



Assessing Nurses' Readiness for Bedside Medication Administration Technology

Ibrahim Saudi Ibrahim Alotaibi, Marzouq Mohammed Alshabawi, Musab Abdullah Hamian Alotaibi, Faiz Faid Mohammed Alenazi, Rashed Sager Alharbi, Hamad Mufarreh Alqahtani, Faisal Ben Shaya Alotaibi

Abstract

The ongoing concern regarding medication errors in hospitals has prompted the recommendation for the implementation of Information Technology (IT) in medication administration processes. This IT initiative aims to support nurses in administering medications safely, reduce the occurrence of medication errors, and enhance overall patient safety. Its imminent introduction in several hospitals underscores the importance of assessing nurses' readiness and acceptance of such technology, crucial for its successful adoption. This descriptive study utilized the Technology Acceptance Model to gauge nurses' preparedness for using IT in medication administration. The study involved nurses from three major hospitals in Beirut, gathering data on their demographics, attitudes, and perceptions of IT's usefulness and ease of use in medication administration. Nurses voluntarily completing the questionnaire either manually or electronically. The findings revealed a correlation between nurses' attitudes towards the proposed IT system and their perceptions of its usefulness and ease of use. While a majority displayed a positive inclination towards the system and scored high on these perceptions, approximately 20% of nurses exhibited a negative attitude towards its adoption.

Keywords: professional development, assessment, evidence-informed practice, integration, nursing.

Introduction

The integration of Information Technology (IT) into medication administration has significantly impacted healthcare by reducing medication errors and adverse drug events, enhancing patient safety, and aiding nurses in adhering to the 5Rs (Right patient, drug, dose, route, and time) at the point-of-care. (Ragan et al., 2005)

In , healthcare institutions are increasingly focused on patient safety due to rising concerns about medication administration errors. Some hospitals are planning to introduce IT applications for medication administration to improve safety and reduce adverse drug events. However, challenges often arise during the implementation phase of new IT systems. Successful implementation of IT in healthcare requires thorough preplanning, including adequate user preparation, to ensure a smooth transition. (Johnson et al., 2002)

Literature emphasizes the importance of users' positive attitudes and perceptions of usefulness and ease of use towards new IT systems for successful implementation. Therefore, assessing users' readiness for IT adoption before implementation is crucial. (Coyle & Heinen, 2005)

Preparing to introduce IT applications for medication administration across various healthcare agencies. However, transitioning from manual to electronic medication administration poses significant challenges and costs for these institutions. The implementation cost, as estimated by the Food and Drug Administration for technologies like bar coding systems, is substantial, impacting hospitals' financial considerations. (Anderson & Wittwer, 2004)

Assessing Nurses' Readiness for Bedside Medication Administration Technology

Additionally, not all registered nurses (RNs) are enthusiastic about adopting IT for medication administration, which can hinder successful implementation. Organizational and behavioral issues often contribute to implementation challenges, including user attitudes towards IT use and inadequate input from potential users during the planning phase. (Murray, 2001)

Internationally, there is a recognized need to implement IT in medication administration to reduce errors and enhance patient safety. In , hospitals striving for accreditation must meet Joint Commission on Accreditation of Health Care Organizations' requirements to enhance medication safety and minimize medical errors. (Patterson et al., 2005)

Literature Review

The adoption of Information Technology (IT) in healthcare organizations for medication administration aims to enhance the quality of this process and improve patient safety. User attitudes towards IT play a critical role in the successful implementation of such systems, with some users showing resistance while others exhibit acceptance. In recent years, IT researchers have focused on understanding user attitudes and acceptance of new IT systems, recognizing that user rejection can impede implementation success. (Greenly & Gugerty, 2002)

Various models, including those rooted in behavioral intention theories from social psychology, have been developed to predict and assess user acceptance of new IT and influence positive attitudes towards its use. One prominent model is the Technology Acceptance Model (TAM). (Department of Health and Human Services; Food and Drug Administration, 2004)

The TAM, introduced by Fred Davis in 1986, is a predictive model specifically designed to explain user acceptance of IT (Figure 1). It provides a theoretically sound framework for studying IT acceptability and usability evaluation, enabling researchers to predict and explain user behavior across different IT user groups. TAM also allows for the examination of external factors' impact on users' beliefs, attitudes, and intentions. (Patterson et al., 2006)

