

# Pembacaan Blood Gas Analysis

## *Sistem Respirasi*

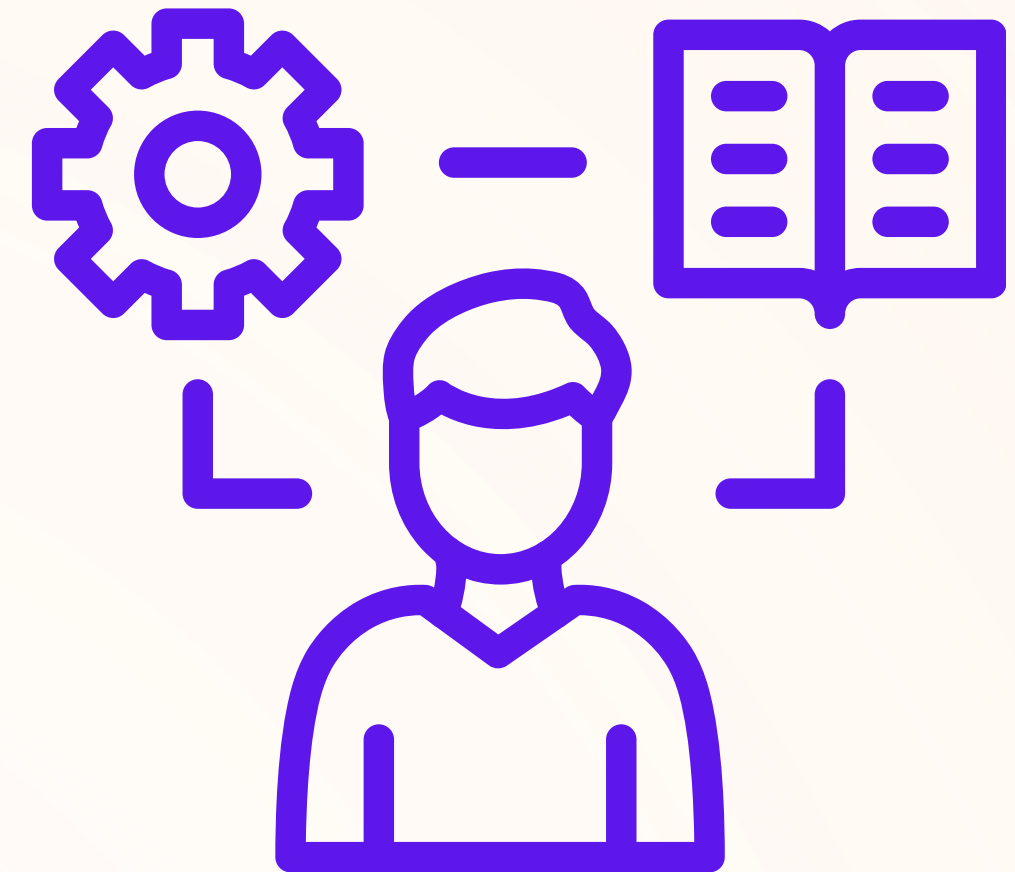
**Baharuddin**

Lecturer, Data Preparation and AI User Experience

Disampaikan dalam **Kuliah Kelas**  
Surabaya, 20 Februari 2024

- Definisi
- Pentingnya BGA dalam praktik klinis.
- Komponen utama BGA: pH, PaCO<sub>2</sub>, PaO<sub>2</sub>, HCO<sub>3</sub><sup>-</sup>, dan saturasi oksigen.
- Ikhtisar proses pengambilan sampel darah arteri.

## Sebuah Pengantar *for Discuss*



# Sebuah Pengantar *for Discuss*

Bahan yang dibicarakan dalam BGA adalah komponen gas terlarut dalam bentuk ion.





# Indikasi Klinis

*for doing BGA*

Arterial blood gases give an indication about a patient's

- oxygenation,
- ventilation,
- acid- base balance and
- metabolic status

[Sumber Referensi: \[9\]](#)





## **Purpose** *for doing BGA*

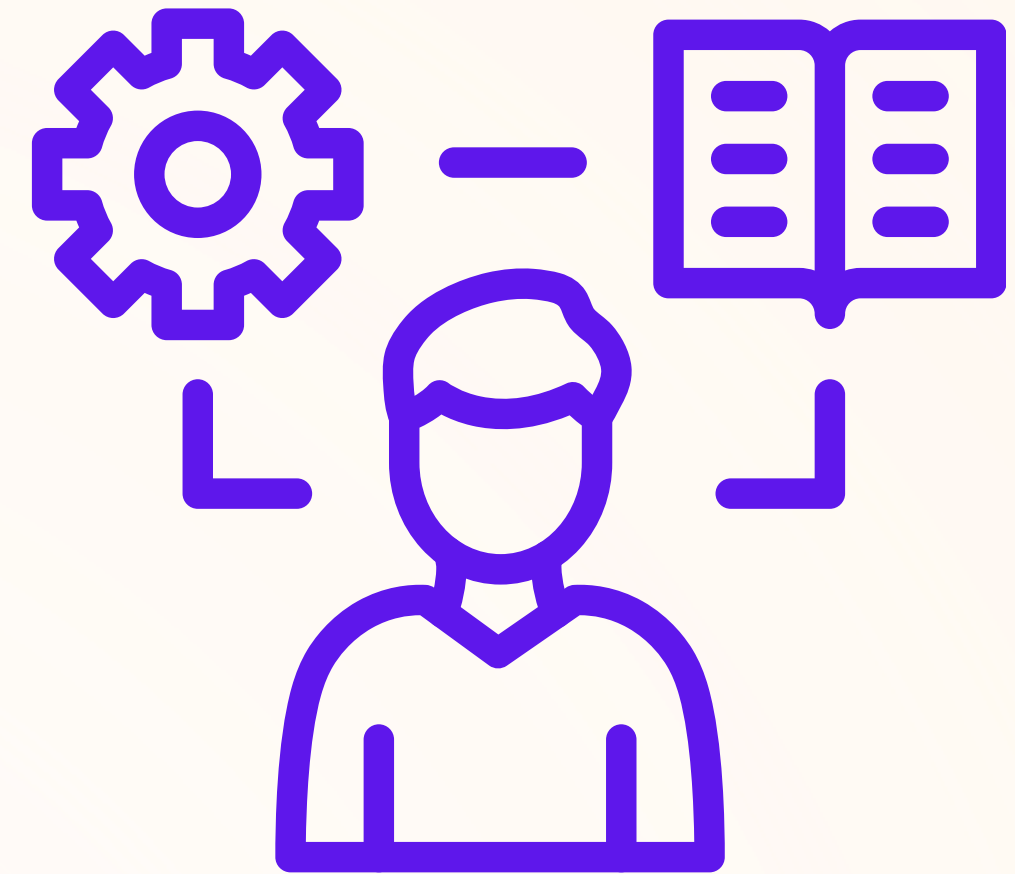
They are used to assess patients who are critically ill, especially when they are **receiving** respiratory support.

