Arterial Blood Gas Analysis

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Arterial Blood Gas

- Drawn from artery- **radial, brachial, femoral**
- It is an invasive procedure.
- **Caution** must be taken with patient on anticoagulants
- The Allen test for blood flow
- The Buffers , lungs and kidneys attempt to maintain balance

Compensatory measures

Buffering---occurs immediately

Respiratory regulation of pCO_2 is intermediate (12-24 hours)

Renal regulation of [H] and $[HCO_3]$ occurs more slowly (several days)

روش انجام تست آلن قبل از سوراخ کردن شریان رادیال

- این روش برای بیمار توضیح داده می شود، از جمله اینکه هدف آن ارزیابی گردش خون تضمین شده است.
- فشار روی شریان اولنار و رادیال به طور همزمان اعمال می شود.
- از بیمار خواسته می شود دست را به طور مکرر باز و بسته کند.
- فشار از شریان اولنار آزاد می شود و شریان رادیال را فشرده نگه میداریم.
- رنگ اندام دیستال به نقطه فشار، ارزیابی می شود. اگر جریان از طریق شریان اولنار خوب باشد، فلاشینگ بلافاصله مشاهده می شود. سپس تست آلن مثبت می شود و می توان از شریان رادیال برای سوراخ کردن استفاده کرد .

ABG Analysis

- **Important assessed:**

1. oxygenation status

arterial gases only

2. acid-base status
3. compensation

Hypoxemia (pao2)

Is low oxygen levels in arterial blood (Pao2) is below normal (normal Pao_2 = **80–100mmHg**)

Hypoxia(sao2)

is low oxygen levels in your tissues(oxygen saturation)

This is a measure of how much oxygen is being carried by hemoglobin on your red blood cells. Normal values for oxygen saturation are **between 95 and 100 percen**

Acid – Base Balance

Lungs

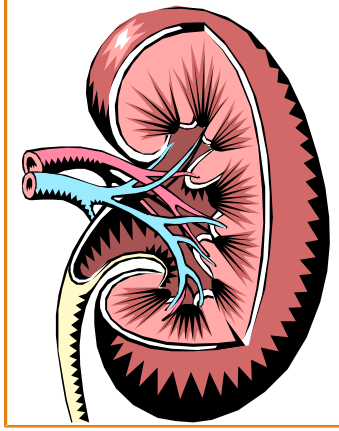
Respiratory

CO_2 (acid)

Kidneys

Metabolic

HCO_3 (base/alkaline)



