



CHEMICAL BURN IN WORK ENVIRONMENT: FATAL CASE REPORT
QUEIMADURA QUÍMICA EM AMBIENTE DE TRABALHO: RELATO DE CASO FATAL
QUEMADURA QUÍMICA EN AMBIENTE DE TRABAJO: RELATO DE CASO FATAL

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ABSTRACT

Objective: to report a fatal work accident due to 60% KCl intoxication. **Method:** this study is descriptive and retrospective, in the clinical case report modality, with data obtained from hospital records of the patient. **Results:** young male, 20 years old, with a history of burial in a container containing granulated KCl. Transported to the emergency room of the emergency room by the mobile emergency service, post cardiorespiratory arrest reversed, tubed, with chemical burn in 75% of body surface, bleeding in mucous membranes, significant hyperkalemia. He was submitted to mechanical ventilation, installed vasoactive drugs, drugs for correction of hyperkalemia and cutaneous decontamination in the lesions. Exposure to KCl caused chemical burn and ischemic necrosis, and systemic absorption resulted in severe hyperkalemia. He died after 14 hours of hospital admission. **Conclusion:** the death was due to the extensive chemical burn and the rapid systemic absorption of the product due to contamination of mucous membranes and accidental ingestion. **Descriptors:** Occupational Health; Occupational Health Nursing; Occupational Risks; Occupational Mortality; Potassium Chloride.

RESUMO

Objetivo: relatar um caso de acidente de trabalho fatal devido à intoxicação por KCl 60%. **Método:** estudo descritivo, retrospectivo, na modalidade relato de caso clínico, com dados obtidos de registros hospitalares do paciente. **Resultados:** jovem, sexo masculino, 20 anos, com histórico de soterramento em *container* contendo KCl granulado. Transportado até a sala de emergência do pronto-socorro pelo serviço de atendimento móvel de urgência, após uma parada cardiorrespiratória revertida, entubado, com queimadura química em 75% de superfície corporal, sangramento em mucosas, hipercalemia significativa. Foi submetido à ventilação mecânica, instaladas drogas vasoativas, drogas para correção da hiperpotasemia e descontaminação cutânea nas lesões. A exposição ao KCl provocou queimadura química e necrose isquêmica e a absorção sistêmica resultou em hipercalemia grave. Evoluiu para o óbito após 14 horas da admissão hospitalar. **Conclusão:** o óbito foi decorrente da extensa queimadura química e da rápida absorção sistêmica do produto por contaminação de mucosas e ingestão accidental. **Descritores:** Saúde do Trabalhador; Enfermagem do Trabalho; Riscos Ocupacionais; Mortalidade Ocupacional; Cloreto de Potássio.

RESUMEN

Objetivo: relatar un caso de accidente de trabajo fatal debido a la intoxicación por KCl 60%. **Método:** estudio descriptivo, retrospectivo, en la modalidad relato de caso clínico, con datos obtenidos de registros hospitalarios del paciente. **Resultados:** joven, sexo masculino, 20 años, con histórico de soterramiento en *container* conteniendo KCl granulado. Transportado hasta la sala de emergencia del pronto socorro por el servicio de atendimento móvel de urgencia, post parada cardiorrespiratoria revertida, entubado, con quemadura química en 75% de superficie corporal, sangrado en mucosas, hiperpotasemia significativa. Fue sometido a ventilación mecánica, instalado drogas vasoactivas, drogas para corrección de la hiperpotasemia y descontaminación cutánea en las lesiones. La exposición al KCl provocó quemadura química y necrosis isquémica y la absorción sistêmica resultó en hiperpotasemia grave. Falleció después de 14 horas de la internación hospitalaria. **Conclusión:** la muerte fue decurrente de la extensa quemadura química y de la rápida absorción sistêmica del producto por contaminación de mucosas e ingestión accidental. **Descriptores:** Salud Laboral; Enfermería del Trabajo; Riesgos Laborales; Mortalidad Laboral; Cloruro de Potasio.

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INTRODUCTION

Burns constitute an important public health problem in Brazil since the long period of hospitalization and recovery of its victims and the need for care in highly complex units culminate in a heavy social and economic burden for patients, families and the health system.¹

Although thermal agents are the major cause of burns, events caused by chemicals are extremely aggressive and are considered more serious. The damage caused by the tissue due to the action of the chemical is progressive since the agent continues to act until its complete removal of the lesion. Thus, the shorter the contact time between the chemical and the skin, the lesser damage will be caused to the tissue.²⁻³

Chemical burns are caused by acidic, alkaline, or organic compounds, and can result in skin, eye, digestive and respiratory tract injuries, and various systemic changes. They differ from thermal burns because the mechanism of action is a chemical reaction, and each case needs to be assessed individually and treated according to its specificities.⁴

