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Reassessment of Fatal Cases of Hypokalemia from a Pharmaceutical Perspective: Medical Quality and Safety in Terms of Rational Drug Use

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***A*bstract:** *Objective:* This study aimed to conduct a pharmaceutical evaluation of a fatal medical accident caused by hypokalemia, identify medication risks and management deficiencies in primary healthcare institutions, and propose targeted strategies to improve rational drug use and medical quality assurance. *Methods:* A case involving a 53-year-old male patient treated at a township-level health center in southwestern China was reviewed. The analysis was based on the patient's clinical course and the official medical accident appraisal report. The study focused on pharmaceutical aspects, including intravenous medication strategies, electrolyte disorder management, drug contraindications, and emergency value handling. *Results:* Multiple medication safety issues were identified in this case, including the failure to recognize and intervene in severe electrolyte imbalances on time, insufficient potassium supplementation, inappropriate use of contraindicated drugs (compound glycyrrhizin), delayed response to critical laboratory values, and lack of pharmacist involvement. These deficiencies, in the context of the patient's underlying conditions, significantly increased the risk of arrhythmia and cardiac arrest, ultimately resulting in a fatal outcome. *Conclusion:* Pharmacists should play a proactive role in primary healthcare by participating in treatment planning, enhancing the identification and management of high-risk medications, and contributing to the establishment of emergency value response systems. A standardized, individualized approach to medication management is essential to improving the overall quality and safety of healthcare services.

Keywords: Hypokalemia; Rational drug use; Pharmaceutical evaluation; Critical value; Medical quality; Primary healthcare institution

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1. Introduction

In clinical practice, electrolyte disorders, particularly hypokalemia, are a relatively common yet often overlooked electrolyte abnormality, especially among elderly patients and those with multiple underlying conditions such as hypertension, arrhythmia, chronic gastrointestinal diseases, and chronic kidney disease. Hypokalemia can present with nonspecific symptoms such as weakness, fatigue, and palpitations. Additionally, it can potentially trigger severe ventricular arrhythmias and even sudden death, resulting in extremely serious clinical consequences [1].

Hypokalemia often results from a combination of factors, such as prolonged diarrhea, vomiting, reduced intake, drug-induced causes (e.g., diuretics, corticosteroids), renal tubular dysfunction, or inappropriate intravenous fluid administration strategies. Timely identification, accurate diagnosis, and standardized management of hypokalemia are crucial for ensuring patient safety and improving overall healthcare quality. However, in some primary healthcare facilities, limitations in resource allocation, an incomplete pharmaceutical services system, and insufficient pharmacist staffing often result in weaknesses in the identification and management of hypokalemia, particularly in the areas of individualized potassium supplementation plans, identification of drug contraindications, and response to critical values. Meanwhile, with the state placing a high priority on medical quality and safety, "rational drug use" has been established as one of the core indicators for improving the quality of medical services. Pharmacists play a crucial role in clinical work, including drug selection, prescription review, medication education, and adverse reaction monitoring. Their level of involvement directly impacts the safety and efficacy of patient medication.

This paper analyzes a real-life case of a fatality due to hypokalemia at a primary healthcare facility, combining the findings of an official medical malpractice technical appraisal. From a pharmaceutical perspective, it conducts an in-depth re-evaluation of medication-related issues in the case, focusing on fluid resuscitation strategies, electrolyte management, drug selection and contraindications, the absence of a mechanism for handling critical values, and pharmacist involvement. The aim is to identify shortcomings in rational drug use practices at grassroots healthcare institutions and propose targeted improvement recommendations. It is hoped that this study will provide a reference for grassroots medical units to optimize pharmaceutical service processes and improve the drug management system for critically ill patients, thereby promoting both clinical drug safety and medical quality.

2. Case review

Patient Huang, male, 53 years old, has a history of long-term alcohol consumption and confirmed hypertension. He reported experiencing recurrent diarrhea, palpitations, and significant fatigue around July 2024, which persisted for approximately one month before he sought medical attention at a primary care facility on July 21, 2024. On initial examination, physical findings revealed: alert and oriented, dusky complexion, irregular heart rhythm, and blood pressure 185/94 mmHg. Auxiliary tests indicated hypokalemia and abnormal liver function. Based on the patient's previous clinical presentation and laboratory findings, a preliminary diagnosis of viral gastroenteritis (rotavirus or norovirus infection) was considered.

The patient received antiviral therapy, acid suppression to protect the stomach, and electrolyte supplementation after admission, but no adequate potassium supplementation regimen was administered for hypokalemia. During the course of the illness, a compound glycyrrhizinate preparation was used. While this medication has some liver-protective effects, it is known to cause potassium loss and increase the risk of arrhythmias. Using such medications without adequate potassium supplementation may further exacerbate the patient's electrolyte imbalance.