[Sumber Referensi: \[9\]](#)



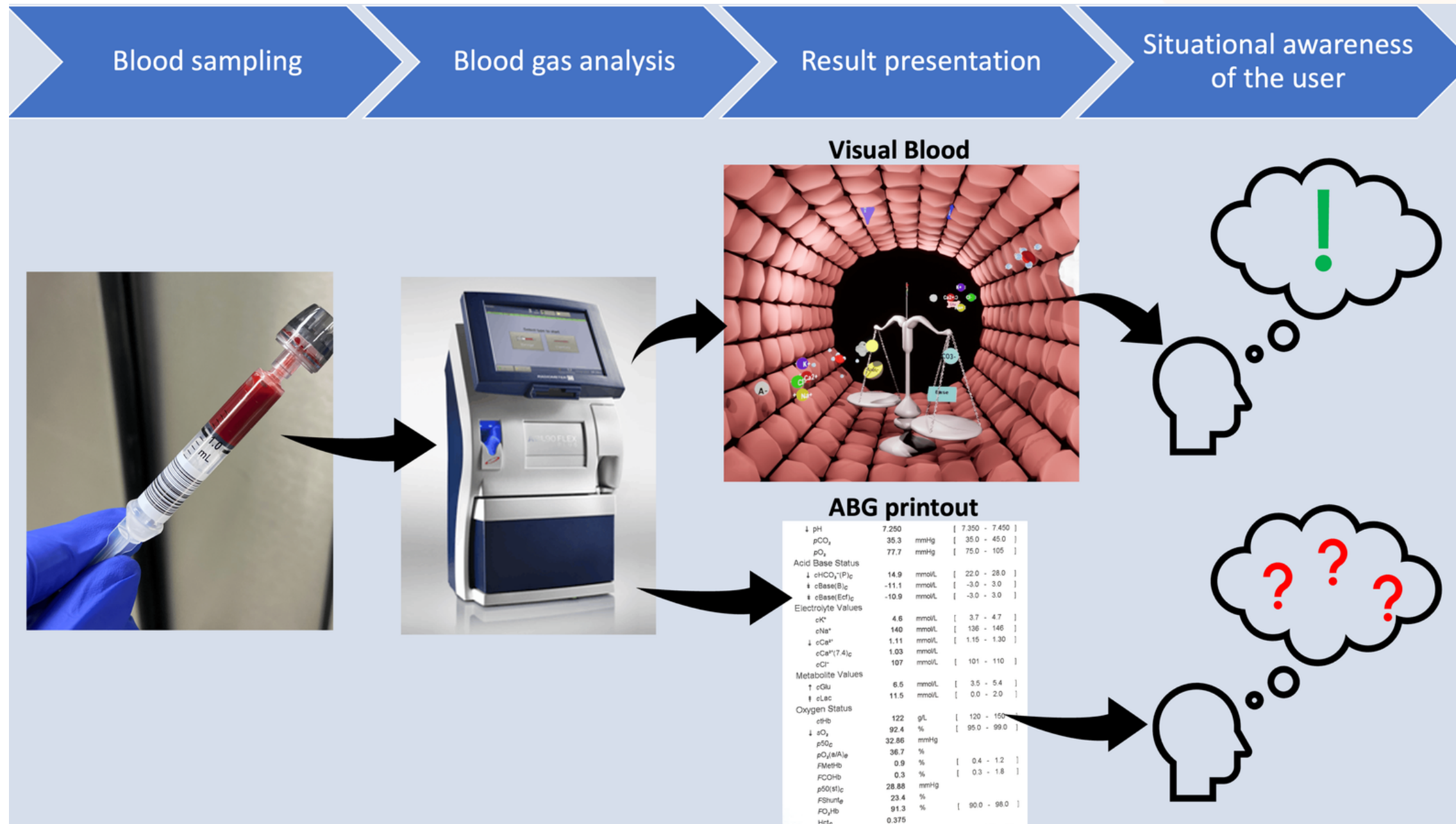
Darah menjadi media alternatif bagaimana fungsi fisiologis paru-paru bekerja dan jaringan melakukan metabolisme. Apakah pertukaran dan transport zat berlangsung dalam keadaan homeostatis?

## Peran *Darah*



[Sumber Referensi: \[1\]](#)

