Acidosis
Acid-Base Made Easy

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Metro Nashville Fire Department
Nashville International Airport

The 3 BMP Rules

1) Check the Numbers
   What lab values are abnormal

2) Calculate the Anion Gap
   \[ \text{Na}^+ - (\text{HCO}_3^- + \text{Cl}^-) \]

3) Apply the Rule of 15
   \[ \text{HCO}_3^- + 15 \] should equal the:
   - pCO\(_2\)
   - last two numbers of pH

Check the Numbers

- Look at BMP for abnormalities
- Hyponatremia, Hyperkalemia, Acidosis?
Anion Gap

- The gap is the Positives minus the Negatives
- The gap is $\text{Na}^+ - [\text{Cl}^- + \text{HCO}_3^-]$
- The gap should be about 8-12 (± 2)
- The gap should always be less than 15

Elevated Anion Gap
$(\text{Na}^+ - [\text{Cl}^- + \text{HCO}_3^-]) \geq 15$

- Methanol (M)
- Uremia (U)
- DKA and AKA (D)
- Paraldehyde/Paracetamol (P)
- INH and Iron (I)
- Lactic Acidosis (L)
- Ethylene Glycol (E)
- Salicylates, Solvents (S)

Normal Gap Acidosis
(Low Bicarb but A.G. is NOT Elevated)

- Hyperventilation (compensation) (H)
- Acids, Addison’s, Carbonic Anhydrase Inhibitors (A)
- RTA (R)
- Diarrhea (D)
- Ureteral Diversion, Ureterosigmoidostomy (U)
- Pancreatic Fistula, Pancreatic Drainage (P)

Always check the Anion Gap
Even if the BMP looks normal!!
Respiratory Alkalosis

Experts in Acid-base can tell if there is Compensation vs. a Second Primary Process

Compensation is Always the Opposite

Acidosis  Alkalosis

Metabolic  Respiratory

Respiratory Compensation in Metabolic Acidosis

Henderson-Hasselbalch Equation

\[ [H^+] = 24 \frac{[pCO_2]}{[HCO_3^-]} \]
Rule of 15

\[ \text{HCO}_3^- + 15 \]

\[ \text{HCO}_3^- + 15 = \text{pCO}_2 \pm 2 \]
\[ \text{HCO}_3^- + 15 = \text{pH} \pm .02 \]

If Rule of 15 satisfied, you have a:
Metabolic Acidosis plus a 2° Respiratory Alkalosis

The Rule of 15 is also called the should be rule because it tells what the pCO\(_2\) and pH should be if there is appropriate respiratory compensation.

Rule of 15

\[ \text{HCO}_3^- + 15 = \text{pCO}_2 \pm 2 \text{ and last 2 digits of pH} \]

As HCO\(_3^-\) falls

\[ \downarrow \]

\[ \text{HCO}_3^- + 15 \]

\[ \text{Should equal new pCO}_2 \]

If NOT followed = Another Primary process

Rule of 15

\[ \text{HCO}_3^- + 15 = \text{pCO}_2 \]

• Establishes a new set point
• Tells you what pCO\(_2\) value is compensatory
• If followed = Pure Compensation
• If followed = No Second Process

The Rule of 15 tell you the pCO\(_2\) and pH if a pure wide gap metabolic acidosis with secondary respiratory compensation exists (a 2° Respiratory Alkalosis)

**Respiratory Compensation in Metabolic Acidosis**

- $\text{HCO}_3^-$  $\text{pH}$  $\text{pCO}_2$
- As $\text{HCO}_3^-$ falls, $\text{pCO}_2$ should equal new $\text{pCO}_2$

**Rule of 15**

$\text{HCO}_3^- + 15 = \text{pCO}_2$ ± 2 and last 2 digits of pH

- As $\text{HCO}_3^-$ falls, $\text{pCO}_2$ should equal new $\text{pCO}_2$

**Example: Rule of 15**

$\text{HCO}_3^- + 15 = \text{pCO}_2$

- If Rule of 15 is followed you have:
  - A Metabolic Acidosis (wide or normal gap) with an appropriate ...
  - Secondary Respiratory Alkalosis

