong base (H^+ bound to water)

Relative acidity of weak acids is expressed by dissoc. constant

- Negative logarithm of d.const. is pK ...it is pH, at which concentration of H^+ and undissociated molecules equals

pH = pK + log $[A^-]/[AH]$

The highest buffering capacity if pH =pK

buffer capacity of blood - 48mmol/l

BUFFERS IN BLOOD

- Plasma proteins dissociate

Free carboxyl: R-COOH <=> $R\text{-}COO^-$ + H^+

Free aminogroups: $R\text{-}NH_3^+$ <=> $R\text{-}NH_2$ + H^+

- Hemoglobin (histidin residua)

Buffering capacity 6x ↑ than that of proteins

Hb is weaker acid than HbO_2 =>

Hb is better buffer than HbO_2 (↓buffering capacity in lungs – easier release of CO_2...opposite effect in tissue helps binding CO_2)

- Phosphates $H_2PO_4^-$ <=> HPO_4^{2-} + H+
- Bicarbonate system HCO_3^- + H^+

$$CO_2 + H_2O \rightleftharpoons H_2CO_3 \rightleftharpoons H^- + HCO_3$$
$$CO_2 + H_2O \rightleftharpoons H^- + HCO_3$$

Equation 27–15

Moreover, we can define a dissociation constant for this pseudo-equilibrium:

$$K = \frac{[H^+][HCO_3^-]}{[CO_2]}$$

Equation 27–16

In logarithmic form, this equation becomes:

$$pH = pK + \log \frac{[HCO_3^-]}{[CO_2]}$$

Equation 27–17

Finally, we may express $[CO_2]$ in terms of P_{CO_2}, recalling from Henry's Law that $[CO_2] = s \cdot P_{CO_2}$:

$$pH = pK + \log \frac{[HCO_3^-]}{s \cdot P_{CO_2}}$$

Equation 27–18

This is the **Henderson-Hasselbalch** equation, a loga-

DISTURBANCES OF ACID/BASE BALANCE

Physiologic value		metabolic		respiratory	
		acidosis	alkalosis	acidosis	alkalosis
HCO_3^-	20	HCO_3^-	HCO_3^-	HCO_3^-	HCO_3^-
CO_2	1	CO_2	CO_2	CO_2	CO_2

Compensation hyper/hypo ventilation kidney excreation

HCO_3^- HCO_3^- HCO_3^- HCO_3^-

CO_2 CO_2 CO_2 CO_2

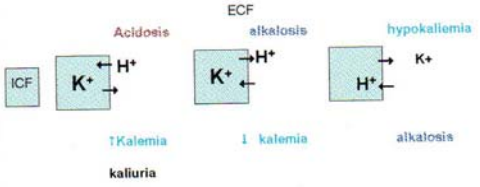
COMPENSATION OF ACIDOSIS

- NEAD OF $NaHCO_3$ mmol/l: BE*0,3*WEIGHT
- Isotonic solution 1,39 % (0,167mol/l)

½ of amount needed, new measurement, (examination of K+)

ACIDOBASIC BALANCE AND MOVEMENT OF K^+ BETWEEN ECF AND ICF

PLASMATIC CONCENTRATION 3.5 – 5.3 mmol/l



↑Kalemia ↓ kalemia alkalosis

kaliuria

Dependence of kaliemie on pH - at a constant total content of K+

pH	7.2	7.4	7.6	
K^+	4.9	4.0	3.2	mmol/l
	6.2	5.0	3.8	
	7.3	6.0	4.5	

Physiologic PLASMATIC CONCENTRATION 3.5 – 5.3 mmol/l

METABOLIC ACIDOSIS

- CAUSES

↑Production of acids (diabetes, loss of weight, anaerobic glycolysis)

Loss of bicarbonate (diarrhea, inhibitors of carbonic anhydrase)

Intake of acids

Renal failure of acid secretion

- RESPIRATORY COMPENSATION

H^+ is bound ($H^+ + HCO_3^- \rightarrow H_2O + CO_2$)

EXSPIRATION (Kussmaul respiration)– ALKALIC RESERVE DECREASES

METABOLIC ALKALOSIS

- CAUSES

Loss of H^+ (vomit, deficiency of K^+)

Intake of bases

Production of bases (oxidation of lactate)

- RESPIRATORY COMPENSATION is limited – hypoventilation - hypoxia + CO_2 – stim of respiration
- EXCRETION of BICARBONATE by KIDNEY
- ↑pH→↓Ca^{++}→tetany

RESPIRATORY ACIDOSIS

- CAUSES

↓Ventilation (barbiturates)

Reduction of lung's tissue

- H^+ BUFFERED BY NONBICARBONATE BUFFERS
- EXCRETION of H^+ ($NH4^+$) by KIDNEY lag by 1-2 days

RESPIRATORY ALKALOSIS

- CAUSES

hyperventilation (hypoxia, psychiatric)

- H^+ RELEASED BY NONBICARBONATE BUFFERS
- EXCRETION of BIKARBONATE by KIDNEY

- First aid - quieting, rebreathing