# Proses Pemeriksaan *BGA Manusia*

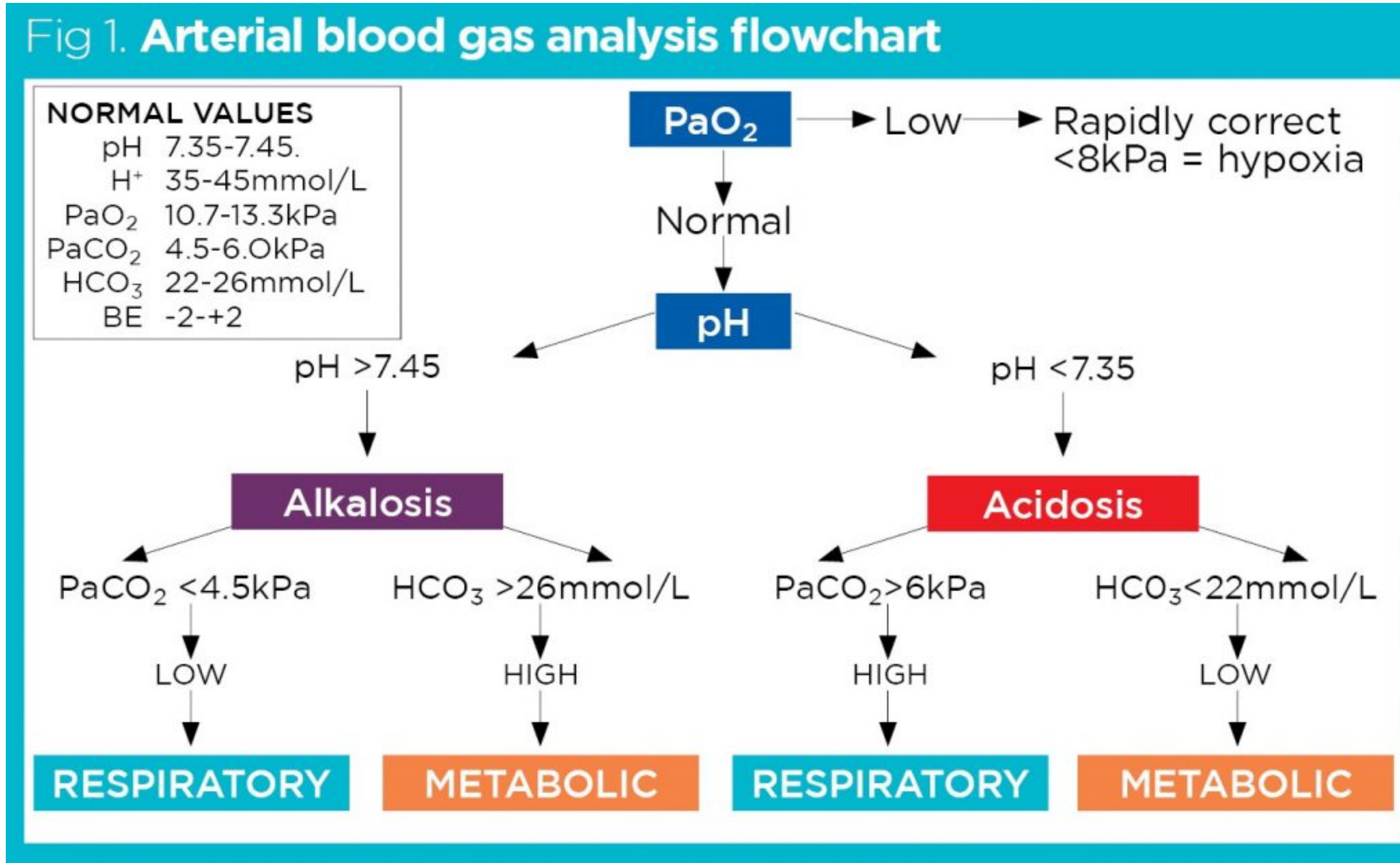


Sumber Referensi: [2]





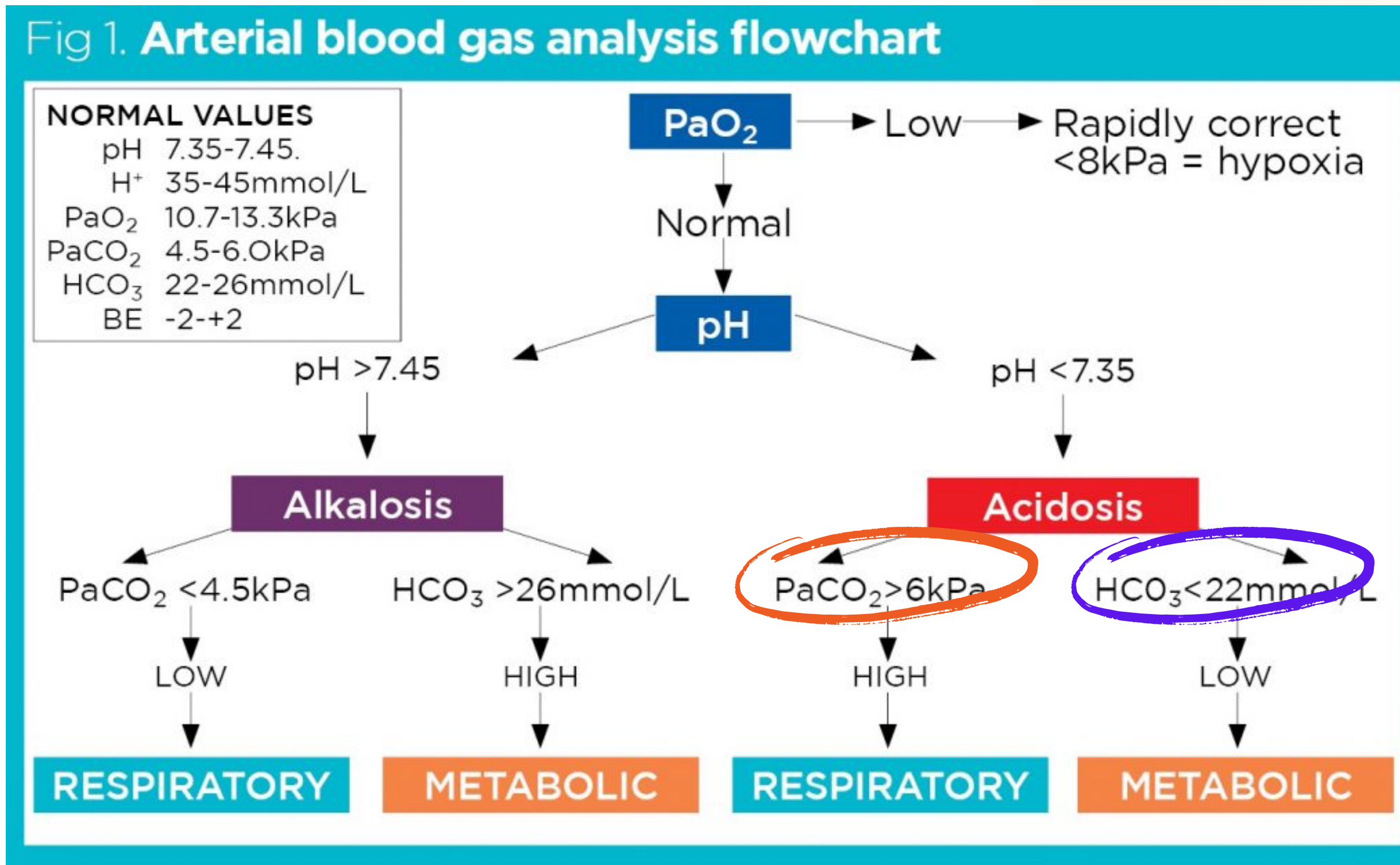
# Mekanisme BGA



Sumber Referensi: [9]