**Rule of 15 Followed**

$\text{HCO}_3^- + 15 = \text{pCO}_2$

- $\text{HCO}_3^-$ plus 15
  - $\text{pCO}_2$ “too high”
    - 1º Respiratory Acidosis
  - Secondary Respiratory Alkalosis
  - $\text{pCO}_2$ “too low”
    - 1º Respiratory Alkalosis

**Rule of 15 Not Followed**

$\text{HCO}_3^- + 15 \neq \text{pCO}_2$

- $\text{HCO}_3^-$ plus 15
  - $\text{pCO}_2$ “too high”
    - 1º Respiratory Acidosis
  - Secondary Respiratory Alkalosis
  - $\text{pCO}_2$ “too low”
    - 1º Respiratory Alkalosis
Rule of 15 Not Followed

\[ \text{HCO}_3^- + 15 \triangleq \text{pCO}_2 \]

- pCO\(_2\) "too high"
  - 1° Respiratory Acidosis
- Secondary Respiratory Alkalosis
- pCO\(_2\) "too low"
  - 1° Respiratory Alkalosis

If you don’t have an arterial blood gas (ABG) you can use just the venous pH (VBG)

Venous pH

- Very close to Arterial unless in Shock
- 0.02 – 0.03 in 99% of patients
- 7.40 vs 7.37 – 7.38
- Great in DKA and AKA
- ABGs only needed for Arterial pCO\(_2\)

Venous pH

\[ \text{VpH} = 0.01 – 0.03 \text{ of Art pH} \]

ABGs

- On Ventilator
- Seriously Ill
- In Shock
- Severe Lung Disease
- Cardiac Arrest

Venous pH

- Very close to Arterial unless in Shock
- 0.02 – 0.03 in 99% of patients
- 7.40 vs 7.37 – 7.38
- Great in DKA and AKA
- ABGs only needed for Arterial pCO\(_2\)
Case #2

\[
\begin{array}{c|c|c}
140 & 100 & \text{pH} = \,? \\
5.0 & 10 & \text{pCO}_2 = \,? \\
\end{array}
\]

- What are the 3 BMP Rules

Case #3

\[
\begin{array}{c|c|c}
140 & 100 & \text{pH} = 7.35 \\
5.0 & 20 & \text{pCO}_2 = 35 \\
\end{array}
\]

\[+15 = 35\]

\[VpH = 7.33\]

Case #4

\[
\begin{array}{c|c|c|c|c}
135 & 100 & \text{BUN} = 30 & \text{pH} = 7.30 \\
6.0 & 15 & \text{GLU} = 600 & \text{pCO}_2 = 30 \\
\end{array}
\]

- Is this pure DKA?
- Is this “just a WGMA + a 2° Respiratory Alkalosis?”
- Is this patient septic also?
- Or could this patient be tiring?

(V pH 7.28)
The Rule of 15 tells you the pCO2 and pH if a pure wide gap metabolic acidosis with secondary respiratory compensation exists (a 2° Respiratory Alkalosis).

\[ \text{HCO}_3^- + 15 = \text{pCO}_2 \pm 2 \text{ and last 2 digits of pH} \]

As HCO3 falls,

- HCO3 - 15
- pCO2

Should equal new pCO2

**Case #4**

<table>
<thead>
<tr>
<th>HCO3</th>
<th>pCO2</th>
</tr>
</thead>
<tbody>
<tr>
<td>+15</td>
<td>15</td>
</tr>
</tbody>
</table>

\[ \text{HCO}_3^- = 15 \quad \text{pH} = 7.30 \quad \text{pCO}_2 = 30 \]

**Case #5**

<table>
<thead>
<tr>
<th>HCO3</th>
<th>pCO2</th>
</tr>
</thead>
<tbody>
<tr>
<td>+15</td>
<td>15</td>
</tr>
</tbody>
</table>

\[ \text{HCO}_3^- = 15 \quad \text{pH} = 7.30 \quad \text{pCO}_2 = 30 \]

**Is this mild DKA?**

(V pH 7.28)
Case #5

<table>
<thead>
<tr>
<th>BUN</th>
<th>GLU</th>
<th>pH</th>
<th>pCO₂</th>
<th>pO₂</th>
</tr>
</thead>
<tbody>
<tr>
<td>40</td>
<td>600</td>
<td>7.30</td>
<td>30</td>
<td>100</td>
</tr>
</tbody>
</table>

Check the numbers.

Calculate the A.G.

