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JOURNAL of INFORMATICS NURSING®

The Official Journal of the American Nursing Informatics Association

Featured Articles

- Medical Device Cybersecurity Risk Assessments: Engaging Clinicians to Mitigate Threat NCPD
- Impact of Using Handheld Mobile Devices on Barcode Medication Administration Overrides among Registered Nurses and Respiratory Therapists in a Community Hospital Setting
- Exploring Influencing Factors for Older Adults' Performance with Electronic Personal Health Records
- Strategic Stewards: Core Teams and Knowledge Maintenance

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Editor's Corner

Looking Ahead to a New Year!

Preparing for the 2025 Annual Conference

In 2025, the ANIA Annual Conference will be held much earlier than in past years – March 27 -29 – and will be here shortly! Be sure to check out the conference details included in this issue (see pages 2 and 45). However, the central source of information is the ANIA conference website at https://ajj.swoogo.com/ania25, which features the complete program, travel information, and registration details.

If you missed the national office's email blast about conference scholarships or the November issue of the ANIA E-News, the 2025 ANIA Conference Scholarship Program is presently open but closes on December 31. The online scholarship application is available at www.surveymonkey.com/r/7L789XH. A reminder about the conference scholarships: they are awarded to a variety of membership year spans: 1, 2-4, 5-10, and greater than 10. Additionally, scholarships are not limited to first-time attendees. These scholarships cover the full conference registration fee, either in-person or virtual, but do not include pre-conference workshops or travel expenses. Be sure to apply before the December 31 deadline.

A New Year's Stimulus for Writing and the Journal

Looking ahead to 2025, the *Journal of Informatics Nursing* is seeking manuscript on topics related to telehealth/virtual nursing, artificial intelligence, and cybersecurity. Included with the topics below are potential ideas to further assist in developing each of the topics. These are only suggestions, however, and you should not be limited by these concepts if you are interested in publishing an article on any of the noted topics.

- Telehealth/ Virtual Nursing: quality improvement, expansion of access and capabilities, or new approaches
- Artificial Intelligence: the role and impact in your nursing clinical environment or nursing education
- Cybersecurity: security drills, quality improvement of downtime readiness, or downtime challenges within nursing and how to overcome them

Also, we are working on a few new elements for the journal in 2025, so be sure stay up to date with the *Journal of Informatics Nursing*.

During the holidays, please remember to take time for your mental health and well-being. Consider doing a few small random acts of kindness. Wishing you a joyous holiday season and a happy new year! ◆

Elizabeth C. Elkind

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Learning Outcome

After completing this education activity, the learner will be able to discuss the use of the Center for Internet Security Risk Assessment Method (CIS RAM) to complete a medical device security risk assessment, and the importance of involving clinicians in the security risk assessment and mitigation process.

Accreditation Statement

This educational activity is jointly provided by Anthony J. Jannetti, Inc., and the American Nursing Informatics Association (ANIA).

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Medical Device Cybersecurity Risk Assessments: Engaging Clinicians to Mitigate Threat

Nicole A. Mohiuddin, Jeannie Corey, and Toby Gouker

This article details an evidence-based cybersecurity risk assessment of a medical devices project in a health system located in the Gulf Coast region of the United States. The assessment identified clinically relevant medical devices with cybersecurity risks and their severity. Clinicians were provided medical device cybersecurity education and were engaged to use the Center for Internet Security Risk Assessment Method (CIS RAM) while ranking high-risk medical devices according to clinical workflow inconvenience and potential to harm patients. This work may serve as an exemplar for other hospitals to include clinical leaders in medical device cybersecurity risk assessments and underscores the value clinicians bring to mitigation of cybersecurity threats.

Keywords: medical device cybersecurity, cybersecurity risk assessments, nursing informatics, medical devices, cyber breaches, CIS RAM, cyber awareness

Cybersecurity is "the art of protecting networks, devices, and data from unauthorized access or criminal use and the practice of ensuring confidentiality, integrity, and availability of information (Cybersecurity & Infrastructure Security Agency, 2021, para. 1). Healthcare clinical practice relies on computers, data, and the internet. This is especially true in the use of medical devices, which are connected to the internet and require strong cybersecurity protocols to ensure their data is secure.

Recent technical advances have resulted in transformations in healthcare delivery, which can improve patient care. A prime example is the increase in interconnectivity between medical devices and other clinical systems. This interconnectivity leaves medical devices vulnerable to security breaches in the same way other networked computing systems are vulnerable (Williams & Woodward, 2015). However, unlike other networked computing systems, there is an increasing concern that the connectivity of these medical devices could compromise clinical care and patient safety (i.e., inaccurate readings of healthcare information, overdoses of drugs, exposure of personal information, and even the delivery of electric shocks at the wrong time).

Background and Significance

Healthcare environments, whether in the hospital or at home, are at risk for cyberattacks against the medical devices and networks to which they are connected. A cyberattack is an international threat to patient care and safety that crosses all healthcare settings. Cyberattacks are usually aimed at accessing, changing, or destroying sensitive information; extorting money from users; and interrupting normal business processes.

Cybersecurity involves protecting information by preventing, detecting, and responding to cyberattacks (Kamerer & McDermott, 2020). Cybersecurity events affecting healthcare organizations have been in the news with increasing frequency, indicating their growing impact and expense (Landi, 2022). Incidents range from breaches affecting millions of patient records to attacks shutting down hospitals across the country, with at least one of them tragically contributing to the death of a patient (Kostic, 2023).

Cyberattacks can be malicious and often are deliberate attempts by an individual or organization to breach the information system of another individual or organization. In 2024, the number of data compromises in the United States totaled 841 cases with over 28 million individuals affected (Statista, n.d.). There are several types of cyberthreats to health care, one of which is ransomware. Ransomware is a type of malicious software designed to block access to a computer system until a sum of money is paid. Recently, the Cybersecurity and Infrastructure Security Agency, Federal Bureau of Investigation, and

Department of Health and Human Services (HHS) issued a joint warning about the healthcare industry being a target of expanding ransomware activity (Riggi, n.d). Cybercriminals also use brazen methods, such as removing healthcare data and extorting patients for financial gain (King, 2021). Increasingly, health care is a prime target for cyberattacks, as 92% of healthcare organizations surveyed experienced at least one cyberattack in the past 12 months. This is an increase from 88% in 2023, with 69% reporting disruption to patient care as a result (Diaz, 2024).

During the COVID-19 pandemic, the healthcare industry faced additional cybersecurity challenges. There were more remote workers and patients using telehealth services, which increased the likelihood of security gaps when organizations and employees failed to follow remote work security best practices. Lack of strong passwords, unsecured Wi-Fi networks, and unencrypted devices were often exploited by cybersecurity criminals. In addition, many internet-connected medical devices were placed in patients' homes, offering a wide range of attack opportunities due to protected health information data being transmitted across home and public networks (Schneider & Wirth, 2021).

Since health care is taking place in much more complex and highly accessible spaces, there is more opportunity for valuable patient data to be harvested by cyber criminals. Healthcare organizations must improve their cyber defenses and "cyber culture." Expanding an organization's understanding of cyber risks, better defining what must be protected, learning how to protect it in ways that support efficient workflows and safety, and instilling good user cyber behavior are ways to minimize the threat, vulnerability, and risk of cybersecurity insults (Schneider & Wirth, 2021). Creating a culture of cybersecurity awareness is vital for the long-term protection of patient data.

Promoting a culture where every employee recognizes the importance of cybersecurity and understands their role in maintaining the security of patient information can be achieved through regular communication, training sessions, and ongoing reminders about best practices for cybersecurity. By fostering a culture of cybersecurity awareness, healthcare organizations ensure that the protection of patient data becomes ingrained in their day-to-day operations. Healthcare organizations can leverage their existing patient safety practices to develop a complementary culture of cybersecurity. When staff members view themselves as proactive defenders of their patients and their data, they can have a tremendous impact on mitigating cyber risk to their patients and organizations.

Information technology, cybersecurity, and clinical engineering departments have traditionally been the primary decision-makers regarding the security of medical devices with minimal to no involvement from clinicians. Creating cyber-savvy clinicians as partners may increase the likelihood that clinical needs are factored into medical device security decisions (Schneider & Wirth, 2021). Clinicians are becoming more dependent upon the information from medical devices to make clinical decisions and typically unknowingly and implicitly trust the data on these devices. To protect the integrity of the information, cybersecurity initiatives and policies have been instituted by hospital cybersecurity/information technology departments. However, there are times when cybersecurity interventions can interfere with clinical processes by interrupting or hampering clinical processes and workflows. A balance between clinical workflow and security measures is needed to combat this dilemma. Clinicians who learn about cybersecurity, are aware of threats, remain alert to them, and are familiar with mitigation and incident response can help protect patients and organizations (Stritch et al., 2021).

Previously identified cybersecurity risks were selected for this evidence-based project. These medical devices were categorized as being of high risk by the health system's medical device asset management software. This software is commonly used by clinical engineering departments to determine what medical devices are currently actively connecting to a hospital's wireless network infrastructure. The asset management and device monitoring software categorize a medical device's level of cybersecurity risk based on publicly disclosed cybersecurity vulnerabilities called common vulnerability exposures (CVEs). The CVE information is sponsored by the U.S. Department of Homeland Security (2019) and the Cybersecurity and Infrastructure Security Agency (CISA). It is not uncommon for a single medical device to have many or even hundreds of known CVEs.

Cybersecurity practices are often managed by a Chief Information Security Officer (CISO) and a team of cybersecurity professionals. They may use general cybersecurity risk assessment tools that are not specific to medical devices. It is not standard practice for hospitals to include clinicians in cybersecurity risk assessments or decision-making. The CISO at the health system sanctioned support in assessing the cybersecurity risk of medical devices in order to provide insight into their current cybersecurity posture. Through personal communication with the health system's clinical engineering department leader, the need for clinicians to learn more and be better informed about medical device security was confirmed.

Problem Statement/ Purpose/Aims

This evidenced-based project evaluated high-risk medical devices for clinical effects of CVEs in a health system in the Gulf Coast region of the United States. While medical device interconnectivity is intended to positively impact clinical care and promote end-user data accessibility, it makes medical devices vulnerable to security breaches that could negatively impact clinical care and patient safety. A clinical engineering professional and the CISO of the health system were proponents of this project. They confirmed through personal communications that cyber awareness in their organization could be improved.

Cybersecurity risk evaluations are not always specific to medical devices, and clinicians are not typically included in this assessment process. Thus, this evidenced-based project assessed medical device cybersecurity risks and identified the need for clinician involvement in medical device cybersecurity risk assessments. The purpose/aims of this project were to: (1) conduct a medical device security risk assessment using the Center for Internet Security Risk Assessment Method (CIS RAM); (2) share medical device assessment results with organizational leadership; (3) explore clinical leader medical device cybersecurity awareness; and (4) develop an evidence-based plan to address high-risk findings.

Figure 1.
Impact and Likelihood Scoring

Impact Score	Impact Score Defined
1	No or minimal harm would result.
2	Harm would not be tolerable.
3	Harm may not be recoverable.

Impact Score	Impact to Our Mission *Mission: Provide information to help remote patients stay healthy.*	Impact to Our Obligations *Obligations: Patients must not be harmed by compromised information.*
1	Patients continue to access helpful information, and outcomes are on track.	No harm would come to patients.
2	Some patients cannot access the information they need for good outcomes.	Few patients may be harmed after compromise of information or services.
3	We can no longer provide helpful information to remote patients.	Many patients may be harmed financially, reputationally, or physically, up to and including death.

Likelihood Score	Likelihood Score Defined
1	Not foreseeable.
2	Expected to occur.
3	Regular occurrence.

Likelihood scoring is defined as the chance that an event may occur.
Source: Center for Internet Security Risk Assessment Method (CIS RAM), Version 2.1. Used with permission.

Theoretical Framework

The Cyber Security Awareness Measurement Model (APAT) was used as the theoretical framework for this evidence-based project (Rahim et al., 2015). The project leader selected the APAT model due to APAT's history of evaluating cybersecurity awareness levels in university students and employees. Employees are viewed as the most vulnerable links in cybersecurity and need cybersecurity awareness training to protect themselves and their organization. It was postulated that this framework would be helpful with other populations (i.e., healthcare professionals).

