Wrap up

and few Friday night cases

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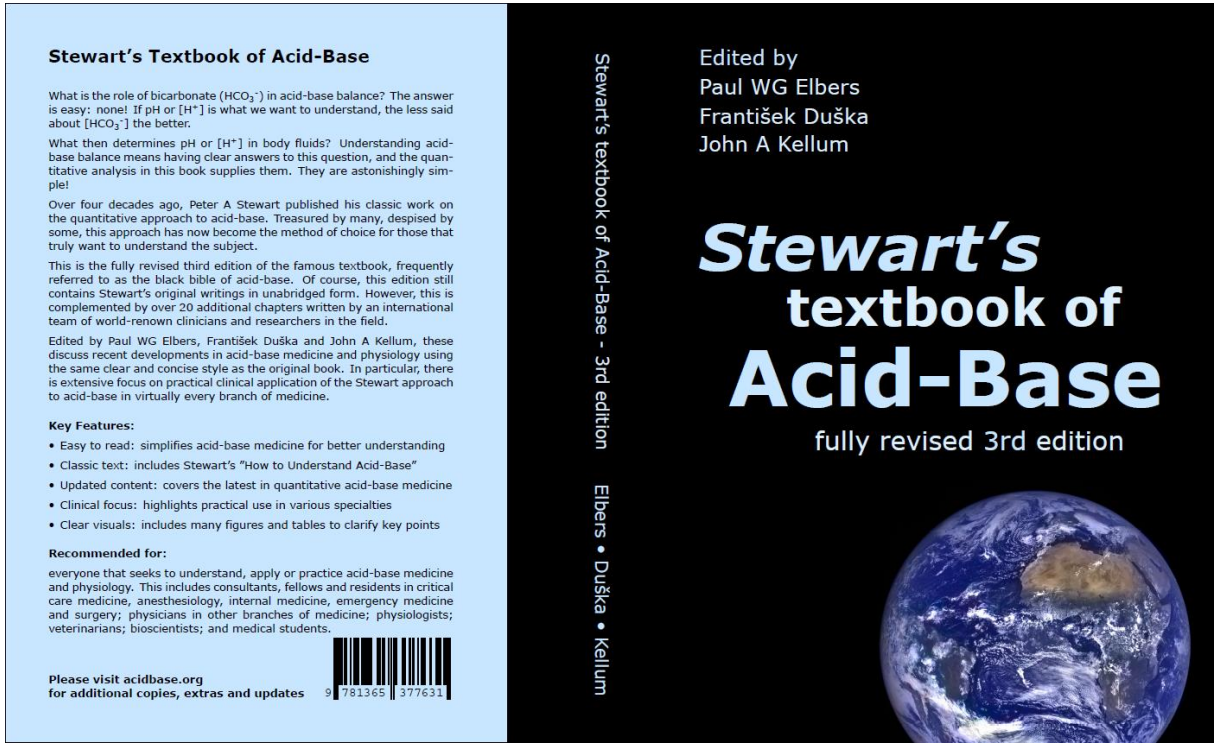

Chapter 29

Example cases

František Duška

29.1 Introduction

Reading a blood gas printout is a daily routine for acute care clinicians, and in most cases, it is interpreted instantly through pattern recognition. However, some cases are more complex and require a deeper, more structured analysis. In this chapter, we will demonstrate the practical use of the simplified electroneutrality-based approach described in the previous chapter for solving complex acid-base cases. The approach, nicknamed "Stewart light" by Niels van Regenmortel, combines Stewartian physical-chemical principles [1] with the pathophysiological foundations laid by the pioneers of the classical approach [2], the empirical "Boston rules" [3] for detecting superimposed

