

Exploring the Lived Experiences and Perceived Challenges of Nurses in Enhancing Compliance with Closed-Loop Medication Administration Systems

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ABSTRACT

Closed-Loop Medication Administration (CLMA) systems are increasingly used to enhance medication safety, yet nurses continue to encounter organizational, technical, personal, and workflow-related barriers that hinder consistent compliance in clinical practice. This qualitative study used a phenomenological design in Saudi Arabia. Nine registered nurses with direct CLMA experience were selected through purposive and snowball sampling. Data were gathered through a validated researcher-made structured written interview guide containing open-ended questions and were analyzed using Colaizzi's phenomenological method to identify significant meanings, categories, and themes. Findings showed that nurses generally viewed CLMA positively because it improved verification, confidence, documentation, and error prevention. Compliance was strengthened by clear policies, supportive leadership, training, reliable equipment, competence, and teamwork, but weakened by workload, fatigue, interruptions, technical failures, equipment shortages, patient-related difficulties, and environmental barriers. The study concluded that CLMA compliance is shaped by interconnected organizational, technological, and individual conditions. Although the system supports patient safety and long-term workflow efficiency, it cannot replace clinical judgment. Consistent adherence requires dependable infrastructure, competent users, responsive leadership, and safe alternatives during emergencies or system downtime. Healthcare institutions should strengthen continuing competency training, nonpunitive reporting, technical support, staffing, equipment availability, and interdisciplinary collaboration. Clear downtime and emergency procedures, regular system evaluation, protected medication rounds, and peer-support mechanisms are recommended to reduce workarounds, preserve clinical judgment, and sustain safe, efficient medication administration across diverse practice settings. These findings provide a foundation for developing an institutional support program focused on sustainable CLMA compliance.

Keywords: *Closed-loop medication administration, medication safety, nurses' experiences, compliance, barcode medication administration, patient safety, clinical workflow*

INTRODUCTION

Medication administration is a major nursing responsibility that requires accuracy, accountability, and adherence to safety protocols. Closed-Loop Medication Administration systems improve patient identification, medication verification, documentation, and error prevention through digital technologies. However, workload, staffing shortages, technical failures, limited training, poor infrastructure, and resistance to change may weaken compliance. Existing research has largely focused on technological outcomes, leaving a limited

understanding of nurses' lived experiences. This study explored their experiences, influencing factors, adherence challenges, perceived effects on patient safety and workflow, and coping strategies. Its findings may guide improvements in nursing education, institutional policies, technical support, workflow design, leadership, and patient safety.

Statement of the Problem

This study aimed to explore the lived experiences and perceived challenges of nurses in enhancing compliance with closed-loop medication administration systems.

Specifically, it sought to answer the following questions:

Central Research Question: What factors and challenges do nurses experience in enhancing compliance with closed-loop medication administration systems?

Scope and Delimitations

This study explored the lived experiences and perceived challenges of nurses in enhancing compliance with Closed-Loop Medication Administration (CLMA) systems. It examined how nurses described their experiences in using CLMA systems. The study employed a qualitative phenomenological research design to obtain an in-depth understanding of the participants' experiences, meanings, perceptions, and reflections regarding CLMA compliance. The participants consisted of nine nurses who had direct experience in using CLMA systems in a selected hospital in Saudi Arabia.

Review of Related Literature

Literature shows that compliance with Closed-Loop Medication Administration systems depends on technology, workflow, organizational support, and user readiness. Usable interfaces and stable routines encourage consistent use, while poor design and workflow mismatch increase safety risks and protocol deviations (Iqbal et al., 2021; Mulac et al., 2021). Reliable equipment, readable barcodes, adequate training, and continuous monitoring also strengthen adherence (Grailey et al., 2023). However, documentation burden, communication gaps, staffing pressures, and technical failures may prompt workarounds and inconsistent compliance (Naamneh & Bodas, 2024). Sustained implementation therefore requires integrated technology, leadership support, competency development, and ongoing systematic evaluation (Williams et al., 2025).

Theoretical Framework

Ida Jean Orlando's Deliberative Nursing Process Theory (1961) supported the exploration of nurses' experiences with CLMA systems during medication preparation, patient identification, medication verification, administration, and documentation.

Jean Watson's Theory of Human Caring (1979) was relevant to the study because nurses' compliance with CLMA systems could be understood as an expression of their professional commitment to protecting patients from medication-related harm.

Madeleine Leininger's Transcultural Nursing Theory (1991) supported the study by explaining how institutional norms, leadership practices, policies, training opportunities, professional backgrounds, and workplace expectations shaped nurses' experiences and compliance with CLMA systems.

METHODOLOGY

A qualitative method was used to explore the lived experiences and perceived challenges of registered nurses in enhancing compliance with Closed-Loop Medication Administration systems in Saudi Arabia.