# Mekanisme BGA



Sumber Referensi: [9]



## Step 1 : Interpreting arterial blood gas report

BLOOD GAS REPORT			
Patient Report	09:32 AM	18/03/2016	
Identifications			
Patient ID	HN0000001		
Patient Last Name	Smith		
Patient First Name	John		
Sex	Male		
Sample Type	Arterial		
FiO <sub>2</sub>	21.0%		
Temperature	37.0°C		
Operator	Dr Jones		
Location	Emergency Department		
Blood Gas Values			
pH	7.23		(7.35 – 7.45)
pCO <sub>2</sub>	7.3	kPa	(4.5 – 6.0)
pO <sub>2</sub>	7.5	kPa	(11.0 – 13.0)
Oximetry Values			
ctHb	112	g/l	(130 – 180)
sO <sub>2</sub>	85.0	%	(95.0 – 100.0)
FCO <sub>2</sub>	1.2	%	(0.0 – 1.5)
FHHb	4.3	%	(0.0 – 5.0)
FMetHb	0.2	%	(0.0 – 1.5)
Electrolyte Values			
cK <sup>+</sup>	3.9	mmol/l	(3.5 – 5.0)
cNa <sup>+</sup>	134	mmol/l	(135 – 145)
cCa <sup>2+</sup>	1.23	mmol/l	(1.15 – 1.30)
cCl <sup>-</sup>	98	mmol/l	(94 – 107)
Metabolite Values			
cGlu	4.4	mmol/l	
cLac	1.8	mmol/l	(0.5 – 2.0)
Acid Base Status			
↑BE (B)	2.8	mmol/l	(-2.0 – 2.0)
cHCO <sub>3</sub> <sup>-</sup> act	26.2	mmol/l	
cHCO <sub>3</sub> <sup>-</sup> std	25.8	mmol/l	(22.0 – 28.0)

# Pembacaan Hasil BGA

Sumber Referensi: [9]





# Pembacaan Hasil BGA

Step 2: What is the primary disturbance?

Respiratory causes →

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Metabolic causes →

0:41 / 5:01 • Step 2 Primary disturbances →

[Sumber Referensi: \[9\]](#)



# Prinsip Respiratory *Asidosis*



= Respiratory ***Acidosis***

[Sumber Referensi: \[9\]](#)

# Prinsip Respiratory *Asidosis*



= Respiratory ***Acidosis***



= Respiratory ***Alkalosis***

[Sumber Referensi: \[9\]](#)





# Prinsip Respiratory *Asidosis*



↓ Bicarbonate Ions → ↓ pH

= Metabolic **Acidosis**

↑ Bicarbonate Ions → ↑ pH

= Metabolic **Alkalosis**

BMJ  
Learning

[Sumber Referensi: \[9\]](#)



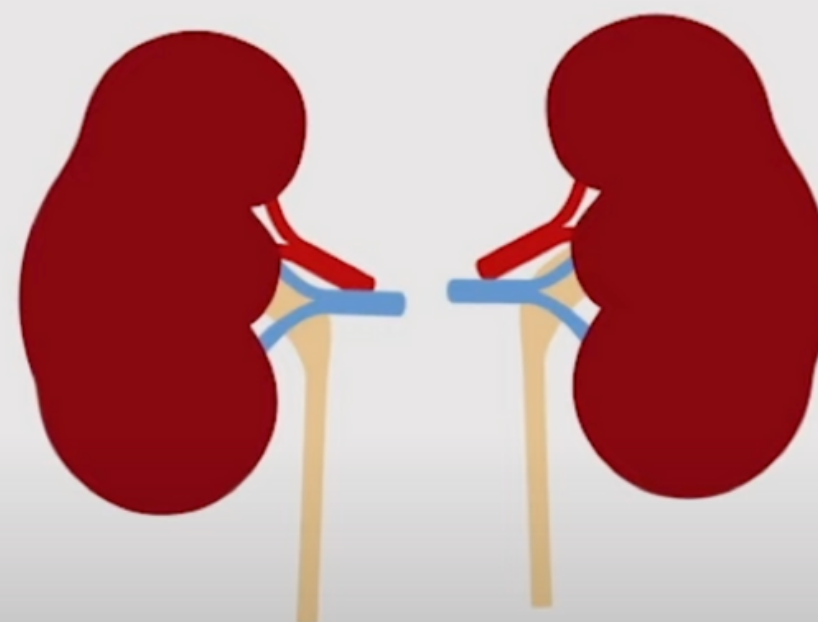
# Prinsip Respiratory *Asidosis*

Step 4: Is there any compensation?

