Novel treatment (new drug/intervention; established drug/procedure in new situation)

Parallel haemodialysis and surgery saves a life after massive overdose of potassium pills

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Summary

Severe poisoning with potassium pills is rare but patients may present with serious cardiovascular symptoms requiring immediate and effective treatment. A 30-year-old healthy woman presented to the emergency department after ingestion of 300 slow-release pills of potassium-chloride with serum potassium of 9.5 mmol/l, and poor cardiovascular function. Gastric lavage was performed with poor outcome. Despite intensive medical treatment serum potassium remained very high around 9 mmol/l. Haemodialysis was initiated but despite ongoing dialysis, potassium increased to 10.3 mmol/l. Hence, a parallel dialysis was started and after 4 h of parallel dialysis, serum potassium decreased to 6.4 mmol/l. An x-ray revealed large amounts of pills remaining in the stomach and the surgeon was able to remove about 200 pills through an acute laparotomy. The patient recovered slowly thereafter, but later developed a gastric stricture and pulmonary embolism.

BACKGROUND

Tablets containing slow-release potassium are widely prescribed in the treatment of hypokalaemia but seldom used for intentional overdose. Acute overdoses of enteral potassium salts rarely cause hyperkalaemia in healthy patients with normal renal function, due to the kidneys capacity to excrete the potassium load, and the propensity of potassium tablets to induce early emesis.¹ Despite many exposures, there are only a few published cases of severe hyperkalaemia in otherwise healthy patients following intentional intoxication.²

Intentional overdose of potassium chloride slow-release tablets may lead to severe hyperkalaemia with symptoms such as nausea and vomiting, bradycardia, slowed conduction, hypotension, supraventricular and ventricular arrhythmias including therapy resistant ventricular fibrillation and finally asystole.³ Also neuromuscular symptoms may present such as weakness, paresthesias, hyporeflexia and paralysis. Electrocardiographic manifestations of hyperkalaemia vary from the classic sine-wave rhythm, which occurs in severe hyperkalaemia, to non-specific repolarisation abnormalities seen with mild elevations of serum potassium. Small-bowel or gastric ulcerations may follow the use of enteric coated potassium chloride tablets, potentially causing local pain, inflammation and intestinal stenoses.⁴

Standard treatment includes the intravenous injection of calcium to counteract the cardiac and neuromuscular symptoms of hyperkalaemia.⁵ Intravenous use of sodium bicarbonate causes rapid movement of potassium into the cells. Similarly, the administration of glucose and insulin causes an intracellular shift of potassium with effect after approximately 30 to 60 min. Sodium polystyrene sulphate is a cation-exchange resin that can be orally or rectally administered. The resin compounds exchange sodium for potassium and work within an hour of administration.

If an immediate decrease in serum potassium is required, additional treatment modalities are therefore

necessary. Standard veno-venous haemodialysis is known to effectively remove serum potassium and may be used in haemodynamically stable patients, especially those with renal failure.⁶

We here describe a case of extreme hyperkalaemia after an intentional intoxication requiring both haemodialysis and surgery to recover.

CASE PRESENTATION

A 30-year-old physically healthy but mentally depressed woman ingested approximately 300 slow-release pills of potassium chloride with suicidal intent, each tablet containing 750 mg KCl or 10 mEq potassium – in total 225 g of potassium. The woman had a medical history of asthma and endogenous depression with one previous suicidal attempt. She was drowsy and dazed on presentation to the emergency department (ED) approximately 5 h after ingestion. Initial blood pressure was 60/35 mm Hg, serum potassium was 9.5 mmol/l and ECG showed a sine-wave tachycardia. Treatment was initiated with intravenous doses of calcium gluconate, glucose and insulin and sodium bicarbonate. Following initial stabilisation, she was transferred to the intensive care unit for further observation and treatment. Serum potassium levels remained very high, at around 9 mmol/l. The patient was intubated and placed on a ventilator in the intensive care unit (ICU). The patient was also given 15 g of sodium polystyrene sulphate orally as well as rectally to counteract her hyperkalaemia. Gastric lavage was performed with very poor result. Following intensive medical treatment including glucose and insulin, 1 mg salbutamol and 300 mmol of sodium bicarbonate, serum potassium remained high at 8.5 mmol/l.

TREATMENT

In consultation with the on-call nephrologist, haemodialysis (HD) was instituted via a dialysis catheter in the right femoral vein 2 h after arrival. HD was initiated

with a dialysate filter (FX100) with an area of 2.2 m², a blood flow (Qb) of 150 ml/min and a dialysate flow (Qd) of 500 ml/min. Four hours after starting HD, blood flow was increased to 250 ml/min, since serum potassium levels increased to 10.3 mmol/l. Two hours later, potassium

Figure 1 Abdominal radiograph approximately 15 h after ingestion showing multiple potassium tablet residues in the ventricle and intestines.

decreased to 9.2 mmol/l and a decision was made to start parallel continuous renal replacement therapy, via a second dialysis catheter in the right internal jugular vein. Applied dialysis mode was continuous veno-venous haemodialysis-filtration with a Qd of 1500 ml/h and Qb of 250 ml/min. After 1 h of parallel dialysis, serum potassium decreased to 9.2 mmol/l and after 3 more hours it decreased to 6.4 mmol/l.

