Interpretation of ABG

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ABG analysis of Ms Rubi

- Ms. Rubi, 20 year-old lady presented with breathlessness. She had ingested few strips of tablets from her fathers table.

PH	7.29
HCO3	14 mmol/L
PCO2	24

ABG analysis of Ms Rubi

- PH 7.29
- Low HCO3
- Metabolic acidosis
- Expected PCO2=

(HCO3+15)± 2 =(14+15)±2=27-31

- More than measured
- Respiratory Alkalosis
- Dx: Metabolic acidosis with respiratory alkalosis

PH	7.29
HCO3	14 mmol/L
PCO2	24

ABG analysis of Mr Razu

- Mr. Razu 46 year-old, a garment worker from Ashulia presented in the late night with headache and dyspnea & h/o exposure to smoke in a closed room while a fire broke out in his office.

pH	7.43
PaO2	**80 mm Hg**
PaCO2,	**38** mm Hg
SaO2 *(calculated from Oxy-haemoglobin dissociation curve*	97%

ABG analysis of Mr Razu

- Few hours later Mr. Razu presented with confusion again.
- ABG analysis this time.

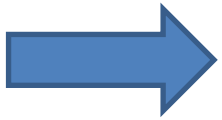
pH	***7.36***
PaO2	***79 mm Hg***
PaCO2,	***32****mm Hg*
SaO2 measured	56%
COHb	46%

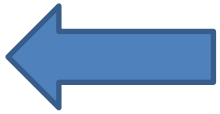
Why ABG

- Aids in establishing a diagnosis
- Helps guide treatment plan
- to evaluate the adequacy of ventilatory (PacO2) acid-base (pH and PaCO2), and oxygenation (PaO2 and SaO2) status, and the oxygen-carrying capacity of blood.
- To quantify the patient's response to therapeutic intervention
- To monitor severity and progression of a documented disease process

ABG INFORMS ..

