



DIGITIZING TIERED NURSING SUPERVISION IN THE ICU: PROTOTYPE DEVELOPMENT AND USABILITY TESTING A CASE STUDY

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ABSTRACT

Tiered nursing supervision in the Intensive Care Unit (ICU) has been routinely conducted; however, its impact on competency development and performance monitoring remains suboptimal due to the absence of a structured schedule, incomplete instruments and documentation, limited reflective practice and self-assessment, high workload, and supervisors' time constraints. This case study aimed to initiate the development of a digital, tiered supervision prototype integrated with the hospital Electronic Medical Record (EMR). The change process was guided by Kotter's eight-step model and aligned with nursing management functions (POSAC). Root causes were identified using an Ishikawa (fishbone) analysis based on the 5M framework. The study population consisted of ICU nursing personnel, with key informants (the ICU head nurse and nursing manager) selected through purposive sampling, and 36 ICU nurses meeting the inclusion criteria (≥ 2 years of experience and minimum PK-1 level) participating as survey respondents. Data were collected from May to June 2025 through semi-structured interviews, direct observations, and structured questionnaires distributed via Google Forms, with informed consent obtained from all participants. Data were analyzed descriptively and analytically using an Ishikawa (fishbone) diagram based on the 5M framework to identify root causes, followed by problem prioritization to inform the development and evaluation of a digital, tiered nursing supervision prototype. The innovation produced a supervision prototype comprising scheduling, standardized checklists, and evaluation outputs to support structured monitoring and feedback. A preliminary usability assessment using the System Usability Scale (SUS) yielded a score of 72/100, indicating acceptable usability. Further work is recommended to finalize integration with the existing EMR, conduct broader-scale testing, provide supervisor training, and strengthen a reflective and structured evaluation culture to comprehensively assess the system's effectiveness.

Keywords: clinical supervision; digitalization; electronic medical record; intensive care unit; nursing management

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INTRODUCTION

Supervision has been implemented in various hospitals; however, numerous challenges persist. A study in South Africa demonstrated that unclear supervision standards contribute to low supervisory effectiveness, decreased quality of nursing care, and an increased risk of hospital-acquired pressure injuries (Shongwe et al., 2024). The implementation of supervision is also influenced by time constraints, supervisors' workload, and non-integrated documentation systems (Ujiana et al., 2024).

The Intensive Care Unit (ICU) is a highly complex setting that requires continuous monitoring and supervision to ensure that all nursing interventions are performed in accordance with standard operating procedures. A study conducted in Belgium reported that ineffective supervision leads to inadequate performance feedback for nurses and suboptimal service quality (Bruyneel et al., 2025). Furthermore, unclear supervisory structures and limited use of digital technology in monitoring processes hinder continuous quality improvement efforts in the ICU environment (Hayatunnisa et al., 2020).

The utilization of technology has been proven to enhance nurse performance, service quality, patient safety, and the effectiveness of nursing supervision. A study in Australia found that the implementation of standardized electronic medical records (EMRs) accelerates service delivery and reduces nurses' cognitive workload in clinical decision-making (Coiera et al., 2025). In the ICU, technology facilitates coordination among nurses, reduces workload, and creates an environment conducive to sustainable supervision, as supervisors can more easily identify guidance needs, provide timely feedback, and ensure the maintenance of care quality. The adoption of digital innovations also helps minimize nurse fatigue, thereby increasing acceptance of supervision and optimizing its impact on care quality and patient length of stay (Tumina, 2025).

Supervision programs are a crucial element of the actuating function, which is a core responsibility of nurse managers. This function focuses on mobilizing and motivating nurses to perform their duties optimally. Actuating is also understood as a management process aimed at ensuring direction, plan implementation, and effective and efficient utilization of resources to achieve organizational goals (Huber, 2020). Effective nursing supervision plays a vital role in improving nurse performance, maintaining the quality of nursing care, and ensuring alignment between individual nurses' goals and those of healthcare organizations (Marquis, 2021). In the nursing context, effective supervision serves as a strategic instrument for translating work plans into concrete actions through coaching, monitoring, and the provision of constructive feedback.