The APAT model's approach follows the steps: analyze, predict, awareness, and test. In the *analyze* step of this evidence-based project, top cyber vulnerability trends were analyzed. Examples of cyber vulnerability trends in health care are phishing, malware, suspicious behavior, and human error/negligence. The *predict* step involved predicting the behavior in the coming years (i.e., cybersecurity vulnerabilities will continue to grow in health care).

This project included informing clinicians of the growing and ongoing threats to medical devices. The *awareness* phase involved giving employees a chance to learn best practices through meetings or learning sessions. Clinicians were allowed to rank high-risk medical devices in terms of their clinical workflow inconvenience and potential harm to patients. The *test* step consisted of performing a baseline assessment of cybersecurity awareness by interviewing/testing users to determine if their awareness increased. At the end of this project, clinicians were asked if they felt that participating in the risk assessment was beneficial to their clinical practice.

Project Design

This evidence-based practice project included two phases:

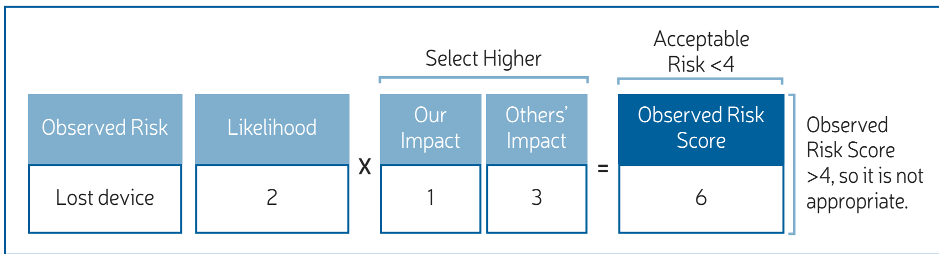
1) Evaluation of selected high-risk medical devices using CIS RAM, an evidence-based cybersecurity risk assessment tool.
2) Conducting a post-intervention education session and sharing CIS RAM medical device evaluation results to facilitate a brainstorming discussion session that informed the development of a proposed mitigation plan for high-risk medical devices.

Project Design – Phase I

A cybersecurity risk assessment was piloted using a valid, reliable risk assessment (CIS RAM). The CIS RAM is a general cybersecurity risk assessment that examines critical security controls related to an organization's hardware, software, and vulnerability management. Risks to an organization's mission and impact on its objectives/obligations can create harm to an organization. For example, a hospital's mission may be to provide information to help remote patients be compliant with their medication regime or treatment plan. An impact to that objective may be to operate profitably. A hospital's obligations may be that patients must not be harmed by compromised information.

Cybersecurity risk assessments are important tools for healthcare organizations to evaluate and prioritize cybersecurity risks and determine when cybersecurity risks are acceptable. When using risk assessments, organizations need to demonstrate "reasonable" safeguards and risk management for regulatory, contractual, or security management purposes (Agaku et al., 2014). The CIS RAM was designed by cybersecurity experts from a variety of industries, including health care. The first version was published in April 2018. Version 2.1 was published in August 2022. The original content of CIS RAM was developed by HALOCK Security Labs. It was based on their extensive experience helping clients and legal authorities resolve cybersecurity and "due-care" issues. The CIS RAM assessment is free and openly available to the entire cybersecurity community regardless of industry sector. The CIS RAM has been adopted by thousands of global enter-

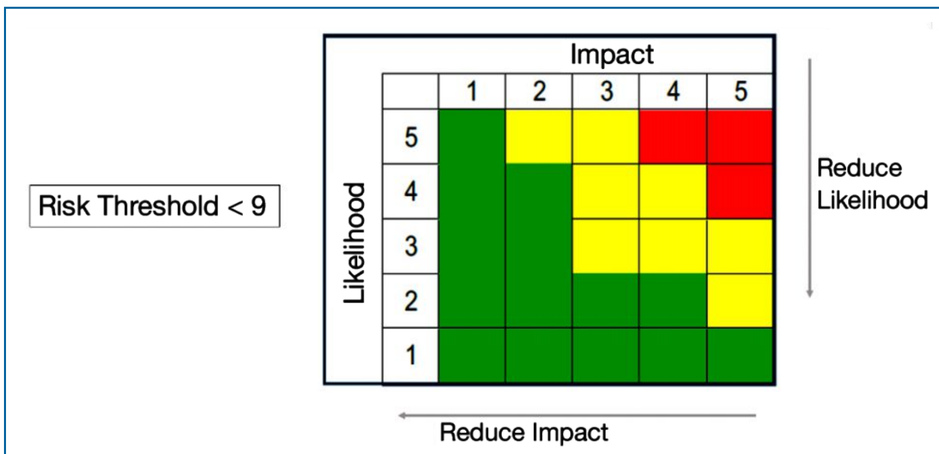
Figure 2.
Risk Score Calculation



This example demonstrates how the Impact and Likelihood scores were calculated as: The Risk + Likelihood x Impact to Mission + Impact to Obligations = A Risk Score

Source: Center for Internet Security Risk Assessment Method (CIS RAM), Version 2.1. Used with permission.

Figure 3.
CIS RAM Risk: Impact vs. Likelihood Heat Diagram



Based on the scoring, a heat diagram demonstrates the threshold of risk of Likelihood and Impact scores are: High Risk (red), Medium Risk (yellow), and Low Risk (green). The goal is to reduce impact and reduce likelihood of a risk. Green areas are what is preferred.

Source: Center for Internet Security Risk Assessment Method (CIS RAM), Version 2.1. Used with permission.

prises, large and small, and is supported by numerous security solution vendors, integrators, and consultants (Center for Internet Security [CIS], n.d.). The tool utilizes cybersecurity best practices and provides a set of standards that helps organizations build a framework for gauging the effectiveness of their cybersecurity programs (CIS, n.d.).

The CIS RAM is a publicly available tool that can be used to assess medical devices that are connected to the internet (i.e., networked devices) for the severity of cybersecurity risk. The tool uses a risk calculation based on "likelihood of risk" versus "impact of risk" to derive a score. A number is assigned to the likelihood and impact of risk. The CIS RAM is divided into three categories: basic, foundational, and organizational. The foundational category provides benefits and actions for organizations by implementing it. The organizational category focuses on people and processes in an organization (CIS, n.d.). The CIS RAM bases its risk analysis using the formula "risk = probability x impact." The impact of security breaches is assessed internally and externally. Medical devices with *High Risk* are those that could pose harm to a patient and require the most urgent attention. *Medium Risk* was determined as medical devices that posed a risk to the organization or were out of compliance with a legal standard and did not need to be addressed as urgently. *Low Risk* was determined as medical devices with cybersecurity risks that could be mitigated last and did not cause harm to patients or organizations. Impact scoring is defined as the possible impact on the hospital's or department's overall mission. It also calculates the possible impact to cause patient harm. Figures 1, 2, and 3 demonstrate how the CIS RAM risk score was calcuated.

A list of medical devices was obtained from the health system's clinical engineering department. It is common for a hospital to have several thousand medical devices actively running on their network. However, for this study, only medical devices that are deemed high risk were analyzed. High-risk devices were identified by using the medical device asset tracking and management software used by the clinical engineering department. This software receives information regarding medical devices and publicly disclosed information about cybersecurity vulnerabilities and exposures. This data is provided and updated by device manufacturers and CISA. A medical device may be categorized as high risk because it may have been running on outdated operating systems software, have outstanding patches that may need to be installed, or have known cybersecurity vulnerabilities that the vendor has divulged.

Project Design – Phase II

A facilitated virtual group session was conducted to educate clinicians about medical device cybersecurity and to collect the results of the CIS RAM assessment. Participants signed waivers of privacy and consent before participating in the discussion session. During this meeting, additional data was collected via a facilitated brainstorming discussion. Data from this discussion was collected to gain insight into participants' perspectives regarding clinician involvement in cybersecurity risk assessments. Responses also were used to inform the development of a proposed mitigation plan for high-risk medical devices. Overall discussion themes were collected via notetaking. The open-ended questions included: (1) How would you score each medical device based on potential harm or clinical workflow inconvenience? (2) What do you suggest to mitigate the high-risk medical devices? (3) Now that you know the results of the assessment, do you find this helpful or not in your clinical practice? (4) How do you suggest that your hospital involve clinicians in medical device cybersecurity?

A scheduled 1-hour online meeting with nurse informaticists and clinical engineering was the mechanism for information sharing. Conversation highlights and brainstorming responses from clinical leaders were recorded with notetaking by project leaders. Project leaders identified key messages and

themes by reviewing the notes and discussing congruent perceptions from the conversations. These answers were used to provide insight into a risk mitigation plan for the health system. In addition, clinicians' insights were used to confirm the value the clinicians can add when being included in medical device cybersecurity risk assessments.

Project Results

Project Setting

The setting was a 792-bed health system located in the Gulf Coast region of the United States. The health system consisted of three hospitals classified as urban, suburban, and rural/community hospitals.

Project Population

The population included in this project were nurse informaticists, a director of informatics, and a clinical engineering professional. Project participants were self-selected by volunteering to attend the virtual educational/results-sharing session. Participants were recruited through email communication 1-2 weeks before the educational/results-sharing session and selected by their manager based on their willingness to participate. All participants had previous experience using medical devices. The sample size was kept small (*n*=19) to provide ample time for interactive conversation and the collection of participants' perspectives during the results-sharing session.

Phase I

There were 4,292 medical devices identified as actively communicating on the health system's network infrastructure. The project's evaluative results involved a complex process that entailed the understanding of the medical device CVEs and the solutions suggested by manufacturers/cybersecurity experts to mitigate cybersecurity risks. Eight hundred six devices were deemed high risk based on the health system's medical device asset management software. This represented approximately 19% of the health system's total medical devices.

The 806 high-risk medical devices were further reviewed for their clinical effects of CVEs and their suggested solutions to mitigate the risks of a medical device. From this review process, only four medical devices were selected for additional evaluation. The key determining factor for selection of these four devices was daily clinical practice use. Due to the project design for ample time allotment during the brainstorming discussion, the final selection of high-risk medical devices was further narrowed to two devices: an infusion pump and an imaging workstation. The infusion pump was found to have a CVE and if a successful cyberattack occurred, the attacker could impact the core functions of the infusion pump. For instance, an attacker could remotely intercept unencrypted communications from the device, permit an unauthorized person to change how the pump delivers intravenous medications, alter medication selection, or even potentially dispense a lethal dose of medication. The CVE for the imaging workstation was that an attacker who successfully exploited the vulnerability could take control of the system. Risk mitigation strategies for each medical device's CVE was researched.

Phase II

The project lead provided a cybersecurity awareness education slide presentation to clinical leadership detailing which high-risk medical devices were used within their facilities and clinical practice. Clinicians also were informed about possible solutions to mitigate the CVEs for each medical device.

Clinicians were then asked to use the CIS RAM methodology to rank each medical device's mitigation strategies based on clinical workflow inconvenience and potential to harm patients. A score of 3 was the highest level of clinical workflow inconvenience and potential to harm patients. A score of 1 was the lowest level of clinical workflow inconvenience and potential harm to patients. Clinicians provided comments if a risk mitigation strategy had an impact on clinical engineering staff or if the medical device's current functionality would be affected (see Table 1).

After ranking the medical devices, clinicians' suggestions were collected for the risk mitigation strategies proposal. These risk mitigation strategies were shared with the health system and formulated the health system's medical device cybersecurity risks process. These brainstorming discussion findings recommended that clinicians be included in ongoing cybersecurity education throughout the health system.

Practice Implications

Healthcare organizations continually face cybersecurity threats, as cybercrimes have drastically increased in type, impact, and frequency. These attacks have the potential to negatively impact patient privacy, the ability of clinicians to deliver care, and the security of healthcare organizations. Medical devices can be compromised by malicious actors, potentially placing the lives of patients at risk. While there are no reports of direct attacks on medical devices, many hospitals have been targeted with ransomware, which can affect patient care. The opportunities to address the issue include conducting cybersecurity risk assessments, educating clinicians about cybersecurity risk, and developing organizational-specific evidence-based cybersecurity risk mitigation plans.

A plethora of medical devices used by clinicians are connected to the internet (ventilators, infusion pumps, defibrillators, patient beds, handheld devices, and systems for patient monitoring and management). Yet, this project highlighted that clinicians were unaware of the amount of internet-connected medical devices utilized in their clinical practice and the risks associated with these devices. However, upon learning about these risks, clinicians felt that being informed was important to their practice, as they are responsible for providing safe and efficient care while using medical devices.