- Assessment of Oxygenation
  &
- ventilatory Status



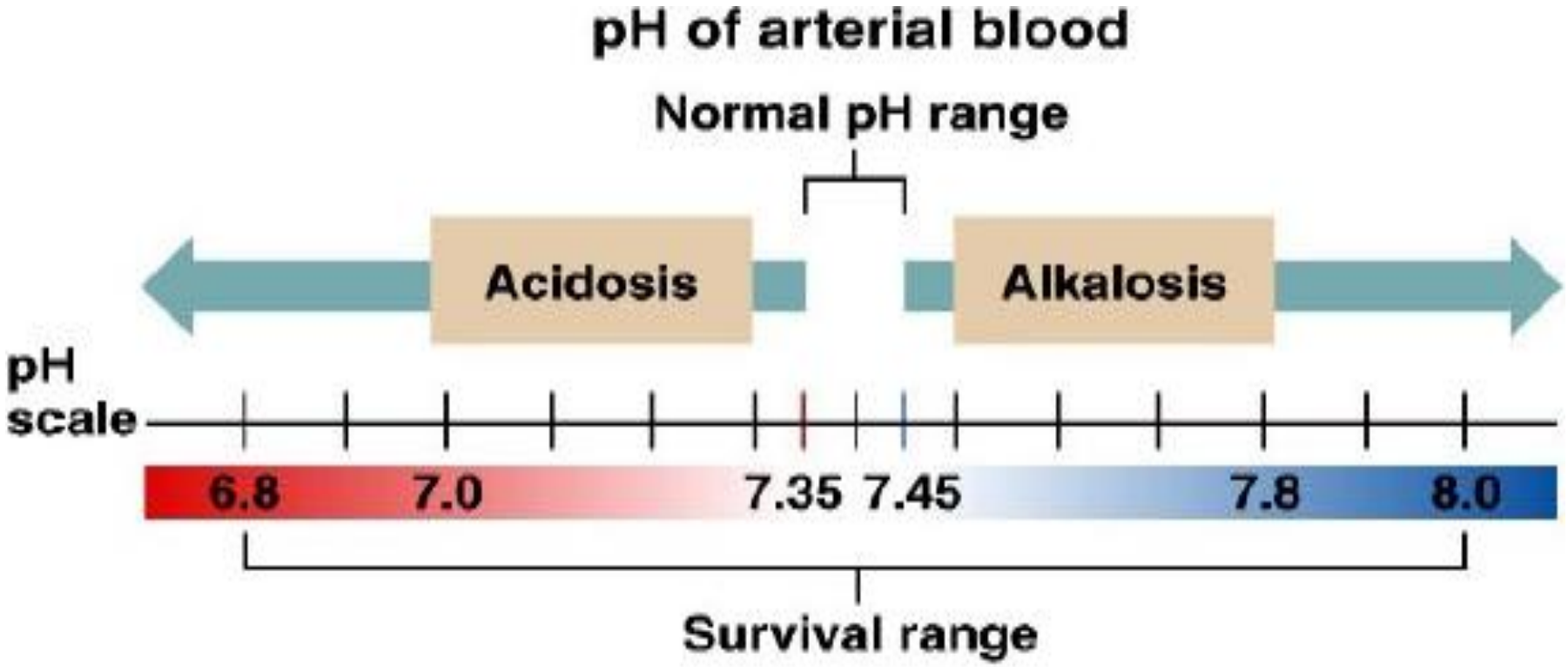


- Assessment of Acid-Base Status

Most important component

- pH
- PaCO2
- HCO3
- PaO2

- acids are produced in the body everyday
- the hydrogen ion concentration of body fluids is small (0.0004mmol/L
- This is maintained within a narrow range to ensure optimum cellular and enzymatic function


pH of arterial blood
Normal pH range
Acidosis
Alkalosis
pH
scale
6.8
7.0
7.35
7.45
7.8
8.0
Survival range

‘Imagine there were no buffer..’