According to Brazilian statistics, this type of burn is responsible for approximately 4% of burns of various etiologies, with a percentage of approximately 36% of lethality,⁵ and the national and international literature has pointed to the work environment as an important scenario for the occurrence of chemical burns, especially in countries with high industrialization rates, with a higher incidence of males.⁵⁻⁶

Regarding chemical agents, a high number of compounds, estimated at 25,000, has the potential to cause skin, mucosal and ocular changes. Because of the differences, these agents have over the mechanism of action; it is important to identify them for appropriate clinical care and management.⁷ Potassium Chloride (KCl), although low in this group at high concentrations, can cause a severe burn and ischemic necrosis. It is a metal found naturally in the earth's crust and most foods. In the world, more than 95% of potassium chloride is used in agriculture as chemical and fertilizer. In 2007, Brazil consumed 4.6 million tons of potassium chloride.⁸

In this study, a clinical case of a male patient who suffered chemical burns with KCl in the work environment was presented. The discussion is based on the event related to the accident, more specifically on the clinical manifestations presented by the patient and

the treatment instituted. Severe dermal intoxications involving KCl as an agent are rare and poorly described in the literature, as well as clinical protocols for performing the first care.

OBJECTIVE

- To report a case of a fatal accident due to intoxication by 60% KCl.

METHOD

This is a descriptive, retrospective study of a qualitative approach, in the case study modality, with data collected from epidemiological records of Toxicological Occurrence (TO), filed by the Poison Control Center at a teaching hospital in the Northwest region of Paraná, and records contained in the medical record of the patient. The sample consisted of a 20-year-old man who died after a work accident involving 60% KCl. The case was reported descriptively and analyzed with the literature review.

The study was carried out with the authorization of the institution, and all ethical precepts were respected by Resolution CNS N° 466 of December 12, 2012, for conducting research involving human beings, preserving the identity of the individual.

RESULTS

♦ Clinical Case Report

A 20-year-old man fell into a container containing granulated KCl, used as a soil fertilizer, at his workplace, a shipping company operating on the rail network, remaining buried for 30 minutes. He was removed from the workplace by his colleagues and attended by professionals from the prehospital public service - Mobile Emergency Care Service (SAMU). He presented cardiorespiratory arrest (CPR) and reanimated by the SAMU team for 15 minutes. He was intubated with pressure ventilation and submitted to a functioning open nasogastric catheter and peripheral venous access. Then, he was referred to the Emergency Room (ER) of a teaching hospital in the Northwest region of Paraná - Brazil, being admitted to an emergency room. He was presented with Glasgow Coma Scale 03, anisocoric and non-reactive mydriatic pupils, with a blood pressure of 90/34 mmHg, body temperature of 36.8°C, heart rate of 82 bpm.

He had a chemical burn in 75% of the body surface, with the formation of vesicles and purplish spots - hematoma simile, burn in the ocular region and mucosal bleeding. After the

admission of the patient to the emergency room in the ER, the case was reported to the Poison Control Center to request and establish the care protocol. Afterward, a large decontamination of the body surface was performed, and vasoactive drugs were installed (Noradrenaline 16mg+SF 0.9% 234ml EV in continuous infusion pump), 10% Calcium Gluconate infusion, Regular Insulin, Bicarbonate Sodium, Hydrocortisone 500mg EV, continuous and administered sedation, via nasogastric tube, Calcium Polystyrenesulfonate. Biological material was collected for laboratory tests and requested complementary examinations - ECG and by imaging - chest, pelvis and femoral D and E radiographs, and computed tomography of the skull and cervical region. He had hypothermia and hypotension, abdominal distension and anuria.

After four hours of admission to the ER, he was transferred to the intensive care unit (ICU). He presented alterations in the following complementary exams: electrocardiogram with increased T wave amplitude, the absence of P wave, ST segment depression, QRS complex enlargement. Laboratory tests: K⁺: 8.2 mmol/L; Arterial gasometry: pH: 6.8mmol/L; HCO₃ 8.5; BE: -21.0; CK total: 37 182 U/L; AST: 1433 U/L; ALT: 719 U/L, Creatinine: 2.02 mg/dL; Lactate 8.7; Hemogram with leukocytosis and left shift. Concentrations of Na⁺, Cl⁻, Ca⁺⁺ within the reference range. CT scan of the skull and cervical region was of normal dimensions and patterns.

The patient died after 10 hours of hospitalization in the ICU, and the cause of death recorded on the death certificate was burial in 60% KCl granulated, post cardiorespiratory arrest - 15 minutes and cardiopulmonary resuscitation, metabolic acidosis, severe hyperkalemia, renal failure, and rhabdomyolysis.