Research Design

This study utilized a phenomenological research design. This design was appropriate because it enabled the researcher to describe and understand how registered nurses experienced the use of CLMA systems in actual clinical practice.

Research Steps

The study commenced with a comprehensive review of related literature concerning medication safety, barcode medication administration, electronic medication records, closed-loop systems, compliance, and nurses' clinical experiences.

Data Collection and Sample Selection

The study involved nine licensed registered nurses currently employed in healthcare institutions in Saudi Arabia who had direct experience using CLMA systems. Purposive and snowball sampling were used to select participants capable of providing relevant and detailed descriptions. Data were collected outside the hospital premises via Google Forms, using a validated, researcher-developed structured written interview guide containing open-ended questions. The guide explored system experiences, influencing factors, adherence challenges, perceived impact, and coping strategies.

Data Analysis Methods

This study utilized Colaizzi's (1978) phenomenological data analysis method. The researcher repeatedly reviewed the written narratives, extracted significant statements, formulated meanings, organized them into categories and theme clusters, and developed an exhaustive description of the phenomenon.

Research Assumptions and Validation

This study assumed that nurses who used closed-loop medication administration systems possessed experiences that could provide reliable insights into the factors affecting compliance. It was assumed that the participants described their experiences, challenges, perceptions, and coping strategies openly and honestly during data collection.

Study Limitations and Ethical Considerations

The study observed informed consent, autonomy, beneficence, nonmaleficence, justice, fidelity, veracity, privacy, and confidentiality throughout the research process. Participants received complete information regarding the study and voluntarily provided electronic informed consent before answering the structured written interview guide.

RESULTS AND DISCUSSION

Question 1. How do nurses describe their experiences in using Closed-Loop Medication Administration systems?

The findings revealed that nurses generally experienced CLMA systems as valuable safety mechanisms that improved patient identification, medication verification, documentation, and confidence during medication administration. Participants appreciated the system's ability to verify the right patient, medication, dose, route, and time and to detect discrepancies before medications reached patients.

Question 2. What organizational, technical, or personal factors influence compliance with these systems?

The findings showed that compliance was shaped by the interaction of organizational support, technological readiness, professional competence, workload, and personal commitment. Nurses were more likely to comply when policies were clear, leadership was supportive, training was continuous, equipment was available, and technical problems were resolved promptly.

Question 3. What challenges do nurses encounter in maintaining adherence to closed-loop protocols?

The findings revealed that nurses experienced difficulty maintaining adherence when emergencies, competing priorities, technical failures, patient-related conditions, and environmental barriers occurred simultaneously.

Question 4. How do nurses perceive the impact of compliance or noncompliance on patient safety and workflow efficiency?

The findings showed that participants perceived consistent CLMA compliance as an important safeguard for patient safety and long-term workflow efficiency.

Question 5. What strategies or coping mechanisms do nurses employ to overcome barriers to compliance?

The findings revealed that nurses used proactive preparation, policy adherence, technical escalation, teamwork, and interdisciplinary communication to overcome barriers.

SUMMARY

The findings demonstrated that CLMA compliance was not solely an individual nursing responsibility but a shared organizational and professional obligation requiring dependable technology, competent users, responsive leadership, adequate resources, teamwork, and appropriate clinical flexibility.

CONCLUSIONS

- Nurses generally experienced CLMA systems as beneficial safety mechanisms that increased confidence, strengthened medication verification, and prevented avoidable errors.
- Compliance was influenced by organizational policies, leadership practices, continuing education, equipment availability, system usability, professional competence, workload, fatigue, and commitment to patient safety.
- Nurses experienced challenges in maintaining adherence during emergencies, high patient volumes, staffing shortages, interruptions, system failures, patient

noncooperation, damaged identification bands, and unfavorable environmental conditions.

- Nurses overcame barriers through advance preparation, equipment checks, careful verification, approved downtime procedures, prompt problem reporting, peer support, workload sharing, and interdisciplinary communication.

RECOMMENDATIONS

Based on the findings and conclusions of the study, the following recommendations are suggested:

- Healthcare institutions should provide regular CLMA competency training, scenario-based simulation, refresher courses, and evaluations addressing barcode scanning, electronic verification, downtime procedures, alert interpretation, and automation bias.
- Nurses should continue using proactive preparation, careful verification, time management, checklists, and approved escalation processes.
- Interdisciplinary teams should conduct regular medication-safety huddles involving nurses, physicians, pharmacists, information-technology personnel, quality teams, and administrators to review recurring system problems and coordinate corrective actions.

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AI DECLARATION STATEMENT

AI-supported tools helped with grammar and structure in creating this article. No AI tools were used to collect, analyze, or interpret data; all authors are credited for their academic contributions.

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