- ( ) = 10 = No A.G. = HARDUP

Case #5

<table>
<thead>
<tr>
<th>HCO₃</th>
<th>pH</th>
<th>pCO₂</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>7.30</td>
<td>30</td>
</tr>
</tbody>
</table>

Too high

2° Respiratory Alkalosis only

Too Low

Case #5

<table>
<thead>
<tr>
<th>BUN</th>
<th>GLU</th>
<th>pH</th>
<th>pCO₂</th>
<th>pO₂</th>
</tr>
</thead>
<tbody>
<tr>
<td>130</td>
<td>105</td>
<td>7.30</td>
<td>30</td>
<td>100</td>
</tr>
</tbody>
</table>

Normal Gap Acidosis
(Low Bicarb but A.G. is NOT Elevated)

H Hyperventilation (compensation)
A Acids, Addison’s, Carbonic Anhydrase Inhibitors
R RTA
D Diarrhea
U Ureteral Diversion, Ureterosigmoidostomy
P Pancreatic Fistula, Pancreatic Drainage

Can’t be mild DKA, no A.G. = no Ketoacidosis

Case #6

An alcoholic comes in with altered mental status and very ill appearing. Someone says he was drinking “windex for car windshields”.

Is this methanol?

Toxic Alcohols

- Ethanol $\rightarrow$ Acetaldehyde
- Isopropyl $\rightarrow$ Acetone
- Methanol $\rightarrow$ Formic Acid
- Ethylene Glycol $\rightarrow$ Oxalic Acid
The most common errors in alcoholics are made by doctors and nurses who assume "He's just drunk."

Ten Commandments of Emergency Medicine

• Assume the Worst

• Always err in a way the patient will suffer the least

Methanol

- CH₃OH; MW 32; 3.2 mg% of methanol = 1 mosm
- Formic acid and formaldehyde once metabolized
- Methanol is non-toxic; breakdown products are not
- Diagnosis: Profound acidosis, blindness, retinal edema, pancreatitis
Ethylene Glycol

HO-CH2-CH2-OH  MW 62 each 6.2 mg% = 1 mosm

- Becomes oxalic acid once metabolized
- An antifreeze agent
- A sweetener for wine
- 40 - 60 deaths a year in USA
- Has no odor
- **Profound acidosis** from oxalic acid
- **Renal failure** from oxalate crystals in kidney

Isopropyl Alcohol

CH3-CHOH-CH3  MW 60 each 6.0 mg = 1 mosm

- Becomes acetone once metabolized
- Usually benign
- Twice as drunk, twice as sick, twice as long
- **Ketosis without acidosis**
- No anion gap
- Hemorrhagic gastritis, hypotension

**Case #6**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>130</td>
<td>90</td>
</tr>
<tr>
<td>5.5</td>
<td>5</td>
</tr>
</tbody>
</table>

- BUN = 20  pH = 7.00
- GLU = 100  pCO₂ = 20
- pO₂ = 110

- Acid Base Diagnosis
- Is this methanol?
- Is bicarbonate indicated?

(V pH 6.98)

**Case #6**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>130</td>
<td>90</td>
</tr>
<tr>
<td>5.5</td>
<td>5</td>
</tr>
</tbody>
</table>

- BUN = 20  pH = 7.00
- GLU = 100  pCO₂ = 20
- pO₂ = 110

Check the numbers.

Calculate the A.G.

\[- ( + ) = 35 = \uparrow = \text{WGMA}\]
Case #6

\[ \text{HCO}_3 = 5 \quad \text{pH} = 7.00 \quad \text{pCO}_2 = 20 \]

Too high

Too low

2° Respiratory Alkalosis only

Corollary to the Rule of 15

As the Bicarbonate falls below 10 and approaches 5, the expected pCO$_2$ is not HCO$_3$ + 15.