Clinicians in this project also wanted to have a "voice" in the cybersecurity risk assessment process. Clinician inclusion provides the healthcare organization with added protection due to cybersecurity awareness and threat mitigation. A healthcare organization's cybersecurity posture can be reinforced because clinicians may be more receptive to requirements or changes to minimize cybersecurity risks. They will no longer feel that workflow changes are occurring randomly and without explanation if a medical device needs to be updated or taken out of service. Ultimately, awareness, open communication, and inclusion promote a culture of engaged clinicians who are committed to detecting and stopping cyber incidents.

The World Health Organization (n.d.) estimates there are over 2 million different kinds of medical devices on the world market. Evidence-based practice tools, such as the CIS RAM, and others should continue to be evaluated for how they can be best utilized to assess medical device cybersecurity risks. The use of CIS RAM for medical device cybersecurity risk evaluation is in its infancy. However, the assessment methodology can

Table 1.
Clinician Feedback Regarding Cybersecurity Risk Mitigation Strategies for Select Medical Devices (*n*=19)

Recommendation/Mitigation	Clinical Workflow Inconvenience	Potential Harm to Patients	Comments
Infusion Pumps			
Manually close Port 20/FTP and Port 23/TELNET on the affected devices	2	1.5	Likely to inconvenience clinical engineering staff
Disconnect the device from the wireless network	3	3	
Place pumps on a separate subnet, isolated from the internet by a firewall	1	1	
Replace current infusion pumps with updated versions of pumps	2	1	
Imaging Workstation			
Microsoft update/patch (offline for 1 day)	3	3+	Updates remove some of the functionality we depend upon
Scan the device occasionally, risks shutting it down or rebooting	1	1	
Remove the system from the internet	3+	3	
Place equipment behind a firewall introducing significant lag ~1 minute	2	1	

be tailored to adequately assess medical device cybersecurity risks.

Conclusion

Cybersecurity risk assessments are complex and involve understanding the common vulnerabilities and exposures that many medical devices may have. Cybersecurity awareness also involves understanding the clinical implications of risk mitigation strategies, such as workflow inconvenience and the potential to harm a patient. Medical device cybersecurity is an interdisciplinary process that cannot be done without clinician involvement. It is hoped that the results of this project may lead to more cybersecurity risk assessment discussions and meetings that engage clinicians. The project team recommends that healthcare organizations create cybersecurity committees that incorporate clinicians into the cybersecurity posture of an organization.

A benefit of this work was strengthened interprofessional relationships. Clinical engineering remarked after the presentation to clinicians that "it was music to their ears!" This resulted in clinicians having a better understanding of cybersecurity and wanting to be involved in their health system's cybersecurity awareness efforts. Furthermore, clinicians identified so well with the presentation slide showing pictures of medical devices used in their daily practice that they requested permission to use the slide in their health system's ongoing cybersecurity awareness campaign.

There is high interest by healthcare organizations regarding cybersecurity and intervention, as cyberattacks continue to plague health care. However, there currently are no published works regarding clinician participation in medical device cybersecurity risk assessments. Dissemination of this work regionally, nationally, and internationally via publication or presentations would be ideal for spreading this message.

This project may serve as an exemplar for other healthcare organizations by highlighting the importance of including clinicians in medical device cybersecurity risk assessments. Clinical leadership and patient safety should be represented in all decisions regarding medical device cybersecurity, including equipment life cycle planning, procurement decisions, replacement planning, and security workflows. An informatics nurse would be ideal for a clinical cybersecurity role within a healthcare organization. They can serve as the intermediary between cybersecurity and clinical engineering professionals. In addition, their expertise would allow them to illustrate to health system leadership the negative effects of not having a clinically supported cybersecurity program. Informatics nurses' strong understanding of working in a clinical setting, technical skills, and ability to quickly adapt to emerging technologies make them ideal to be the clinical link in a medical device cybersecurity paradigm. ◆

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References

Agaku, I.T., Adisa, A.O., Ayo-Yusuf, O.A., & Connolly, G. . (2014). Concern about security and privacy, and perceived control over collection and use of health information are related to withholding of health information from healthcare providers. *Journal of the American Medical Informatics Association*, *21*(2), 374-378. https://doi.org/10.1136/amiajnl-2013-002079

Center for Internet Security. (n.d.). *CIS RAM (risk assessment method)*. https://www.cisecurity.org/insights/white-papers/cis-ram-risk-assessment-method

Cybersecurity & Infrastructure Security Agency. (2021). *What is cybersecurity?* https://www.cisa.gov/news-events/news/what-cybersecurity

Diaz, N. (2024, October 9). 92% of healthcare organizations experienced a cyberattack in 2024. *Becker's Health IT.* https://wwwbeckershospitalreview.com/cybersecurity/92-of-healthcare-organizations-experienced-a-cyberattack-in-2024.html

Kamerer, J.L., & McDermott, D. (2020). Cybersecurity: Nurses on the front line of prevention and education. *Journal of Nursing Regulation,10*(4), 48-53. https://doi.org/10.1016/S2155-8256(20)30014-4

King, R. (2021, August 11). *May cyberattack cost Scripps nearly $113M in lost revenue, more costs.* Fierce Healthcare. https://www.fiercehealthcare.com/hospitals/may-cyber-attack-cost-scripps-nearly-113m-lost-revenue-more-costs

Kostic, N. (2023, July 13). *Healthcare cybersecurity statistics – an overview*. https://phoenixnap.com/blog/healthcare-cybersecurity-statistics

Landi, H. (2022, February 1). *Healthcare data breaches hit all-time high in 2021, impacting 45M people*. Fierce Healthcare. https://www.fiercehealthcare.com/health-tech/healthcare-data-breaches-hit-all-time-high-2021-impacting-45m-people

Rahim, N.H.A., Hamid, S., Kiah, M.L.M., Shamshirband, S., & Furnell, S. (2015). A systematic review of approaches to assessing cybersecurity awareness, *Kybernetes, 44*(1), 606-622. https://doi.org/10.1108/K-12-2014-0283

Riggi, J. (n.d.). *Why and how to incorporate cyber risk management into enterprise risk management.* American Hospital Association. https://www.aha.org/center/cybersecurity-and-risk-advisory-services/why-how-incorporate-cyber-risk-management-enterprise-risk-management

Schneider, J., & Wirth, A. (2021). Balancing patient safety, clinical efficacy, and cybersecurity with clinician partners. *Biomedical Instrumentation & Technology, 55*(1), 21-28. https://doi.org/10.2345/0899-8205-55.1.21

Statista. (n.d). *Number of data violation incidents and individuals impacted in the United States from 1st quarter 2021 to 1st quarter 2024*. https://www.statista.com/statistics/1418469/us-number-of-data-compromises-individuals-affected

Stritch, M.M., Winterburn, M., & Houghton, F. (2021). The Conti ransomware attack in Ireland: Exploring the impacts of a cybersecurity breach from a nursing perspective. *Canadian Journal of Nursing Informatics*, *16* (3-4). https://cjni.net/journal/?p=9383

U.S. Department of Homeland Security. (2019). *A lifeline: Patient safety and cybersecurity. 2019 Public-Private Analytic Exchange Program.* Government Publishing Office. https://www.govinfo.gov/app/details/GOVPUB-HS-PURL-gpo150339

Williams, P.A.H., & Woodward, A.J. (2015). Cybersecurity vulnerabilities in medical devices: A complex environment and multi-faceted problem. *Medical Devices Evidence and Research, 8*, 305-316. https://doi.org/10.2147/MDER.S50048

World Health Organization. (n.d.). *Medical devices.* https://www.who.int/health-topics/medical-devices

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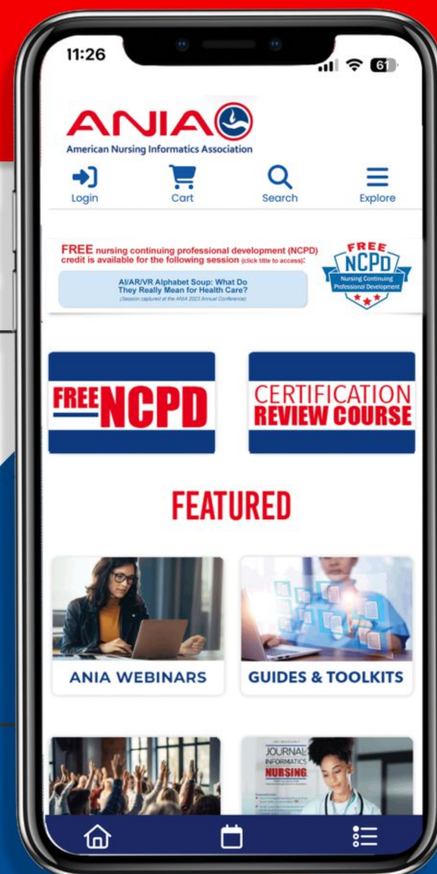


Impact of Using Handheld Mobile Devices on Barcode Medication Administration Overrides among Registered Nurses and Respiratory Therapists in a Community Hospital Setting

Lilly Mathew, Luciann Sackett, Bissoondaye Ragoonanan, Maria Grella, Erica Gateau, and Theresa Dillman

A research study was conducted to understand barcode medication administration overrides among registered nurses and respiratory therapists in a community hospital setting using handheld mobile devices. Statistically significant differences were found among groups and specialty units

Keywords: handheld mobile devices, barcode medication administration, BCMA overrides, registered nurses, respiratory therapists, specialty units

Barcode medication administration (BCMA) technology involves placing a unique identifier (barcode) on each medication that is machine readable by an optical scanner and that encodes the National Drug Code (Cochran et al., 2007). Hospitalized patients have the barcode affixed to their identification bracelets for accurate patient identification. Several patient safety organizations, such as the Agency for Healthcare Research and Quality and Institute of Medicine, have endorsed BCMA technology. Overriding BCMA systems can potentially lead to medication errors and patient harm.

Background and Significance

The purpose of the BCMA system is to promote patient safety. It can prevent medication errors by 57% (Khammarnia et al., 2015). The consistent use of BCMA improves patient safety by decreasing the number of patients harmed by medication administration errors (Thompson et al., 2018). Technical factors like compatibility, interconnectivity, integration, design, and ease of use play a role in the safe use of BCMA systems (Heikkinen, 2022). BCMA process issues lead to BCMA overrides, documented as workarounds in the literature, and have consequences due to bypassing the safety features of BCMA technology (Boehme et al., 2022). The shortcomings in BCMA design, implementation, and workflow integration encourage workarounds. Therefore, integrating BCMA within real-world clinical workflows requires attention to ensure safety (Koppel et al., 2008). Studies have found that BCMA detects and eliminates medication administration errors (Zheng et al., 2021). Thus, overriding BCMA is a patient safety issue as it increases the risk of medication administration errors. BCMA overrides are documented as workarounds in the literature with consequences of wrong medication administration, wrong doses, wrong times, and wrong formulations (van der Veen et al., 2018). Some ergonomics and behavioral factors like poor cart ergonomics and perceived time inefficiency also were found to be contributing factors to BCMA overrides, and the importance of behaviors and motivation were also identified as key factors to consider for decreasing BCMA workarounds (Grailey et al., 2023).

Traditionally, scanners attached to desktop computers were used for BCMA, but they are increasingly being replaced with handheld mobile devices (HHMDs). HHMDs are mostly mobile wireless devices like cell phones that directly interface with the electronic health record (EHR) and have BCMA scanning applications. Prime examples are the Epic System Rover™ and Sunrise System Zebra™ phones. In recent literature, use of handheld barcode scanning devices for nurses has been found to reduce the time for medication administration with an average time saving of 5 minutes and 19 seconds per item and 3 hours and 24 minutes of nursing time per day (Meren & Waterson, 2021). Literature suggests work system adaptations are needed to optimize the use of BCMA by nurses during medication dispensing and administration (Mulac et al., 2021). Therefore, it is important to study how newer mobile applications impact BCMA overrides and generate new evidence to advance nursing science. It is important to understand if HHMDs decrease BCMA overrides and improve barcode scanning compliance with medication administration. Therefore, this study sought to determine if using HHMDs decreases BCMA override entries in various clinical specialty units, and the differences between override reasons when using HHMDs compared to traditional scanners.