At 12:09 p.m. on July 22, the patient suddenly lost consciousness, with dilated pupils on both sides and no response to light, indicating severe impairment of cerebral perfusion. After emergency on-site resuscitation, although spontaneous heart rhythm was temporarily restored, there was no spontaneous breathing, and blood pressure was extremely low. The patient was then urgently transferred to a higher-level hospital, where the diagnosis was: successful resuscitation from cardiac arrest, respiratory and circulatory failure, hypoxic-ischemic encephalopathy, acute liver and kidney injury, and pulmonary infection, among other multiple organ dysfunction syndrome. The patient's condition continued to deteriorate, and he passed away at home on July 27, 2024.

The patient's family members believe that the medical institution failed to adequately address the high-risk signals indicated by early electrocardiogram and electrolyte tests during the treatment process, resulting in delayed potassium supplementation, contraindicated medication use, and a lack of prompt response to critical values, constituting diagnostic and therapeutic delays and inappropriate medication use. Subsequently, an application was made for a medical accident

technical appraisal. According to the official medical accident technical appraisal conclusion, it was determined that the medical institution had multiple negligence issues in diagnosis, treatment, and medication management, including failing to establish an individualized potassium supplementation plan, using medications with potential adverse reaction risks, and delayed response to critical values. The appraisal conclusion was a Grade 1A medical accident, clearly assigning primary responsibility to the medical institution.

3. Analysis of pharmaceutical issues

3.1. Inadequate potassium supplementation and electrolyte management deficiencies

Based on the medical records and expert assessment report, the patient exhibited obvious signs of hypokalemia upon admission. Combined with abnormal electrocardiogram findings and a history of hypertension, the patient was classified as a high-risk individual for electrolyte imbalance. Appropriate clinical management should have initiated potassium supplementation therapy at the initial consultation, with continuous monitoring of serum potassium levels and electrocardiogram changes to guide subsequent treatment. However, in practice, there was no record of potassium level rechecks, potassium supplementation dosage or frequency, nor any monitoring information related to potassium concentration control. Such management deficiencies led to the patient's potential arrhythmia not being addressed in a timely manner, ultimately resulting in life-threatening arrhythmia and cardiac arrest.

In pharmaceutical practice, potassium supplementation therapy should be graded according to the patient's blood potassium level and combined with renal function, urine output, underlying disease status, and concomitant medication to formulate an individualized treatment plan [2]. Pharmacists should be responsible for treatment plan design, potassium supplement formulation selection, drip rate control, and medication risk assessment to ensure the scientific and safe implementation of electrolyte intervention measures.

3.2. Contraindications for drug use exist, and the patient's baseline condition has not been considered

Compound glycyrrhizin preparations used during treatment exhibit certain anti-inflammatory and hepatoprotective effects under certain clinical indications. However, this drug is also widely recognized for its adverse effects of causing water and sodium retention and potassium loss, particularly posing risks to patients with underlying conditions such as hypokalemia, electrolyte imbalances, arrhythmias, and hypertension [1,3]. Using this drug in patients with confirmed hypokalemia, hypertension, and arrhythmias violates the basic principle of individualized medication.

This medication practice reflects a lack of effective pharmaceutical support from the treatment team in terms of drug selection and risk assessment. Failure to make reasonable judgments based on the patient's clinical background, drug metabolism characteristics, and known adverse reactions constitutes a disregard for the principles of "indications, contraindications, and risk-benefit ratio" and is a typical example of inappropriate medication use.

3.3. Slow response to critical values and lack of multidisciplinary intervention mechanisms

Upon admission, the patient's laboratory and ancillary test results indicated a critical condition, including significant hypokalemia, abnormal electrocardiogram, and elevated D-dimer levels. These indicators may all suggest a risk of acute cardiac events, pulmonary embolism, or severe infection [4]. However, according to the records, there was no evidence of the timely implementation of critical value grading protocols, re-examination mechanisms, specialist consultations, or referral recommendations. Additionally, there was no documentation of pharmacists providing feedback or intervention recommendations regarding potential drug intervention risks.

In modern healthcare systems, critical value management is not only the responsibility of clinicians but should also involve collaboration between physicians, nurses, and pharmacists to establish a data-driven closed-loop management system [5]. Pharmacists should use laboratory abnormal indicators to propose medication adjustment recommendations, intervention plans, or alternative drug options to improve response efficiency and reduce risks.

3.4. Lack of pharmaceutical service support in primary healthcare institutions

The various medication decisions reflected in the case did not involve the participation of pharmacists. There was no professional intervention in the formulation of the potassium supplementation plan upon admission or in the use of contraindicated drugs [6,7]. Primary care institutions generally have weak pharmaceutical capabilities, insufficient numbers of pharmacists with adequate skills, and incomplete medication management systems.