The model posits that two key beliefs, perceived ease of use and perceived usefulness, are primary determinants of IT acceptance. Acceptance, in this context, refers to the willingness of a user group to utilize IT for its intended tasks. Perceived ease of use reflects the belief that using a system would be effortless, while perceived usefulness indicates the belief that using the system would enhance job performance. (Anderson & Wittwer, 2004)

Davis selected these constructs based on the assumption that users evaluate an IT system based on how it improves their job performance (perceived usefulness) and the effort required to use it (perceived ease of use). Additionally, TAM suggests that IT usage is influenced by users' behavioral intention, which is in turn influenced by their attitude towards using IT. User attitude towards IT usage refers to the evaluative affect associated with using the system in their job, indicating favorable or unfavorable feelings towards it. (Murray, 2001)

The individual's attitude and internal beliefs are influenced by various external factors, including system design characteristics, user involvement in system development, the implementation process, and cognitive style. These external factors contribute to shaping users' attitudes and acceptance of IT for medication administration. (Patterson et al., 2006)

The Bar-Coding Medication Administration

The Bar-Coding Medication Administration (BCMA) system has emerged as a crucial point-of-care safety measure, significantly improving medication administration accuracy and patient safety. This technology, often integrated into mainframe-based systems with portable devices like laptops or computers on wheels, operates by scanning medications and patient wristbands using barcode scanners. The system, accessible from networked terminals within the hospital, employs real-time communication via a wireless network, ensuring up-to-date information and preventing errors that could occur with manual data collection and entry.

Upon scanning the patient's wristband, nurses can access the patient's active medication orders. Each medication is scanned to validate its timeliness and correct dosage against the orders. The BCMA system

interfaces with pharmacy software to verify and display medication orders, streamlining the medication administration process and reducing the potential for errors.

The effectiveness of BCMA systems in reducing medication errors is evident from studies such as the Veterans Affairs Medical Center at Colmery-O'Neil, where the implementation of BCMA led to a significant decrease in error rates. Errors related to administering the wrong medication, wrong dose, wrong patient, wrong time, and missed administrations were substantially reduced, highlighting the system's impact on patient safety.

Nurses' attitudes towards IT use for medication administration play a pivotal role in the successful adoption and implementation of BCMA systems. Studies have shown that a majority of nurses using IT technology for medication administration perceive it as reducing the risk of medication errors. However, challenges arise when nurses face problems related to system flexibility, leading to dissatisfaction and potential inefficiencies in system utilization. Addressing these issues is crucial to maintaining nurses' satisfaction and ensuring the effectiveness of BCMA systems in improving medication safety.

Methodology

Aim of the Study

This study aims to assess the acceptance level of potential users regarding the use of Information Technology (IT) for medication administration. By understanding nurses' attitudes and perceptions regarding the ease of use and usefulness of IT in medication administration, this research seeks to predict potential user rejection rates and identify implementation barriers. This knowledge will contribute to the development of better IT implementation guidelines, improve technology design, and enhance methods for evaluating and predicting user responses to new technology.

Research Questions

The research questions addressed in this study are:

1. What are nurses' attitudes towards using IT for medication administration?
2. What are nurses' perceptions regarding the ease of use of IT for medication administration?
3. What are nurses' perceptions regarding the usefulness of IT for medication administration?
4. How does previous experience with IT use in clinical practice influence nurses' attitudes and perceptions?
5. Is perceived ease of use of IT for medication administration positively related to nurses' attitudes towards its use?
6. Is perceived usefulness of IT for medication administration positively related to nurses' attitudes towards its use?
7. Is perceived ease of use of an IT system a more significant determinant of users' attitudes towards its use than perceived usefulness?

Design and Sampling

This descriptive study assesses Registered Nurses' (RNs) attitudes towards using IT for medication administration in clinical settings and examines factors influencing these attitudes and the implementation of IT medication administration systems. The study was conducted in three major hospitals in Beirut that were planning to deploy IT for medication administration applications. A total of 300 RNs from these hospitals were invited to voluntarily participate in the survey using convenience sampling.

