A Patient with Hypokalemia and Hypoxemia—What Is the Culprit?

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CASE DESCRIPTION

A 72-year-old female presented to the hospital with a 2-month history of poor oral intake and lethargy. There was no history of vomiting or diarrhea, and she was not on any medications. On admission, she had a body temperature of 37.2°C, blood pressure of 110/73 mmHg, pulse rate of 111/minute, respiratory rate of 19/minute and oxygen saturation (Carescape V100, GE Healthcare) under room air was 98%. An electrocardiogram showed no conduction abnormality. Cardiovascular and respiratory systems were unremarkable, and abdominal examination did not reveal hepatosplenomegaly. She had no muscle weakness.

Blood investigations revealed hyperleukocytosis with anemia, thrombocytopenia, and severe hypokalemia (Table 1). Immunocytochemistry confirmed the diagnosis of acute myeloid leukemia with the presence of 93% blasts. Other abnormal blood results include hyperuricemia, raised lactate dehydrogenase, raised creatinine, hypoproteinemia, and hypoalbuminemia (Table 1). She was started on intravenous potassium replacement (40 mmol over 24 hours, Injecsol K10; Ain Medicare Sdn. Bhd.) given in 1000 mL 0.9% NaCl and oral hydroxyurea (500 g stat and 1 g once daily, DHNP Hydroxyurea®; Dae Han New Pharm). The serum potassium concentration obtained 24 hours later following treatment (Table 1) had worsened. A repeated blood sample with a shorter time interval between blood collection and analysis [blood collected in a blood gas syringe, placed on ice, and immediately analyzed on a point-of-care (POC) blood gas analyzer (ABL90 Flex analyzer, Radiometer)], had a higher potassium level of 2.9 mmol/L.

During her ward admission, the patient developed a fever of 39.4°C. Blood culture with sensitivity, arterial blood gas measurements (Table 1), and chest x-ray were ordered in response. The blood gas sample was placed on ice at the point of collection and for transport to the nearest POC analyzer. The arterial oxygen tension (PO2), and arterial oxygen saturation (SaO2) measured on the sample were discrepant from the chest radiograph findings and peripheral oxygen saturation as measured by pulse oximetry (Carescape V100, GE Healthcare) (Table 1). The patient also did not exhibit any respiratory distress or cyanosis.

Blood culture subsequently confirmed Streptococcus dysgalactiae bacteremia. Despite being started on intravenous piperacillin and tazobactam (4.5 g 6 hourly, Tazocin EF, Pfizer), supportive care with antipyretics—acetaminophen (1 g 6 hourly, Paracil, SM Pharmaceuticals Sdn. Bhd.) and oral potassium replacement (16 mmol 8 hourly, Potrelease TR, SM Pharmaceuticals Sdn. Bhd.)—the patient deteriorated and passed away on day 3 of admission.

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QUESTIONS TO CONSIDER	
1.	What are the possible causes of hypokalemia and hypoxemia in this patient?
2.	What are possible causes of discrepant potassium and oxygen saturation results?
3.	How can the laboratory identify falsely low potassium and oxygen saturation results?
4.	What can be done to minimize the incidence of pseudohypokalemia and pseudohypoxemia in a patient with hyperleukocytosis?

Table 1 follows on the next page.

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Table 1. Baseline laboratory blood test results on and following hospital admission.

Parameter	Admission	24 hours after admission	48 hours after admission	72 hours after admission	Unit	Reference interval
Hematology						
Hemoglobin	7.1	6.2	5.5	4.9	g/dL	13.0–17.0
WBC	181.0	352.3	423.4	412.9	10^9/L	4.0–10.0
Platelets	85	86	111	45	10^9/L	150–450
Renal profile						
Blood urea nitrogen	8	7	9	16	mg/dL	8–23
Sodium	130	137	140	142	mmol/L	136–145
Potassium	2.2	1.7[a] 2.9[b]	3.1	2.5	mmol/L	3.4–4.5
Creatinine	0.97	1.01	0.98	1.23	mg/dL	0.50–0.90
eGFR	58	56	58	44	mL/min/1.73 m^2	>90
Liver function test						
Total protein	—	—	65	—	g/L	66–87
Albumin	—	—	18	14	g/L	35–52
Globulin	—	—	47	—	g/L	20–36
Total bilirubin	—	—	0.76	—	mg/dL	<1.23
Alanine transaminase	—	—	35	—	U/L	10–35
Alkaline phosphatase	—	—	123	—	U/L	35–104
Other investigations						
Uric acid	—	407	249	—	umol/L	143–339
Lactate dehydrogenase	—	918	—	—	U/L	<250
Magnesium	—	—	—	0.89	mmol/L	0.66–0.99
Phosphorus	—	—	—	0.6	mmol/L	0.8–1.5
Oxygenation readings						
pH[b]		7.46		7.43	—	7.35–7.45
PCO_2[b]		35		26	mmHg	35–45
PO_2[b]		13		30	mmHg	75–100
SaO_2[b]		17		63	%	94–100

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Table 1. (continued)

Parameter	Admission	24 hours after admission	48 hours after admission	72 hours after admission	Unit	Reference interval
SpO_2[c]		97		97	%	94–100
FMetHb[b]		0		0	%	0–3
$sHCO_3$[b]		25		18	mmol/L	22–28
Inspired oxygen		Room air		3L/min nasal canula	—	—

Conversion factors: blood urea nitrogen (mg/dL)×0.357 = urea (mmol/L); creatinine (mg/dL)×88.42 = creatinine (umol/L); bilirubin (mg/dL)×17.1 = bilirubin (umol/L); uric acid (umol/L)×0.02= uric acid (mg/dL).

eGFR, estimated glomerular filtration rate based on Chronic Kidney Disease Epidemiology Collaboration; PCO_2, arterial carbon dioxide tension; SpO_2, peripheral oxygen saturation; FMetHb, methemoglobin fraction; $sHCO_3$, standard bicarbonate.

[a]Sample transported in room temperature to the laboratory analyzer (Cobas 6000 autoanalyzer, Roche Diagnostics) (estimated time from blood collection to analysis is 60 minutes).

[b]Sample transported in ice slurry to a POC analyzer (ABL90 Flex analyzer, Radiometer) (estimated time from blood collection to analysis is 15 minutes).

[c]Readings obtained via pulse oximeter (Carescape V100, GE Healthcare).

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Final Publication and Comments

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