Interpretation: 4 steps

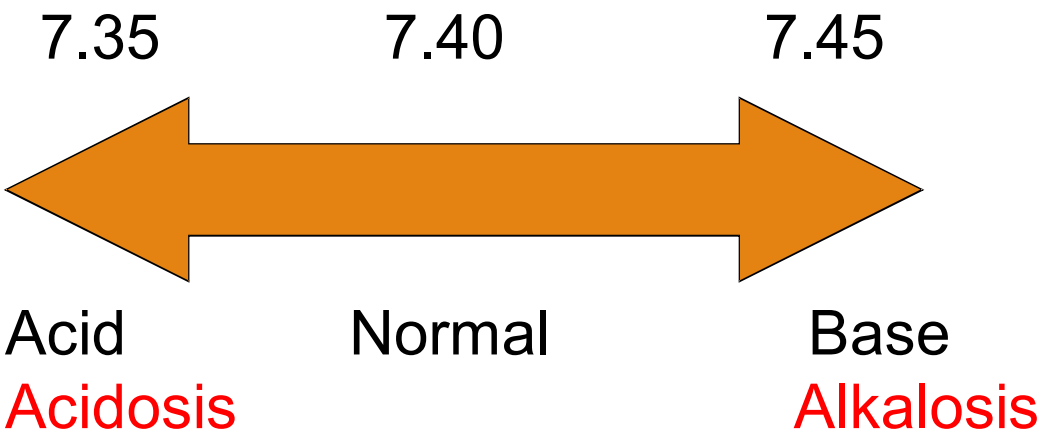
Normal Values

pH	7.35 – 7.45
pCO2	35 – 45 mmHg
HCO3	22 - 26 mEq/L

Evaluate each component as Acid or Base

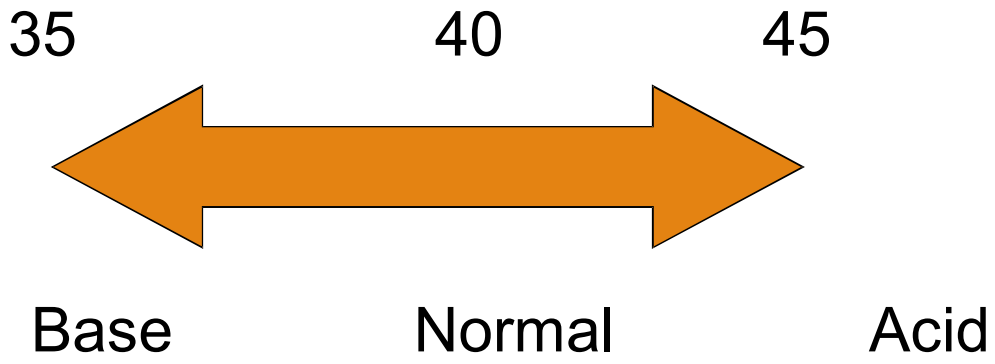
Step 1

Evaluate pH and determine acidosis or alkalosis



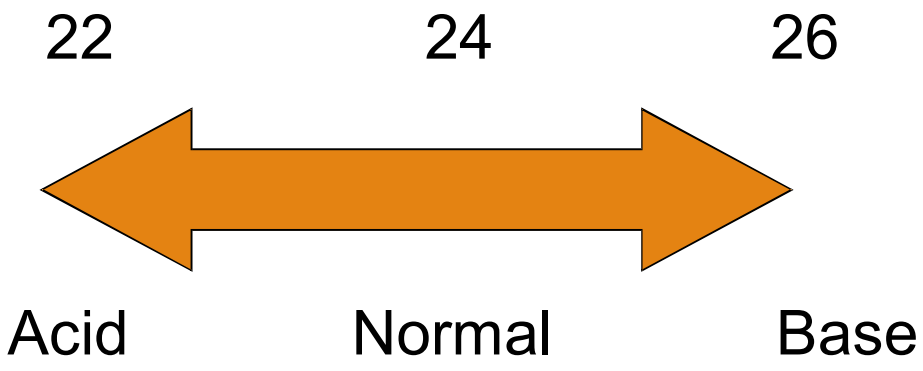
Step 2…

- Evaluate pCO_2 (respiratory)



Step 3…

Evaluate HCO_3 (metabolic)



Step 4…

Compensation

When an acid – base imbalance exists, over time the body attempts to compensate.

Uncompensated

the alternate system has not attempted to adjust

pH abnormal and one other abnl

Example

- pH 7.30 ABNL
- pCO2 60 ABNL
- HCO3 25 N

Uncompensated Respiratory Acidosis

Partial Compensation

the alternate system is trying to create a balanced , but hasn't yet succeeded

All 3 abnormal.

Example

- pH 7.34 ABNL
- pCO2 59 ABNL
- HCO3 28 ABNL

Partially Compensated Respiratory Acidosis

Fully Compensated

the alternate system has adjusted enough to restore balance

and normalize the pH

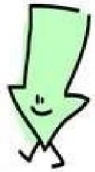
PH Nl but others both Abnl

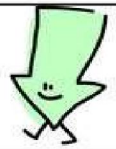
Example

- pH 7.36 N (but slightly A)
- pCO2 58 ABNL
- HCO3 31 ABNL

Compensated Respiratory Acidosis

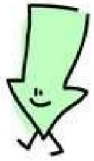
EXAMPLE #1

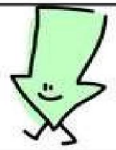
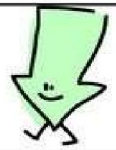
- pH: 7.22 
- $PaCO_2$: 55 
- HCO_3: 25

	pH	$PaCO_2$	HCO_3
Respiratory Acidosis			Normal

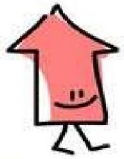
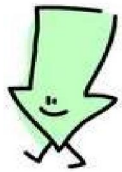
EXAMPLE #2

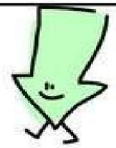
- pH: 7.31
- PaCO2: 35
- HCO3: 20



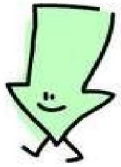
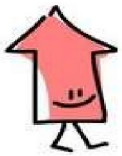
	pH	$PaCO_2$	HCO_3
Metabolic Acidosis		Normal	

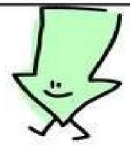
EXAMPLE #3

- pH: 7.49 
- $PaCO_2$: 30 
- HCO_3: 23

	pH	$PaCO_2$	HCO_3
Respiratory Alkalosis			Normal

EXAMPLE #1 (COPD PTS)

- pH: 7.31 
- $PaCO_2$: 55 
- HCO_3: 28 

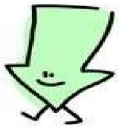
	pH	$PaCO_2$	HCO_3
Partially Compensated Respiratory Acidosis			

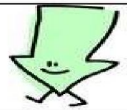
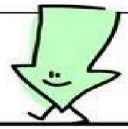
EXAMPLE #2 (Kidney Issues)

- pH: 7.31
- $PaCO_2$: 25
- HCO_3: 20

	pH	$PaCO_2$	HCO_3
Partially Compensated Metabolic Acidosis			

EXAMPLE #3 (Anxiety)

- pH: 7.48 
- $PaCO_2$: 25 
- HCO_3: 21 

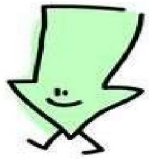
	pH	$PaCO_2$	HCO_3
Partially Compensated Respiratory Alkalosis			