Literature Review

To understand research gaps in BCMA overrides with HHMDs, literature reviews were conducted in CINAHL, One Search, Google Scholar, and PubMed using key terms like *BCMA or barcode medication administration overrides and mobile devices, BCMA overrides and handheld mobile devices, BCMA and medication systems, overrides and workaround with BCMA,* and *nursing and smartphone or handheld device and patient safety.* Articles included were original evidence-based research studies, evidence-based practice projects, and quality improvement (QI) projects within the last 7 years.

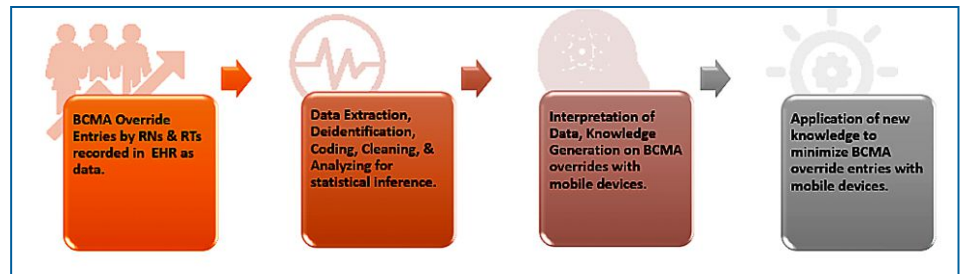
Specifically, two QI initiatives were found to be related to understanding the impact of HHMDs on BCMA compliance. Rapid Plan-Do-Study-Act (PDSA) cycles improved BCMA scanning compliance in the emergency department (ED) using redesigned workflows and addressing challenges with the current process through intense educational efforts (George & Jacob, 2022). Another QI project on understanding staff compliance with BCMA using post-implementation of the Rover app on mobile devices in the ED found that scanning compliance peaked at 93%-94%. In addition, staff reported ease of use in a staff-perceived usefulness self-report survey, and mobile devices helped increase staff compliance with barcode scanning and decreased the reasons like a scanner being broken or unavailable (Kirit, 2023).

Another study evaluated nurses' compliance with BCMA scanning post-implementation of the Epic Rover app and found that BCMA compliance increased in the ED from 82% to 95% when compared to the overall hospital-wide units (Baptiste et al., 2020). Overall, the use of a handheld mobile barcode scanning device for nurses has been found to have positive outcomes, such as time saving of 3 hours and 24 minutes of nursing per day (Meren & Waterson, 2021). Research evidence supports the use of HHMDs to improve BCMA compliance mostly in the ED area. No studies were found to be related to BCMA overrides within various specialty units in a simultaneous manner within a community hospital setting among interdisciplinary staff who administer medications like the registered nurses (RNs) and respiratory therapists (RTs). Additionally, published study designs were mostly QI projects or self-reported surveys. Therefore, this study was designed to address this gap as it was conducted in a community hospital setting in the northeast region of the United States including various practice units and among interdisciplinary staff RNs and RTs utilizing retrospective data analysis of all override events 6 months prior (with scanner) and 6 months post (with HHMD). In the research setting, HHMDs for BCMA were implemented for RNs and RTs to promote ease and improve medication scanning compliance and safe medication administration. The study was conducted to understand if using HHMDs decreases BCMA override events in all specialty units among RNs and RTs within a community hospital setting.

Theoretical Framework

This study was grounded in the theoretical foundation of nursing informatics in the data, information, knowledge, and wisdom (DIKW) framework (Graves & Corcoran, 1989; Nelson, 2018, 2020; Nelson & Joos, 1989). DIKW concepts are considered meta structures supporting all nursing informatics practice, originating from computer and information sciences, and are the most current model adopted in the field of nursing informatics (Matney et al., 2011). In this study, the override entries by RNs and RTs in the EHR were considered as the primary data points, which were then extracted and coded together to generate information that was then analyzed into knowledge that can be clearly applied in related clinical settings (see Figure 1).

Figure 1.
Research Process



BCMA=bar code medication administration, EHR=electronic health record, RN=registered nurse, RT=respiratory therapist

Research Aims

A literature gap was identified related to understanding the frequency and reasons for BCMA overrides with HHMDs within various specialty units in a simultaneous manner within a community hospital setting among interdisciplinary staff (RNs and RTs) who administer medications. Therefore, this study was designed to address this gap. The study aims were to understand if using HHMDs decreased BCMA override events in a community hospital setting among RNs and RTs who administer medications in various specialty units, namely medical-surgical (MS), acute rehabilitation (AR), critical care (CC), telemetry unit (TU), peri-operative units (PU), and ED.

Research Objectives

The objectives of the research were to:

1) Study overall differences in BCMA overrides among RNs and RTs before and after implementation of a HHMD in a community hospital setting.
2) Study differences in types and frequencies of BCMA override reasons reported by RNs and RTs at various practice units within a community hospital setting.

Research Questions

1) Does using HHMDs for medication administration in a community hospital setting decrease overall BCMA override events among RNs and RTs?
2) What are the differences in types and frequencies of BCMA override reasons reported by RNs and RTs at various practice units within a community hospital before and after the implementation of HHMDs for medication administration?

Research Method

Research Design

This quantitative quasi-experimental ex-post facto observation study compared BCMA override events of RNs (*n*=208) and RTs (*n*=20) from 6 months before to 6 months after implementation of HHMDs. In the 6-month pre-period, scanners connected to workstations on wheels were used for BCMA. In the 6-month post-period, HHMDs were used for BCMA.

Setting

The study was conducted in a 175-bed community hospital setting in the northeast region of the United States. The hospital specialized units included in the study were ED, CC, MS, PU, TU, and AR. The hospital employed 208 RNs and 20 RTs, including part-time, full-time, and per diem staff at the time of the study. Approval to conduct the research study was obtained from the system's institutional review board with additional institutional approval. Datasets did not contain any personal identifiers of RNs, RTs, or patients who received medications.

Data Collection

Data were entered as BCMA override entries in the EHR during practice by RNs and RTs. BCMA override entries were extracted from the EHR in the form of BCMA compliance reports generated from System Healthcare Analytics Prod. BCMA override events were entries in the Sunrise Clinical Management Systems™. De-identified datasets were obtained from systems healthcare analytics prod after the removal of all identifiers linked to RNs, RTs, and patients. Datasets were coded and retro analyzed using both Microsoft Excel® and Statistical Package for

Table 1.
Barcode Medication Administration Override Reasons Reported with Descriptions

	Override Category	Descriptions	Total Count	Percentages
1.	Technical Malfunctions (TM)	Barcode not scanning, system downtime, mobile device malfunction, mobile device timed out, data transfer issues to EHR, computer malfunction, need IT association (linking barcode with medications), internet connectivity issues and system error	*n*=14,313	71.0%
2.	Barcode-Related (BR)	Barcode missing, no patient ID bracelet, barcode damaged, label missing, no scanning code	*n*=2,834	14.1%
3.	Emergency Situations (ES)	Rapid response and code	*n*=1,200	6.0%
4.	Medication-Related (MR)	Dosage changes, patient's own medications, late medication delivery, pharmacy approved overrides, double and duplicate order, dosage adjustment	*n*=263	1.3%
5.	Patient-Related (PR)	Patient unavailable, patient refused, patient refused then requested, medication held, patient combative or agitated, patient self-administered, patient no longer on medication, patient not in the census to scan, patient requested	*n*=114	0.6%
6.	Device-Related (DR)	Scanner unavailable, mobile phone unavailable	*n*=292	1.4%
7.	Medication Administration-Related (MA)	Administered earlier by other, not in timeframe, awaiting pharmacy verification, no EHR access for orientees, late administration	*n*=187	0.9%
8.	COVID Isolations (CI)	Patient in isolation room	*n*=140	0.7%
9.	Human Factors (HF)	Label discarded accidently, forgot to mark the complete, forgot to scan, family requested, late documentation	*n*=94	0.5%
10.	Other (OT)	No reason for override was provided, used alpha-numerical code, illegible and incomprehensible reasons were listed	*n*=710	3.5%

Social Sciences (SPSS) version 28.0® (IBM, 2021).

Data Analysis

Extracted data were initially separated 6 six months pre when scanners were used and 6 months post when HHMDs were used. The data were analyzed descriptively and compared using inferential statistical tests. The significance level for this study was set at alpha ≤.05, with confidence interval set at 95%. Frequency distributions were obtained for BCMA overrides pre and post among RNs and RTs and then separated into various specialty units, including MS, AR, CC, TU, PU, and ED, and were compared before and after for differences.

Nonparametric tests were used to determine if a significant difference was noted between the two groups (RNs and RTs) pre and post. BCMA pre- and post-override differences on various units by specialty areas were analyzed using cross tabulations in SPSS, which is a simple extension of frequency analysis that enables examination of frequency associations between two or more categorial variables (Kim et al., 2022).

The descriptives, frequency distributions, cross tabulations, and nonparametric tests like the Mann-Whitney U test were utilized for data analysis. Mann-Whitney U test is a nonparametric test that can be used to compare all data belonging to one group with the other group and calculate the probability of one group being greater or lesser than the other (Nahm, 2016). Categories for override reasons were compared among RNs, RTs, and units during pre (scanner) and post (HHMD) using cross tabulations and Pearson's chi-square tests to identify statistically significant differences.

The reported override reasons were coded numerically and then were analyzed for frequency distributions (see Table 1) and compared to understand differences in reported reasons for overrides in the pre and post period. Override reasons that were similar in nature were combined, and a color-coded table showing the differences in override reasons in various specialty units was generated (see Table 2).

Results

The total number of BCMA override events observed during the study period (12 months) was 20,149. Overall pre overrides with scanners were 9,775 (48.5%) and post-overrides with HHMDs were 10,374 (51.5%), an overall increase in overrides of 3%, Mann-Whitney U z=(-4.44), p<.001. Among RNs, pre overrides with scanners were 9,650 (48.4%) and post with HHMDs were 10,303 (51.6%), an increase of 3.2%, z=(-141.24), p<.001. Among RTs, pre overrides with scanners were 126 (64.3%) and post with HHMDs were 70 (35.7%), a decrease of 28.6%, z=(-13.96), p<.001.

RNs

Among RNs, BCMA override event decreases were noticed in the ED pre 1,426 (56.2%) and post 1,110 (43.8%), a decrease of 12.4%, z=(-50.30), p<.001; CC pre 951 (53%), and post 842 (47%), a decrease by 6%, z=(-42.33), p<.001; MS pre 1,190 (53%) and post 1,055 (47%), a decrease of 6%, z=(-47.37), p<.001; and TU pre 569 (51.8%) and post 530 (48.2%), a decrease by 3.6%, z=(-33.14), p<.001. Override events increased in the PU pre 405 (48%) and post 439 (52%), an increase of 4%, z=(-29.03), p<.001; and AR pre 5,100 (44.6%) and post 6,327 (55.4%), an increase of 10.8%, z=(-106.89), p<.001.

RTs

Among RTs, override events decreased in the ED pre 10 (100%) and post 0 (0%), a 100% reduction; PU pre 11 (84.6%) and post 2 (15.4%), a decrease of 69.2% (15.4%), z=(-3.46), p<.001; MS pre 39 (83%) and post 8

Table 2.
Barcode Medication Administration Override Reasons Reported in Specialty Units

Override Reason	Emergency Department		Acute Rehab Unit		Med-Surg Unit		Critical Care Unit		Telemetry Unit		Peri-Operative Unit	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
TM	53	58	4754	4569	875	926	772	699	476	431	335	352
BR	776	572	58	1352	44	2	10	3	3	2	2	8
ES	467	380	45	26	16	8	72	75	23	29	33	13
MR	3	14	26	115	14	39	4	11	5	19	0	11
PR	0	19	29	32	23	5	0	2	2	1	0	1
DR	61	13	56	26	22	5	19	15	29	12	10	24
MA	24	14	34	46	12	3	13	6	9	3	9	5
CI	0	0	22	26	24	13	7	10	11	9	8	10
HF	1	1	17	31	17	3	0	6	6	9	1	2
OT	50	40	96	140	182	59	54	15	20	17	18	15

Note: Red indicates increased reasons with handheld mobile devices. Blue indicates decreased reasons with handheld mobile devices.