It is:

\[ \text{HCO}_3 = 15 \quad (12-15) \]

Corollary to the Rule of 15

As the HCO$_3$ falls below 10 and approaches 5:

\[ \text{HCO}_3 \neq 15 = \text{pCO}_2 \]

Corollary to the Rule of 15

HCO$_3$  PCO$_2$  pH
24  40  7.40
20  35  7.35
15  30  7.30
10  25  7.25
5  15  7.12
2.5  15  6.88

1° Respiratory Acidosis

2° Respiratory Alkalosis
Case #6

<table>
<thead>
<tr>
<th>130</th>
<th>90</th>
<th>BUN = 20</th>
<th>pH = 7.00</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.5</td>
<td>5</td>
<td>GLU = 100</td>
<td>pCO₂ = 20</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>PO₂ = 110</td>
</tr>
</tbody>
</table>

Wide Gap Metabolic Acidosis
Respiratory Acidosis

To check for Methanol and Ethylene Glycol:

1) Get levels
2) Check osmolar gap
3) Treat based on history and/or physical and/or lab NOT just levels and/or gap

*If they have already metabolized the toxin, they can be acidotic with low or no detectable serum levels or osmolar gap!*

Osmolar Gap
For Unexplained Wide Gap Acidosis or History of Ingestion of Toxic Alcohol

- Calculate Osmolarity
- \( \text{Osmolarity} = \left( \frac{\text{Na} \times 2 + \text{GLU}}{20} + \frac{\text{BUN}}{3} + \frac{\text{ETOH}}{4} \right) \)
- Get measured osmolarity from lab
- Measured – Calculated should = 10
- Elevated Osmolar Gap = Methanol or E.G.

Treatment of Methanol and Ethylene Glycol

- Secure ABCs
- Consider NGT
- Reverse Acidosis
- Block Metabolism
- Enhance Elimination

Treatment of Methanol and Ethylene Glycol

- Secure ABCs
  - Hydrate as needed
- Consider NGT
  - Provide glucose and usually start ETOH cocktail
  - Always give thiamine

- Reverse Acidosis
  - 1 amp of bicarbonate for each 0.1 pH unit below 7.35
  - 1 meq/kg over 5-10 min will raise pH by 0.1-0.15
  - Get pH to 7.35-7.40
- Block Metabolism
  - Block Alcohol Dehydrogenes
  - Begin Fomepizole (4-MP)
    - 15 mg/kg IV then 10 mg/kg IV Q 12 H
  - Block Creation of Formic or Oxalic Acid
Treatment of Methanol and Ethylene Gylcol

- Enhance Elimination
  - Hemodialysis for Symptomatic, acidotic patients or those with levels > 25-50 mg%.
  - HD until levels below 25 mg%.
  - May delay HD once patient stable and Fomipazole on board.
  - HD emergently for:
    - visual changes, severe acidosis, coma.

Is Bicarbonate Indicated?

Bicarbonate: Yes and No

Yes: in bicarbonate consuming overdoses like ASA, Methanol, Ethylene Glycol
Replenish the consumed bicarbonate

No: for diseases that cause acidosis like DKA, Sepsis and Lactic Acidosis
Correct the underlying disease

Using Bicarbonate

Each amp raises pH by 0.1 if given in under 3-5 minutes

1 meq/kg raises pH by 0.1 – 0.15

Case #7

A 23 yo man presents with altered mental status. He is agitated, febrile and hyperventilating.

<table>
<thead>
<tr>
<th>BUN</th>
<th>GLU</th>
<th>pH</th>
<th>pCO₂</th>
<th>pO₂</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>70</td>
<td>7.32</td>
<td>20</td>
<td>80</td>
</tr>
</tbody>
</table>

- What is the differential of AMS?
- Acid Base Diagnosis?
- Immediate Rule Out?

(V pH 7.30)

Status Seizures

- Vital Signs
- Toxic–Metabolic
- Structural
- Infectious
- Epilepsy

AMS

- Vital Signs
- Toxic–Metabolic
- Structural
- Infectious
- Psychiatric
Case #7

Check the numbers.

Calculate the A.G.

\[-(\text{ + }) = 30 = \uparrow = \text{MUDPILES}\]

If the patient’s pCO₂ is lower than it “should be” via the Rule of 15, or V pH is higher than it should be, then the patient is hyperventilating more than expected from compensation.

This is also a Primary Respiratory Alkalosis.