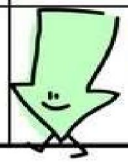
EXAMPLE #4 (NG drainage/vomiting)

- pH: 7.48 
- $PaCO_2$: 55 
- HCO_3: 31 

	pH	$PaCO_2$	HCO_3
Partially Compensated Metabolic Alkalosis			

EXAMPLE #5

- pH: 7.39 Normal 
- $PaCO_2$: 60 
- HCO_3: 30 

	pH	$PaCO_2$	HCO_3
Fully Compensated Respiratory Acidosis	 N		

Respiratory Acidosis

failure of the lungs(Excessive CO_2 retention)

ph ↑ pco2 ↓ Ventilation

- pH < 7.35
- PCO_2 > 45

Causes

Hypoventilation due to

- Respiratory Disease(COPD /asthma..)
- CNS depression(OPIOID)
- Neuromuscular disorders(Myasthenia gravis)
- Depression of respiratory system

Sedatives, analgesics

- Head trauma

Signs and Symptoms

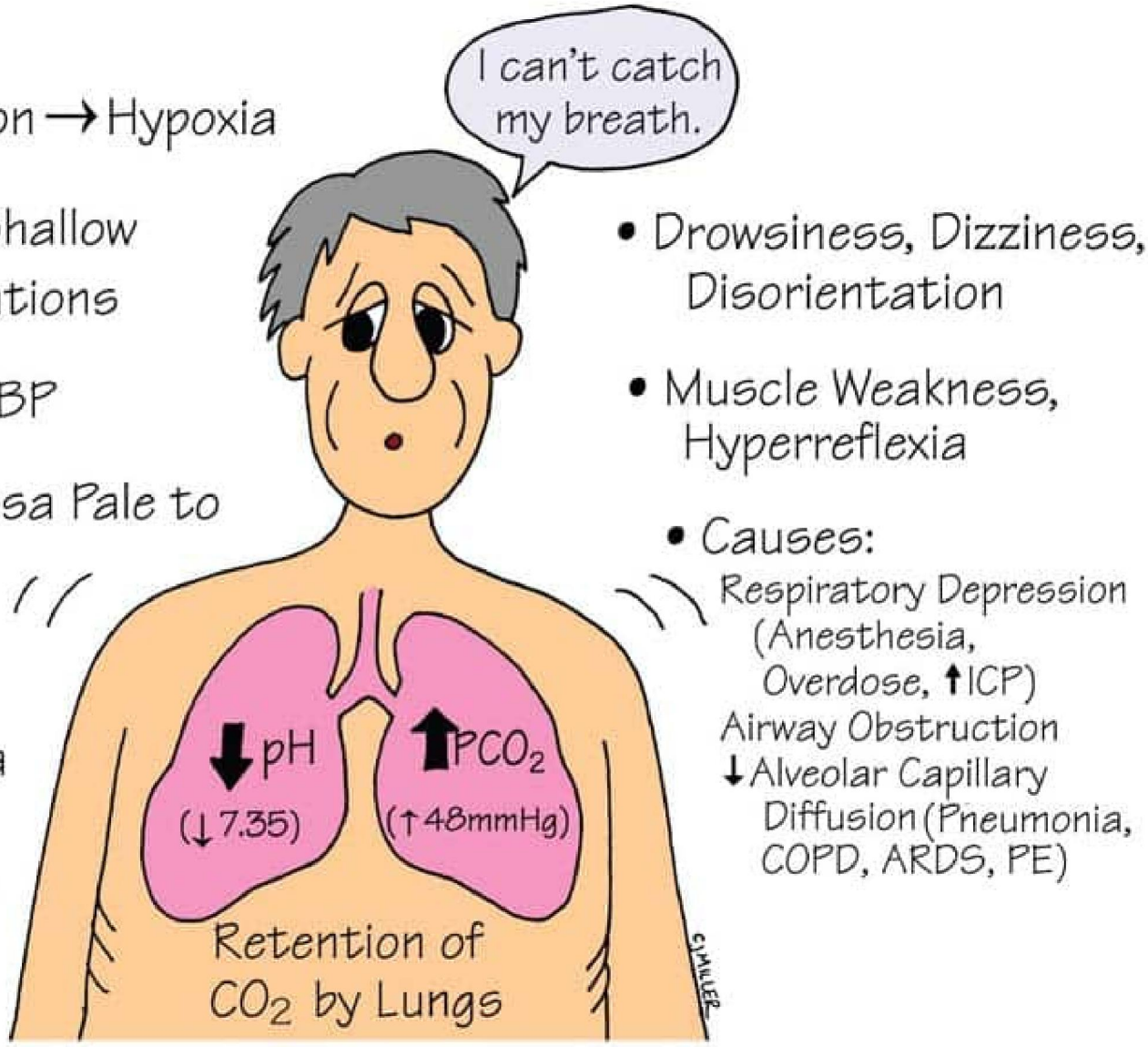
- CNS disturbances: restlessness, confusion, tremor and coma.