## Two main compensatory mechanisms



Adjustments to ventilation



Kidney absorption and excretion

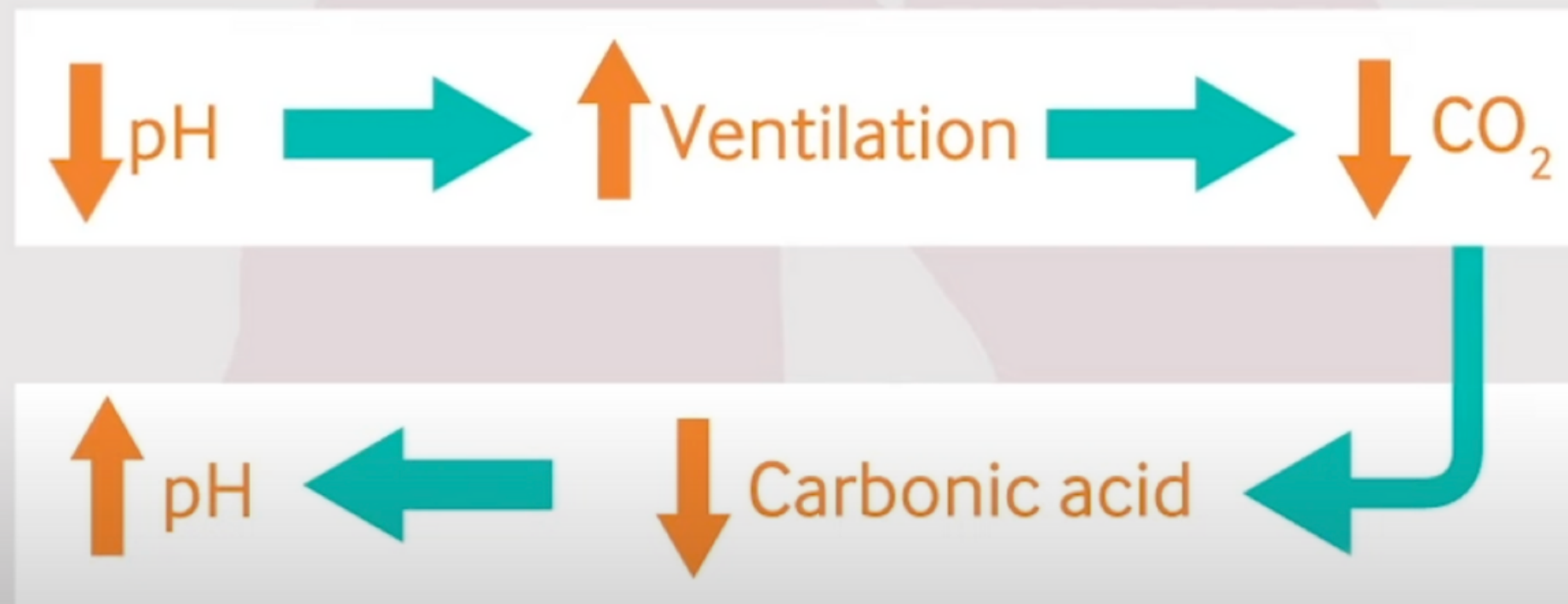
BMJ  
Learning

[Sumber Referensi: \[9\]](#)

# Prinsip Respiratory *Asidosis*

Step 4: Is there any compensation?

## Metabolic acidosis - Respiratory compensation



**Respiratory compensation** usually begins in the first hour

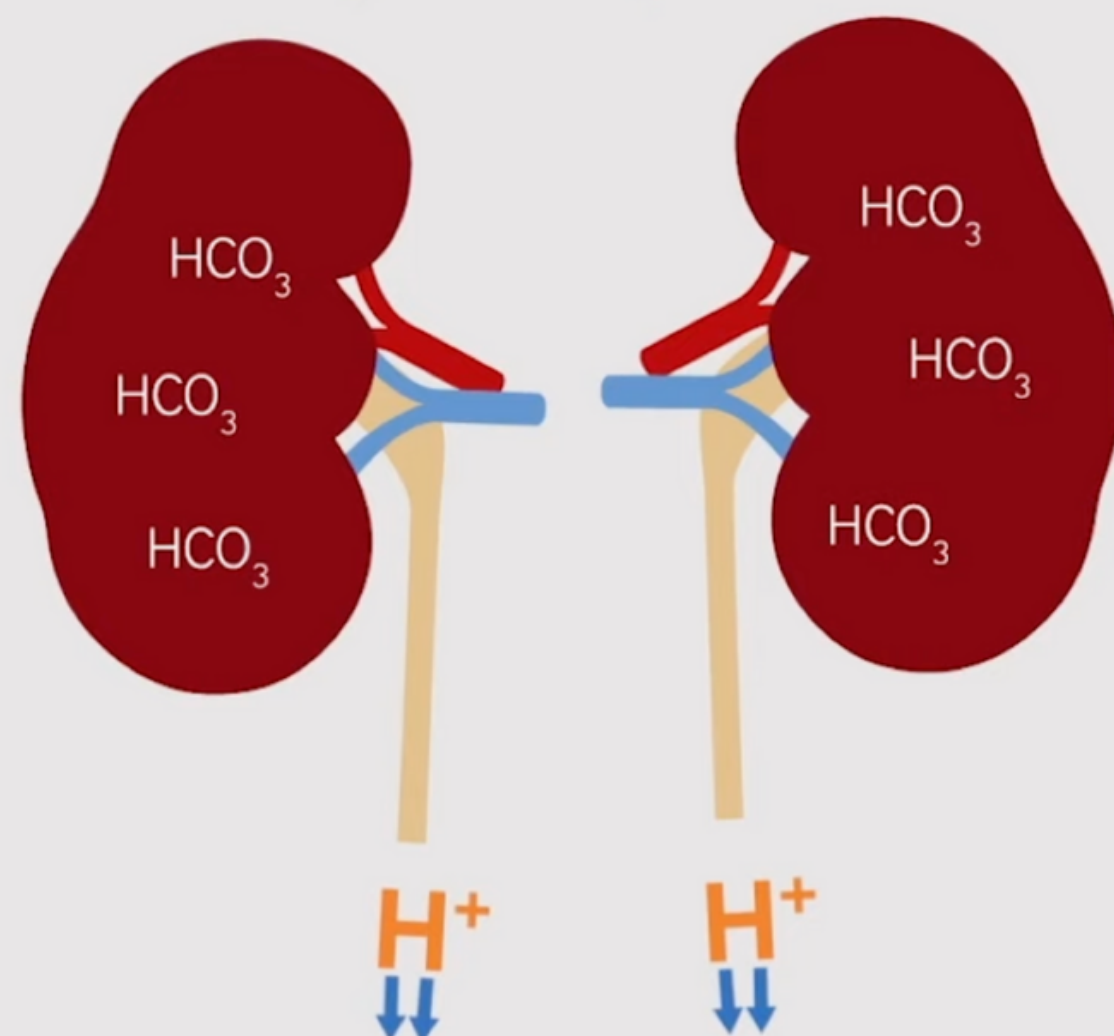
[Sumber Referensi: \[9\]](#)



# Prinsip Respiratory *Asidosis*

Step 4: Is there any compensation?