BR=barcode-related, CI=COVID isolations, DR=device-related, ES=emergency situations, HF=human factors, MA=medication administration-related, MR=medication-related, OT=other, PR=patient-related, TM=technical malfunctions

(17%), a decrease by 66%, z=(-6.78), p<.001; and TU pre 15 (88.2%) and post 2 (11.8), decreasing by 76.8%, z=(-4.00), p<.001. There was an increase in override events in the AR pre 37 (49.3%) and post 38 (50.7%), an increase by 1.4%, z=(-8.60), p<.001. RTs do not administer medications in the critical care settings at the study site.

Specialty Units

When overall overrides were examined by specialty units combining RNs and RTs, decreased BCMA overrides were found in the ED pre 1,435 (56.4%) and post 1,111 (43.6%), a decrease by 12.8%, z=(-50.45), p<.001; CC pre 951 (53%) and post 842 (47%), a decrease by 6%, z=(-42.33), p<.001; MS pre 1,229 (53.6%) and post 1,063 (46.4%), a decrease by 7.2%, z=(-47.86), p<.001; and TU pre 584 (52.3%) and post 532 (47.7%), a decrease by 4.6%, z=(-33.39), p<.001. Overrides increased in the AR pre 5,137 (44.7%) and post 6,365 (55.3%), an increase of 10.6%, z=(-107.24), p<.001; and PU pre 416 (48.5%) and post 441 (51.5%), an increase by 3%, z=(-29.26), p<.001.

Reported Override Reasons

Reasons for BCMA override events reported by RNs and RTs were coded numerically. Initially, a total of 49 types of override reasons were reported, which were further grouped into 10 main categories based on similarities in consultation with the research team members and were further analyzed for frequency distribution (see Table 1). The 10 categories with their frequency in percentages were technical malfunctions (TM, n=14,313, 71%), accounting for the highest reason documented for BCMA overrides, followed by barcode-related (BR) issues (n=2,834, 14.1%), emergency situations (ES, n=1,200, 6%), other (OT, n=710, 3.5%), device-related (DR, n=292, 1.4%), medication-related (MR, n=263, 1.3%), medication administration-related (MA, n=187, 0.9%), COVID isolations (CI, n=140, 0.7%), patient-related (PR, n=114, 0.6%), and human factors (HF, n=94, 0.5%). Each category is described in Table 1.

The differences in overall BCMA override reason categories were compared for pre– and post-tabulations in SPSS using cross tabulations. Among RNs, a decrease in TM, ES, DR, MA, CI, and OT and an increase in BR, MR, PR, and HF were noted with HHMD, Pearson's chi-square X^2 (9, n=19,951) =540.49, p<.0 01. Among RTs, no statistically significant differences were noted, Pearson's chi-square X^2 (8, n=196) =10.42 p>.0 01. However, overall reductions were found in TM, BR, ES, MR, PR, DR, MA, HF, and OT with the use of HHMDs. No CI overrides were noted among RTs.

When reported overriding reasons per specialty units were compared, all units consistently had an increase in overrides using HHMDs in the MR category and a consistent decrease in overrides related to other (OT) reasons in all units. A decrease in TM, BR, and DR overrides was noted across all units with HHMDs, except for a slight increase in PU units.

In the ED, a decrease was found in BR, ES, DR, MA, and OT, and an increase was seen in TM, MR, PR, and OT with the use of HHMDs, Pearson's chi-square X^2 (8, n=2,546) =60.78, p<.001. In CCU, there was a decrease in TM, BR, DR, MA, and OT and an increase in ES, MR, PR, CI, and HF using HHMDs, Pearson's chi-square X^2 (9, n=1,793) = 37.86 (p<.001). In SU, there was a decrease in ES, MA, CI, and OT and an increase in TM, BR, MR, PR, DR, and HF, Pearson's chi-square X^2 (9, n=857) =31.75, p<.001. In MS, there was a decrease in BR, ES, PR, DR, MA, CI, HF, and OT and an increase in TM and MR using HHMDs, Pearson's chi-square X^2 (9, n=2,292) =146.51, p<.001. In TU, a decrease was found with TM, BR, PR, DR, MA, CI, HF, and OT, and an increase was found in ES, MR, and HF, Pearson's chi-square X^2 (9, n=1,116) =20.34, p<.05. In RU, there was a decrease in TM, ES, and DR with an increase in BR, MR,

PR, MA, CI, HF, and OT using HHMDs. Statistically significant differences were found X^2 (9, n=11,500) =1160.51, p<.001. In MS, a decrease was found in BR, ES, PR, DR, MR, CI, HF, and OT and an increase was found in TM and MR, Pearson's chi-square X^2 (9, n=2,292) =146.52, p<.001 (see Table 2).

Discussion

An overall increase in BCMA override events were noted with the use of HHMDs among RNs when compared to RTs where there was an overall decrease. When examining overrides by unit, there was a decrease in BCMA override events in the emergency department, critical care areas, medical-surgical units, and telemetry units. However, we found increase in BCMA overrides with HHMDs in peri-operative and acute rehabilitation units. The finding of improved BCMA scanning with mobile devices in the emergency room also was noted previously in the literature (Kirit, 2023).

The major reason reported for BCMA overrides was technical malfunctions (71%), which included scan failures, mobile device malfunction, electronic data transfer issues from the mobile application to EHR, internet connectivity, and system and information technology related issues. These are circumstances in which the staff who administer medications have no control, and since medication must be administered in a timely manner, a workaround to override the BCMA system occurs.

When examining the reasons for overrides noted among RNs and RTs, there was a decrease in all 10 classified override reasons reported among RTs using HHMDs and six among RNs, namely TM, ES, DR, MA, CI, and OT. It is interesting to note that the most common BCMA override reported reason of technical malfunctions decreased with the use of HHMDs. Additionally, overriding in emergency situations, and in COVID-related isolation rooms also decreased with the use of HHMDs. This is a promising find. However, an increase in override reasons with HHMDs among RNs was found with barcode scanning issues, medication-related, patient-related, and human factors. Medications with faded barcodes, like ointments in tubes and missing barcodes due to damaged labels, were noted to increase. Overrides due to patient's own medication use during hospitalizations were noted to increase. Among human factors, forgetting to scan the medications before opening them and discarding labels before scanning were noted issues that are linked to practice behaviors. This finding is consistent with previously identified nurse behaviors and motivation as key factors to consider for decreasing BCMA workarounds (Grailey et al., 2023). In all units, an increase in overrides were related to medication dosage changes, patient's own medications, late medication delivery, pharmacy-approved overrides, double and duplicate orders, and dosage adjustment.

Strengths and Limitations

The strengths of the study included the ability to examine a real-world situation in the naturalistic setting as it occurred. BCMA overrides occur daily in clinical settings as a workaround to administer medications in a timely manner. We were able to study the overrides under two conditions, during the pre-period when scanners were used and post-period when HHMDs were used for barcode scanning. The study was cost-effective as we did not manipulate any variables or need to create artificial settings. The study decreased data collection time as we utilized existing data. We were able to obtain and analyze a large sample size of 20,149 BCMA override entries. The ethical concerns were minimal as we did not manipulate data to study outcomes, which limited bias. The study findings are generalizable to a similar setting.

The study also had clear limitations. We were unable to study within subject differences among RNs and RTs using HHMDs. This could not happen due to the sensitive nature of the study. It was required to remove all staff and patient identifiers to protect the subjects, and we could not pair the dataset but only study it as a pre- and post-group, independent of the condition of using a scanner in pre-group and HHMD in post-group. Another limitation of this study was that it was a single-site study with limited specialty areas. Another major limitation is that the override reasons entered in the system were self-reported and the system itself lacks the capability of verifying override reasons as accurate. Another limitation of an ex post facto study is that we can find and report a change between two conditions but cannot state the cause for the change due to the inability to manipulate or control variables, and the design lacks randomization.

Implications and Recommendations

Innovative technologies that promote convenience like mobile handheld devices for medication administration are promising and may contribute to a decrease in BCMA overrides in some clinical units. Therefore, it is essential to monitor BCMA overrides and identify units that need technical support, improved workflows, and nurse behaviors to enhance and promote safety practices like barcode scanning to prevent medication errors and promote patient safety. HHMD overrides due to technical malfunction of the device have decreased along with overriding in emergency situations and in COVID-related isolation rooms.

This study supports the use of HHMDs for BCMA and recommends close monitoring of BCMA compliance per unit to track patterns in BCMA overrides. BCMA override reasons reported in this study can be used to design unit/specialty-based and targeted interventions to improve BCMA compliance and promote patient safety. Also, we recommend making personal weekly override logs available to nurses to improve insight into personal performance and compliance with BCMA scanning.

Among RNs who administer medications in a much larger capacity in a healthcare facility than RTs, they should consider focusing on barcode-related issues, including medication-related, patient-related, and human factors to improve BCMA compliance. Human factor-related issues like accidentally discarding labels with barcodes, forgetting to scan medications, forgetting to complete essential steps, and late documentation of medication administration in BCMA scanning can be improved through education and practice. To decrease barcode-related issues, nurses must work closely with the pharmacy and consider making a barcode printer available on units to replace previously approved and verified but damaged or missing barcodes.

Regarding medication-related issues that were identified in this study, we recommend that patients' own medications are all re-labeled with barcodes upon patient arrival if used and to speed up pharmacy verifications with new prescriptions and with changes of dosage of medications using advanced technologies. The EHR should be capable of automatically detecting and

eliminating double and duplicate medication orders.

Regarding patient-related issues like patient refusal, it is important to educate nurses to avoid overriding and indicating patient refusal. However, in cases where the patient refused and then later changed their mind, there should be provisions made available in the EHR to reverse refusal, add an addendum, or use the reset function. When a patient is combative and agitated, nurses should have an alternate identification label placed elsewhere, secure it in the patient's bedside, and have additional identifiers like biometrics and facial recognition capable applications.

Additionally, advanced EHRs should be able to detect override reasons automatically, eliminating self-reporting capability. For example, if a scan fails, then it should allow an automatic override and capture, therefore eliminating all self-reporting and self-overriding capabilities with limited managerial override approvals, only in emergencies.

In conclusion, BCMA override events can be minimized by implementing strategies that address reasons that staff indicate in the EHR when overriding. However, it is important to extract BCMA compliance data regularly and identify patterns and trends through data analytical techniques so that unit-based targeted interventions can be implemented to improve BCMA compliance and promote patient safety by decreasing medication errors.

Nursing Informatics Practice Implications

The study has direct implications on nursing informatics practice. Nurse informaticists should regularly review BCMA compliance reports with the increasing use of mobile devices. The majority of the override reasons reported in the study were technical malfunctions, which requires nurse informaticists' engagement and intervention. Issues like barcode not scanning, system downtime, mobile device malfunction, mobile device time out, data transfer issues to EHR, computer malfunction, IT association issues with linking barcode with medications, internet connectivity issues, and system error require informatics intervention. With increased use of advanced technologies like HHMDs in clinical practice, there is a need to increase appointments of nurse informaticists to address technical issues.

Conclusion

This study examined overall differences in BCMA overrides among RNs and RTs before and after implementation of HHMDs in a community hospital setting. We were able to study differences in types and frequencies of BCMA override reasons reported by RNs and RTs in various practice units. Use of HHMDs for medication administration did not decrease BCMA overrides among RNs, but they decreased significantly among RTs. The most common reason reported for BCMA overrides in all specialty units was technical malfunctions, which were noted to decrease with the use of HHMDs among RNs and RTs.

The insight gained from this study supports the use of HHMDs for BCMA, as we found decreased BCMA overrides in many specialty units. The next step is to design unit-based targeted interventions to support the use of BCMA systems and decrease overrides by providing technical support, education, improved workflows, improved collaboration with pharmacy, and changing institutional policy to allow overrides due to verified technical malfunctions. Currently, the institutional policy only allows overriding in emergency situations. This study has provided adequate evidence to advocate for a change in policy to allow verified overrides due to technical malfunctions, as RNs and RTs have no control over technical malfunctions and might not have technical support available on hand to address this immediately.

