



**Third Faculty
of Medicine**
Charles University

Summer School of Clinical Acid-Base and Homeostasis

5th Edition · 9 to 12 September 2026 · Prague · Third Faculty of Medicine, Charles University

The Stewart computer modelling station: Session II

Room 523. Friday 11 September, 12:30 to 16:30. The cases, in order.

Answers are overleaf, so do not turn over until you have one. Application: Stewart Lite v0.6.0.

Block B, 4 minutes. Case 1

 **CLINICAL CASE** A 68-year-old man, day 1 after emergency laparotomy for a perforated sigmoid. He was resuscitated overnight with about six litres of 0.9% saline. He is warm, making urine, and the lactate is normal. The morning gas shows a base excess of -12 and the surgical team asks whether the bowel is ischaemic. This is yesterday's Case 1 back again, and it is here because the answer is already known: the whole disorder is the chloride.

The gas and the panel. This page takes six numbers and no more; potassium, calcium, magnesium and phosphate are held at normal and are not offered.

pH	7.18		7.35 to 7.45
pCO ₂	40.0 mmHg / 5.3 kPa		35 to 45 / 4.7 to 6.0
Na ⁺	144	mmol/L	136 to 145
Cl ⁻	120	mmol/L	98 to 107
Albumin	44	g/L	35 to 50
Lactate	1.0	mmol/L	0.5 to 1.6

Do it by hand first, then load the preset **Hyperchloraemic acidosis**, the second in the list.

what the page adds	Normal	This patient	
Base excess (SBE)	0.0	-12.0	mEq/L
SBE from Na ⁺ – Cl ⁻	0.0	-11.0 (-12.0)	
SBE from albumin	0.0	0.0 (0.0)	
SBE from lactate	0.0	0.0 (0.0)	
SBE from unmeasured anion	0.0	-1.0 (+0.0)	
Strong ion gap recovered	2.8	3.8	against a true 2.8

The arithmetic, written out. Na⁺ – Cl⁻ is 144 – 120 = **24** against a reference of 35, so the first term is 24 – 35 = **-11.0**. The albumin is 44, unchanged, so the second term is **0.0**. The lactate is 1.0, unchanged, so the third is **0.0**. Those three predict a base excess of **-11.0** and the gas says **-12.0**, so:

$$\text{what is left} = \text{base excess} - \text{the three terms} = -12.0 - (-11.0) = \mathbf{-1.0}$$

 **QUESTION** The chloride alone predicts a milliequivalent less acidosis than the patient actually has. Is that milliequivalent an unmeasured anion?

✔ **ANSWER No, and the full model says so.** Its own remainder, the bracketed number, is **+0.0** and its strong ion gap is **2.8** against a normal of 2.8. Nothing unmeasured has appeared and nothing has gone. The milliequivalent is the shortcut's own error, and this case exists to measure it.

It is not $\text{Na}^+ - \text{Cl}^-$ standing in for SIDa. That substitution is exact in this patient: potassium, calcium, magnesium and lactate are all normal, so SIDa fell by 11.0 and $\text{Na}^+ - \text{Cl}^-$ fell by 11.0 as well. Nor is it the albumin coefficient, whose bar reads zero and is right to.

It is the step from strong ions to base excess. The rule assumes that if the strong ion difference falls by 11, the base excess falls by 11. It falls by 12.0, because as the pH drops the weak acids take up protons and hand charge back, and because the base excess formula carries a pH term of its own. The two do not cancel. That is why the whole discrepancy sits on the first bar, **-11.0 against the model's -12.0**: that bar is not the ion difference, it is the base excess the ion difference buys.

And why is the recovered gap positive at all? Because a healthy person's is: normal plasma carries about 2.8 mEq/L of anion this arithmetic does not name, and that is the zero of this page. A leftover of -1.0 therefore means 1.0 *more* unmeasured anion than normal, and the page says so: $2.8 + 1.0 = 3.8$, against a true 2.8. A gap is a number well above 2.8, not a number above zero.