## Respiratory acidosis



[Sumber Referensi: \[9\]](#)

# Apa Bahayanya Alkalosis atau Asidosis

Metabolic Disorders		
DISORDER	Acidosis Gain $H^+$ / Loss $HCO_3^-$	Alkalosis Loss $H^+$ / Gain $HCO_3^-$
ARTERIAL BLOOD PROFILE	$\downarrow pH$ 	$\uparrow pH$ 
RESPIRATORY COMPENSATION	Hyperventilation $\downarrow PaCO_2$ 	Hypoventilation $\uparrow PaCO_2$ 
RENAL COMPENSATION	<ul style="list-style-type: none"> <li>■ Conserve <math>HCO_3^-</math></li> <li>■ Excrete <math>H^+</math></li> </ul>	<ul style="list-style-type: none"> <li>■ Excrete <math>HCO_3^-</math></li> <li>■ Conserve <math>H^+</math></li> </ul>

Sumber Referensi: [9]



# Apa Bahayanya Alkalosis atau Asidosis

DISORDER	Metabolic		Respiratory	
	Acidosis Gain $H^+$ /Loss $HCO_3^-$	Alkalosis Loss $H^+$ /Gain $HCO_3^-$	Acidosis Gain $CO_2$	Alkalosis Loss $CO_2$
ARTERIAL BLOOD PROFILE	<p>↓ pH</p> <p>↓ <math>HCO_3^-</math> ↑ <math>H^+</math></p>	<p>↑ pH</p> <p>↑ <math>HCO_3^-</math> ↓ <math>H^+</math></p>	<p>Acute: ↓↓ pH Chronic: ↓ pH</p> <p>↑ <math>Pa_{CO_2}</math> ↑ <math>HCO_3^-</math></p>	<p>Acute: ↑↑ pH Chronic: ↑ pH</p> <p>↓ <math>Pa_{CO_2}</math> ↓ <math>HCO_3^-</math></p>
RESPIRATORY COMPENSATION	<p>Hyperventilation</p> <p>↓ <math>Pa_{CO_2}</math></p>	<p>Hypoventilation</p> <p>↑ <math>Pa_{CO_2}</math></p>	None	None
RENAL COMPENSATION	<p>■ Conserve <math>HCO_3^-</math> ■ Excrete <math>H^+</math></p>	<p>■ Excrete <math>HCO_3^-</math> ■ Conserve <math>H^+</math></p>	<p>■ Conserve <math>HCO_3^-</math> ■ Excrete <math>H^+</math></p>	<p>■ Excrete <math>HCO_3^-</math> ■ Conserve <math>H^+</math></p>
COMMON CAUSES	<p>Normal Anion Gap</p> <ul style="list-style-type: none"> <li>✓ Diarrhea</li> <li>✓ RTA</li> <li>✓ Renal failure</li> </ul> <p>Increased Anion Gap</p> <ul style="list-style-type: none"> <li>✓ Methanol</li> <li>✓ Uremia</li> <li>✓ DKA</li> <li>✓ Paraldehyde</li> <li>✓ Iron</li> <li>✓ Lactate</li> <li>✓ Ethylene glycol</li> <li>✓ Salicylates</li> </ul>	<ul style="list-style-type: none"> <li>✓ Vomiting (↓ <math>H^+</math>)</li> <li>✓ Loop &amp; Thiazide diuretics (↑ <math>HCO_3^-</math>)  <ul style="list-style-type: none"> <li>■ ↓ ECF volume triggers <math>HCO_3^-</math> reabs.</li> </ul> </li> <li>✓ Hyperaldosteronism (↓ <math>H^+</math>)</li> </ul>	<p>Hypoventilation</p> <ul style="list-style-type: none"> <li>✓ Medullary resp. center inhib.  <ul style="list-style-type: none"> <li>■ Sedatives, lesions</li> </ul> </li> <li>✓ Neuromuscular defects</li> <li>✓ Gas exchange defects  <ul style="list-style-type: none"> <li>■ COPD</li> </ul> </li> </ul>	<p>Hyperventilation</p> <ul style="list-style-type: none"> <li>✓ Medullary resp. center stimulation</li> <li>✓ Hypoxemia</li> <li>✓ Physical/mental distress</li> </ul>

**ACID-BASE DISTURBANCES**

**+ Key Terms**

- ✓ *Metabolic Disorder*
- ✓ Imbalance b/w bicarbonate and a fixed (non-volatile) acid.
- ✓ *Respiratory Disorder*
- ✓ Imbalance b/w bicarbonate and  $CO_2$  (volatile) acid.

**Anion Gap**

- ✓ Used to determine etiology of metabolic acidosis.
- ✓ Unmeasured anions = (measured cations) - (measured anions)

$$[Na^+] - ([HCO_3^-] + [Cl^-])$$

12 mEq/L

- ✓ ↑ Anion gap (> 12) means  $HCO_3^-$  has been lost and replaced by unmeasured ions.
- ✓ Normal anion gap means that  $Cl^-$  is the ion that replaced  $HCO_3^-$

Sumber Referensi: [9]





Akibat Asidosis (pH darah <7.35)

Kardiovaskular:

- Penurunan kontraktilitas jantung, yang dapat menyebabkan hipotensi dan syok.
- Risiko aritmia meningkat karena perubahan keseimbangan elektrolit, khususnya kalium (hiperkalemia).

Neuromuskular:

- Kelemahan otot dan kelelahan karena perubahan dalam eksitabilitas neuromuskular.
- Pada kasus asidosis berat, bisa terjadi depresi sistem saraf pusat, yang mengarah pada kebingungan, somnolen, hingga koma.

Respirasi:

- Pernapasan cepat dan dalam (Kussmaul breathing) sebagai upaya kompensasi untuk mengeluarkan CO<sub>2</sub> dan meningkatkan pH darah.