It is important to continue to review and analyze BCMA overrides on a regular basis to identify trends and patterns so that unit-based interventions can be implemented to improve safe medication administration. It is crucial to avoid overriding systems that are designed for decreasing medication administration errors and promoting patient safety. ◆

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References

Baptiste, D.-L., Whalen, M., Gardner, H., Waweru, M., & Maliszewski, B. (2020). Implementation of the Epic Rover App® to improve barcode-assisted medication administration compliance among nurses in the adult emergency department. *Journal of Informatics Nursing*, *5*(4), 22-25. https://library.ania.org/p/a/implementation-of-the-epic-rover-app-r-to-improve-barcode-assisted-medication-administration-compliance-among-nurses-in-the-adult-emergency-department-9668

Boehme, S., Wohlt, P., Valentine, J., & Ensign, R. (2022). Sustained barcode medication administration rates less than 2 percent in a large healthcare system. *Journal of Patient Safety and Risk Management*, *27*(6), 268-274. https://doi.org/10.1177/25160435221137145

Cochran, G.L., Jones, K.J., Brockman, J., Skinner, A., & Hicks, R.W. (2007). Errors prevented by and associated with bar-code medication administration systems. *Joint Commission Journal on Quality and Patient Safety*, *33*(5), 293-301. https://doi.org/10.1016/s1553-7250(07)33034-1

George, A., & Jacob, R. (2022) Overcoming barcode medication administration scanning challenges in the emergency department. *Journal of the American Nurses Association – New York*, 20-27. https://doi.org/10.47988/janany.23101964.2.2

Grailey, K., Hussain, R., Wylleman, E., Ezzat, A., Huf, S., & Franklin, B. D. (2023). Understanding the facilitators and barriers to barcode medication administration by nursing staff using behavioural science frameworks: A mixed methods study. *BMC Nursing, 22*, Article 378. https://doi.org/10.1186/s12912-023-01382-x

Graves J.R., & Corcoran, S. (1989). The study of nursing informatics. *Image: The Journal of Nursing Scholarship*, *21*(4), 227-231. https://doi.org/10.1111/j.1547-5069.1989.tb00148.x

Heikkinen, I. (2022). Barcode medication administration and patient safety: A narrative literature review. https://www.theseus.fi/handle/10024/745259

IBM Corp. (2021). *IBM SPSS Statistics for Windows* (Version 28.0).

Khammarnia, M., Kassani, A., & Eslahi, M. (2015). The efficacy of patients' wristband bar-code on prevention of medical errors. *Applied Clinical Informatics*, *6*(4), 716-727. https://doi.org/10.4338/ACI-2015-06-R-0077

Kim, M., Mallory, C., & Valerio, T. (2022). *Statistics for evidenced-based practice in nursing* (3rd ed.) Jones & Bartlett Learning.

Kirit, I. (2023). *Improving patient safety and emergency department staff efficiency in barcode medication administration by using the Rover™ mobile application* [DNP scholarly project, University of New Hampshire]. https://scholars.unh.edu/scholarly_projects/94

Koppel, R., Wetterneck, T., Telles, J.L., & Karsh, B.-T. (2008). Workarounds to barcode medication administration systems: Their occurrences, causes, and threats to patient safety. *Journal of the American Medical Informatics Association*, *15*(4), 408-423. https://doi.org/10.1197/jamia.M2616

Matney, S., Brewster, P.J., Sward, K.A., Cloyes, K.G., & Staggers, N. (2011). Philosophical approaches to the nursing informatics data-information-knowledge-wisdom framework. *Advances in Nursing Science*, *34*(1), 6-18. https://doi.org/10.1097/ans.0b013e3182071813

Meren, U.H., & Waterson, J. (2021). Evaluating an automated compounding workflow software for safety and efficiency: Implementation study. *JMIR Human Factors*, *8*(4), e29180. https://doi.org/10.2196/29180

Mulac, A., Mathiesen, L., Taxis, K., & Granas, A.G. (2021). Barcode medication administration technology use in hospital practice: A mixed-methods observational study of policy deviations. *BMJ Quality & Safety*, *30*(12), 1021-1030. https://doi.org/10.1136/bmjqs-2021-013223

Nahm, F.S. (2016). Nonparametric statistical tests for the continuous data: The basic concept and the practical use. *Korean Journal of Anesthesiology*, *69*(1), 8-14. https://doi.org/10.4097/kjae.2016.69.1.8

Nelson, R. (2018). Informatics: Evolution of the Nelson data, information, knowledge and wisdom model: Part 1. *The Online Journal of Issues in Nursing*, *23*(3). https://doi.org/10.3912/OJIN.Vol23No03InfoCol01

Nelson, R. (2020). Informatics: Evolution of the Nelson data, information, knowledge and wisdom model: Part 2. *The Online Journal of Issues in Nursing*, *25*(3). https://doi.org/10.3912/OJIN.Vol25No03InfoCol01

Nelson, R., & Joos, I. (1989). On language in nursing: From data to wisdom. *PLN Visions, 1*(5), 6.

Thompson, K.M., Swanson, K.M., Cox, D.L., Kirchner, R.B., Russell, J.J., Wermers, R.A., ... Naessens, J.M. (2018). Implementation of bar-code medication administration to reduce patient harm. *Mayo Clinic Proceedings: Innovations, Quality & Outcomes*, *2*(4), 342-351. https://doi.org/10.1016/j.mayocpiqo.2018.09.001

van der Veen, W., van den Bemt, P., Wouters, H., Bates, D.W., Twisk, J.W.R., de Gier, J.J. ... Mangelaars, I. (2018). Association between workarounds and medication administration errors in bar-code-assisted medication administration in hospitals. *Journal of the American Medical Informatics Association*, *25*(4), 385-392. https://doi.org/10.1093/jamia/ocx077

Zheng, W.Y., Lichtner, V., Van Dort, B.A., & Baysari, M.T. (2021). The impact of introducing automated dispensing cabinets, barcode medication administration, and closed-loop electronic medication management systems on work processes and safety of controlled medications in hospitals: A systematic review. *Research in Social and Administrative Pharmacy*, *17*(5), 832-841. https://doi.org/10.1016/j.sapharm.2020.08.001

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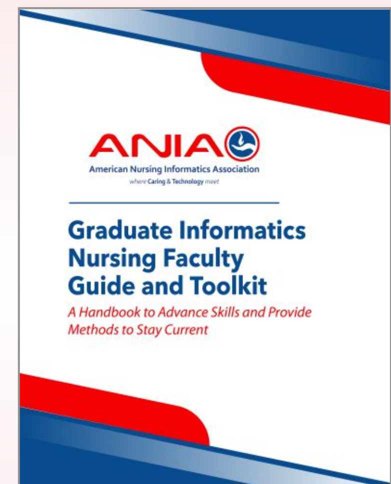

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Exploring Influencing Factors for Older Adults' Performance with Electronic Personal Health Records

Janelle L. Theisen, Julia A. Snethen, Julie L. Ellis, Seok Hyun Gwon, and Murad H. Taani

This study examined the relationship between older adult factors and performance with electronic personal health records (ePHRs). A correlational design identified significant results, including relationships among performance, depression, and intent to use ePHRs. Understanding facilitators and barriers of performance with ePHRs could increase usability

Keywords: older adults, electronic personal health record, ePHR, facilitators, barriers, usage, performance

Adoption of digital technology is required in business, including health care (Oh et al., 2021). Technology contributes to improved health outcomes and positively impacts individuals' quality of life, including the improvement of geriatric care and the ability to connect to inaccessible populations (Abdelrahman et al., 2021). The older adult population (age 65 and older) is projected to grow by 36% in the next 50 years (Administration on Aging [AoA], 2020) and is the fastest growing subset of internet users (Portz et al., 2019). Although the percentage of older adults using technology has increased, it is proportionally smaller than younger generations (Oh et al., 2021).

Inclusion and engagement of older adults in technology use is vital for healthcare organizations (Oh et al., 2021), as it increases provider access to health information. Electronic personal health records (ePHRs) are secure websites that contain personal health information and are directly connected to a provider's electronic medical system (Portz et al., 2019). Utilization of ePHRs can assist individuals to manage their health, leading to care coordination for improved health outcomes and communication with providers (Portz et al., 2019). Benefits of ePHRs include enabling early intervention for healthcare problems, which can reduce healthcare costs (Portz et al., 2019). Telehealth platforms have been implemented to increase older adults' access to health care (Oh et al., 2021).

Although ePHRs are a promising tool in managing older adults' health, a lag in older adults' adoption of ePHR technology exists (Portz et al., 2019). Barriers to adoption of ePHR use in the older adult population include discomfort with technology, privacy concerns, and limited understanding of the benefits of ePHRs (Portz et al., 2019). However, according to the National Poll on Health Aging (2018), approximately 49% of adults between ages 65 and 80 reported having an ePHR. There are demographic differences that contribute to higher utilization of ePHRs in older adults, including higher education level, higher income, and gender (56% of women versus 45% of men) (National Poll on Aging, 2018). While research on older adults' low usage of ePHRs was found in the literature (Oh et al., 2021), research on older adults' user interface or performance with ePHRs and adoption barriers is lacking (Portz et al., 2019). Therefore, this study aims to identify and understand older adults' performance with ePHRs and barriers to ePHR adoption.

Background

An older adult is defined as an individual who has reached the chronological age of 65 years (Kowal & Dodd, 2001). AoA (2020) divides older adults into three groups: young old (65-74 years), middle-old (75-84 years), and old-old (85 years and older). There are approximately 31.5 million older adults who fall within the young-old group, compared to only 6.6 million older adults in the old-old group (AoA, 2020).

Chronic disease significantly affects healthcare costs for older adult patients and healthcare systems. Estimates show that treatment and monitoring of chronic diseases consume more than 85% of healthcare costs (Holman, 2020). Chronic and mental health conditions account for 90% of the nation's $4.1 trillion in annual healthcare expenditures (Centers for Disease Control and Prevention [CDC], 2023). The aging population has important implications for spending due to the higher incidence of chronic disease and healthcare expenditures (Bao et al., 2020). Research indicates that self-management and collaboration with providers leads to better health outcomes in patients with chronic conditions (Bao et al., 2020). One solution to improving engagement and self-management of the older adult is the implementation of ePHRs.

Historically, patients with chronic conditions and older adults sought primary providers face-to-face to provide direct care and manage co-morbidities (McAlearney et al., 2016). In 2009, the Health Information Technology for Economic and Clinical Health (HITECH) Act was created to encourage development of health information systems (HealthIT.gov, n.d.). The HITECH Act provides organizations opportunities to establish programs to improve healthcare quality, safety, and efficiency using health information systems (HealthIT.gov, n.d.). Organizations have since implemented electronic health records, provided decision support interventions, and started remote monitoring of older adults (Bowles et al., 2015). In addition, legislative incentives to implement ePHRs have shifted the role of providers from director to facilitator of disease self-management (McAlearney et al., 2016).

The legislation and incentives for organizations to utilize health information technology and the cost of chronic conditions fuel a collision within the older adult population. Factors including computer self-efficacy and digital disengagement challenge health systems to find effective solutions to overcome barriers to using ePHRs (Nahm et al., 2020; Price-Haywood et al., 2017). Online health management systems such as ePHRs are already utilized and will continue to increase in popularity and use (Nahm et al., 2020). Therefore, it is critical to understand factors

that influence older adult patient enrollment and usage of ePHRs to best facilitate engagement.

Research indicates that factors such as health literacy level and socioeconomic status affect older adults' use of ePHRs (McMaughan et al., 2020; Wildenbos et al., 2017). Research also has been conducted on the effect of biological, psychological, and social aging processes in relation to older adults' ePHR use (Wildenbos et al., 2017). Physical limitations such as impaired range of motion have been researched, whereas sensoriperceptual deficits have not been studied (Chaffin & Harlow, 2005). In addition, older adults' cognition and memory impairment are prevalent (Patomella et al., 2011; Rosenberg et al., 2009; Wolff et al., 2022), but evidence of depression as a factor affecting ePHR use is absent. Mental health conditions, such as depression (Finlay & Kobayashi, 2018), as well as socioeconomic status (Cotterell et al., 2018) have been linked to another factor: loneliness. Research on loneliness indicates that individuals who are lonely have a greater risk for developing chronic conditions (Cotterell et al., 2018). However, there is a lack of evidence on the effect of loneliness on older adults' intent to use and performance with ePHRs. Initial research suggests that perceived control and user experience with ePHRs impact older adults' intent to use, but further research is needed (Caboral-Stevens, 2015).