An abdominal x-ray showed the presence of a huge pharmacobezoar in the stomach with a large amount of tablets still remaining (figure 1). A surgical consultant performed a gastroscopy, showing conglomerates of tablets adherent to the gastric mucosa. It was not possible to remove the tablets by the gastroscope and a decision was made to take the patient to surgery. The patient was transferred to the operating theatre with ongoing dialysis. The surgeon was able to successfully remove about 200 tablets via a laparotomy (figures 2 and 3). The tablets were adjacent to one another and the mucosa of the stomach was severely edematous and discoloured (figures 3 and 4). Serum potassium dropped from 6.4 to 5.2 mmol/l following surgery with ongoing bimodal hemodialysis. Potassium levels, blood gases, serum lactate and blood glucose levels were thereafter normalised.

OUTCOME AND FOLLOW-UP

The patient recovered slowly after 7 days in the ICU. She was discharged to further psychiatric care where she recovered mentally, but later developed a duodenal stricture with secondary problems of gastric retention. The patient also developed pulmonary embolism that required treatment with low-molecular weight heparin (LMWH) for 6 months. However, 1 year later she was fully recovered.

Figure 2 Intraoperative removal of potassium pills with ongoing parallel dialysis.

Figure 3 Intraoperative photographs showing the tablets removed from the patient's stomach.

DISCUSSION

The initial management of hyperkalaemia due to an acute ingestion of potassium chloride does not differ from that of hyperkalaemia of other aetiologies. Because of the small, ionic nature of potassium chloride, potassium is unlikely to be adsorbed effectively by activated charcoal.⁷ Gastric lavage is usually not considered in acute intoxications unless the procedure can be undertaken within an hour after the ingestion. However, potassium chloride and other slow-release tablets may remain in the ventricle unabsorbed for many hours.⁸ In the face of continued absorption with persistent hyperkalaemia, patients may benefit from gastric lavage or whole-bowel irrigation later than the general recommendations of up to 1 h after ingestion. The use of whole-bowel irrigation as a means of removing potassium from the gastrointestinal tract in acute overdose of slow-release preparations has been recommended.¹⁻⁸ However, in this case nothing was retrieved by gastric lavage and the surgeon could confirm that a large pharmacobezoar was adjacent to the gastric mucosa. If gastric lavage fails to retrieve any tablets the use of whole-bowel irrigation may be less effective and it may become necessary to remove tablets manually, either by gastroscopy or by open surgery.⁹⁻¹⁰

Standard medical treatment of acute hyperkalaemia includes the administration of calcium.⁵ The effects of intravenous calcium occur within 1 to 3 min but last only for 30 to 60 min. In our case, calcium effectively counteracted ventricular arrhythmias present at the ED. Sodium bicarbonate infusion can shift potassium from the extracellular space to the intracellular space. The routine use of sodium bicarbonate is controversial but in our experience it is usually effective in the acute setting where 60 mmols of sodium bicarbonate (100 ml) lowers potassium by approximately 0.5 mEq/l. In our case, due to the magnitude of potassium load, serum values continued to increase even after administration of 300 mmols of sodium bicarbonate. Another method of inducing intracellular shift of potassium is to administer glucose and insulin. Insulin stimulates the Na-K ATPase pump, which moves potassium intracellularly in exchange for sodium. This effect is independent of insulin's effect on glucose.⁵

Figure 4 Slow-release tablets retrieved from the stomach by surgery. The tablets tended to form into conglomerates.

The effect of insulin is seen within 10 to 20 min of administration and can be expected to decrease potassium levels by 0.5 to 1.0 mEq/l. In our case, glucose and insulin were not effective enough. Ion exchange resins may be administered orally or rectally and work by exchanging gut cations, most importantly potassium for sodium ions released from the resin. This method is generally slow and normally decreases potassium levels by about 1 mEq/l over a 24-h period.⁵

In addition to commonly used pharmacological treatment, haemodialysis can be used to increase clearance of potassium. In cases of non-intentional toxicity, it has been shown that 50 mEq/l may be removed over a 10-h period.⁶ The extent of potassium removal depends on the dialysate composition, treatment time, the potassium gradient, blood and dialysate flow. However, with a load of more than 40 mEq/kg, the use of single haemodialysis technique was simply insufficient in this case even if blood flow and the potassium gradient were adjusted. The addition of a continuous haemofiltration technique improved potassium removal further and within 4 h potassium levels decreased from 9.2 to 6.4 mmol/l.

In this situation it was obvious from the abdominal x-ray that there was still a substantial amount of potassium tablets remaining in the stomach. Sustained-release potassium tablets are clearly visualised by standard radiography.¹ Using abdominal radiograph or a CT-scan seems mandatory in extensive potassium overdose since gastric lavage alone was unable to reveal the presence of a huge mass of tablets in the stomach.

Finally, a laparotomy revealed a huge mass of potassium pills still present in the stomach after gastric lavage. This mass of potassium constituted a serious threat to life since more than 200 tablets were more or less undissolved and unabsorbed in the stomach (figures 3 and 4). Slow-release tablets have a gelatin or cellulose capsule that needs a minimum amount of fluid around them to dissolve. If the amount of fluid around them is meager they will not dissolve but rather attach to one another as shown in this case (figure 4). It is possible that whole-bowel irrigation in this context will promote dissolution and absorption of the tablets rather than preventing it in contrast to surgery.

Learning points

- ▶ A parallel bi-modal dialysis system may be life-saving when a single dialysis is insufficient to remove an extensive potassium load.
- ▶ Surgery may be the final solution for removal of conglomerates of tablets in extreme overdoses.
- ▶ Surgery may be better than whole bowel irrigation since dissolution of conglomerates of potassium pills is avoided.

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Competing interests None.

Patient consent Obtained.

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