Development of the Study Measure

The study utilized a 29-item survey instrument developed by the author, including instructions for respondents to rate their perceived ease of use, perceived usefulness, and attitude towards using IT for medication administration. The questionnaire began with demographic questions and included items to assess nurses' perceptions of IT usefulness and ease of use based on Davis's model. Nurses' attitudes towards IT use were measured using standard 7-point semantic differential rating scales.

Data Analysis

Data collected from the survey were analyzed using statistical methods to assess nurses' attitudes, perceptions, and the relationships between variables such as perceived ease of use, perceived usefulness,

Assessing Nurses' Readiness for Bedside Medication Administration Technology

and attitudes towards IT use. Statistical software was used to analyze the data and draw conclusions regarding acceptance levels and potential barriers to IT adoption in medication administration.

The validity and reliability of the questionnaire used in this study were assessed through several methods.

Face and Content Validity:

The questionnaire underwent a review by two experts to ensure face and content validity. Their feedback was incorporated into the revised questionnaire to enhance its validity.

Construct Validity:

Construct validity was assessed using factor analysis with the principal component extraction method and varimax rotation. For the domain of usefulness, all six items loaded on one component, indicating good construct validity. The Cronbach's alpha for these items was 0.88, indicating high internal consistency. Similarly, for the ease-of-use domain, although the items loaded on two components, the Cronbach's alpha for all six items was 0.73, demonstrating acceptable internal consistency. The attitude domain also showed good construct validity with items loading on a single component, and the Cronbach's alpha for these items was 0.95, indicating high internal consistency.

Sample and Procedures:

Approval from the relevant authorities and institutional review boards was obtained. The nursing directors at the three institutions invited current RNs to participate voluntarily. A designated contact person at each hospital facilitated the distribution and collection of questionnaires. A cover letter explaining the study's purpose, time frame, and anonymity of responses was provided to participants. A total of 276 nurses, potential users of the proposed IT, participated in the study.

Data Analysis:

Descriptive statistics were used to analyze all items on the questionnaire. Statistical analyses were performed using SPSS software. Pearson correlations were used to examine relationships among the three domains (usefulness, ease of use, attitude). Mean differences were assessed, and multivariate regression models were used for multivariate associations. Goodness of fit was evaluated using R-square, and significance levels were set at 0.05..

Results

The study involved 276 participants, and their characteristics were detailed, including their previous experience with IT in clinical practice and their perceptions of self-involvement in medication errors with manual medication administration.

Computed domain scores for usefulness, ease of use, and attitude towards IT use in medication administration were calculated, with mean and standard deviation provided for each domain along with minimum and maximum scores.

A two-dimensional correlation matrix was used to analyze the relationships between the computed domain scores. All three domains (usefulness, ease of use, attitude) were significantly correlated with varying strengths of correlation.

Bivariate association analysis examined the influence of general characteristics on domain scores. Factors such as institution, age, education level, computer skills, exposure to Nursing Informatics (NI), and fear of medication errors significantly affected domain scores.

Multivariate regression analysis revealed key determinants for each domain, including location of work, computer skills, perception of self-involvement in medication errors, ease of IT use, attitude towards IT use, age, education level, years of experience, and usefulness of IT.

Overall, the study findings highlight the complexity of factors influencing nurses' attitudes and perceptions towards IT use in medication administration, emphasizing the role of institutional context, individual characteristics, previous experience with IT, and perceptions of usefulness and ease of use in shaping nurses' acceptance of IT adoption in healthcare settings.

Discussion

The study utilized the Technology Acceptance Model (TAM) to assess the acceptance of IT usage among potential users, focusing on perceived usefulness, perceived ease of use, and user attitude. The TAM framework proved to be suitable for evaluating IT acceptance, capturing a significant portion of the variance in users' acceptance levels. (Yang et al., 2002)

Results indicated an overall positive perception of IT usefulness, ease of use, and attitude towards the proposed system across the three institutions studied. However, significant differences were noted in the factors influencing IT usage acceptance. Characteristics such as computer skills, exposure to Nursing Informatics (NI), and the perception of future involvement in medication errors due to manual systems had a notable impact on user perceptions and attitudes. (Coyle & Heinen, 2005)

Nurses in Institution-A, which is undergoing accreditation and magnet certification preparations, exhibited the highest acceptance levels of IT usage. This suggests that structured training programs aimed at accreditation and magnetization positively influence nurses' perceptions and attitudes, emphasizing the role of IT in enhancing patient safety and quality care. (Anderson & Wittwer, 2004)