Block C, 6 minutes. Case 2

CLINICAL CASE The case van Regenmortel presents in his lecture. An 83-year-old woman, resuscitated in her nursing home after a cardiac arrest, and now back with a circulation of her own. The gas an hour later is the reason it is worth walking through: pH 7.34, pCO₂ 47, bicarbonate 24.3, base excess −1.8. On paper there is almost nothing wrong. The lactate is 9. The albumin is 23, the potassium 2.6, and the creatinine is normal at 0.97 mg/dL, so this is not a kidney that has stopped.

The arterial blood gas:

pH	7.34		7.35 to 7.45
pCO ₂	47 mmHg / 6.3 kPa		35 to 45 / 4.7 to 6.0
HCO ₃ [−] , calculated	25.1	mmol/L	22 to 26
Base excess (SBE), calculated	−0.2	mmol/L	−2 to 2
Lactate	9.0	mmol/L	0.5 to 1.6
Anion gap	17	mmol/L	8 to 16

The italic lines are recomputed from the pH and the pCO₂, as the page does. His slide printed 24.3 and −1.8; the answer overleaf says why.

From the laboratory:

Na ⁺	141	mmol/L	136 to 145
K ⁺	2.6	mmol/L	3.5 to 5.1
Cl [−]	99	mmol/L	98 to 107
Albumin	23	g/L	35 to 50
Creatinine	0.97	mg/dL	0.6 to 1.1

Do the three subtractions by hand first. Sodium minus chloride is 141 − 99 = **42**, against 35, so **+7.0**. The albumin term is 0.3 × (44 − 23) = **+6.3**. The lactate term is −(9.0 − 1.0) = **−8.0**. Those three say her base excess ought to be about **+5.3**, and the gas says **−0.2**. Write down the difference: it is what nothing on the panel explains.

Then load **Van Regenmortel: CPR, lactate 9**. The full model's answer is in brackets.

what the page adds	Normal	This patient	
Na ⁺ − Cl [−]	35.0	42.0	against a reference of 35.0
A [−] from albumin	12.3	6.0	mEq/L
Base excess (SBE)	0.0	−0.2	mEq/L
pCO ₂ artefact	0.0	0.0 (−0.5)	
SBE from Na ⁺ − Cl [−]	0.0	+7.0 (+7.3)	
SBE from albumin	0.0	+6.3 (+6.3)	
SBE from lactate	0.0	−8.0 (−8.5)	
SBE from unmeasured anion	0.0	−5.5 (−4.8)	
Strong ion gap recovered	2.8	8.3	against a true 7.2

? TWO QUESTIONS Nobody is going to miss a lactate of 9 after a cardiac arrest. Name the two disorders a base excess near zero is hiding, and say whether they are bigger or smaller than the lactate.

✔ **ANSWER Two alkaloses, and together they are bigger than the lactate.** A sodium-chloride difference of 42 against 35 is **+7.0**, and an albumin of 23 is another **+6.3**: **+13.3** of alkalosis in a woman nobody would have called alkalotic. Against them, the lactate is **-8.0** and a further **-5.5** is acid that nothing on the panel measured. Four things are wrong and they cancel, which is the only reason the base excess reads **-0.2**. Treat that number and you will treat none of them.

Your arithmetic and the page agree: $-0.2 - (7.0 + 6.3 - 8.0) = -5.5$.

Why his slide's -1.8 is not in the table. It is almost certainly the base excess of whole blood, which carries the haemoglobin; Stewart light needs the standard base excess of the extracellular fluid, and from pH 7.34 and pCO₂ 47 that is **-0.2**. His bicarbonate of 24.3 does not quite fit his own pH and pCO₂ either, which give 25.1. Read a base excess off an analyser only once you know which one it is.

In his lecture the same patient reads -13. Van Regenmortel uses two terms, with albumin as $0.25 \times (40 - \text{albumin})$ and no lactate term, so everything he cannot name lands in one bucket. On this page that bucket is two bars: **-8.0** of lactate and **-5.5** of the rest, **-13.5** together. The same finding: of his 13, the lactate explains 8 and something unmeasured explains 5.

Every bar is measured from a healthy person, not from zero. Written the way the papers write it, a normal person reads +4.0, -0.5, -1.0 and -2.0: four numbers that happen to cancel. Here a healthy person reads zero on all four, so a bar that is not zero is a thing that is wrong.