- Headache
- Dyspnea
- Tachypnea
- Dysrhythmia
- Weakness

Interventions in Respiratory Acidosis

- Check airway and ensure patent
- Place in semi-Fowler's position
- mechanical ventilation to increase rate and tidal volume
- Non-invasive ventilation
- Avoid Opiates
- Bronchodilators
- Drain effusions
- Treat infections

RESPIRATORY ACIDOSIS



- Hypoventilation → Hypoxia
- Rapid, Shallow Respirations
- ↓ BP
- Skin/Mucosa Pale to Cyanotic
- Headache
- Hyperkalemia
- Dysrhythmias (↑K^+)
- Drowsiness, Dizziness, Disorientation
- Muscle Weakness, Hyperreflexia
- Causes:
  - Respiratory Depression (Anesthesia, Overdose, ↑ICP)
  - Airway Obstruction
  - ↓Alveolar Capillary Diffusion (Pneumonia, COPD, ARDS, PE)

Metabolic Acidosis

- failure of kidney function

↓pH ↓HCO3

- pH < 7.35
- HCO_3 < 22

Causes

- renal failure
- diabetic ketoacidosis(DKA)
- Hyperglycaemia
- excessive diarrhea
- Shock

Signs and Symptoms

- headache
- confusion
- weakness
- increased respiratory rate and depth
- nausea and vomiting
- diminished cardiac output with pH below 7, which results in

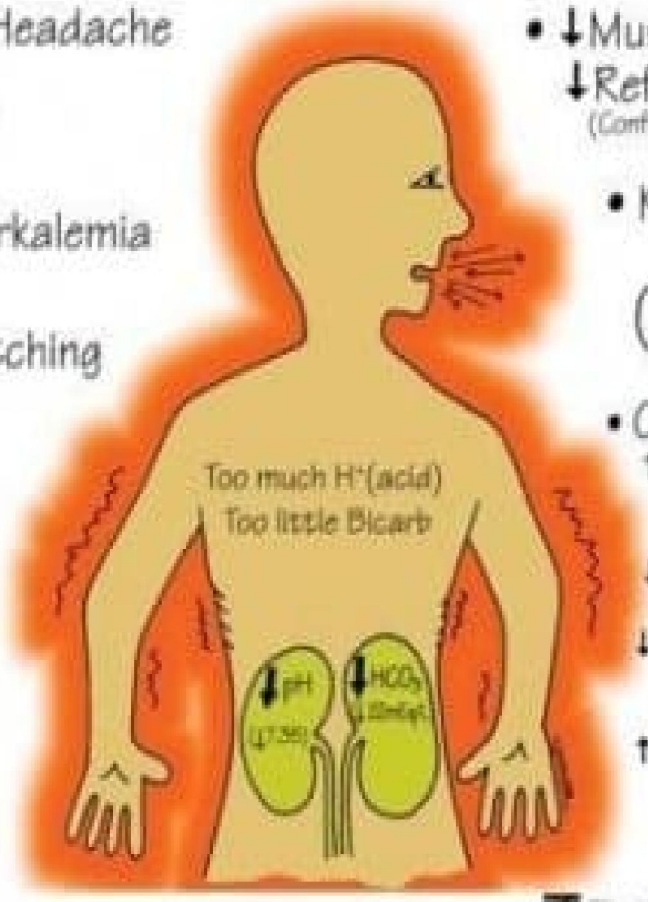
hypotension, cold clammy skin and cardiac arrhythmias.

Interventions inMetabolic Acidosis

- Shock support blood pressure
- Assess LOC
- Provide seizure or coma precautions and bed in low position, use of side rails, frequent observation.
- Monitor serum electrolytes, especially potassium
- Keep sodium bicarbonate ampules handy for emergency administration.
- Hyperglycaemia give insulin
- Dehydration give fluids

METABOLIC ACIDOSIS

- Headache
- ↓BP
- Hyperkalemia
- Muscle Twitching
- Warm, Flushed Skin (Vasodilation)
- Nausea, Vomiting



- ↓Muscle Tone, ↓Reflexes (Confusion, ↑Drowsiness)
- Kussmaul Respirations (Compensatory Hyperventilation)
- Causes:
  - ↑H+ Production (DKA, hyper-metabolism)
  - ↓H+ Elimination (renal failure)
  - ↓HCO_3 Production (dehydration, liver failure)
  - ↑HCO_3 Elimination (diarrhea, fistulas)

METABOLIC ACIDOSIS

PH

↓ HCO_3 (Bicarbonate)