While the use of ePHRs is linked to healthcare benefits, lack of utilization could negatively affect older adult health outcomes (Bao et al., 2020; Depatie & Bigbee, 2015). If chronically ill older adults continue to have low ePHR adoption, they may not experience all the services offered (Nahm et al., 2020; Wildenbos et al., 2017). Evaluation of older adults' experiences and preferences for ePHR use can lead to increased adoption rates (Nahm et al., 2020; Wildenbos et al., 2017). Therefore, it is essential to identify and understand facilitators and barriers to ePHR use in the older adult.

Theoretical Model

The Use of Technology for Adaptation by Older Adults and/or Those with Limited Literacy (U.S.A.B.I.L.I.T.Y.) Framework for Older Adults was selected for study guidance and support (Caboral-Stevens et al., 2015). The purpose of the U.S.A.B.I.L.I.T.Y. Framework is to utilize theories and concepts that explain or predict intent to use ePHRs by the older adult (Caboral-Stevens et al., 2015). The framework consists of developed concepts, propositions, assumptions, and outcomes that directly relate to the older adult (Caboral-Stevens et al., 2015). The framework incorporates internal and external variables that predict an older adult's intent to use ePHRs.

The U.S.A.B.I.L.I.T.Y. Framework incorporates the constructs of efficiency, learnability, perceived user experience, and perceived control to measure intent to use technology (Caboral-Stevens et al., 2015). Two determinants are categorized as user components: perceived user experience and perceived control (Caboral-Stevens et al., 2015). Learnability and efficiency are categorized as computer system components (Caboral-Stevens et al., 2015).

The U.S.A.B.I.L.I.T.Y. Framework provides structure for incorporation of other variables that affect ePHR use in older adults. The independent variables of perceived control and perceived user experience define the characteristics of the user (Caboral-Stevens, 2015). This study sought to identify the relationship between user variables and intent to use and performance with ePHRs. The user in this study is the older adult. The older adult interacted with the technology/system component, which measured perceived ease of use and performance. An ePHR test account was used during the data collection phase for the primary researcher to observe performance. The interface in the study was the ePHR. Finally, measured unique individual factors included sensoriperceptual deficits, presence of depression, presence of loneliness, along with demographic information and presence of chronic illness. The components of usability and behavior were not directly measured. However, study results may be able to predict or explain improved self-management of chronic conditions in older adults (Caboral-Stevens et al., 2015). Identifying factors that influence ePHR use in older adults may lead to improved health outcomes as a result of behavior changes.

Purpose

The purpose of the study was to examine the relationship between individual factors of older adults and their performance with ePHRs. Seven research questions were identified:

1) What is the older adult's level of depression?
2) What is the older adult's level of loneliness?
3) What is the older adult's perceived control with ePHRs?
4) How do older adults describe their user experience with ePHRs?
5) What is the relationship between sensoriperceptual deficits and performance to use ePHRs in the older adult?
6) What is the relationship between older adults' performance and their intent to use ePHRs?
7) What is the relationship between independent variables and performance with ePHRs in the older adult?

Hypotheses

The research hypothesis for this study was controlling for older adults' sensoriperceptual deficits, degree of depression, degree of loneliness, perceived control, and user experience was negatively correlated with older adults' performance with ePHRs. The second research hypothesis was controlling for older adults' sensoriperceptual deficits, perceived control, and user experience was positively correlated with older adults' performance with ePHRs.

Methods

Research Design

This investigation was conducted as part of a larger study, which was developed using a correlational design. Four independent variables – depression, perceived control, experience, and loneliness – were chosen based on the research questions for the study and examined. Sensoriperceptual deficits, age, and education were control variables, and performance was the dependent variable. Descriptive statistics and standard multiple regression analyses were performed to identify and describe relationships between the independent and dependent variables. This study was presented to and approved by the university institutional review board.

Sample/Subjects

The target population for this study was the older adult, which is classified as individuals aged 65 years or older (Kowal & Dodd, 2001). The criteria for inclusion: adults age 65 years or older, able to speak and read English, no diagnosis of cognitive impairment or dementia, and with a minimum of telephone access to communicate. Since this study

Table 1.
Regression Analysis Summary for Variables Influencing Older Adults' Performance with ePHRs (*N*=57)

Variable	*B*	*SE B*	β	*t*	*p*
Sensoriperceptual Deficits	-.89	.46	-.25	-1.95	.06
Age	-.19	.06	-.39	-3.02	.004
Education	.37	.32	.15	1.17	.25
Depression Total Score	-.41	.19	-.32	-2.14	.04
Loneliness Total Score	.02	.06	.05	.34	.74
Perceived Control	.04	.23	.03	.16	.88
User Experience	-.06	.14	.14	-.48	.64

Note: R^2=.26 (*N*=57, *p*<.05)

researched the older adult's performance with ePHRs, participants needed either to have access to a screen for videoconferencing or participate in face-to-face data collection for observation. Due to the lack of substantial evidence in the literature, the recommended average correlation was used instead of Cohen's *d* (Gray et al., 2017). The average correlation determined the sample size would be achieved by obtaining at least 30 subjects for each study variable measured (Gray et al., 2017), indicating a total of 210 participants needed for this study. Out of the 210 total participants, 63 participants were able to complete the observed performance of accessing a sample ePHR. The regression results revealed six extreme values, which were eliminated from the analysis, bringing the total participant sample reported here to 57 (see Table 1).

Setting

Recruitment was completed through multiple methods, including face-to-face invitations; handing out advertisements, flyers, and letters; social media posts; sending emails; as well as convenience and snowball sampling. The majority of participants were regionally located, but participants from across the United States were included. To ensure participant confidentiality, the environment was screened for potential security breaches prior to data collection. If the environment could not remain confidential, a different location was chosen. Data was collected virtually over the videoconferencing platform, Zoom, or face-to-face meetings. In-person data collection took place at senior housing facilities and local churches. Virtual settings were used to collect data from participants nationally, whereas in-person data was limited regionally.

Measures

Five measures were used for data collection. Demographic information was gathered through a questionnaire developed by the primary researcher. Data included age, gender, race or ethnicity, education level, and income. Information regarding chronic conditions, computer and ePHR ownership and usage, hearing loss, and visual deficits was reported. All survey items provided participants with options for their responses, except for the fill-in-the-blank option for age.

Independent Variables

The Geriatric Depression Scale (GDS): Short Form (Sheikh & Yesavage, 1986) was used to measure the degree of depression in the older adult. A validation study was conducted, comparing the Geriatric Depression Scale and the Short Form (Sheikh & Yesavage, 1986). The GDS: Short Form was able to differentiate depressed from non-depressed participants (*r*=.84, *p*<.001). There are 15 yes/no questions on the GDS: Short Form. For 10 of the questions, if the participant answered "yes," the presence of depression was indicated. The remaining five questions indicated symptoms of depression when the participant answered "no." A total score was calculated to determine the overall degree of depression.

The UCLA Loneliness Scale Version 3 (Russell, 1996) was used to measure the degree of loneliness in the older adult. Version 3 is reliable with coefficient alpha ranges from .89-.94 across all samples (Russell, 1996). Convergent validity was indicated by significant correlations with other measures of loneliness, such as the Differential Loneliness Scale (*r*=.72) (Russell, 1996). The scale consists of 20 items measuring the participant's subjective feelings of loneliness using a 4-point Likert scale. Each item is scored from 1 (Never) to 4 (Often), and a sum score calculated. Three categories of scores could be obtained: no/low, moderate, and high. A total score less than 28 indicated no/low loneliness, scores 29-43 suggest moderate loneliness, and scores greater than 43 indicate a high level of loneliness (see Table 2).

An adapted version of the U.S.A.B.I.L.I.T.Y. Survey© (Caboral-Stevens, 2015) was used to measure the variables of perceived control, user experience, and intent to use. The adapted U.S.A.B.I.L.I.T.Y. survey was created using selected questions pertaining to independent and dependent variables. For all questions on the adapted version, permission to change wording and instructions to reflect ePHRs was granted by the survey developer. Items 10-12 on the adapted U.S.A.B.I.L.I.T.Y. Survey measure perceived control. Items 7-9 on the adapted U.S.A.B.I.L.I.T.Y. Survey measure intent to use, and items 1-6 measure user experience. Each item on the adapted U.S.A.B.I.L.I.T.Y. Survey is a 5-point Likert scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*).

Dependent Variable

A researcher-developed observation checklist was used to record observations of participants' performance. The checklist consisted of 6 Likert items, developed with guidance from the U.S.A.B.I.L.T.Y. Survey. Each performance task was rated, ranging from 1 (*unable to perform*) to 5 (*independent*). Each item identified tasks to perform within a sample ePHR. Tasks were also individually timed and recorded from the initiation to completion of the task.

Procedures

Participants were screened initially to ensure they met the inclusion criteria for the study and informed consent process completed. Participants were informed of their right to withdraw from the study at any point. Each survey was administered by the primary researcher who verbally read each item to the participant. Participant answers were electronically recorded in a Microsoft Word document by the primary researcher, and then verified with the participant for accuracy. Management of data included storage of all forms in locked file cabinets and utilization of a password protected database for data entry to ensure security and confidentiality.

A demographic survey was completed, including items on hearing loss and visual

Table 2.
Frequencies of Participant Total Scores on the UCLA Loneliness Scale Version 3 (*N*=210)

Total Score	*n*	%
20	5	2.4
21	4	1.9
22	9	4.3
23	4	1.9
24	6	2.9
25	3	1.4
26	6	2.9
27	5	2.4
28	7	3.3
29	3	1.4
30	9	4.3
31	17	8.1
32	12	5.7
33	8	3.8
34	11	5.2
35	6	2.9
36	14	6.7
37	3	1.4
38	8	3.8
39	4	1.9
40	8	3.8
41	5	2.4
42	3	1.4
43	4	1.9
44	8	3.8
45	3	1.4
46	4	1.9
48	1	0.5
50	4	1.9
51	7	3.3
52	3	1.4
53	1	0.5
54	1	0.5
55	1	0.5
56	2	1.0
57	2	1.0
58	1	0.5
61	2	0.5
62	1	0.5
65	2	1.0
66	1	0.5
70	1	0.5
77	1	0.5

deficits. The Geriatric Depression Scale: Short Form was administered, and if the participant received a total score greater than 5, the participant continued with the study, though the researcher verbally recommended a follow-up assessment with a provider. All participants were offered a list of resources for services addressing depression, regardless of score. Participants completed the UCLA Loneliness Scale: Version 3. The researcher asked the participant the 20 items and calculated a total score, ranging from a minimum of 20 to a maximum of 80.

Upon completion of the first three surveys, participants with videoconferencing capability proceeded to perform tasks within a sample ePHR provided by Twin Cities Physicians. Tasks to perform in the ePHR were: (a) log into the ePHR; (b) send message; (c) read notes or messages; (d) look up lab values; (e) review medications; and (f) log out of the ePHR. Video and screen sharing meetings were set up as screen share only, so the participant's face was not visible. A majority of participants (56%) did not require instructions on how to share screens via videoconferencing at the beginning of the observation phase. Once the participant's screen was shared, video recording began. Participants were given verbal instructions to complete six basic tasks, such as logging in, sending a message to a provider, and reviewing medications. Each task was timed from the initiation of the task to the completion of the task. The researcher scored whether the participant could independently (68%) perform each task, or if they required assistance (32%), using the observer checklist (see Table 3). Video recording was stopped at the completion of the observation phase. Recordings were reviewed by the primary investigator within 10 minutes following data collection for verification of how long it took for the participant to complete each of the 6 tasks, and then the recording was permanently deleted.

After the participant completed tasks within the sample ePHR, the adapted U.S.A.B.I.L.I.T.Y. Survey was administered. Participants answered 12 items on perceived control, intent to use, and user experience with ePHRs. The researcher electronically recorded participants' responses on a Microsoft Word document, and verified the responses with the participant. At the completion of the data collection, participants were thanked, and the researcher responded to any remaining participant questions or comments.

Results

Data Analysis

Data analysis was conducted using SPSS software, version 28. Missing data were identified, and the individual items were not used in the data analysis. Descriptive statistics, including frequencies, means, and standard deviations were computed to describe the participants' demographic characteristics. The independent variables of intent to use, user experience, sensoriperceptual deficits, and perceived control were transformed to produce a sum score. The distribution of the variables was assessed through Shapiro-Wilks test, revealing a normal distribution. Correlations between the independent and dependent variables were identified through a Pearson *r* correlation, and due to the small sample size of participants completing the sample ePHR (*n*=57), a standard multiple regression was run. A statistical significance was identified with a *p* value of 0.05.