The results of the preliminary assessment of managerial roles and functions in the ICU indicate that the implementation of supervision still faces several obstacles, including inadequate preparation and limitations in data processing and analysis. Supervision processes are predominantly conducted manually, resulting in less specific and less effective monitoring. This case study aims to develop a tiered supervision program using Kotter's eight-step change model as a planned change approach to strengthen supervisory effectiveness and improve the quality of nursing services in the ICU.

METHOD

This study employed a case study approach using Kotter's Eight-Step Change Model as its conceptual framework, which includes establishing a sense of urgency, forming a powerful guiding coalition, developing a clear vision and strategies to support change, communicating the vision and strategies to all stakeholders, removing obstacles, generating short-term wins, consolidating improvements, and institutionalizing change. This approach was used to examine the implementation of nursing supervision in the ICU.

The study was conducted in the ICU from May 27 to June 30, 2025. The activities involved key informants selected through purposive sampling, consisting of the ICU head nurse and the nursing manager, to obtain an in-depth understanding of nursing supervision practices. In addition, 36 ICU nurses who met the inclusion criteria of a minimum of two years of work experience and a minimum career level of PK-1 participated as survey respondents. Data were collected using a structured questionnaire distributed via Google Forms.

All participants provided informed consent after receiving a detailed explanation of the study, and data confidentiality was strictly maintained throughout the research process. Observational data were collected during routine ICU service hours to directly assess the implementation of nursing supervision. Data analysis was conducted using an Ishikawa (fishbone) diagram to identify root causes based on the aspects of manpower, money, machines, materials, and methods. Problem prioritization was determined by considering frequency, impact, feasibility of improvement, and strategic value. The primary problems identified subsequently served as the basis for developing a Plan of Action (POA) and for evaluating the implementation of nursing supervision.

RESULT

The initial assessment revealed that nursing supervision in the ICU was conducted monthly using Google Forms; however, it was hindered by incomplete competency instruments, the absence of a structured weekly schedule, and the lack of evaluation and self-reflection tools. Although a supervision SOP was available, it was not fully understood by all staff. Additional barriers included difficulties in data analysis due to large data volumes, limited supervisor training, and the absence of budget allocation for training, incentives, and digital supervision system development. Observations further identified non-compliance with SOPs in several nursing procedures. Questionnaire results indicated that most nurses had adequate knowledge of supervision, yet consistent use of checklists and motivational feedback remained suboptimal.

Based on these findings, a digital-based nursing supervision program was implemented using Kotter's Eight-Step Change Model integrated with the POSAC management framework. Priority problems identified through Ishikawa analysis included the lack of a systematic supervision schedule and the absence of digital integration. The intervention focused on developing standardized supervision instruments, tiered scheduling based on clinical nurse levels, role assignment, and integration with the Electronic Medical Record (EMR) system.

Pilot testing of the digital supervision prototype demonstrated positive outcomes, achieving a usability score of 72, indicating good user acceptance. Continuous monitoring and evaluation supported the consolidation of structured supervision practices and facilitated gradual integration into routine ICU nursing workflows. Overall, the implementation showed that digital-based supervision is feasible and effective in strengthening supervision processes, improving adherence to standards, and supporting sustainable professional nursing practice in the ICU.