DISCUSSION

Occupational accidents generate high costs due to the hospitalization process and recovery of the victims and can be minimized with preventive measures. However, for the adoption of these measures, it is necessary to be aware of the real magnitude of the problem, identifying areas of risk, and providing guidance and permanent education to workers, making the work environment safe.⁵

Among the causes of occupational accidents, chemical burns deserve special mention, especially in countries with high

indices of industrialization and precarious working conditions such as Brazil. In a study conducted in Zhejiang, province of China, with 492 patients who suffered chemical burns, 87.6% of accidents occurred in the workplace, 82.9% of which were male. A Treatment Center for Burns in Brazil, over a period of 10 years, showed that 94.4% of chemical burns occurred in the work environment, about the sex of the victims, a man-woman ratio of 3.71:1.⁵

As shown, the involvement of a man in a work accident with a chemical agent is corroborated in the literature. It is also noted the non-use of personal protective equipment by the worker and the availability of an agent with the high potential to cause serious accidents.

This type of situation could be prevented through the adoption of measures such as worker education, managerial improvements, and government regulations. Also, the provision of first aid in the workplace, including irrigation and emergency showers are a key. In a company, causal agents can expose all workers and also the population involved in the production, transportation, use, disposal, and recycling. Management efforts need to be emphasized because of the inevitable nature of occupational injuries, despite precautions. Government inspections are also important to monitor companies, workers exposed, to follow standards and prevent the occurrence of chemical burns.⁴

Despite varying substances and different causes of chemical burns, massive water irrigation is the most convenient and effective means of first aid on the place, as it not only avoids further damage by removal of the chemical, but it is a cooling agent removing the heat from the place. If there is no risk of life concomitant with the injury, irrigation with water should be started as early as possible and continue for a minimum of 30 minutes. In the initial care of the patient with chemical burns, special attention should be paid to the staffing of the care team to protect him from the damages resulting from exposure to the chemical agent.^{6,9}

In chemical burns, the amount of chemical damage depends on eight factors: concentration, duration of contact, amount of substance in contact with the skin (or gastrointestinal or respiratory tract), time of exposure, mucosal or epidermal region or Mucosa, the penetrability of chemistry, and its form and speed of action.¹⁰

Thus, the reported case is considered of high severity because it includes aggravating

factors such as second and third-degree injuries, extensively burned body surface, chemical damage and involvement of noble areas such as face, neck, hands and feet. Other factors such as the non-use of personal protective equipment (PPE), the absence of emergency showers for decontamination in the workplace, a considerable time of exposure to the highly concentrated chemical agent and the systemic absorption of it through the skin and mucous membranes to the unfavorable clinical picture of the patient.

Due to the high potential severity of chemical burns, the Brazilian Society of Burns recommends the transfer of victims of this type of accident, after adequate stabilization, to burn treatment units.¹¹ This type of burn causes severe local pain and significant tissue damage, besides the systemic effects of skin absorption of the agent, as well as the risks of ingestion and inhalation has always to be considered.⁵ Therefore, in the case presented, the transfer of the patient to a CTQ was indicated, which did not occur due to the outcome fast.

Regarding KCl, although it has little representativeness among the agents that cause chemical burns at high concentrations the chemical involved in the reported accident is capable of causing burn and ischemic necrosis due to vascular ischemia.¹² The rare cases of KCl intoxication described in the literature are suicide attempts by intravenous administration, or by the oral intake of drugs containing this agent.¹²⁻¹⁴

The systemic absorption of the agent results in severe hyperkalemia, with changes in the cardiovascular, neurological and gastrointestinal systems. Since there is no antidote to potassium, the agile and aggressive treatment of hyperkalemia is crucial to avoid cardiovascular damage caused by the substance in the body. In toxicokinetics, absorption of KCl is rapid and effective. Under natural circumstances, 90% of potassium is eliminated through the kidneys, and a small amount is eliminated in the stool and sweat. The distribution is largely intracellular, but it is the intravascular concentration that is primarily responsible for toxicity.⁸

Little is known in the literature about KCl intoxication. It is known that in mild and moderate intoxication by KCl, symptoms such as nausea, vomiting, diarrhea, paresthesias, muscular cramps and, rarely, gastrointestinal bleeding are observed. Severe toxicity of potassium chloride occurs at concentrations

greater than eight mEq/L, as observed in the mentioned case. Symptoms in these cases are muscle weakness progressing to paralysis and cardiac arrhythmias. Death occurs by cardiac arrest generally at concentrations of 9 to 12 mEq/L.⁸