Whenever you have a WGMA and a 1º Respiratory Alkalosis always immediately consider and rule out:

ASPIRIN
SEPSIS

Aspirin

- The great imitator
- AMS, Seizures
- Anxiety, Tachypnea, Tachycardia
- Hypoglycemia
- Febrile, Meningitis
- DIC, MOSF
Aspirin Kills

- Acidosis
- Hypoglycemia
- Hypokalemia
- Dehydration – Fever
- Edema: Pulmonary and CNS

Treating Aspirin

- Acidosis: Bicarbonate
- Hypoglycemia: Glucose
- Hypokalemia: KCL
- Dehydration: Volume
- Edema: Judicious Volume

Treating Aspirin

D5 + 3 Amps HCO3 + 40 KCL
200cc/hr

- Keep urine non acidotic at 100 cc +/- hr
- If not: - more volume if flow too low
  - more bicarb if pH too low

Very Acidotic Aspirin Overdoses

If you intubate an Aspirin Overdose they will get a respiratory acidosis if you do not ventilate at very high rates and volumes

- ETT = DOA if not careful
- Call Tox, Use Bicarb, Dialyze
A 19 yo Jeet Kun Do Sensei is found down in his dojo.

- Is there pure wide gap metabolic acidosis?
- Any new Rule of 5 to use here?

PE: Decorticate, Papilledema

ECG: Diffuse ST and T waves changes

Check the numbers.

Calculate the A.G.

\[- ( + 15 ) = 25 = \uparrow = \text{MUDPILES} \]

\[
\begin{align*}
\text{HCO}_3 & = 15 \\
pH & = 7.30 \\
pCO_2 & = 30 \\
pO_2 & = 98 \\
\text{O}_2 \text{ sat} & = 100\%
\end{align*}
\]

\[
\begin{align*}
\text{HCO}_3 & = 15 \\
pH & = 7.30 \\
pCO_2 & = 30 \\
pO_2 & = 98 \\
\text{O}_2 \text{ sat} & = 100\%
\end{align*}
\]

Too high

2º Respiratory Alkalosis only

Too Low

Trust No One
Believe Nothing
Pulse Oximetry Basics

- Pulses light at about 400 cycles/sec
- Can compare arterial to venous saturation
- Accuracy is ± 2% when sats above 70 - 80%
- Accurate to levels of pO₂ of 50 (80% sat)
- Compares arterial and venous absorbance at both wavelengths

Carbon Monoxide but
100% Saturated, 75% O₂, 25% CO

Co-Oximetry

- Measures true saturation's
- Measures at 4 wavelengths
- Specifically evaluates
  - Saturated Hgb (O₂)
  - Desaturated Hgb (CO₂)
  - Carbon Monoxide (CO)
  - Methemoglobin (Me)
AMS of Unknown Cause
5 ABG Values

- pO₂
- pCO₂
- pH
- Measured O₂ Sat
- CO Level

O₂ Saturation

- O₂ Sat Monitor Calculated
- O₂ Sat by ABG Calculated
- O₂ Sat by Co Oximetry Direct Measure

ABG, O₂ Sat, pO₂, % Sat

The Only True Measurement of O₂ Saturation is via Co Oximetry.

Case # 9
A German Shepard Activates 911 due to her masters AMS.

140 | 100
3.2 | 10

pH = 7.20
pCO₂ = 30
pO₂ = 80

• Diagnosis?

Check the numbers.

Calculate the A.G.

− ( + ) = 30 = ↑ = MUDPILES
Case # 9

<table>
<thead>
<tr>
<th>HCO₃</th>
<th>pH</th>
<th>pCO₂</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>7.20</td>
<td>30</td>
</tr>
</tbody>
</table>

1° Respiratory Acidosis
pCO₂ = 40
Too high

10
+15

Name That Acidosis

- Blindness
- Urine Findings
- Abdominal Pain
- Funny Breath
- Hypoglycemia
- Status Seizures

- Methanol
- Ethylene Glycol, DKA, RF
- Methanol, Iron, DKA, Sepsis, ASA
- Uremia, DKA, Aspirin (Methyl Salycilate)
- ASA, Sepsis, Methanol, E.G.
- INH, Lactic Acidosis

Case # 9

<table>
<thead>
<tr>
<th>PO₂</th>
<th>pH</th>
<th>pCO₂</th>
</tr>
</thead>
<tbody>
<tr>
<td>80</td>
<td>7.20</td>
<td>30</td>
</tr>
</tbody>
</table>