Additionally, users with higher computer skills showed more positive perceptions and attitudes towards IT usage, indicating that prior IT experience can influence users' intentions. (Walstrom & Wilson, 1997)

Exposure to Nursing Informatics also influenced users' perceptions and attitudes positively, as understanding technology's impact on nursing practice and patient safety led to better acceptance of IT systems. (Coyle & Heinen, 2005)

Furthermore, users who perceived a higher risk of medication errors with manual systems showed a greater acceptance level towards IT usage. This awareness of manual process flaws and associated errors enhanced users' intentions to use IT for patient safety and quality care improvement. (Succi & Walter, 1999)

The study emphasizes the importance of users' positive attitudes and perceptions of IT usefulness and ease of use in fostering successful IT adoption. Users' beliefs about the system's utility and usability significantly influence their intention to use IT, highlighting the need for IT systems to align with users' perceptions and needs for optimal acceptance and usage. (Greenly & Gugerty, 2002)

Conclusion and recommendations

In conclusion, this study using the Technology Acceptance Model (TAM) provided valuable insights into nurses' attitudes and perceptions regarding the use of IT for medication administration in . The results indicated an overall positive perception of IT usefulness, ease of use, and attitude among nurses in the three selected hospitals. However, significant variations were noted in the influence of different factors on nurses' perceptions and attitudes towards IT usage.

Based on the findings, it is essential for healthcare organizations to focus on improving nurses' attitudes, perceived ease of use, and perceived usefulness towards IT systems. This can be achieved through targeted training programs, workshops, and seminars on Nursing Informatics (NI) to enhance nurses' knowledge about the benefits of IT in medication administration and patient safety. Additionally, efforts should be made to improve nurses' computer skills through access to computer labs and free training sessions.

A key recommendation is to tailor training programs to address specific needs identified in this study, such as targeting nurses with limited exposure to NI and those with lower computer skills. By adequately preparing nurses and addressing their concerns and perceptions, healthcare organizations can increase the acceptance and successful implementation of IT for medication administration.

Furthermore, continuous monitoring and evaluation of IT implementation, along with ongoing support and training for nurses, are crucial for sustaining positive attitudes and ensuring the effective use of IT systems in healthcare settings. This study's findings can serve as a foundation for developing comprehensive strategies to promote the successful integration of IT into medication administration practices, ultimately improving patient safety and healthcare outcomes.

References

1. Gould, D., Boies, J., & Lewis, C. (1991). Making usable, useful, productivity-enhancing computer applications. *Communications of the ACM*, 34, 75–85.

