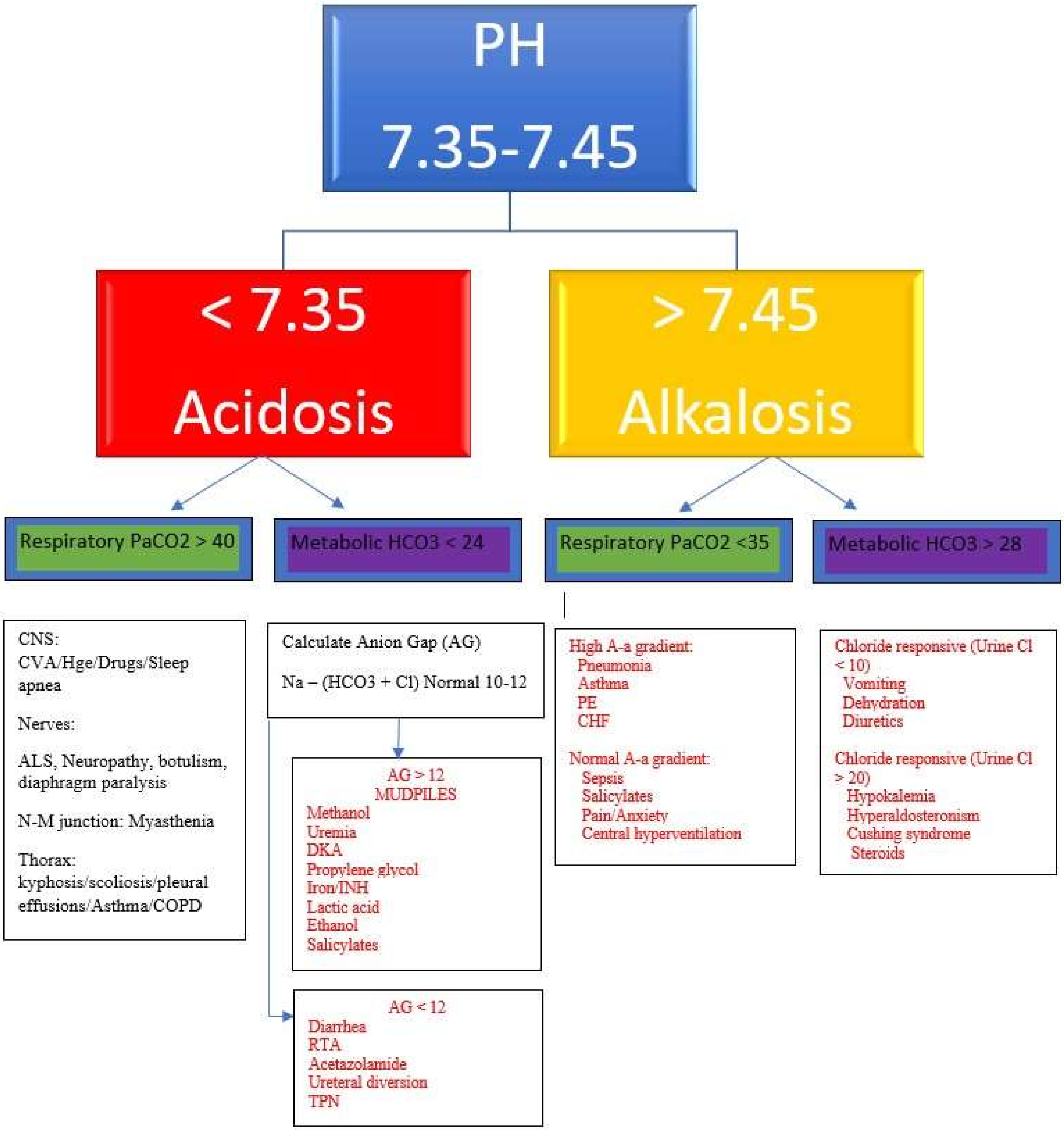
SMV
Society of Mechanical Ventilation

Discussion / Answers



Compensation

Respiratory compensation for Metabolic Acidosis

Winter's formula: $PaCO_2 = (HCO_3 \times 1.5) + 8 \pm 2$

Or

1 meq/L decrease in HCO_3 → 1 mmHg decrease in $PaCO_2$

Or

$PaCO_2$ = last 2 digits of PH

Respiratory compensation for Metabolic Alkalosis

$PaCO_2 = 0.7\ (HCO_3) + 21$ mmHg

Or

1 meq/L increase in HCO_3 → 1 mmHg increase in $PaCO_2$

Or

$PaCO_2 = HCO_3 + 15$

(If $PaCO_2 > 50$, not compensation, but additional primary respiratory acidosis)