Metabolisme:

- Osteopenia atau osteoporosis jangka panjang karena tubuh mencoba menetralkan asidosis dengan kalsium yang dilepaskan dari tulang.

Sistem Ginjal:

- Ginjal berusaha untuk meningkatkan ekskresi ion hidrogen dan reabsorpsi bikarbonat, yang bisa mengakibatkan penurunan fungsi ginjal jika berlangsung lama.

[Sumber Referensi: \[9\]](#)

# Apa Bahayanya *Alkalosis atau Asidosis*



# Apa Bahayanya *Alkalosis atau Asidosis*

Akibat Alkalosis (pH darah >7.45)

## 1. Kardiovaskular:

- Penurunan aliran darah koroner dan sensitivitas aritmia karena perubahan konsentrasi ion kalsium dan kalium, berpotensi menyebabkan aritmia.

## 2. Neuromuskular:

- Gejala neurologis seperti kejang, tremor, kram otot, parestesia (rasa kesemutan), dan kelemahan otot karena perubahan eksitabilitas neuromuskular.
- Pada alkalosis berat, bisa terjadi konfusi atau delirium.

## 3. Respirasi:

- Depresi pernapasan sebagai upaya kompensasi untuk menahan CO<sub>2</sub> dan menurunkan pH darah.

## 4. Elektrolit:

- Hipokalemia (rendahnya kalium darah) dan hipokalsemia (rendahnya kalsium darah), yang dapat mempengaruhi fungsi otot, jantung, dan saraf.

## 5. Sistem Ginjal:

- Pada alkalosis metabolik, ginjal berusaha untuk menurunkan reabsorpsi bikarbonat dan meningkatkan ekskresi ion hidrogen, yang bisa berdampak pada keseimbangan elektrolit.

[Sumber Referensi: \[9\]](#)



# Tabel Standar

Table 1. **ABG values and clinical significance in critical care**

Measure	Normal values	Clinical significance
PaO <sub>2</sub>	10.7-13.3kPa 80-100mmHg	● <8kPa or <60mmHg = hypoxaemia
pH	7.35-7.45	● <7.35 = acidaemia ● >7.45 = alkalaemia
PaCO <sub>2</sub>	4.7-6kPa 35-45mmHg	● >6kPa or >45mmHg = respiratory acidosis ● <4.7kPa or <35mmHg = respiratory alkalosis
HCO <sub>3</sub>	22-26mmol/L	● <22mmol/L = metabolic acidosis ● >26mmol/L = metabolic alkalosis
Base excess	-2 to +2	The amount of acid (in mmol/L) required to restore 1L of tested blood to a pH of 7.4 ● >+2 mmol/L = metabolic alkalosis or compensating respiratory acidosis ● <-2mmol/L = metabolic acidosis or compensating respiratory alkalosis
SaO <sub>2</sub>	93-98%	● <93% = hypoxia [†]
Hb	>7g/dL	● <7g/dl = anaemia
K <sup>+</sup>	3.5-5mmol/L	Potassium is most commonly found intracellularly, and is needed to maintain heart conduction ● <3.5mmol/L = hypokalaemia ● >5mmol/L = hyperkalaemia
Na <sup>+</sup>	135-145mmol/L	Sodium helps maintain fluid balance and blood pressure ● <135mmol/L = hyponatraemia ● >145mmol/L = hypernatraemia [†]
Lactate	<2mmol/L	Measure of anaerobic respiration

ABG = arterial blood gas; g/dL = grams per decilitre; mmHg = millimetres of mercury; mmol/L = millimoles per litre.  
Sources: Wilkinson et al (2017); Joynt and Choi (2016)

Sumber Referensi: [9]





# Tabel Standar

Table 2. Example ABG results

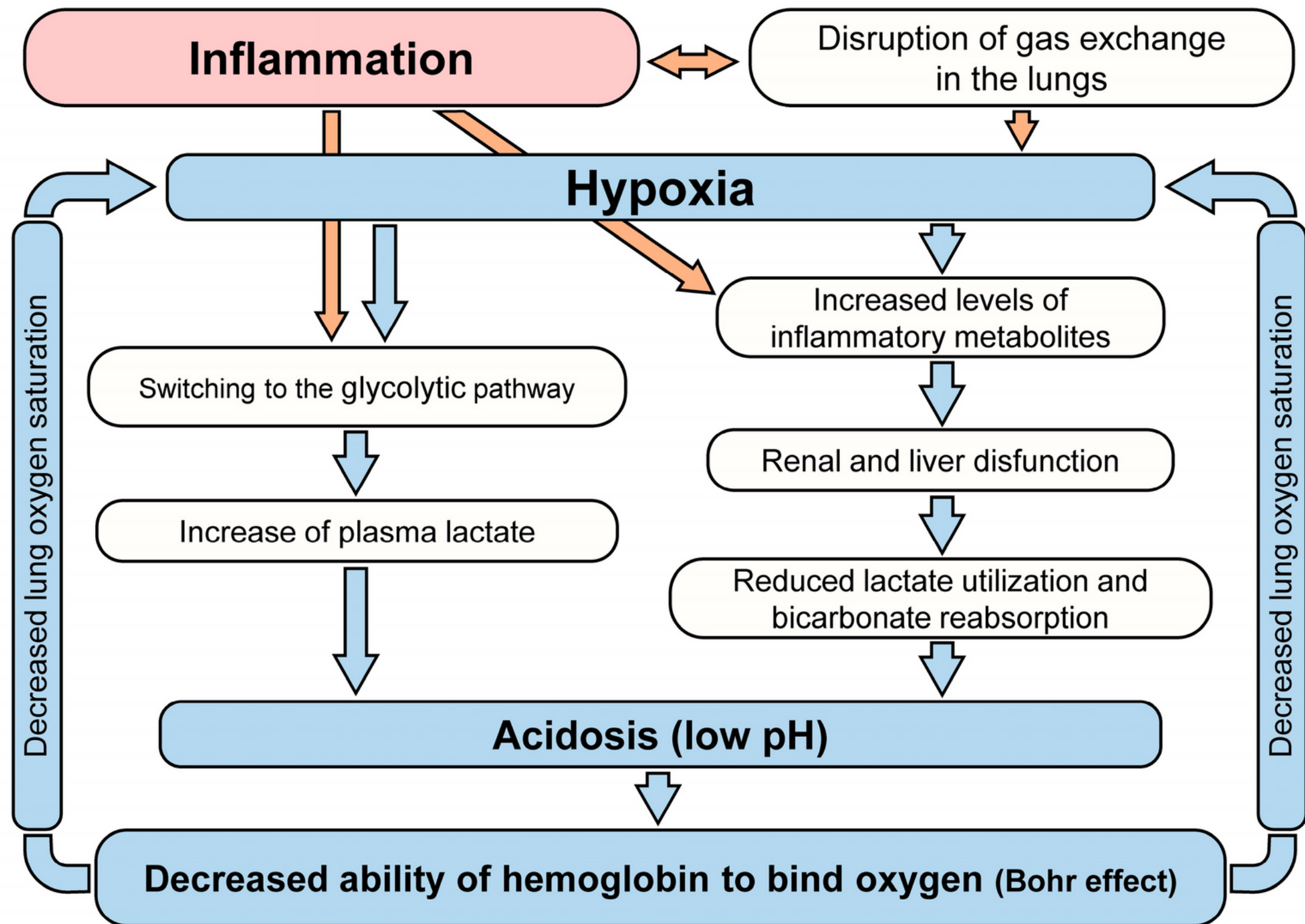
Example	PaO <sub>2</sub>	pH	PaCO <sub>2</sub>	HCO <sub>3</sub>
Example 1	10.5kPa ↔	7.43 ↔, alkalosis side	6.7kPa ↑	32mmol/L ↑
Example 2	11.9kPa ↔	7.3 ↓	12.5kPa ↑	30mmol/L ↑

