

## CASE REPORT

# Overcoming the Challenges in Deaths by Intravenous Potassium Chloride: A Case Report

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## Abstract

**Introduction:** Potassium chloride is extensively used as a potassium supplement, both by physicians as a therapeutic modality and by the general public, mostly in the form of salt substitute. In the oral formulation, the overdose of potassium is not frequently encountered as homeostasis is maintained by daily consumption and renal excretion mechanisms. Lethal injection of potassium chloride (KCl) is yet used either for suicide or homicide, particularly by the healthcare professionals.

**Case Report:** We report a case of a medical professional, found dead in a hotel's bathroom with intravenous drip set connected to an intravenous cannula, present in situ. The autopsy did not reveal any significant finding except hypo-calcemic tetany in both hands and multiple horizontally placed incised wounds on front of both forearms suggestive of suicidal tendency.

**Discussion:** Fatal intravenous injection of potassium produces subtle or no specific anatomic changes at all thereby posing a challenge to the autopsy surgeon to unpack the cause and manner of death. Since, it is only the extracellular potassium that can be measured in the laboratory, attributing death due to potassium poisoning becomes difficult.

**Conclusion:** In such cases when the post-mortem biological tests are unable to differentiate endogenous from exogenous substances, decisions can only be substantiated by history and circumstantial evidence.

**Keywords:** Suicide, Injection, Post mortem examination

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## INTRODUCTION

Most of the physicians commonly prescribe oral and intravenous form of potassium as a supplement for therapeutic use [1,2]. In some countries, potassium is also a part of lethal drug injection regime used for the execution of people [3]. Basically, the overdose of oral potassium is not frequently considered in clinical practice because homeostasis is maintained very delicately by daily consumption of potassium and the renal excretion mechanisms. Under normal circumstances, 90% of potassium is eliminated via the kidneys; a small amount is also eliminated in the faeces and sweat. Although distribution is largely intracellular, it is the intravascular concentration that is primarily responsible for toxicity [4].

Severe hyperkalemia after large i.v or oral overdoses causes neuromuscular dysfunction including muscle weakness, ascending paralysis, listlessness, vertigo, mental confusion, hypotension, cardiac dysrhythmias (concentrations greater than 8 mEq/L), or death from cardiac arrest (concentrations of 9 to 12 mEq/L or higher) [5]. Gastrointestinal symptoms manifest as nausea, vomiting, paralytic ileus, and local mucosal necrosis, which may lead to perforation [6,7]. There are instances of toxic

hyperkalemia due to drug intakes [8,9], side effects, or overdose of therapeutic medication such as potassium sparing diuretics, cardiac glycosides (ie, digoxin), NSAIDs, succinylcholine, ACE inhibitors and angiotensin- converting enzymes inhibitors particularly in individuals with renal failure, adrenal insufficiency, rhabdomyolysis, and hemolysis [10]. Subcutaneous injection of potassium salt results in local pain and inflammation, while skin rash has rarely been reported with potassium preparations [11].

As a matter of fact, lethal intravenous injection of potassium chloride (KCl) is one of the common methods used either for suicide or homicide by the healthcare professionals [1]. We report a case of suicidal death caused by infusion of KCL.

## CASE REPORT

A female medical professional was found dead, sitting upright on the floor of a hotel's bathroom. At the crime scene, an intravenous cannula was present in situ in the left cubital fossa of the deceased; distal end of cannula was attached to a tubing and 100 ml of a plastic bottle labeled as 'NS' found hanging from the inside of door latch of the bathroom.[fig 1 & fig 2] Used syringes, needles, surgical blades, adhesive tapes, along with 10 empty vials of potassium chloride (10 ml

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Fig 1. Insitu IV canula connected to 100 ml NS bottle through a dripset



Fig 2. Detached IV tubing set containing some fluid

of 10 mEq each) were recovered in the dustbin alongside the body. A suicide note was also recovered from the room holding her husband responsible for the entire act. On further investigation, it was found that, the deceased was in a strained marital relationship for the past one year. Recently, she had

posted various adverse comments on the social media regarding her spouse's same sex inclination being the cause of disharmony and discord. Online public posts relating to desire for nullification of marriage and intention to end her life was obtained as substantial evidence for the deposition of this case.