- If add 12 mM H+ to closed system

  –No Respiration

  – [CO2] = 13.2, [HCO3] = 12, pH = 6.06: **lethal**

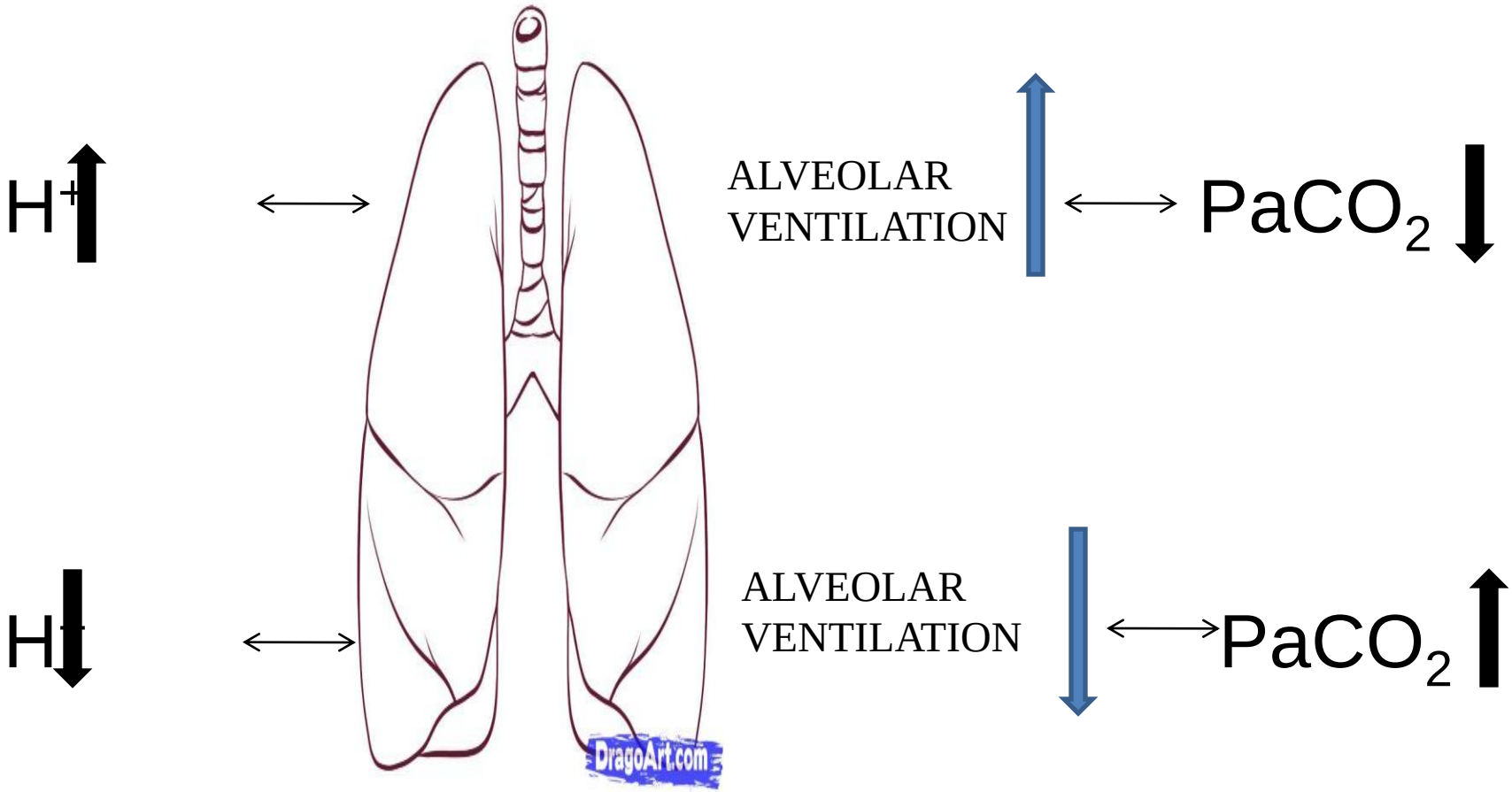
- If add 12 mM H+ to body

  Body is open through lungs, all extra CO2

  expelled

- [CO2] = 1.2, [HCO3] =12, pH = 7.1

Respiratory Regulation of Acid Base Balance



Kidneys control the acid-base balance by excreting either an acidic or a basic urine

Reabsorption of HCO_3 in blood

Secretion of H^+ ions in tubules and excretion

PCO2 in ECF

H+ ion

ECF Volume

K+

Aldosterone

Angiotensin II

- Proximal Convulated Tubules (85%)
- Thick Ascending Limb of Loop of Henle (10%)
- Distal Convulated Tubule
- Collecting Tubules(5%)

Blood Gas Report

----- XXXX Diagnostics ------

Blood	Gas	Report
248	05:36	Jul 22 2000
Pt ID	2570 / 00	

Measured	37.0° C	
pH	7.463	
pCO_2	44.4	mm Hg
pO_2	113.2	mm Hg

Corrected	38.6° C	
pH	7.439	
pCO_2	47.6	mm Hg
pO_2	123.5	mm Hg

Calculated Data		
HCO_3 act	31.1	mmol / L
HCO_3 std	30.5	mmol / L
BE	6.6	mmol / L
O_2 CT	14.7	mL / dl
O_2 Sat	98.3	%
ct CO_2	32.4	mmol / L
pO_2 (A - a)	32.2	mm Hg
pO_2 (a / A)	0.79	