The deleterious effects on the electrical activity of the heart are the most important consequences of hyperkalemia, involving depression in the generation and conduction of impulses in all tissues and eventual asystole, which usually occurs with plasma concentrations of potassium between 8 and nine mEq/L.¹³ However, patients with persistent symptoms, with gastrointestinal abnormalities, changes in ECG, or major hyperkalemia should be admitted to the hospital unit. Patients with arrhythmias or cardiovascular collapse or those requiring dialysis should be admitted to the intensive care unit.¹⁵

In patients with extensive chemical burns as in this case, there is a need for replacement of fluids and electrolytes, as well as the prevention of infection. These patients are generally at risk of a systemic inflammatory response syndrome, which occurs when the severity of the lesion is too great, and the inflammatory response, usually local, becomes systemic, resulting in decreased cardiac output, reduced systemic vascular resistance, and Lactic acidosis that precede hypotension, hypermetabolism, and multiple organs dysfunction.¹⁰

Despite advances in intensive medicine and ongoing research, patients with systemic inflammatory response syndrome still have a serious prognosis. In the case in question, the highly concentrated chemical remained in contact with the surface of the skin for an important period, with the progression of tissue injury and systemic absorption.

The treatment of severe cases of KCl intoxication consists of an aggressive reversal of hyperkalemia; use of beta agonists, one mEq/kg sodium bicarbonate, and intravenous calcium chloride, preferably by central venous access or administration of calcium gluconate and ten units of insulin with 25 g. These therapies are known to displace potassium intracellularly but do not increase the elimination of potassium from the body.

Diuretics acting on the renal tubule loop of Henle can be used to increase the urinary elimination of potassium but not used in the patient due to extensive burn, hypotension, and renal failure. In anuric patients, the conduct is the enteral administration of an exchange resin that promotes intestinal

secretion of K⁺ in exchange for the absorption of another ion. Calcium polystyrene sulfonate can be used orally and partially releases calcium, receiving the potassium that will be eliminated in the feces. The combination with mannitol prevents constipation caused by the product and accelerates elimination of the ion. Hemodialysis can be instituted in severe cases as it remains in hemodynamic stability. Orotracheal intubation for protection of the airway should be performed if the patient is hemodynamically unstable.⁸

Although extensive cutaneous decontamination was performed at the site of the lesions, shortly after admission to the hospital, the young man had a long history of being buried in the product, causing burns of great extent, contributing to systemic absorption. Burns presented by the patient were of 2° and 3° degrees and purplish coloration, unlike other burns of the same depth caused by other agents. However, another study that reported a case of chemical burn caused by the dermal injection of KCl was also described and presented images with the presence of lesions staining similar to those of the patient in this case.¹²

Although chemical burns of the skin are common, death by chemical burn is rare, even occupational and mass casualty situations. This is surprising given the large number of chemicals available on the market, the number of new chemicals produced each year, and the general lack of information on the potentially harmful effects of these chemicals on human beings.^{10,16}

In this case, the rhabdomyolysis resulting from burn and polytrauma caused a great release of K⁺ by myocytes as well as lactate elevation. The acidemia presented led to the influx of H⁺ to the interior of the cell in the attempt of tamponade. In exchange, there is K⁺ outflow to the extracellular. In the renal tubule, the H⁺ was excreted in detriment of the elimination of K⁺, leading to the increase of the serum ion concentration. These factors corroborated the severity of the case, culminating in death.

CONCLUSION

Chemical burns caused by KCl are not very prevalent, and there is the scarce publication of scientific papers. However, it can be observed that the clinical severity presented by the patient is consistent with the described in the scientific literature, mainly due to the evidence of hyperkalemia and cardiovascular alterations.

The treatment performed followed the standards established by the Center for Intoxications and literature with scientific evidence, and the unfavorable clinical outcome was due to the extensive chemical burn and the rapid systemic absorption of the product by direct contact with the mucosa and accidental ingestion. However, the severity of the case was directly related to the burial time and toxicity of the product.

The gold standard in attending this young man was the agility in pre-hospital care, with the establishment of cardiopulmonary resuscitation protocols and advanced life support. In hospital care, who promptly started cutaneous decontamination as a measure to reduce absorption and vital support measures, obtaining support from the Poison Center for the standardization of the protocol to attend to this toxicological urgency.

It is noteworthy in this study that the severity of intoxication, burial with probable asphyxiation, high-level drop and the absence of the use of personal protective equipment contributed to the death of this young man, considered potentially preventable if preventive measures of occupational accidents and improved working conditions had been implemented in this company.

Given the innumerable occupational risks to which the workers are submitted, the importance of the work nurse's role in the promotion of orientation and incentive activities to the use of PPE, as well as in the evaluation of the risks present in the workplace, is remarkable. Minimizing or even eliminating occupational accidents, promoting an environment with greater safety for workers.

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Meschial WC, Hungaro AA, Alves BD et al.

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