On autopsy, externally, the body was found to be cyanosed at the extremities with signs of hypocalcaemia (hypocalcemic tetany in both hands) and multiple horizontally placed fresh incised wounds on front of both forearms [fig 3]. Multiple puncture marks suggestive of needle prick sites were present on the back of left hand, medial aspect of left wrist, front of left forearm, and medial aspect of left ankle. On internal examination, lung showed massive edema suggesting features of cardiac failure, rest all organs were unremarkable. The viscera and cardiac blood did not reveal any toxicological component, while the contents of the intact i.v tubing gave positive results for detection of 'potassium chloride' and 'sodium chloride'; analysis was performed by chemical, microscopic, TLC, GC-MS, and ion chromatography. However, the concentration of these substances were not determined. Histo-pathological examination of the visceral organs did not show any significant results. Hence, based on the above findings, the decision about the cause of death was mentioned 'as a result of cardiogenic shock possibly caused by potassium chloride injection.'

## DISCUSSION

Potassium chloride is an essential constituent of the body for maintaining intracellular osmotic pressure and buffering, cell permeability, acid-base balance, muscle contraction, and nerve conduction [1,5]. Remarkably, 98% of the body potassium being intracellular is non-measurable, while it is only the extracellular potassium that can be measured in the



**Fig 3. Hypocalcemic tetany of hand with multiple incised wounds**

laboratory [4]. The critical role of this ion is in the depolarization of the myocardial cell and the cell of sinoatrial node (concentration between 3.7 and 5.3 mmol/L), which gets disrupted by hyperkalemia. Such disturbance can be detected timely by ECG as there is an close relationship between plasma potassium concentration and electrocardiographic signs [12,13].

However, in the treatment of hyperkalaemia, the whole clinical picture should be taken into account rather than the numerical potassium values [5]. In cases of intravenous potassium poisoning, rapid diagnosis by history, clinical presentation, and ECG carries a higher chance of survival for the patients [1]. Along with general measures, specific treatment should be promptly implemented in the form of administering sodium bicarbonate at a dose of 1 mmol/kg, which results in intracellular potassium transfer within 15 minutes [1,13]. Other modalities of treatment include administration of calcium chloride or calcium gluconate, beta-2-adrenergic agonists, insulin associated with 30% glucose-added serum, and hemodialysis. The ion exchange resins (sodium polystyrene sulphonate) and diuretics are however useful only in treating cases of chronic hyperkalemia [13].

Fatal intravenous injection of potassium produces no specific anatomic changes and if any findings, it is only subtle [14]. On autopsy, it becomes difficult to conclude potassium poisoning due to relatively high potassium concentrations in hemolyzed blood (25-80 mM) compared to serum (about 4 mM), by analysis of biologic samples.<sup>15</sup> However, there has been a study in which potassium the

concentration was significantly higher in heart blood in a suicide case (cardiac potassium concentration was 160.0 and femoral 87.3) [15]. In another study, cases of pregnancy was terminated by KCl injection which revealed whitish deposits on the tissues on macroscopic examination and histological examination showed clumps of lanceolate crystals in the internal organs. These findings suggest that pathological study may have useful applications in forensic medicine when death by potassium injection is suspected [16]. In our case, no such findings were observed.

The use of post-mortem biochemical investigations has also been assessed within a relatively short post-mortem interval by a study involving 21 autopsy cases. Several biological samples (left and right vitreous, post-mortem serum from peripheral and cardiac blood, urine, pericardial, and cerebrospinal fluid potassium concentrations) were obtained for diagnosing exogenous potassium administration. However, no statistically significant differences were observed between the measured concentrations in fatal cases of intravenous potassium administration and the control cases in any of the tested samples [17]. In our case, vitreous sample, CSF, bile, urine or pericardial fluid were not collected; sample for toxicological analysis was procured only from cardiac blood.

There is a similar suicidal case of a health professional reported, in which evidence was circumstantial as there was elevated level of potassium in plasma and vitreous humor [18]. The subtle findings in our case too, corroborate the conclusion of former scholars who emphasized that circumstantial evidence provides the greatest diagnostic contribution in suspected potassium poisoning.

As in poisoning with potassium chloride, the findings in fatal sodium chloride intoxication are also highly unspecific [19, 20]. However, in our case this was excluded due to the absence of diagnostic features such as crenated erythrocytes, cerebral edema, subarachnoid, intracerebral micro-hemorrhages, and micro-thrombi [21].

## CONCLUSION

Deaths by substances which are one of the inherent components of human body are almost impossible to detect making the identification of the cause of death uncertain. Even with the latest advancements in technology, in such cases, biological tests are still inadequate to differentiate endogenous from exogenous substance. Hence, opinions and decisions regarding the cause of death can only be substantiated by circumstantial evidence.

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