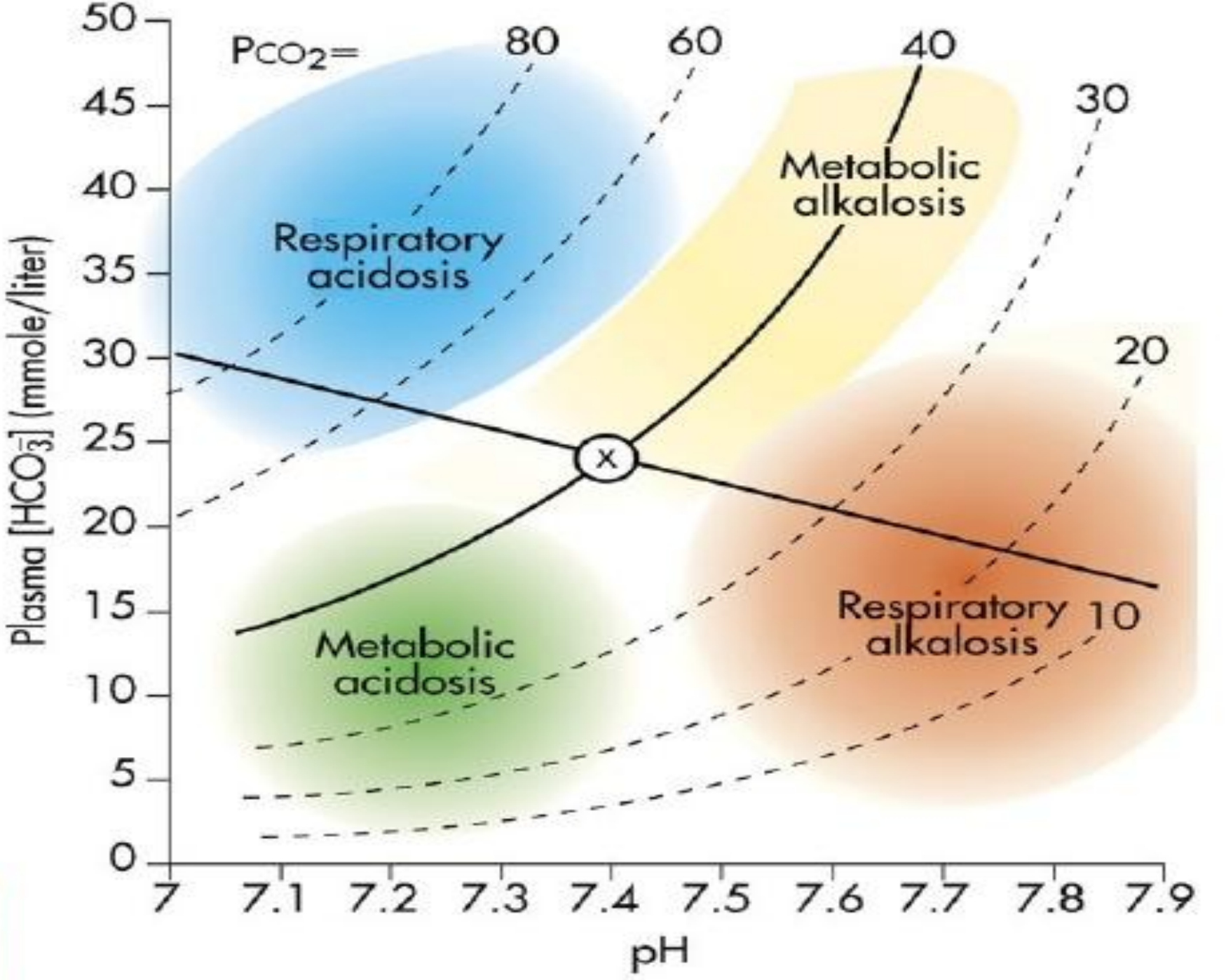
Entered Data		
Temp	38.6	°C
ct Hb	10.5	g/dl
FiO_2	30.0	%

Measured Values : most important

Temperature Correction:

Calculated Data:

Entered Data:


PCO2=
80
60
40
30
20
10
Respiratory acidosis
Metabolic alkalosis
Metabolic acidosis
Respiratory alkalosis
X
Plasma [HCO3-] (mmole/liter)
50
45
40
35
30
25
20
15
10
5
0
7
7.1
7.2
7.3
7.4
7.5
7.6
7.7
7.8
7.9
pH

STEP WISE APPROACH
to
Interpretation Of
ABG reports

Six steps logical approach originally proposed by Narins and Emmett (1980) and modified by Morganroth in 1991

STEP 1 **ACIDEMIA OR ALKALEMIA?**

Look at pH

ph		
< 7.35	7.35-7.45	> 7.45
Acidosis	Normal or Compensated	Alkalosis

An acid base abnormality may be present even if either the pH or PCO2 are Normal.

STEP 2 **RESPIRATORY or METABOLIC?**

Look at the PaCO2 to look at the Respiratory Mechanism

PaCO2		
< 35	35 -45	> 45
• Tends toward alkalosis • Causes high pH • Neutralizes low pH	Normal or Compensated	• Tends toward acidosis • Causes low pH • Neutralizes high pH

STEP 2 **RESPIRATORY or METABOLIC?**

- **HCO_3 to look at the Metabolic Mechanism**

HCO_3		
< 22	22-26	> 26
• Tends toward acidosis • Causes low pH • Neutralizes high pH	Normal or Compensated	• Tends toward alkalosis Causes high pH • Neutralizes low pH

STEP 2 **RESPIRATORY or METABOLIC?**

IS PRIMARY DISTURBANCE RESPIRATORY OR METABOLIC?

↑ pH ↑ PCO_2 or ↓ pH ↓ PCO_2

METABOLIC

↑ pH ↓ PCO_2 or ↓ pH ↑ PCO_2

RESPIRATORY

If either the pH or PCO_2 is Normal, there is a mixed metabolic and respiratory acid base disorder.

STEP 3

RESPIRATORY- **ACUTE/CHRONIC?**

IF RESPIRATORY, IS IT ACUTE OR CHRONIC?

Acute respiratory disorder - $\Delta \mathbf{pH_{(e\text{-}acute)}} = \mathbf{0.008 \times (Pco_2 - 40)/10}$

Chronic respiratory disorder - $\Delta \mathbf{pH_{(e\text{-}chronic)}} = \mathbf{0.003x (Pco_2 - 40)/10}$

Compare, $pH_{measured}$ (pH_m) v/s $pH_{expected}$ (pH_e)

$\mathbf{pH_{(m)} = pH_{(e\text{- }acute)}}$	$\mathbf{pH_{(m)}}$ = **between** $\mathbf{pH_{(e\text{- }acute)}}$ & $\mathbf{pH_{(e\text{- }chronic)}}$	$\mathbf{pH_{(m)} = pH_{(e\text{-}chronic)}}$
ACUTE RESPIRATORY DISORDER	PARTIALLY COMPENSATED	CHRONIC RESPIRATORY DISORDER

STEP 4 **ADEQUATE COMPENSATION?**

IS THE COMPENSATORY RESPONSE ADEQUATE OR NOT?

➢METABOLIC DISORDER ⟶ **$PCO_{2expected}$**

$PCO_2measured \neq PCO_2expected$ ⇨ MIXED DISORDER

➢RESPIRATORY DISORDER ⟶ **$pH_{expected\ acute\text{-}chronic}$**

$pH_m \neq pH_e$ range ⇨ MIXED DISORDER

Compensation…The Rules

- The body always tries to normalize the pH so… **CO2 and HCO3 should rise and fall** together in simple disorders
- **Compensation never overcorrects the pH**
- Lack of compensation within an appropriate time interval defines a 2nd disorder
- Compensatory responses require normally functioning lungs and kidneys

STEP 5 Calculate the anion gap **?**

Calculate the anion gap if it is more there is Metabolic acidosis

$$AG = [Na+K] - [Cl- + HCO3-]$$

$$12 \pm 2$$

Acidosis

High Anion gap :

