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Extravasation of 3% NaCl (Sodium Chloride) in Patients with Electrolyte Imbalance: A Case Report

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Abstract: Extravasation resulting from the administration of hypertonic electrolyte solutions, such as 3% sodium chloride (NaCl 3%, 513 mEq/L sodium, 1027 mOsm/L), a hyperosmolar agent, can pose a significant risk of local tissue injury, particularly when administered via peripheral vein access. Peripheral vein access is commonly used for IV therapy, including the administration of medications, blood products, and fluids, but it carries an elevated risk of extravasation.
Methods: A literature review was conducted to evaluate clinical approaches for managing extravasation, including the application of hydrocolloid dressings, warm compresses, and saline irrigation.
Results: A 61-year-old female presented to the emergency department with complaints of pain, erythema, and swelling in the left arm, which had progressively worsened over the previous two days. The symptoms were localized to the site of a previous peripheral IV insertion, where 3% sodium chloride had been administered during prior inpatient treatment.
Conclusion: Extravasation of hypertonic electrolyte solutions such as 3% NaCl can lead to serious local tissue damage if not managed promptly. Close monitoring of infusion sites is essential to prevent complications.
Keywords: extravasation, intravenous infusion, hypertonic electrolyte solutions

INTRODUCTION

The primary purpose of intravenous (IV) catheter insertion is to facilitate the administration of medications, blood products, and fluids directly into the bloodstream. However, the risk of extravasation is significantly higher when using peripheral vein access (1). Extravasation is the unintentional leakage of IV fluids or drugs into the surrounding subcutaneous tissue, primarily resulting in tissue damage and skin necrosis (2, 3). Several risk factors contribute to extravasation occurrence, including improper vein selection, repeated venipuncture, obesity, dehydration, patient discomfort during catheter use, advanced age, catheter type, cannula gauge, and the clinical skill of the healthcare provider (nurse) (4, 5). Clinical manifestations of extravasation include irregular or obstructed infusion flow, pain at the insertion site, localized swelling, erythema, skin tightness, and in severe cases, tissue necrosis that may necessitate surgical intervention, including debridement or even amputation. Furthermore, extravasation can indirectly increase healthcare costs and prolong hospital stays (6-8).

This case report focuses on extravasation caused by the administration of hypertonic electrolyte solutions, particularly 3% sodium chloride (3% NaCl), which contains 513 mEq/L of sodium and has an osmolarity of 1027 mOsm/L. As a hyperosmolar agent, 3% NaCl carries a significant risk of causing local tissue reactions when administered via peripheral vein access.

METHODS

This report used a qualitative method with a case study approach. The subject was a single patient who presented with complaints of pain, erythema, and swelling at the site of a previous IV insertion. A literature review was conducted to support the case analysis. Articles were retrieved from major medical and nursing databases, including Google Scholar, PubMed, CINAHL, and Wolters Kluwer. Search terms included extravasation, intravenous therapy, and hypertonic electrolyte solutions. The reviewed literature discussed various management strategies for extravasation, including the use of hydrocolloid dressings, warm compresses, and saline irrigation. The healing duration for extravasation injuries, according to the literature, can range from 20 days to several months.

RESULTS AND DISCUSSION

Case

A 61-year-old female presented to the emergency department with complaints of pain, erythema, and swelling in the left arm, which had progressively worsened over the previous two days. The patient reported that these symptoms were localized to the site of a previous peripheral IV insertion during prior inpatient treatment (two days earlier). At presentation, the patient's vital signs were as follows: temperature 37.6°C, heart rate 110 beats per minute, respiratory rate 23 breaths per minute, and blood pressure 140/70 mmHg. Physical examination revealed swelling of the left hand, with skin tightness and continuous pain rated at 6 on the numeric pain scale. The overlying skin appeared reddish-black, and purulent discharge was noted. Medical record review indicated that the patient had recently been discharged following inpatient treatment for electrolyte imbalance, during which she received two administrations of 3% sodium chloride (3% NaCl) as part of her electrolyte replacement therapy. The IV catheter had been inserted into the metacarpal region (a peripheral vein) using a 20-gauge (20G) IV catheter. An infusion pump was employed to control the administration rate of 500 mL of 3% NaCl over 12 hours. According to nursing documentation, infusion site monitoring was conducted every 15 minutes during the first hour of therapy initiation, then hourly thereafter until the hypertonic solution was fully administered. Following the development of extravasation-related symptoms, the attending physician prescribed topical silver sulfadiazine ointment. The nursing team initiated non-pharmacologic management, including the application of warm compresses four times daily, and provided patient education regarding the cause of symptoms, attributing them to the extravasation of a hypertonic electrolyte solution.

