Not all unexplained hyperkalaemia is pseudohyperkalaemia

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ABSTRACT

We describe a patient with hyperkalaemia due to localised rhabdomyolysis caused by upper limb ischaemia. Initially, this was erroneously classified as pseudohyperkalaemia, as an earlier measurement of potassium concentration in a venous sample from the contralateral arm was within the reference range. Detailed scrutiny of pathology test results from a second sample by laboratory staff revealed high concentrations of creatine kinase and lactate dehydrogenase, raising the possibility of rhabdomyolysis caused by localised ischaemia. This led clinical staff to reassess the patient, confirming a local arterial occlusion in the arm. This was successfully treated with embolectomy. This report highlights the importance of systematic scrutiny of pathology results, especially when they do not fit the "clinical picture", and the crucial role of the laboratory in aiding the clinician.

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Clinical record

A 62-year-old man was brought to the emergency department with chest pain radiating to the left arm along with tingling and cold sensations, with onset within the previous 90 minutes. He was noted to be confused. The chest pain decreased with glyceryl trinitrate spray and morphine given by the paramedics.

On clinical examination, the patient was noted to have a water hammer pulse and systolic and diastolic heart murmurs consistent with known mixed aortic–valve disease. Initial examination revealed no radioradial or radiofemoral delay, but the left radial pulse was thought to be weaker than the right. Although no objective weakness was found on examination, he had decreased sensation on the lateral border of the left arm and was unable to adduct or abduct his left fingers.

The patient's past medical history included type 2 diabetes mellitus, hypertension, and ischaemic and valvular heart disease. A recent coronary angiogram showed triple vessel disease with moderate aortic stenosis. He was awaiting coronary artery bypass graft surgery and aortic valve replacement. The initial differential diagnosis was acute coronary syndrome or aortic dissection.

Biochemical analysis of an initial blood sample taken at 11:15 revealed a potassium concentration of 3.3 mmol/L (reference range, 3.5–4.5 mmol/L) (Table 1). An arterial blood gas specimen taken at 15:15, before computed tomography (CT), showed mixed respiratory and metabolic acidosis, a minimal increase in lactate concentration, and potassium concentration again in the reference range. The CT scan of the brain appeared essentially normal, and a CT angiogram ruled out aortic dissection.

On return from the radiology department, the patient became increasingly unwell, and acute pulmonary oedema was diagnosed. An attempted arterial blood gas puncture at 15:50 resulted in inadvertent collection of venous blood, which revealed a potassium concentration of 8.5 mmol/L. This raised level was thought to be due to haemolysis. A second venous blood sample was taken immediately for repeat analysis, which confirmed a raised potassium concentration.

As is often the case, no clinical information was provided on the pathology request form. A biochemistry staff member immediately contacted the treating clinician to discuss the blood gas and enzyme results (specifically lactate dehydrogenase and creatine kinase). The staff member suggested that the rapid change in biochemical parameters might be a result of the samples being collected from different arms, and raised the possibility of isolated left-arm ischaemia with subsequent rhabdomyolysis (Table 1). It emerged that the first blood sample (at 11:15) had been collected from the right arm, and the venous blood gas and second venous specimens (at 15:50 and 15:55, respectively) from the left arm.

On re-examination of the patient, it was noted that radial and brachial pulses were absent in the left arm. An urgent Doppler ultrasound examination showed occlusion of the left axillary artery proximal to the brachial artery. The patient underwent urgent embolectomy, which removed a 6 cm-long blood clot, restoring perfusion to his left arm and forearm. Microbiological examination of the clot showed gram-positive cocci, and *Streptococcus oralis* was grown on culture.

Discussion

The typical features of acute arterial occlusion causing limb ischaemia include pain, swelling, weakness of the affected limb, pallor, paraesthesia, pulselessness and paralysis.[1] However, about 50% of patients do not display all these

Table 1. Biochemistry results, by sampling site (right or left arm) and time

Analyte	Right arm 11:15	Right arm (arterial) gas 15:15	Left arm (venous) gas 15:50	Left arm 15:55	Right arm 18:00	Reference range
Blood concentrations						
Sodium (mmol/L)	128			128	130	135–145
Potassium (mmol/L)	3.3	4.0	8.5	8.2	4.2	3.5–4.5
Urea (mmol/L)	5.9			5.7	5.9	2.9–8.2
Creatinine (μmol/L)	110			126	115	70–120
Glucose (mmol/L)	15.9			15.8	15.1	3.8–7.8
Alanine aminotransferase(U/L)	34			68	58	< 45
Aspartate aminotransferase (U/L)	50			199	132	< 35
Lactate dehydrogenase (U/L)	498			850	660	150–280
Creatine phosphokinase (U/L)	86			11 400	4770	46–171
Troponin I (μg/L)	0.4			0.4	1.1	< 0.04
Blood gas analysis						
pH		7.21	6.83			7.35–7.50 (arterial), 7.32–7.42 (venous)
PCO_2 (mmHg)		60	130			35–45 (arterial), 41–51 (venous)
PO_2 (mmHg)		87	34			80–100 (arterial), 25–40 (venous)
Lactate concentration (mmol/L)		4.0	10.1			0.7–2.5