- Keto-acidosis
- Uremia/Renal failure
- Salicylate/Aspirin poisoning
- Starvation ketosis
- Methanol poisoning
- Alcohol
- Uremia
- Lactic acidosis
- Ethylene glycol poisoning

Normal anion gap

- GI loss
- RTA

STEP 6

Metabolic : does it coexist with non anion gap acidosis**?**

CorrectedHCO3= measured HCO3+(anion gap-12)

If the patient has HCO3 15 and anion gap 26

Corrected HCO3 29

Higher than 24 so, metabolic alkalosis coexist

Mixed Acid-base Disorders

- In chronically ill respiratory patients, mixed disorders are probably more common than single disorders, e.g., RAc + MAlk, RAc + Mac, Ralk + MAlk.
- In renal failure (and other conditions) combined MAlk + MAc is also encountered.
- **Clues to a mixed disorder:**
  - Normal pH with abnormal HCO_3 or CO_2
  - $PaCO_2$ and HCO_3 move in opposite directions
  - pH changes in an opposite direction for a known primary disorder

ABG analysis of Ms Salma

- A 25 year-old gentle lady presented with sudden breathlessness and tingling and numbness around mouth.

P^H	7.52
$PaCO_2$	32mm
HCO_3	22mmol/L
PaO2	90

ABG analysis of Ms Salma

- Alkalosis
- PaCO2 is low
- HCO3 is low
- Respiratory Alkalosis
- Expected HCO3

24-(40-32)X 0.2= 22.4

Within normal

- Respiratory Alkalosis with partial compensation

P^H	7.52
$PaCO_2$	32mm
HCO_3	22mmol/L
PaO2	90

ABG analysis of Mr. Salam

Mr. Salam presented with breathlessness for 2 months. He is smoker and suffers from chronic cough. On examination there was B/L expiratory rhonchi

P^H	7.25
PCO2	60mm
PO2	76mm
HCO3	32mmol/L
SaO2	89%

Cont.

ACIDEMIA

- Low pH high PCO_2
- Respiratory
- Expected HCO3

  24+(60-40) X 0.4=32

  Within measured range

  Primary Respiratory Acidosis,

  partially compensated

PH	7.25
PCO2	92mm
PO2	76mm
HCO3	21mmol/L
SaO2	89%

- Thank you

BASE EXCESS

- BE is the amount of acid or base needed to return a sample of whole blood to normal pH 7.4 under standard conditions of Pco2 [40] , Po2 [100] and temp of 37c .

Basic terminology

- • **pH – signifies free hydrogen ion concentration. pH is inversely**
- related to H+ ion concentration.
- • **Acid – a substance that can donate H+ ion, i.e. lowers pH.**
- • **Base – a substance that can accept H+ ion, i.e. raises pH.**
- • **Anion – an ion with negative charge.**
- • **Cation – an ion with positive charge.**
- • **Acidemia – blood pH< 7.35 with increased H+ concentration.**
- • **Alkalemia – blood pH>7.45 with decreased H+ concentration.**
- • **Acidosis – Abnormal process or disease which reduces pH due to**
- increase in acid or decrease in alkali.
- • **Alkalosis – Abnormal process or disease w**

disturbance	response	Expected changes
Respiratory acidosis		
acute	HCO3 ↑	1mEq/L/10 mm of Hg inc .in Paco2
chronic	HCO3 ↑	4mEq/L/10 mm of Hg inc .in Paco2
Respiratory alkalosis		
acute	HCO3 ↓	2mEq/L/10 mm of Hg dec .in Paco2
chronic	HCO3 ↓	4mEq/L/10 mm of Hg dec .in Paco2
Metabolic acidosis	PPaco2 ↓	1.2 x the decrease in HCO3
Metabolic alkalosis	Paco2 ↑	0.7 x the increase in HCO3