Pharmaceutical services should cover the entire process, from admission assessment, prescription review, clinical pathway monitoring, critical value intervention, to discharge medication education and medication adherence follow-up, and are an important means of ensuring patient medication safety and improving medical quality [6,8]. In the management of high-risk populations, the involvement of pharmacists is particularly critical. Their clinical responsibilities and team status should be strengthened institutionally to achieve truly rational medication use.

4. Recommendations for rational drug use

4.1. Clarify the professional responsibilities of pharmacists in primary healthcare institutions and promote deep clinical integration

Currently, most primary healthcare facilities still operate under a "physician-led" model for medication decision-making, resulting in overall low clinical involvement of pharmacists and underutilization of their professional expertise. Recommendations: (1) Clarify the scope of responsibilities for pharmacists in the design of clinical treatment plans to facilitate their transition from traditional medication supply roles to clinical decision-support roles; (2) When using high-risk medications (such as electrolyte solutions, antiarrhythmic drugs, or medications with clear contraindications), include pharmacists in mandatory review processes and grant them the authority to suggest modifications to prescriptions; (3) Establish a multidisciplinary medication consultation mechanism. For critically ill or complex medication cases, organize joint consultations among medical, pharmacy, and nursing staff, document the discussions, and ensure the rationality and safety of treatment plans [9].

4.2. Building a closed-loop management system for critical values supported by information systems

Critical values serve as key indicators reflecting a patient's rapidly deteriorating condition, and their response speed and handling quality directly impact patient outcomes. Recommendations: (1) Establish detailed critical value grading and response procedures, clearly defining pharmacist involvement points; (2) Integrate a critical value pop-up alert mechanism into the hospital information system, enabling automatic notification to relevant responsible parties and recording of handling traces to ensure "traceability"; (3) Introduce a pharmacist-led medication intervention module that automatically generates a "drug risk assessment form" based on critical values, driving the closed-loop process of "abnormal indicators-prescription adjustments-dynamic follow-up," thereby enhancing the efficiency of medication intervention for critically ill patients [10].

4.3. Promote high-risk medication pathways and standardized electrolyte management tools

Primary healthcare facilities should develop and implement medication toolkits based on guidelines and evidence-based research, tailored to their specific circumstances. Recommendations: (1) Develop and implement a "graded intervention pathway for hypokalemia," clearly defining key parameters such as potassium supplement dosage forms, administration rates, target serum potassium levels, and follow-up frequency; (2) Establish a "key monitoring drug list," including compounds such as glycyrrhizin, digoxin, and furosemide, requiring dual-signature approval and documentation of the rationale for use in high-risk populations; (3) Develop and apply auxiliary tools such as the "Pharmaceutical Intervention Risk Assessment Form" and "Individualized Medication Monitoring Form" to enhance physicians' ability to identify potential risks before prescribing medications, thereby achieving proactive risk management [11].

4.4. Comprehensively enhance the awareness and capabilities of grassroots medical, nursing, and pharmaceutical teams regarding rational drug use

Rational drug use relies not only on institutional design but also on the clinical team's sensitivity to and ability to respond to drug-related risks. Recommendations: (1) Regularly conduct interdisciplinary training programs for healthcare professionals to enhance pharmaceutical competencies, focusing on practical exercises related to adverse reaction identification, prescription review techniques, and emergency management of electrolyte imbalances; (2) Promote the "Pharmacists in the Ward" initiative, where pharmacists regularly participate in rounds and conduct preemptive interventions in high-risk medication administration processes; (3) Establish a "Medication Safety Case Warning System" to conduct regular reviews of adverse medication events, create a case repository, and use it as training material to promote continuous improvement and the development of a "medication culture" [12].

5. Conclusion

This study is based on a real-life case of a fatality due to hypokalemia at a primary healthcare facility, combined with a medical malpractice technical appraisal report, and conducts an in-depth analysis from a pharmaceutical perspective of the issues related to inappropriate medication use during the treatment process. The case revealed numerous typical medication safety hazards, including improper electrolyte management, contraindications in drug use, delayed response to critical values, and the pharmacist's failure to effectively intervene, ultimately leading to worsening arrhythmia and progression to cardiac arrest, resulting in severe medical consequences.

This incident highlights the current challenges faced by some grassroots medical institutions in rational drug use and underscores the irreplaceable role of pharmaceutical services in ensuring medical quality and patient safety. Through systematic analysis and reflection, this paper proposes several strategies, including strengthening the role of pharmacists, establishing a critical value response mechanism, promoting high-risk drug management pathways, and conducting drug safety training, to guide for improving rational drug use in grassroots medical institutions. In the future, efforts should be made to further integrate pharmacists into the primary care diagnostic and treatment process, improve the clinical pharmacy service system, strengthen individualized medication management, and truly achieve patient-centered, safe, effective, and precise drug therapy.

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