Two footnotes worth saying out loud. Her potassium is 2.6, and this page holds potassium at normal, so the strong ion gap it recovers is about a milliequivalent out on that account alone. And her pCO₂ is 47, not 40, which is why the first bar is no longer flat: a plasma with nothing metabolically wrong with it reads a base excess of -0.5 at this pCO₂, and the bedside method has no term for that at all.

Block D, 9 minutes. Case 3

CLINICAL CASE Duška's own case. A man of 34 with a known history of alcohol abuse, brought in after three days of vomiting and an inability to walk. He is confused and tachycardic. His blood alcohol is zero, so whatever this is, it is not the drink he had last night. The blood gas comes back and nobody is worried, because on the gas there is nothing to be worried about: pH 7.43, pCO₂ 36.1 mmHg, bicarbonate 24.0, base excess -0.3. The chloride, when the panel arrives, is 70.

pH	7.43		7.35 to 7.45
pCO ₂	36.1 mmHg / 4.8 kPa		35 to 45 / 4.7 to 6.0
HCO ₃ ⁻	24.0	mmol/L	22 to 26
Base excess	-0.3	mmol/L	-2 to 2
Na ⁺	132	mmol/L	136 to 145
K ⁺	4.6	mmol/L	3.5 to 5.1
Cl ⁻	70	mmol/L	98 to 107
Albumin	22	g/L	35 to 50
Glucose	8.0	mmol/L	3.9 to 5.6
Lactate, sent later	20.0	mmol/L	0.5 to 1.6

Do the first two terms by hand before you touch the computer, and do them without the lactate, the way the ward had it. Then load **Duška's case**.

what the page adds	Normal	This patient	
Na ⁺ - Cl ⁻	35.0	62.0	against a reference of 35.0
A ⁻ from albumin	12.3	5.7	mEq/L
Base excess (SBE)	0.0	-0.2	mEq/L
pCO ₂ artefact	0.0	0.0 (+0.3)	
SBE from Na ⁺ - Cl ⁻	0.0	+27.0 (+27.9)	
SBE from albumin	0.0	+6.6 (+7.1)	
SBE from lactate	0.0	-19.0 (-19.6)	
SBE from unmeasured anion	0.0	-14.8 (-16.0)	
Strong ion gap recovered	2.8	17.6	against a true 17.5

? TWO QUESTIONS Without the lactate, what does the arithmetic predict the base excess should be, and what does the gas actually say? And once the lactate arrives at 20, is the account closed?

✔ **ANSWER** Without the lactate: the arithmetic predicts **+34** and the gas says zero. $\text{Na}^+ - \text{Cl}^-$ of 62 against 35 is **+27**, an alkalosis, and it is enormous. An albumin of 22 is another **+6.6**. Those two are on the first panel and they are worth **+33.6** between them, so a patient whose base excess is -0.3 is carrying **34 mEq/L of acid that the first panel did not measure**. Nothing on the gas says that. A base excess of zero is not the absence of a disorder; here it is four disorders adding to zero.

Then the lactate comes back at 20 and closes two thirds of the hole: **-19.0** on this page, measured from a normal of 1.0. Nearly fifteen still do not add up. **He died of fulminant liver failure a few hours later**. The likeliest anions are **ketones** (mostly β -hydroxybutyrate, which the dipstick misses) and organic anions a failing liver no longer clears, with **pyroglutamate** if he took paracetamol. A toxic alcohol still has to be excluded with the osmolal gap.

Four disorders in one patient, and the page names all four:

- **+27.0** hypochloraemic (high SIDa) alkalosis
- **+6.6** hypoalbuminaemic alkalosis
- **-19.0** lactic acidosis
- **-14.8** acidosis from something still unmeasured

Duška's own dissection of this case reads +27, +6, -20 and -13, and the difference is the two anchors from Block A: his albumin term starts from 40 rather than 44, and his lactate term from zero rather than 1.0. Two milliequivalents between the two answers, all of it convention, none of it disagreement about the patient. His slide prints a base excess of -0.3 and a bicarbonate of 24.0; this page, from his pH and his pCO_2 , computes -0.2 and 23.7 with its own constants.