# Iatrogenic High-Dose Unfractionated Heparin Administration via Central Venous Catheter in an Adult Female in South-South Nigeria: Drug Delivery Safety Implications, A Case Report

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**ABSTRACT**

**BACKGROUND** Unfractionated heparin (UFH) remains indispensable in clinical practice but is recognized as a high alert medication with a narrow therapeutic index. Errors involving UFH, particularly confusion between high concentration therapeutic preparations and low-dose catheter flush solutions, constitute a critical vulnerability within drug delivery systems.

**CASE PRESENTATION** A 40-year-old female managed for postoperative paralytic ileus required central venous access. During routine catheter maintenance, 20,000 IU of UFH was inadvertently administered in place of a dilute heparin flush solution due to drug misidentification. Immediate cessation was followed by urgent evaluation, revealing markedly prolonged coagulation parameters (prothrombin time 84 seconds; unrecordable clotting indices) with stable hematological indices. Intravenous protamine sulphate (100 mg) was administered promptly. Serial assays demonstrated progressive normalization within one hour, and the patient remained hemodynamically stable without hemorrhagic complications.

**CONCLUSION** This case highlights system level vulnerabilities in drug delivery processes involving UFH. Early recognition and timely reversal are pivotal to favorable outcomes. Strengthening medication safety frameworks, particularly within catheter based drug delivery pathways, is imperative.

**Keywords:** Unfractionated heparin, medication error, drug delivery safety, central venous catheter, anticoagulant overdose, protamine sulphate.

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## INTRODUCTION

Unfractionated heparin (UFH) is widely utilized for both prophylactic and therapeutic anticoagulation due to its rapid onset of action and reversibility. Notwithstanding these advantages, UFH is consistently classified among high-alert medications because of the substantial risk of harm associated with dosing errors[1,2].

Medication errors involving UFH commonly arise from confusion between high concentration therapeutic formulations and low-dose solutions intended for maintaining central venous catheter (CVC) patency. The coexistence of multiple formulations within clinical environments, often with similar labeling and storage conditions, predisposes to inadvertent substitution during drug preparation or administration[3].

Within contemporary healthcare systems, CVCs function as critical interfaces for drug delivery. However, they also represent potential points of failure where lapses in standardization, verification, and human factors may converge to produce adverse events. The inadvertent administration of high-dose UFH via a CVC can

result in immediate systemic anticoagulation with potentially catastrophic consequences.

We report a case from South-South Nigeria and examine its implications within the broader framework of drug delivery safety.

## CASE REPORT

A 40-year-old female was admitted for the management of paralytic ileus following surgery. Owing to inadequate peripheral venous access, a central venous catheter was inserted to facilitate intravenous therapy.

During routine catheter maintenance, 20,000 IU of unfractionated heparin was inadvertently administered instead of a standard dilute heparin flush solution. The error was attributed to drug misidentification.

The administration was discontinued immediately upon recognition. Urgent laboratory evaluation revealed:

Prothrombin Time (PT): 84 seconds

International Normalized Ratio (INR): 1.5

Activated clotting parameter: No clot detected

Hemoglobin: 11.1 g/dL

Packed Cell Volume: 33.5%

White Blood Cell Count: 9.8 × 10⁹/L

Platelet Count: 186 × 10⁹/L

The patient remained clinically stable with no evidence of bleeding or hemodynamic compromise.

Intravenous protamine sulphate (100 mg) was administered promptly. Serial coagulation studies demonstrated progressive improvement:

30 minutes: PT 21 seconds; INR 1.5

1 hour: PT 20 seconds; INR 1.4

No hemorrhagic complications were observed.

TABLE 1: TIMELINE OF EVENTS

| TIME | EVENT |
|---|---|
| 0 min | Administration of 20,000 IU UFH |
| Immediate | Error recognized; drug discontinued |
| Initial Labs | PT 84 sec; no clot detected |
| Minutes later | Protamine sulphate 100 mg administered |
| 30 minutes | PT improved to 21 sec |
| 1 hour | Near normalization of coagulation parameters |

## DISCUSSION

Medication errors involving unfractionated heparin (UFH) remain a persistent and clinically significant challenge within contemporary healthcare systems, particularly given its classification as a high alert medication with a narrow therapeutic index[1,2]. The present case exemplifies a critical failure within the drug delivery continuum, wherein system level vulnerabilities culminated in inadvertent high-dose administration via a central venous catheter.

The rapid and marked derangement in coagulation parameters observed in this patient is consistent with the pharmacodynamic profile of UFH, which exerts immediate anticoagulant effects following intravenous administration[1]. Contemporary evidence indicates that excessive anticoagulation often manifests initially as laboratory abnormalities prior to the development of overt clinical bleeding, thereby underscoring the importance of early biochemical monitoring[3,4]. The absence of hemorrhagic complications in this patient, despite profound coagulopathy, further highlights the importance of early recognition and prompt intervention.