Metabolic compensation for Respiratory Acidosis

Acute (1- 4 days): Each 10 increase in $PaCO_2$ → 1-2 increase in HCO_3

Chronic (> 4 days): Each 10 increase in $PaCO_2$ → 4-5 increase in HCO_3

Metabolic compensation for Respiratory Alkalosis

Acute (1- 4 days): Each 10 decrease in $PaCO_2$ → 1-2 decrease in HCO_3

Chronic (> 4 days): Each 10 decrease in $PaCO_2$ → 4-5 increase in HCO_3

Interpreting Acid-Base

1) PH: Acidosis or Alkalosis
2) 1ry problem: Metabolic or Respiratory
3) Adequate compensation or not
   (e.g. if metabolic acidosis with HCO_3 10, then expected $PaCO_2$ should be 21-25, if $PaCO_2$ 17, then there is additional 1ry respiratory alkalosis, or if $PaCO_2$ 30, then additional 1ry respiratory acidosis)
4) Additional 1ry problems: in AG metabolic acidosis, calculate Delta Gap/Delta HCO_3 ($\Delta AG/\Delta HCO_3$) should be around 1
   < 1 additional non-AG metabolic acidosis
   >1 additional metabolic alkalosis

e.g. Na 120, HCO_3 10, Cl 90

AG 20, then $\Delta AG = 10$ (20-10)

HCO_3, 10 then $\Delta HCO_3 = 14$ (24-10)

$\Delta AG/\Delta HCO_3$ 10/14: <1 then additional metabolic acidosis

Important Notes

- Each change of 10 PaCO2 → PH changes by 0.08 other direction
- Each change of 10 HCO3 → PH changes by 0.15 in same direction
- Each change in PH by 0.1 → K changes by 0.05 in other direction

Answers

1) B: No

This patients' baseline PaCO2 is around 80-90 as evident by HCO3 45 (increase from normal by 21). Each increase PaCO2 by 10 chronically, the HCO3 increase by 4-5. If this is acute hypercapnia in patient with normal PaCO2 of 40, the PH would be expected to be 6.96 (each acute increase of PaCO2 by 10 the PH would decrease by 0.08)

2) D: 90

As above

3) E: 7.6

If the PaCO2 in this case drop acutely by 45 points, the patient would develop acute respiratory alkalosis on top of chronic respiratory acidosis, and the PH will increase by about 3.6 (45 x 0.08) to about 7.66 which is extremely dangerous as patient can develop seizures or fatal cardiac arrhythmias

4) B: No

According to winter's formula, the expected PaCO2 IS 18-22 (PaCO2 = 1.5 (HCO3) + 8 ± 2

Since this patient's PaCO2 is 14, he is overcompensating and has additional acute respiratory alkalosis (e.g. sepsis, pneumonia, salicylate toxicity, etc.)

5) C: 20

As above

6) C: Primary metabolic acidosis and respiratory alkalosis

As above

7) D: Emergent Intubation

Though emergent dialysis and nebulized bronchodilators would reduce K but will take long time, also patient has normal renal function. Calcium does not change the potassium level but is protective to the heart from hyperkalemia. This patient has acute respiratory acidosis, and the K increase (gets out of the cells into the serum) is proportional to the drop in PH (K increase by 0.5 meq for each o.1 drop in PH). Emergent intubation and decreasing the $PaCO_2$ back to within normal levels will normalize the K level.

8) B: 13-15

As in question 4. The winters formula $PaCO_2 = (5 \times 1.5) + 8 \pm 2$

9) B: Primary metabolic alkalosis and respiratory acidosis

PH is 7.52 is alkalotic, the HCO_3 is elevated to 40. $PaCO_2$ compensation should be: $0.7 (HCO_3) + 21 = 49$, so $PaCO_2$ of 55 is considered additional primary acute respiratory acidosis.

10 C: Stop diuretics

As the above question, the patient has developed acute metabolic alkalosis 2ry to excessive diuretics with good respiratory compensation, so stopping the diuretics is the best option. Adding acetazolamide will induce metabolic acidosis though might correct the PH slowly, it wouldn't solve the primary problem of dehydration, obviously increasing diuretics will additionally worsen the problem, placing the patient on NIPPV for mild increase $PaCO_2$ will cause respiratory alkalosis and will worsen the PH.