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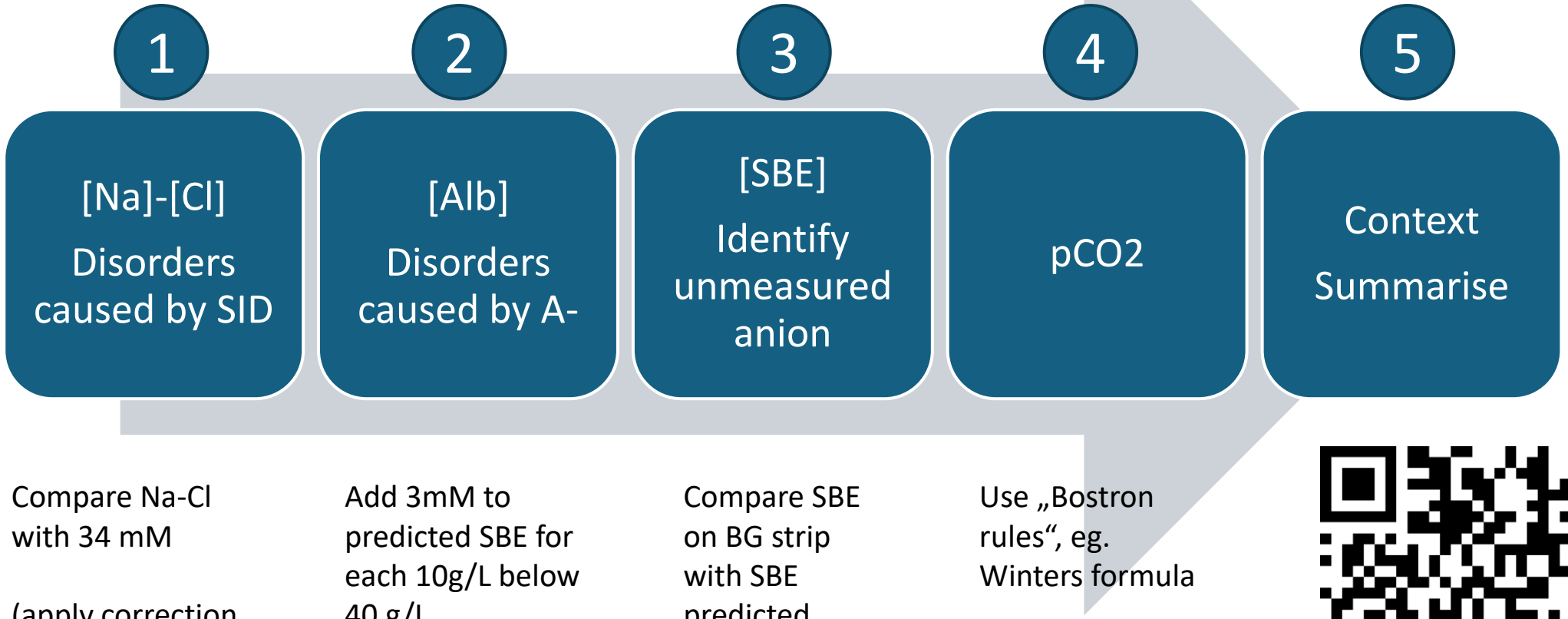
Stewart light approach



Compare Na-Cl with 34 mM

(apply correction to 34 if pH is extreme: +1.5 for pH -0.1)

Add 3mM to predicted SBE for each 10g/L below 40 g/L

Compare SBE on BG strip with SBE predicted.
Look at lactate

Use „Bostron rules“, eg. Winters formula

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Case 1: The “black bible” case

Presentation

Man, 34 years old, known history of alcohol abuse, presented with three days of inability to walk and vomiting. He was confused, tachycardic, and had a blood alcohol level of 0 g/L. Author’s own case.

pH	7.432	Na^+	132 mmol/L	Hb	7.45 mmol/L (12 g/dL)
PCO_2	4.81 kPa (36.1 mmHg)	K^+	4.6 mmol/L	Glucose	8.0 mmol/L (144 mg/dL)
HCO_3^-	24.0 mmol/L	Cl^-	70 mmol/L	Lactate	20 mmol/L
SBE	-0.3 mmol/L			Albumin	22 g/L

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- STEP 1: Calculate Na-Cl, compare with 35 , predict SBE based on this (lower = acidosis)
- STEP 2: Look at Albumin, predict SBE based on this (3 mM for each 10g/L below 40)
- STEP 3: Compare predicted SBE from step 1 and 2 and compare with SBE on blood gas.
  Difference = lactate + unmeasured ions
- STEP 4: Assess pCO2
- STEP 5: Summarise

Write down all disorders you have identified

What acid base disorders are present?