While inadvertent heparin overdosing has been previously reported, this case uniquely contextualizes the event within a drug delivery systems framework, emphasizing the role of central venous access as both a therapeutic conduit and a potential amplifier of upstream medication errors. Comparable contemporary reports have documented similar medication errors with variable outcomes, including life-threatening hemorrhage[3,9]; however, the present report

advances the discourse by explicitly interrogating the system level failures underlying such events.

From a drug delivery systems perspective, this event may be conceptualized as a multi-level failure encompassing drug selection, labeling differentiation, storage protocols, and administration verification. The central venous catheter, while serving as a high efficiency delivery conduit, simultaneously amplifies the clinical consequences of upstream errors. This underscores the need to reconceptualize medication errors involving highalert drugs such as UFH as failures of integrated delivery systems rather than discrete point of care lapses.

Human factors also play a critical contributory role. Cognitive load, lookalike drug presentations, workflow interruptions, and environmental pressures may collectively predispose to such errors, particularly in high-acuity clinical settings. These considerations highlight the importance of human factors engineering in the design of safer medication systems.

Medication errors involving UFH have been widely attributed to similarities in drug packaging, labeling, and storage practices[5]. The Institute for Safe Medication Practices continues to identify heparin as a high-risk medication requiring stringent safeguards, including standardized concentrations and independent verification processes[5]. Similarly, the World Health Organization has emphasized anticoagulants as priority targets in global patient safety initiatives[6].

Within the broader context of intravenous drug delivery, studies have demonstrated that failures in preparation, labeling, and administration verification remain major contributors to medication errors[7,8]. In resource variable settings, where standardized safety systems may be inconsistently implemented, these risks are potentially amplified, thereby underscoring the broader relevance of this case beyond the index patient.

The prompt administration of protamine sulphate in this case was pivotal in reversing anticoagulation and preventing adverse outcomes. Protamine remains the definitive antidote for UFH toxicity, rapidly neutralizing its anticoagulant effects through stable complex formation[1,10]. The favorable clinical course observed in this patient aligns with current evidence supporting early recognition and intervention as critical determinants of outcome.

KNOWLEDGE GAPS AND CONTRIBUTION

This report addresses several important gaps in the literature. First, there remains a relative scarcity of contemporary data from low and middle income settings, particularly sub-Saharan Africa, where structural medication safety systems may be variably implemented[6,8]. Second, existing literature has predominantly emphasized clinical outcomes, with comparatively limited focus on the drug delivery pathways that precipitate such errors. Third, there is insufficient integration of clinical pharmacology and drug delivery science in the discourse on anticoagulant safety.

By explicitly linking central venous catheter use with medication error pathways, this case provides a systems-oriented and interdisciplinary perspective, thereby contributing meaningfully to evolving global patient safety frameworks.

LIMITATIONS

As a single case report, the findings are not generalizable. A formal root cause analysis was not conducted, limiting detailed characterization of contributory system failures. Additionally, comprehensive coagulation monitoring beyond the reported parameters was not performed.

**RECOMMENDATIONS**

To mitigate similar occurrences, the following strategies are recommended:

Standardization of heparin formulations across clinical settings

Implementation of clear and differentiated labeling systems

Mandatory independent double check protocols for high alert medications

Development of structured guidelines for catheter based drug delivery

Integration of human factors engineering principles into medication system design

Continuous professional education and simulation based training

Establishment of institutional medication error surveillance and audit systems

Future efforts should prioritize the integration of drug delivery safety principles into routine clinical practice, particularly in high risk therapeutic domains such as anticoagulation.

## CONCLUSION

Iatrogenic high-dose unfractionated heparin administration via central venous access represents a preventable yet potentially life-threatening event. This case delineates critical vulnerabilities within drug delivery systems, emphasizing the interplay between pharmacologic risk, human factors, and system level failures.

Prompt recognition, immediate reversal with protamine sulphate, and vigilant monitoring are essential to favorable outcomes. However, prevention remains paramount.

Ultimately, the prevention of heparin-related adverse events lies not in vigilance alone, but in the deliberate design of resilient and standardized drug delivery systems capable of minimizing the impact of human and process-related errors.

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## AUTHOR CONTRIBUTIONS

Enovwo Obaro Omatighene: Conceptualization, study design, clinical supervision, manuscript drafting, and overall coordination of the study.

Ayo Bemigho Odonmeta: Data acquisition and critical review of the manuscript.

Iboyitie Imonivwerha: patient management contribution, Data collection, literature review, and assistance in manuscript preparation.

Ekokidolor Onoriode Emuoghenerue: Literature review, critical revision of the manuscript for important intellectual content, and final editing.

All authors read and approved the final manuscript and agree to be accountable for all aspects of the work.

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## CONFLICT OF INTEREST

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## ETHICAL APPROVAL AND CONSENT

Informed consent was obtained from the patient. Ethical approval was not required.

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