manifestations,[2] as exemplified by our patient. In his case, the symptoms were atypical for both angina and arterial occlusion. It is likely that the embolus initially caused partial occlusion of the left axillary artery, and the clot progressively led to complete occlusion. Severe or prolonged limb ischaemia can lead to rhabdomyolysis, resulting in myoglobinuria and tea-coloured urine.[3] With localised rhabdomyolysis, this may not be evident.

In our patient, the dramatic differences between the two blood gas samples with respect to PCO_2 and lactate and potassium concentrations was the first clue to a localised ischaemic process, which was readily identified by the laboratory staff. Their interpretation of these results was further aided by the fact that other biochemical parameters remained unchanged, while indicators of skeletal muscle necrosis (potassium, lactate dehydrogenase and creatine kinase concentrations) increased rapidly. Lactate dehydrogenase is a non-specific marker, but is very useful when organ or limb ischaemia is present.

Hyperkalaemia occurs in 1%–10% of hospitalised patients.[4] Frequently adding to the difficulty of interpreting a raised potassium concentration is the phenomenon of pseudohyperkalaemia resulting from cell lysis (haemolysis, white cell lysis, most prominent in leukocytosis, or platelet lysis in thrombocytosis)[5] or the use of a tourniquet with fist clenching during phlebotomy.[6] Samples from emergency departments are the most common source of in-vitro haemolysed samples.[5,7,8] In our hospital, the frequency of grossly haemolysed samples (haemolysis index > 6.0 g/L) has been found to be 0.14%, with 54% of these samples originating in the emergency department.[5] The consequence is that clinicians often attribute "unexplainable hyperkalaemia" to haemolysed specimens, as in our case.

However, in our patient, neither of the two samples had clinically significant levels of haemolysis (haemolysis index, < 0.5 g/L), and the localised hyperkalaemia in the lower left arm was real. However, comparison with a measurement from the contralateral arm could have led to the erroneous diagnosis of pseudohyperkalaemia. Of interest is the observation that the potassium released from muscle breakdown in the left arm was not sufficient to cause systemic hyperkalaemia, as indicated by the potassium level observed in a blood sample collected later from the right arm (at 18:00). It was fortunate the laboratory alerted the emergency department treating team of the likely potassium source (ischaemia of the arm) in the sample collected at 15:50, and treatment for hyperkalaemia was not initiated.

This case highlights the importance of systematic scrutiny of pathology results, the potential risk in dismissing an elevated serum potassium concentration as pseudohyperkalaemia when this does not fit the "clinical picture", and the crucial role of the laboratory in aiding the clinician. Clinicians and laboratory staff should be vigilant for unusual causes of hyperkalaemia and work together to diagnose

promptly before inappropriate treatment is instituted, to minimise unfavourable outcomes.

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References

1 Norgren L, Hiatt WR, Dormandy JA, et al; TASC II Working Group. Inter-society consensus for the management of peripheral arterial disease (TASC II). *Eur J Vasc Endovasc Surg* 2007; 33 Suppl 1: S1-75.

2 Bagley WH, Yang H, Shah KH. Rhabdomyolysis. *Intern Emerg Med* 2007; 2: 210-8.

3 Slater MS, Mullins RJ. Rhabdomyolysis and myoglobinuric renal failure in trauma and surgical patients: a review. *J Am Coll Surg* 1998; 186: 693-716.

4 Mahoney BA, Smith WA, Lo DS, et al. Emergency interventions for hyperkalaemia. *Cochrane Database Syst Rev* 2005; (2): CD003235.

5 Dimeski G, Clague AE, Hickman PE. Correction and reporting of potassium results in haemolysed samples. *Ann Clin Biochem* 2005; 42: 119-23.

6 Schaefer TJ, Wolford RW. Disorders of potassium. *Emerg Med Clin North Am* 2005; 23: 723-47.

7 Pretlow L, Gandy T, Leibach EK, et al. A quality improvement cycle: hemolyzed specimens in the emergency department. *Clin Lab Sci* 2008; 21: 219-24.

8 Grant MS. The effect of blood drawing techniques and equipment on the hemolysis of ED laboratory blood samples. *J Emerg Nurs* 2003; 29: 116-21. ❑