Stewart light dissection

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- Na-Cl = 62 (should be 35) = this predicts BE +27
- Alb = 20g/L = this predicts BE + 6
- I expect BE +33, but it is 0, that means there are 33 mM of negative charge unaccounted for
  - 20 is explained by lactate
  - 13 remains unacounted for = another GOLDMARK anion

Stewart light dissection

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- BE +27 High SIDa (“hypochloridemic”) alkalosis
- BE + 6 Hypoalbuminemic acidosis
- BE - 20 lactic acidosis
- BE -13 another ion acidosis (Ethylenglycol metabolites? Ketones?)

Case 2: Acid base at osmolarity disorders

Presentation

Man, 42 years old with known schizophrenia, was found at home unconscious, intubated at scene. Author's own case. On site, paramedics measured blood glucose of 3.7 mM (67 mg/dL) and administered an intravenous bolus of 40% glucose.

pH	7.170	Na^+	106 mmol/L	Hb	-
PCO_2	5.34 kPa (40.1 mmHg)	K^+	2.3 mmol/L	Glucose	11.5 mmol/L (202)
HCO_3^-	15.8 mmol/L	Cl^-	68 mmol/L	Lactate	1.0 mmol/L
SBE	−10.0 mmol/L			Albumin	40.6 g/L

Q1: Is there any SID disorder (e.g. hypochloremic alkalosis or hyperchloridemic acidosis)?

Is there any SID disorder?

Explanation

- Correct answer: No SID disorder is present

- Na-Cl = 106-68 = 38
  - In normal pH, this would compare with 35, meaning SBE +3
  - BUT with acidosis, Na-Cl normally widens by 1.5 mM for each 0.1 pH drop below 7.4 (this is due to Hamburgers effect/intracellular buffering)
  - Therefore, in our patient with pH 7.15, Na-Cl should be 35 + 3= 38, exactly as measured. No SID disorder is present.
- Take home message: For SID diagnostic at extremes of pH, apply pH correction of Na-Cl reference of 35

(Giosa et al., J Appl Phys, 2023)

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Q2: Assess pCO2.

What respiratory disorder is present?

Explanation

- Correct answer: Respiratory acidosis

- Explanation:
  - Although pCO2 is in normal range, during metabolic acidosis, pCO2 is expected to be lower

What is the expected level of pCO2 in patient with HCO3=15mM?

Explanation

- Correct answer = 4.0 kPa

- Winters formula **$pCO2 = HCO_3^-/5 + 1$ kPa** (±0.3 kPa)

- Take home message: Superimposed respiratory disorders can be diagnosed in patients with metabolic acid base disorders
  - Too little compensation can mean impeding respiratory failure or inappropriate ventilator setting
  - Too much compensation = respiratory alkalosis needs explanation

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Q3: Use Stewart light to quantify non-lactic anion that is present.

How much non-lactic anion is present?

Explanation

- STEP 1: Na-Cl = 38 mM, with pH 7.15, it should be 35+3 = 38, i.e. no SID disorder present (predicted SBE =0)
- STEP 2: Albumin is normal (predicted SBE =0)
- STEP 3: SBE predicted from steps 1 and 2 is 0, but ABG reads SBE= -10 mM. This means 10 mM of anions, and this is not lactate. Hence, unmeasured anions are 10 mM

Further investigations revealed starvation ketosis and hypoosmolarity due to polydipsia. Patient recovered.

Do you have more questions?

- What is exactly the cause of hyponatremia and how do I find out?
- What will 2 L of 0.9 NaCl i.v. do with acid base status of this patient?
- How do I interpret the blood gas and set the ventilator if patient temperature turns out to be 32 C?
- And many more?

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