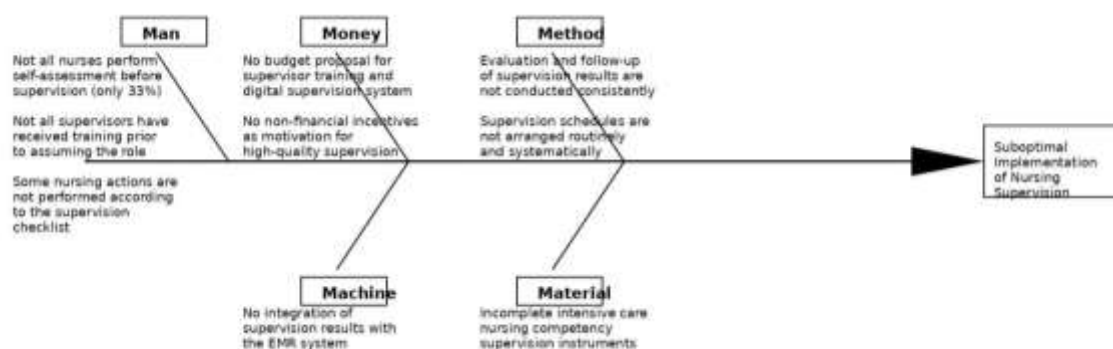


Figure 1. Ishikawa/Fishbone Diagram Analysis of Nursing Supervision Implementation in the ICU

After all data were collected, a grading process was conducted by summing the scores for frequency, impact, feasibility of improvement, and strategic value of each identified problem. This process was used to determine priority issues to be addressed and incorporated into the Plan of Action (PoA). Based on the grading results and discussions with hospital stakeholders, the absence of a structured supervision schedule and the lack of digitalization of the supervision application were identified as priority problems requiring follow-up. The developed PoA was then implemented according to a timeline jointly established with the hospital, followed by an evaluation phase.

The development of a digital-based nursing supervision program began with the structured preparation of supervision schedules and instruments using digital documents through group discussions. This stage aimed to ensure that supervision implementation was systematic and measurable. Subsequently, a supervision prototype was developed using a design thinking approach to generate solutions aligned with clinical needs, which was then coordinated with the hospital IT team to enable integration into the Electronic Medical Record (EMR) system. The next stage

involved the development of a supervision evaluation program through Focus Group Discussions and document reviews to establish success indicators.

The sequence of activities concluded with a pilot test of the supervision application for supervisors using video tutorials and questionnaires to ensure user readiness and competence in implementing digital supervision effectively. The pilot test involved 10 users who met the inclusion criteria of more than two years of work experience and a minimum clinical career level of PK-1. The pilot results were analyzed using the System Usability Scale (SUS), yielding a score of 72 out of 100, which reflects positive user acceptance and promising prospects for successful implementation.



Figure 2. Prototype of Nursing Supervision in the ICU

The prototype entitled “D-Super: Digital Supervision for Nurses” is a digital-based nursing supervision system that consists of several main menus, including supervision schedules, supervision instruments, results, supervision evaluation, and supervision performance graphs. The

supervision schedule displays the names of supervisors and supervisees along with the competencies to be supervised. When a supervision instrument is selected, detailed procedural guidelines are presented for user reference. After all supervision stages are completed, the assessment results are generated and analyzed with the assistance of artificial intelligence (AI). The prototype also includes the final stage of the supervision process, namely supervisor evaluation and supervisee self-reflection, as well as performance data visualization in the form of tables and graphs. These features are designed to support systematic evaluation and continuous improvement of nurses' competencies in the ICU setting.

DISCUSSION

Nursing supervision in the Intensive Care Unit (ICU) is an essential component of quality assurance and patient safety systems, given the complexity of clinical interventions and the high risk of errors. Unstructured supervision in intensive care settings contributes to variations in nursing practice, increased missed nursing care, and decreased adherence to clinical standards (Abawaji et al., 2025). Strengthening supervision through a systematic and technology-based approach is therefore a strategic necessity in ICU service governance (Tumina, 2025).