Figure 1. Condition and appearance of the skin surface at the infusion site in patients

Twelve hours after the initial observation, the skin discoloration along the peripheral vein access transitioned from blackish-red to red, though mild swelling (edema) persisted. The nursing staff continued to provide education, explaining that the residual erythema and swelling were consistent with the ongoing inflammatory response. Warm compresses were applied four times daily in alternating intervals with silver sulfadiazine ointment. By 36 hours, blister formation was noted. The same treatment regimen was continued. Over the course of one week, the wound began to dry, and the associated swelling gradually subsided. Upon discharge, the patient was counseled that there were no specific restrictions on physical activity, aside from avoiding movements that might exacerbate pain at the affected site.

DISCUSSION

The risk of extravasation can be categorized based on patient-related factors (such as small and fragile veins, particularly in neonates, children, or the elderly; vascular fragility; or in oncology patients who may have sclerosed veins due to repeated venipunctures), procedural factors (including lack of clinical experience and improper selection of venous access sites), and pharmacologic factors (such as the concentration of the infusate, duration of exposure, and volume of extravasated fluid). Vigilant clinical practice and competent technique are important in preventing extravasation occurrence. Proper site selection is particularly important—areas such as the dorsum of the hand or near joints with frequent movement should be avoided (9). Most extravasation occurrence happens in peripheral vein access. Early identification of extravasation is essential. If a patient reports discomfort or pain at the infusion site, the access should be evaluated immediately and, if necessary, discontinued and relocated. It is important to note that infusion pumps may not always detect flow resistance or occlusion; therefore, infusion flow assessment should be correlated with patient symptoms. If infiltration or obstruction is suspected, the infusion must be stopped immediately. Severe complications of extravasation include tissue necrosis, which may necessitate surgical debridement or excision (10)

The administration of hypertonic electrolyte solutions, such as 3% or 2% sodium chloride, is strongly recommended via a central venous catheter rather than a peripheral vein due to their high osmolarity. Continuous infusion of 3% NaCl through peripheral vein access increases the risk of infiltration, thrombophlebitis, tissue ischemia, and venous thrombosis. Potential complications include phlebitis, infiltration, extravasation, thrombosis, and infection, all of which require close monitoring and accurate documentation. Nonetheless, the insertion of central venous access in hemodynamically stable patients also carries inherent risks, including vascular injury, pneumothorax, barotrauma, and catheter-associated infections. As current clinical guidelines do not universally dictate whether hypertonic electrolyte solutions should be administered via central or peripheral access, the decision is typically made based on the patient's overall clinical status (11).

Nursing interventions for extravasation should include the immediate cessation of the infusion, removal of the IV catheter, aspiration of any residual drug from the catheter if feasible, and prompt notification of the physician. Cold compresses applied for 15 to 20 minutes can promote local vasoconstriction, thereby limiting the spread of the extravasated agent, minimizing inflammation, and alleviating pain. Cold compresses may be applied up to six times daily, for multiple days if needed. Conversely, warm compresses induce vasodilation, which can facilitate the absorption of extravasated substances and aid in tissue recovery. Alternating warm and cold compresses every four hours for 15–20 minutes over a 24 to 48-hour period is a recommended approach in this report. Preventive measures include ensuring that healthcare providers are well-informed about protocols for administering hypertonic electrolyte solutions. Routine assessment of the infusion site and frequent inquiry into patient symptoms—

such as burning, numbness, or altered sensation—are important. Infusion access should be placed at a site distinct from drug administration when possible. Patency of the IV line should be confirmed before and during fluid administration, which includes aspirating for blood return and flushing the catheter with 0.9% sodium chloride. Upon removal of the IV catheter, the site should be elevated and compressed for a minimum of five minutes (5, 9, 12, 13).

Additional nursing interventions include wound care based on the principles of maintaining a moist, clean, and thermally stable environment. Necrotic tissue can hinder re-epithelialization and should be removed via debridement to promote optimal healing. Consistent and thorough wound care can significantly accelerate tissue regeneration and reduce discomfort. Daily dressing changes are necessary to sustain a moist wound bed. Appropriate dressings include hydrocolloid products such as Exuderm or Comfeel, which absorb exudate, preserve skin moisture, and minimize trauma during dressing changes. For wounds with substantial exudate, the use of alginate or hydrofiber dressings is highly recommended (13-15).

CONCLUSION

Extravasation resulting from the administration of hypertonic electrolyte solutions can lead to serious complications if not managed promptly. In this case, extravasation occurred via a peripheral vein. To minimize the risk of such occurrence, it is recommended that hypertonic electrolyte solutions be administered through larger-calibre central veins, accompanied by continuous and close monitoring. Increasing nurses' knowledge and competence in the safe administration of hypertonic electrolyte solutions—such as 3% sodium chloride—is essential to improving patient safety and preventing adverse outcomes. Further research is warranted using larger sample sizes and employing controlled study designs, including intervention and control groups, to generate more robust and generalizable findings.

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