ABG = arterial blood gas; ↔ in reference range; ↑ above reference range; ↓ below reference range.

[Sumber Referensi: \[9\]](#)



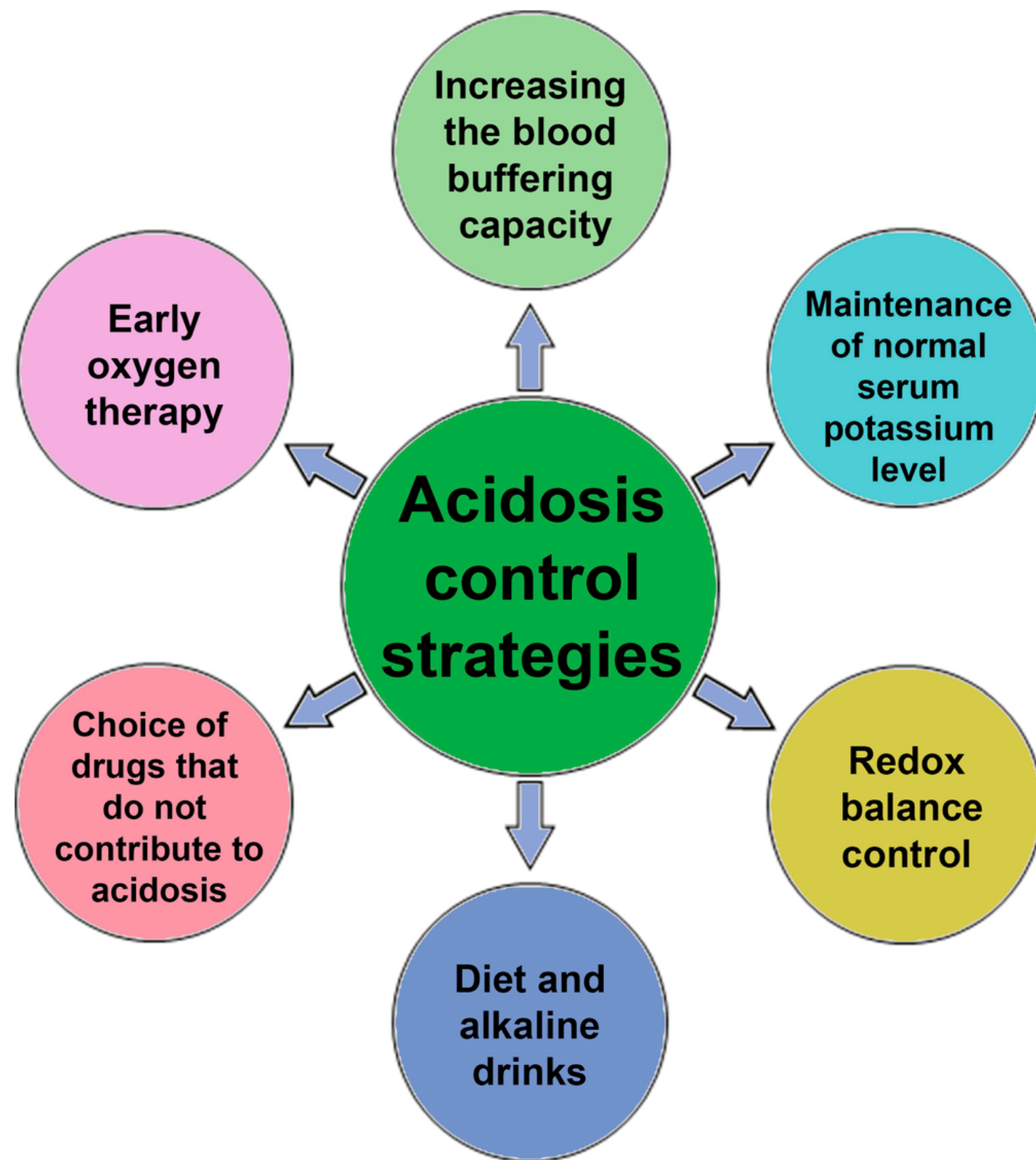
# Hipoksia dan *Inflamasi*



Sumber Referensi: [9]



# Strategi *Keseimbangan BG*



Sumber Referensi: [9]



**Terima Kasih**  
*for Attention*

“Menulislah agar ilmu yang  
kita telah miliki menjadi abadi”