The use of Kotter's planned change model in the development of digital-based nursing supervision is highly relevant, as the changes implemented encompass behavioral, systemic, and organizational culture dimensions. Recent studies in the healthcare sector indicate that Kotter's model is effective in implementing digital nursing innovations because it emphasizes collaborative leadership, vision communication, and continuous quality improvement (Carreno, 2024). The application of Kotter's model has been shown to enhance nurses' acceptance of digital systems, improve compliance with practice standards, and strengthen patient safety culture (Booth et al., 2021). Thus, integrating Kotter's change model into the development of digital nursing supervision is not merely theoretical but is empirically supported as an effective strategy to ensure the success and sustainability of digital transformation in hospital settings.

The analytical process in this study was conducted after all data had been collected using an Ishikawa (fishbone) diagram. Root cause analysis through the Ishikawa diagram provides a systemic approach to identifying barriers to supervision, particularly in terms of methods, human resources, and technology (Seong et al., 2025). This approach enables structured mapping of cause–effect relationships, allowing organizations to identify underlying problems rather than focusing solely on surface-level symptoms. In complex healthcare environments, the use of Ishikawa diagrams has proven effective in supporting managerial decision-making, service quality improvement, and evidence-based workflow optimization (Sokovic et al., 2021). Furthermore, integrating fishbone analysis into the evaluation of nursing supervision aligns with continuous quality improvement principles and quality management frameworks that emphasize systemic approaches to organizational performance enhancement (Antony et al., 2024). Therefore, the selection of the Ishikawa method is appropriate for designing comprehensive supervision interventions.

The digitalization of nursing supervision through integration with the Electronic Medical Record (EMR) offers substantial opportunities to enhance supervisory efficiency and accountability. Recent international studies indicate that EMR-integrated digital systems improve traceability of nursing performance, accelerate evaluation processes, and support data-driven managerial decision-making (Nguyen et al., 2025). This innovation is particularly relevant in ICU settings, which require real-time quality monitoring. The positive usability outcomes of the prototype are consistent with contemporary findings in health technology acceptance research. Ease of use and alignment with clinical workflows have been identified as key determinants of successful adoption of nursing technologies (Carayon et al., 2025). Accordingly, involving nurses in the prototype design phase represents an appropriate strategy to enhance acceptance of the digital supervision system.

The integration of digital supervision with POSAC management functions strengthens the operational and sustainable implementation of supervision. The effectiveness of actuating and controlling functions in nursing management is highly dependent on information systems capable of providing timely and accurate performance feedback (Rahmadani et al., 2024). In this context, EMR-based supervision serves as a strategic quality control tool. From a patient safety perspective, digital supervision has the potential to reduce adverse events by improving procedural compliance and enabling early detection of practice deviations. Recent longitudinal ICU studies demonstrate that structured and electronically documented supervision is associated with reduced incidences of care-related infections and procedural errors (Tumina, 2025). These findings reinforce the clinical value of digital-based supervision innovations.

Overall, the development of an EMR-based tiered supervision prototype using Kotter's change model and Ishikawa analysis reflects best practices in modern nursing management transformation. Contemporary literature emphasizes that the success of supervision innovations is determined not only by technological factors but also by leadership, organizational readiness, and the reinforcement of a reflective culture. Therefore, the model developed in this study holds strong potential for replication and further development across diverse healthcare settings.

CONCLUSION

The digital-based nursing supervision program in the ICU was systematically developed and implemented by referring to the POSAC management functions and Kotter's change stages. The activities progressed from the initial stage of creating a sense of urgency to the sixth stage of achieving short-term wins. The program included the development of a structured supervision schedule, cross-team coordination for organizing activities, clarification of roles between supervisors and supervisees, and the socialization and pilot testing of the prototype to ensure readiness for EMR integration. All stages of change were implemented collaboratively, including active involvement of the IT team in refining the application. Based on the program evaluation, key outcomes included the availability of structured supervision schedules and instruments, as well as the development of an application design that achieved a usability score of 72, indicating good user acceptance. Overall, this program demonstrates strong potential to strengthen professional, well-documented, and digitally supported nursing supervision practices in the ICU setting.

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