+15

Wide Gap Metabolic Acidosis
Primary Respiratory Acidosis

Name That Acidosis

- Hypoxia
- Hypocalcemia
- Papilledema
- “In a snow storm”
- pH < 6.8

- Lactic Acidosis
- Ethylene Glycol
- Methanol
- Methanol
- INH, ME, EG

SUMMARY

1) Check the Numbers
What lab values are abnormal

2) Calculate the Anion Gap
Na⁺ - (HCO₃⁻ + Cl⁻)

3) Apply the Rule of 15
HCO₃⁻ + 15 should equal the:
- pCO₂
- last two numbers of pH

The 3 BMP Rules
Elevated Anion Gap
\[
(Na^+ - [Cl^- + HCO_3^-] \geq 15)
\]

- Methanol
- Uremia
- DKA and AKA
- Paraldehyde
- INH and Iron
- Lactic Acidosis
- Ethylene Glycol
- Salicylates, Solvents

Always check the Anion Gap
Even if the BMP looks normal!!

Rule of 15
\[
HCO_3^- + 15 = pCO_2 \pm 2 \text{ and last 2 digits of pH}
\]

As HCO_3 falls
\[
\text{pCO}_2
\]
\[
\text{Should equal new pCO}_2
\]

Corollary to the Rule of 15

As the Bicarbonate falls below 10 and approaches 5 the expected pCO_2 is not HCO_3 + 15.

It is:
\[
HCO_3^- = 15 \ (12-15)
\]

Whenever you have a WGMA and a 1° Respiratory Alkalosis always immediately consider and rule out:

ASPIRIN
SEPSIS
The Delta Gap

- The Rule of 15 looks for “hidden” respiratory processes
- The Delta Gap looks for “hidden” metabolic processes in wide gap acidosis.
- Is there a metabolic alkalosis or a second acidosis (hyperchloremic metabolic acidosis) in addition to elevated gap acidosis?

The Delta Gap (1:1)

The bicarbonate should go down by the same amount (± 4)

As the anion gap goes up

The fall in $\Delta HCO_3^-$ should mirror the rise in AG ($\Delta$ AG)
**Wide Gap Metabolic Acidosis Plus a Concomitant Metabolic Alkalosis**

- HCO₃: 20
- A.G.: 30

**Wide Gap Metabolic Acidosis Plus a Second Metabolic Acidosis (non-gap acidosis)**

- HCO₃: 10
- A.G.: 20

There are 3 possibilities with the Delta Gap:

1) The $\Delta$ HCO₃ = the $\Delta$ AG ($\pm 4$):
   - thus: no hidden process
2) The HCO₃ is higher than it “should be”:
   - $=$ Metabolic Alkalosis
3) The HCO₃ is lower than it “should be”:
   - $=$ Metabolic Acidosis
   - (1° Hyperchloremic Metabolic Acidosis)

**Case #11**

```
<table>
<thead>
<tr>
<th>pH</th>
<th>pCO₂</th>
<th>pO₂</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.38</td>
<td>30</td>
<td>60</td>
</tr>
</tbody>
</table>
```

- Diagnosis?

**Case #11**

```
<table>
<thead>
<tr>
<th>pH</th>
<th>pCO₂</th>
<th>pO₂</th>
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<tbody>
<tr>
<td>7.38</td>
<td>30</td>
<td>60</td>
</tr>
</tbody>
</table>
```

- Check the numbers.
- Calculate the A.G.

$- (\text{AG}) = 30 = \uparrow = \text{MUDPILES}$
### Case #11

<table>
<thead>
<tr>
<th>HCO₃ = 20</th>
<th>pH = 7.38</th>
<th>pCO₂ = 30</th>
</tr>
</thead>
</table>

**1° Respiratory Alkalosis**

pCO₂ = 40

**2° Respiratory Alkalosis only**

Too Low

\[\text{HCO}_₃ \text{ should fall by } -15 \text{ but it hasn’t. HCO}_₃ \text{ is higher than it “should be.”} \]

**Metabolic Alkalosis**


### Case #11

<table>
<thead>
<tr>
<th>142</th>
<th>92</th>
<th>pH = 7.38</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.0</td>
<td>20</td>
<td>pCO₂ = 30</td>
</tr>
<tr>
<td>20</td>
<td></td>
<td>pO₂ = 60</td>
</tr>
</tbody>
</table>

Wide Gap Metabolic Acidosis
Primary Respiratory Alkalosis
Metabolic Alkalosis

**VanderbiltEM.com**