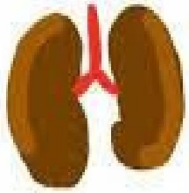
Gastro intestinal Tract

Eg: Small bowel diarrhoea

HCO_3 in diarrhoea > HCO_3 in plasma

HYPERCHLOREMIC METABOLIC ACIDOSIS

Renal



Carbonic anhydrase inhibitor

Proximal Renal Tubular acidosis

↑ ACIDS

Production or Accumilation of Acids

① uncontrolled diabetes
Starvation → Beta hydroxy butyrate, Acetoacetate

DIABETIC KETOACIDOSIS

② Hypotension / Hypoxia → Impaired O_2 delivery → Anaerobic metabolism → Lactic Acidosis

Carbon monoxide → Inhibition of oxidative phosphorylation → Anaerobic metabolism

Liver disease → Impaired Lactate clearance → Lactic Acidosis

Impaired excretion of Acids

① Renal failure
② Distal Renal Tubular acidosis
③ Hypoadrenocorticism

Respiratory Alkalosis

- too much CO_2 exhaled (hyperventilation)

↑ pH ↓ PCO2 ↑ Ventilation

- pH > 7.45
- PCO_2 < 35

Causes

Hyperventilation due to

- Anxiety
- Fever(metabolism- Hyperventilation)
- Pain(overstimulate resp center)
- Over ventilation
- Hypoxia (stimulate resp center)
- Aspirin overdose

Signs and Symptoms

- Shortness of breath.
- Dizziness.
- Confusion.
- Nausea.
- Hypo calcemia:Numbness and /or tingling in your fingertips, toes and lips.
  - Irritability.
  - **Muscle** spasms **or** twitching.

Interventions in Respiratory Alkalosis

- Reduce ventilation
- breathe into paper bag(re-breath CO_2).
- Encourage patient to breathe slowly and deeply. Speak in a low, calm tone of voice. Provide safe environment.

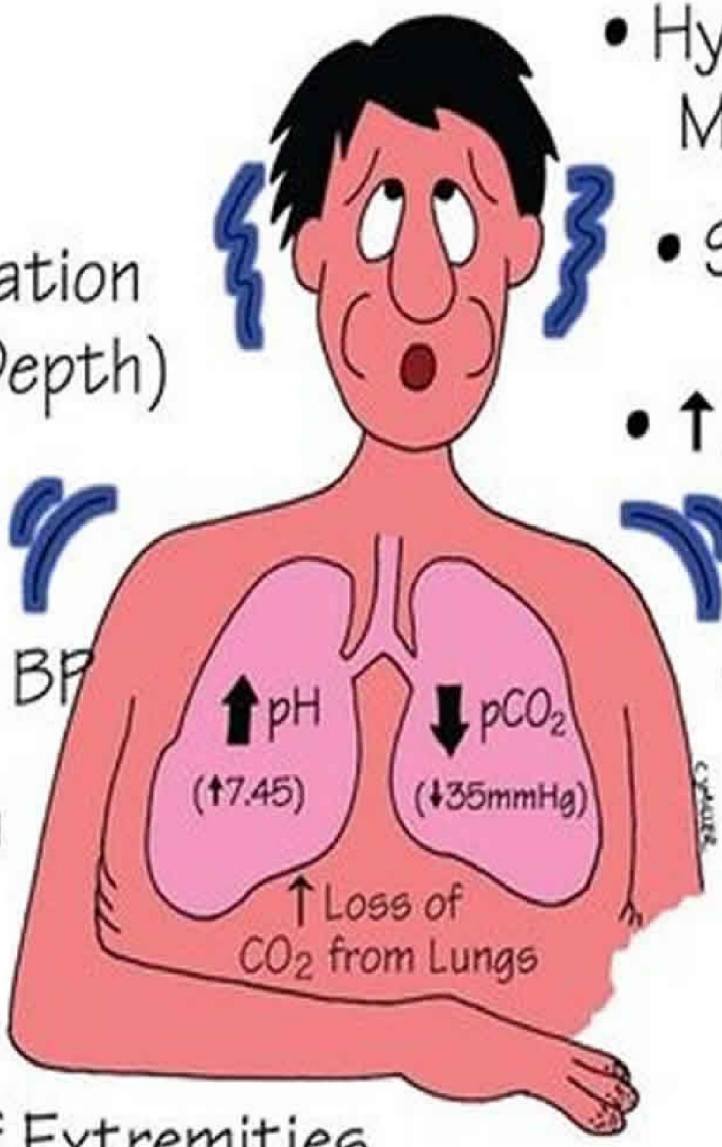
Treat pain and fever

reduce anxiety

Check for overdose and consider active charcoal/IV fluids

RESPIRATORY ALKALOSIS

- Hyperventilation (↑Rate & Depth)
- Tachycardia
- ↓or Normal BP
- Hypokalemia
- Numbness & Tingling of Extremities



- Hyper Reflexes & Muscle Cramping
- Seizures
- ↑Anxiety, ↑Irritablity
- Causes:
  Hyperventilation (Anxiety, PE, Fear)
  Mechanical Ventilation