2. Davis, D. (1993). User acceptance of information technology: system characteristics, user perceptions and behavioral impacts. *International Journal of Man-Machine Studies*, 38, 475–487.
3. Department of Health and Human Services; Food and Drug Administration. (2004). Bar code label requirements for human drug products & biological products. *Federal Register*, 69(38). Retrieved from <http://www.fda.gov/CbER/rules/barcodelabel.pdf>
4. Beuscart-Zephir, C., Brender, J., Beuscart, R., & Menager-Depriester, I. (1997). Cognitive evaluation: how to assess the usability of information technology in healthcare. *Computer Methods and Programs in Biomedicine*, 54, 19–28.
5. Davis, D., Bagozzi, R. P., & Warshaw, P. R. (1989). User acceptance of computer technology: a comparison of two theoretical models. *Management Science*, 35, 982–1003.
6. Dillon, A., & Morris, M. (1996). User acceptance of new information technology: theories and models. *Journal of the American Society for Information Science*, 31, 3–32.
7. Davis, D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, 13, 319–340.
8. Igbaria, M. (1993). User acceptance of microcomputer technology: an empirical test. *OMEGA-International Journal of Management Science*, 21, 73–90.
9. Cole, G. (1992). User acceptance key to success of voice processing. *Computing Canada*, 18, 39–40.
10. Ajzen, I., & Fishbein, M. (1980). *Understanding Attitudes and Predicting Social Behavior*. Englewood Cliffs, NJ: Prentice-Hall, Inc.
11. Fishbein, M., & Ajzen, I. (1975). *Belief, Attitude, Intention and Behavior: An Introduction to Theory and Research Reading*. Boston, MA: Addison-Wesley.
12. Ajzen, I., & Fishbein, M. (1977). Attitude-behavior relations: a theoretical analysis and review of empirical research. *Psychological Bulletin*, 84, 888–918.
13. Igbaria, M., Zinatelli, N., Cragg, P., & Cavaye, A. (1997). Personal computing acceptance factors in small firms: a structural equation model. *MIS Quarterly*, 21, 279–305.
14. Keil, M., Beranek, P. M., & Konsynski, B. R. (1995). Usefulness and ease of use: field study evidence regarding task considerations. *Decision Support Systems*, 13, 75–91.
15. Succi, M. J., & Walter, Z. D. (1999). Theory of user acceptance of information technologies: an examination of health care professionals. *Proceedings of the 32nd Annual Hawaii International Conference on System Sciences (HICSS-32)*. Maui: IEEE Computer Society.
16. Benbasat, I., & Dexter, A. S. (1986). An Investigation of the effectiveness of color and graphical presentation under varying time constraints. *MIS Quarterly*, 59–84.
17. Baroudi, J., Olson, M. H., & Ives, B. (1986). An Empirical study of the impact of user involvement on system usage and information satisfaction. *Communications of the ACM*, 29, 232–238.
18. Ginzberg, M. J. (1978). Steps towards more effective implementation of MS and MIS. *Interfaces*, 8, 57–63.
19. Huber, G. P. (1983). Cognitive style as a basis for MIS and DSS design: much ado about nothing? *Management Science*, 29, 567–582.
20. Greenly, M., & Gugerty, B. (2002). How bar coding reduces medication errors. *Nursing*, May, 1–2. Retrieved from http://findarticles.com/p/articles/mi_qa3689/is_200205/ai_n9084283
21. Ragan, R., Bond, J., Major, K., Kingsford, T., Eidem, L., & Garrelts, J. C. (2005). Improved control of medication use with an integrated barcode-packaging and distribution system. *American Journal of Health-System Pharmacy*, 62, 1075–1079.
22. Johnson, C. L., Carlson, R. A., Tucker, C. L., & Willette, C. (2002). Using BCMA software to improve patient safety in Veterans Administration medical centers. *Journal of Healthcare Information Management*, 16, 46–51.
23. Yang, M., Brown, M. M., Trohimovich, B., Dana, M., & Kelly, J. (2002). The effect of bar-code enabled point-of-care technology on medication administration errors. In R. Lewis (Ed.), *The Impact of Information Technology on Patient Safety* (pp. 37–56). Chicago, IL: Healthcare Information and Management Systems Society.

24. Coyle, G. A., & Heinen, M. (2005). Evolution of BCMA within the Department of Veteran Affairs. *Nursing Administration Quarterly*, 29, 32–38.
25. Anderson, S., & Wittwer, W. (2004). Using bar-code point-of-care technology for patient safety. *Journal of Healthcare Quality*, 26, 5–11.
26. Baker, H. M. (1997). Rules outside the rules for administration of medication: a study in New South Wales, Australia. *Journal of Nursing Scholarship*, 29, 155–158.
27. Murray, M. (2001). Automated medication dispensing devices. In K. Shojania, B. Duncan, K. McDonald, & R. Wachter (Eds.), *Making Health Care Safer: A Critical Analysis of Patient Safety Practices* (pp. 111–117). Rockville, MD: AHRQ.
28. Patterson, E. S., Cook, R. I., & Render, M. L. (2002). Improving patient safety by identifying side effects from introducing bar coding in medication administration. *Journal of the American Medical Informatics Association*, 9, 540–553.
29. Patterson, E. S., Cook, R. I., & Render, M. L. (2005). Fifteen best practice recommendations for bar-code medication administration in the Veterans Health Administration. *Joint Commission Journal on Quality and Safety*, 30, 355–365.
30. Patterson, E. S., Rogers, M. L., Chapman, R. J., & Render, M. L. (2006). Compliance with intended use of Bar Code Medication Administration in acute and long-term care: an observational study. *Human Factors*, 48, 15–22.
31. Walstrom, K. A., & Wilson, R. L. (1997). Gaining user acceptance of an EIS. *Information Systems Management*, 14, 54–59.