Metabolic Alkalosis

- ↑ plasma bicarbonate
- ↑ PH ↑ HCO3

- pH > 7.45
- HCO_3 > 26

Causes

- ↑ loss acid from stomach or kidney
  - Vomiting
  - Excessive diuretics
  - hypokalemia
  - excessive alkali intake
  - Anorexia
  - Excessive ingestion of antacids

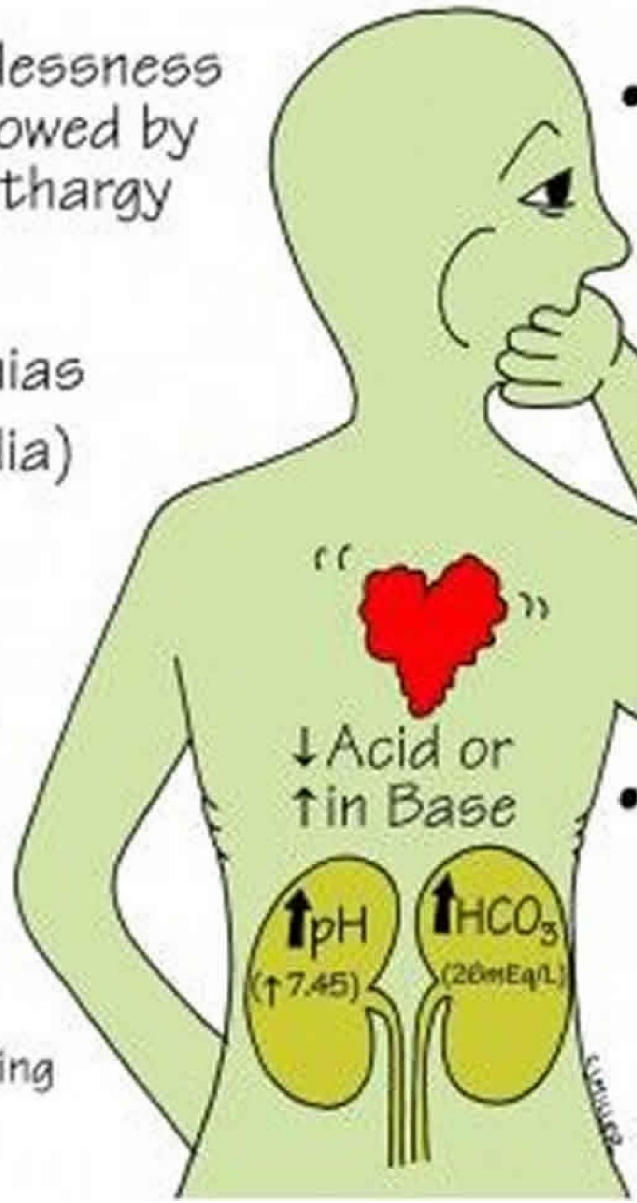
Signs and Symptoms

- Irritability.
- Muscle twitching.
- Muscle cramps.
- Muscle spasms.
- Fatigue.
- Confusion.
- Tremor.
- Tingling and numbness.
- Abnormal heart rhythm (arrhythmia).
- Seizures.
- Coma.

Interventions in Metabolic Alkalosis

- Vomiting give anti-emetics
- Avoid Diuretics
- Stop ingestion of antacids
- Observe seizure precautions .

METABOLIC ALKALOSIS



- Restlessness Followed by Lethargy
- Confusion (↓LOC, Dizzy, Irritable)
- Dysrhythmias (Tachycardia)
- Nausea, Vomiting, Diarrhea
- Compensatory Hypoventilation
- Tremors, Muscle Cramps, Tingling of Fingers & Toes
- Causes:
  - Severe Vomiting
  - Excessive GI Suctioning
  - Diuretics
  - Excessive $NaHCO_3$
- Hypokalemia

Respiratory Acidosis : pco2↑-PH↓	Metabolice Acidosis: HCO3↓ PH↓
✓ علت: • تجمع co2 • هایپوونتیله-RR↓ • نارکوتیک-آسم-آپنه-HT-COPD ✓ درمان: • O2-اینتوبه- • Increase in ventilator rate from	✓ علت: • دفع بیکربنات:اسهال • احتباس اسید:DKA • salicylate intoxication ✓ درمان: • سدیم بیکربنات • جبران با تنفس کوسمال(افزایش عمق و ریت تنفس)
Alk-Resp: : pco2↓-PH↑	**Alk-Meta: HCO3↑ PH↑**
❑ علت: • هایپرونتیلیشن-RR↑ • درد-اضطراب anxiety ❑ درمان:تنفس لب غنجه ای	❑ علت: • از دست دادن اسید معده:استفراغ شدید –ساکشن NG • antiacids ❑ درمان:ریه وارد عمل شده RR↓ و هایپوونتیله که باعث احتباس CO2و اسیدوز متابولیک میشود

ACID

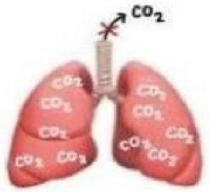
balance

BASE

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14

acidic — neutral — alkaline

respiratory acidosis



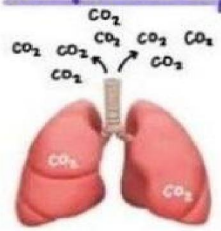
inability to breathe out CO_2 causes CO_2 buildup in the body

$\uparrow CO_2 = \downarrow pH$

acidic

examples:
- respiratory depression
- sleep dyspnea
- COPD
- asthma
- alcohol intoxication
- CNS depressants:
  - benzodiazepines
  - morphine
  - hydrocodone

respiratory alkalosis



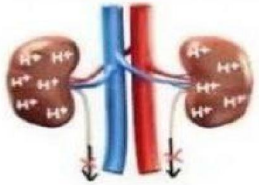
breathing out too much CO_2 means less CO_2 in the body

$\downarrow CO_2 = \uparrow pH$

alkaline

examples:
- hyperventilation
- panic
- anxiety
- pain

metabolic acidosis

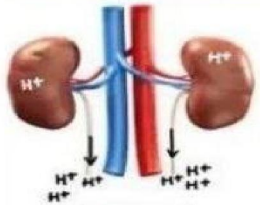


$\uparrow H^+$
$\downarrow HCO_3$

acidic

examples:
- diarrhea
- renal failure
- diabetic ketoacidosis

metabolic alkalosis



$\downarrow H^+$
$\uparrow HCO_3$

alkaline

examples:
- vomiting
- NG tube suctioning
- diuretics
- antacids

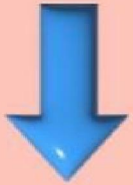
METABOLIC ACIDOSIS

VS

METABOLIC ALKALOSIS

Created by @nursebecsupplies

TOO MUCH
Acid in the body



TOO MUCH
Bicarbonate in the body

CAUSES*

- Kidney Disease
- DKA
- Severe Diarrhoea

SYMPTOMS*

Can be asymptomatic

- Tachycardia
- Fatigue
- Confusion
- Changes to breathing
- Appetite changes
- Nausea/vomiting

CAUSES*

- Medication such as diuretics
- Vomiting
- Hormonal Disorders

SYMPTOMS*

Can be asymptomatic

- Muscle twitching
- Tingling
- Nausea Vomiting
- Arrhythmias

*THIS LIST IS NOT EXHAUSTIVE. THIS IS NOT MEDICAL ADVICE

Problem 1:

ABGs: pH: 7.43

PaCO2: 28

HCO3: 18

Acid	Normal	Base
HCO3	pH	PaCO2

•PH: 7.43 (falls within 7.35-7.45) = NORMAL but is on the **alkalotic side**

•PaCO2: 28 (less than 35) = ALKALOTIC

•HCO3: 18 (less than 22) = ACIDOTIC

✓ *To determine the type of compensation look at the pH…is it normal or abnormal? It's NORMAL!*

✓ **full compensation**.

respiratory alkalosis, fully compensated by the means of metabolic acidosis.

- **pH: 7.37 (falls within 7.35-7.45)**

  (NORMAL but it's on the acidotic side)

- **PaCO2: 33 (less than 35) = ALKALOTIC**

- **HCO3: 17 (less than 22) = ACIDIC**

- PH= NORMAL! **full compensation.**

- ***metabolic acidosis, fully compensated by the means of respiratory alkalosis***

Problem 2:

ABGs: pH: 7.50

PaCO2: 49

HCO3: 30

Acid	Normal	Base
PaCO2		pH HCO3

- pH: 7.50 (greater than 7.50)

(Abnormal…ALKALOTIC)

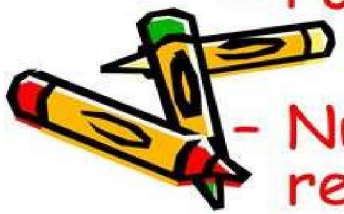
- PaCO2: 49 (greater than 45) = ACIDIC
- HCO3: 30 (greater than 26) = ALKALOTIC

Partially compensated metabolic alkalosis

Case Study

A 21 year old college student is admitted to the Emergency Department after taking an overdose of Oxycontin. The patient is unconscious & breathing at a rate of 6 to 7 bpm. The patient's ABG on room air is as follows:

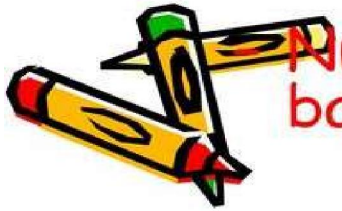
- pH: 7.23 (low); $PaCO_2$: 71 (high); PaO_2: 64; HCO_3: 26 (normal)
  - Interpretation: (resp. acidosis. Uncompensated)
  - Possible Cause? Drug overdose
  - Nursing Interventions: intubation (high resp above 20, high Fio2 40) NARCAN



Case Study

A woman with a history of panic disorder arrives at the Emergency Department complaining of not being able to "catch her breath". The woman is crying, shaking and breathing rapidly. An ABG is obtained:

- pH: 7.52 (high); $PaCO_2$: 28 (norm); HCO_3: 22 (norm); SaO_2: 90%
  - Interpretation: Respiratory Alkalosis uncompensated, hypoxia
  - Possible Cause? Hyperventilating
  - Nursing Interventions: Calm down, paper bag, pain



Case Study

A patient has been mechanically ventilated for the past two days in the ICU. The ventilator settings are as follows: AC, rate of 16, FIO_2 50%, and TV 600. The patient's 6am ABG results are as follows:

- pH: 7.49 (high); $PaCO_2$: 29 (low); PaO_2: 70; HCO_3: 25 (normal):
  - Interpretation? Respiratory alkalosis uncompensated
  - Possible Cause? Hyperventilation, slow rate/tidal volume
  - Nursing Interventions? Pain control, increase PEEP,

Lab Values Cheat Sheet

Basic Metabolic Panel (BMP)

- Albumin: 3.4-5.4 g/dL
- BUN: 5-20 mg/dL
- Calcium: 9-11 mg/dL
- Chloride: 95-105 mEq/L
- Creatinine: 0.6-1.2 mg/dL
- Glucose: 70-100 mg/dL
- Potassium: 3.5-5 mEq/L
- Sodium: 135-145 mEq/L
- Total protein: 6.2-8.2 g/dL

Liver Function Test (LFT)

- ALP: 40-120 U/L
- ALT: 7-56 U/L
- AST: 10-40 U/L
- Bilirubin: 0.1-1.2 mg/dL

BMP plus LFT equals Comprehensive Metabolic Panel (CMP)

Lipid Panel

- HDL: >60 mg/dL
- LDL: <100 mg/dL
- Total cholesterol: <200 mg/dL
- Triglyceride: <150 mg/dL

Renal = BMP plus:

- GFR: 90-120 mL/min/1.73m^2
- Magnesium: 1.5-2.5 mg/dL
- Phosphorus: 2.5-4.5 mg/dL

ABGs

- HCO_3: 22-26 mEq/L
- $PaCO_2$: 35-45 mmHg
- PaO_2: 75-100 mmHg
- pH: 7.35-7.45
- O_2: 95-100%
- Remember ROME:
  - Respiratory
  - Opposite
  - Metabolic
  - Equal

Complete Blood Count (CBC)

- Hct:
  - Female: 37-47%
  - Male: 42-52%
- Hgb:
  - Female: 12-16 g/dL
  - Male: 14-18 g/dL
- PLT: 150,000-450,000
- RBCs: 4.5-5.5 million
- WBC: 5,000-11,000

COAGs

- aPTT: 30-40 seconds
- INR:
  - NOT on warfarin: <1 sec
  - ON warfarin: 2-3 sec
- PT: 10-13 seconds
- PTT: 25-35 seconds

Pancreas

- Amylase: 30-110 U/L
- Lipase: 0-150 U/L

HbA1c

- Non-diabetic: 4-5.6%
- Pre-diabetic: 5.7-6.4%
- Diabetic: >6.5%
- Diabetic Target: <6.5%

Vital Signs

- Blood pressure:
  - Systolic: 120 mmHg
  - Diastolic: 80 mmHg
- Heart rate: 60-100 BPM
- Oxygen: 95-100%
- Respirations: 12-20/min
- Temperature: 97-99°F

Common Drugs

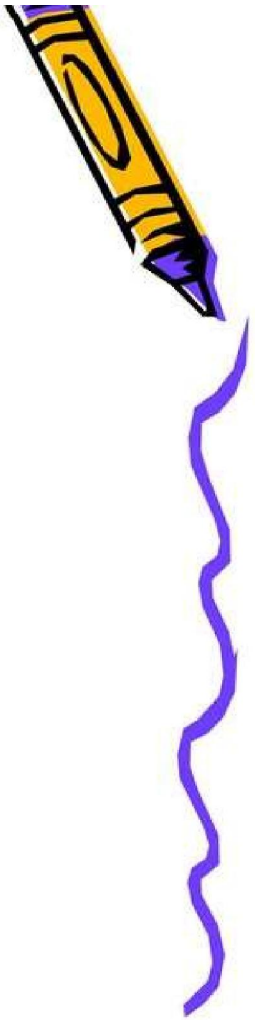
- Carbamazepine (Tegretol): 4-10 mcg/mL
- Digoxin: 0.5-2 ng/mL
- Dilantin: 10-20 mcg/mL
- Lithium: 0.5-1.2 mmol/L
- Phenobarbital: 15-40 mcg/mL
- Theophylline: 10-20 mcg/mL
- Valproic Acid (Depakote): 50-100 mcg/mL

Other

- BMI target: 18.5-24.9
- MAP: 70-105 mmHg
- Glascow coma scale
  - Mild: 13-15
  - Moderate: 9-12
  - Severe: 8 or less

Exact lab values will vary in different labs/facilities

SCRUB studies



- Thank you for your participation