Table 3.
ePHR Task Observation Checklist

Task	Time to Complete	Independent	Minimal Assistance	Moderate Assistance	Significant Assistance	Unable to Perform	Comments
Log into the ePHR		5	4	3	2	1	
Send message		5	4	3	2	1	
Read notes or messages		5	4	3	2	1	
Look up lab values		5	4	3	2	1	
Review medications		5	4	3	2	1	
Log out of the ePHR		5	4	3	2	1	

Participant Characteristics

A total of 210 adults aged 65 and older participated in the study. Table 4 summarizes participant characteristics. Half of the participants were 65-74 years old. Gender was equally represented, with 49% being male and 51% being female, and most participants were White (*n*=207). A majority of participants had college or higher levels of education (*n*=117) and reported at least one chronic condition, with the most common disorder being high blood pressure (*n*=124). When asked about sensoriperceptual deficits, the majority of participants (*n*=179) used glasses for vision, 84 participants reported a hearing impairment, and 53 needed to use a hearing aid for assistance.

Most participants owned a computer for over 5 years (*n*=154), with 156 having greater than 5 years of computer experience. When asked to select their level of computer use, 141 participants were intermediate level or higher. Participant responses about knowledge of and use of ePHR were evaluated. A majority of participants (54%) knew about, understood, and used an ePHR to manage their health. Participants primarily learned about ePHRs from their providers (52.9%). However, most participants (*n*=127) had never received help with learning how to utilize an ePHR. Nearly half (*n*=95) had utilized an ePHR for greater than 5 years. Participants mostly reviewed their lab results (*n*=113), communicated with their providers (*n*=108), and reviewed their medications and health history (*n*=86) in the ePHR.

Findings

A correlational analysis was conducted to look at the relationship between the participant's age and each of these variables: computer ownership, computer experience, level of experience, knowledge, ownership, and experience with ePHRs. All the correlations were statistically significant, yet there were weak negative correlations (see Table 5).

Additionally, a Pearson's correlation coefficient analysis was conducted to assess the relationship between participants' level of education and their experience with using computers (see Table 6). Moderate positive correlations were found between participants' education and their ownership of computers ($r(208)=.35, p<.01$), and participants' education and experience with computers ($r(208)=.36, p<.01$).

Household income was explored in relation to participants' income. A Pearson's correlation coefficient was calculated to identify whether there was a relationship between the participant's household income (see Table 7) and computer ownership. A statistically significant relationship was found between participants' household income and the variables of computer ownership ($r(208)=.31, p<.01$) and experience with computers ($r(208)=.33, p<.01$).

All 210 participants completed the depression screen. Frequencies from the depression screen were calculated to identify the older adults' *degree of depression* (see Table 8) and amount of *loneliness* (see Table 1). Twenty-seven participants scored a 5 or greater on the depression screen, which is suggestive of some depressive symptoms. Three percent of participants (*n*=6) had a total score of 10 or greater, which is highly indicative of depression. On the UCLA Loneliness Scale Version 3, scores could range between 20 and 80 (*M*=50). Participants scored between 20 and 77 (*M*=36). Most participants (*n*=115) had total loneliness scores in the moderate range (29-43), with equal percentages scoring in the low (*n*=49) and high ranges (*n*=46) (see Table 1).

Perceived control calculations included using items 10, 11 and 12 from the subscale included on the adapted U.S.A.B.I.L.I.T.Y. Survey. Participants selected options ranging from strongly agree to strongly disagree (see Table 9). When asked whether the ePHR gave participants a feeling of control over their health, 95 agreed or strongly agreed with that statement. Participants (*n*=129) knew what information was needed from the ePHR and could access it from the record, and 111 participants felt more control with the information they received from the ePHR (see Table 9).

The adapted U.S.A.B.I.L.I.T.Y. Survey measured the concept of *user experience*, including ease of use through items 1-6 on the survey. Participant responses ranged from strongly agree to strongly disagree, with the majority responding that an ePHR was exactly what they needed (*n*=121). While most participants were satisfied with the appearance of their ePHR (*n*=133), a few were less satisfied with the audio features within the ePHR (*n*=125). The majority of participants (*n*=132) identified they could successfully use an ePHR, and just under half (*n*=103) thought the ePHR was pleasant to use. Additionally, 128 of the participants would recommend an ePHR to a friend (see Table 9).

The ePHR observation section was completed by 63 participants. Most participants (*n*=38) independently performed the first task, logging into the sample ePHR account. However, 12 participants were unable to log

Table 4.
Demographic Characteristics of Participants (N=210)

Characteristic	*n*	%
Age at time of survey		
65-74	105	50.0
75-84	69	32.0
85-101	36	17.0
Gender		
Male	103	49.0
Female	51	51.0
Race/Ethnicity		
White	207	98.6
Hispanic or Latino	3	1.4
Education Level		
Less than high school diploma	3	1.4
High school degree or equivalent	78	37.3
Bachelor's degree	70	33.5
Master's degree	38	18.2
Doctorate	9	4.3
Other	11	5.3
Household Income		
<$10k	5	2.4
$10k-$50k	67	31.9
$50k-$100k	64	30.5
$100k-$150k	16	7.6
>$150k	16	7.6
Chronic Conditions		
Diabetes	43	20.5
Asthma	18	8.6
Chronic obstructive pulmonary disease	18	8.6
Heart failure	22	10.5
Kidney dialysis	2	1.0
Kidney disease	9	4.3
Hypertension	124	59.0
High cholesterol	90	42.9
Lung disease	5	2.4
Arthritis	85	40.5
Osteoporosis	35	16.7
Depression	30	14.3
Alzheimer's disease	4	1.9
Cancer	31	14.8
Other	19	9.0

Table 4. ***(continued)***
Demographic Characteristics of Participants (*N*=210)

Characteristic	*n*	%
Computer Ownership		
No computer ownership	36	17.1
6-12 months	3	1.4
1-5 years	15	7.1
>5 years	154	73.3
Computer Experience		
No computer experience	30	14.3
<3 months	3	1.4
3-6 months	3	1.4
6-12 months	2	1.0
1-5 years	16	7.6
>5 years	156	74.3
Computer Experience Level		
Beginner	69	32.9
Intermediate	119	56.7
Expert	22	10.5
Daily Hours of Computer Use on Average		
No computer use	42	20.0
0-2 hours	85	40.5
2-5 hours	64	30.5
5-8 hours	14	6.7
>8 hours	5	2.4
Electronic Personal Health Record (ePHR) Knowledge		
Never heard of ePHR	20	9.5
Heard of ePHR but didn't understand	25	11.9
Heard of ePHR and understood	50	23.8
Heard of ePHR, understood and used	115	54.8
ePHR Source		
Never heard of ePHR	26	12.4
Provider	111	52.9
Nurse	23	11.0
Medical staff	29	13.8
Family/friends	10	4.8
Internet	4	1.9
Other	7	3.3
Amount of ePHR Help Received		
No help received	127	60.5
Minimal amount	51	24.3
Moderate amount	19	9.0
Significant amount	11	5.2

Table 4. ***(continued)***
Demographic Characteristics of Participants (*N*=210)

Characteristic	*n*	%
ePHR Source of Help		
No help received	123	58.6
Provider	26	12.4
Nurse	7	3.3
Medical staff	9	4.3
Family/Friends	29	13.8
Training program/course	7	3.3
Internet	6	2.9
Other	3	1.4
Length of ePHR Ownership		
No ePHR ownership	54	25.7
<3 months	4	1.9
3-6 months	1	<1.0
6-12 months	5	2.4
1-5 years	52	24.8
>5 years	94	44.8
Length of ePHR Usage		
No ePHR usage	87	41.4
<3 months	8	3.8
3-6 months	3	1.4
6-12 months	3	1.4
1-5 years	36	17.1
>5 years	73	34.8
Features Used within ePHR		
No features used	82	39.0
Logged in	122	58.1
Sent/received messages	108	51.4
Scheduled appointments	68	32.4
Reviewed lab values	113	53.8
Paid medical bills	34	16.2
Reviewed medications/health history	86	41.0
Request prescription refills	54	25.7
Other	1	<1.0
Sensoriperceptual Information		
Hearing impairment	84	40.0
Visual impairment	149	71.0
Wear eyeglasses	179	85.2
Wear contacts	9	4.3
Use hearing aids	53	25.2
Use other vision assistive devices	12	5.7

Table 5.
Intercorrelations Among Demographic Items with Participant Age (*N*=210)

Measure	1	2	3	4	5	6	7
Age	___						
Computer Ownership	-.25**	___					
Computer Experience	-.21**	.74**	___				
Level of Experience	-.16*	.54**	.50**	___			
Knowledge of ePHR	-.25**	.51**	.47**	.46**	___		
Have ePHR	-.28**	.44**	.42**	.39**	.65**	___	
Experience with ePHR	-.19**	.45**	.50**	.47**	.73**	.73**	___

**Correlation is significant at the 0.01 level (2-tailed).
*Correlation is significant at the 0.05 level (2-tailed).

Table 6.
Intercorrelations Among Demographic Items with Participant Education Level (*N*=210)

Measure	1	2	3	4	5	6	7
Education	___						
Computer Ownership	.35**	___					
Computer Experience	.36**	.74**	___				
Level of Experience	.24**	.54**	.50**	___			
Knowledge of ePHR	.27**	.51**	.47**	.46**	___		
Have ePHR	.22**	.44**	.42**	.39**	.65**	___	
Experience with ePHR	.23**	.45**	.50**	.47**	.73**	.73**	___

**Correlation is significant at the 0.01 level (2-tailed).

Table 7.
Intercorrelations Among Demographic Items and Participant Household Income (*N*=168)

Measure	1	2	3	4	5	6	7
Household Income	___						
Computer Ownership	.31**	___					
Computer Experience	.27**	.74**	___				
Level of Experience	.33**	.54**	.50**	___			
Knowledge of ePHR	.10	.51**	.47**	.46**	___		
Have ePHR	.13	.44**	.42**	.39**	.65**	___	
Experience with ePHR	.13	.45**	.50**	.47**	.73**	.73**	___

**Correlation is significant at the 0.01 level (2-tailed).

Table 8.
Frequencies of Participant Total Scores on the Geriatric Depression Scale: Short Form (*N*=210)

Total Score	*n*	%
0	60	28.6
1	49	23.3
2	35	16.7
3	25	11.9
4	14	6.7
5	3	1.4
6	5	2.4
7	6	2.9
8	4	1.9
9	3	1.4
10	1	0.5
12	2	1.0
13	3	1.4

into the sample ePHR account and required assistance from the researcher to complete the task. Participants during the second task were requested to send a message within the sample ePHR, which 45 participants were able to do without assistance. Older adults were able to perform Task 3, read notes (n=50); Task 4, find lab results (n=54); and Task 5, reviewing medications (n=54) with little to no assistance. Only 42 participants were able to log out of the sample ePHR account. However, participants on videoconferencing often had the video screen covering the logout icon. With minimal guidance from researcher regarding the manual process for moving the video screen, participants were then able to successfully log out without further assistance (see Table 10).

Each task completed by participants was timed in seconds from start to completion of the task. It took participants between 12 seconds to 5 minutes to log into the sample ePHR account, after both written and verbal instructions were provided. The time range for participants to complete the remaining tasks in the sample ePHR account was 1 second to 5 minutes (see Table 11).

A Pearson correlation coefficient was conducted to determine if there was a relationship between *sensoriperceptual deficits* and older adults' *performance* with ePHRs. A weak but not significant correlation was found ($r(62)=-.130, p>.05$). In addition, a correlation analysis was conducted to identify whether there was a relationship between older adults' *performance* with and *intent to use* ePHRs. A moderate negative correlation was found ($r(62)=-.540, p<.001$), indicating there is a significant linear relationship between older adult's' *performance* and their *intent to use* ePHRs.

The relationships among *depression*, *loneliness*, *perceived control,* and *user experience* with *performance* with ePHRs was examined using standard multiple regression (see Table 1). Multicollinearity was not a concern in the regression as tolerance levels were not less than 0.1 and the variance inflation factor (VIF) for all variables was less than 10. The normal probability-probability plot (P-P plot) and the scatter plot indicate there are no deviations from normality, but six extreme values were removed. The overall model explains 26.3% of the total variance in older adults' *performance* with ePHR with an adjusted explanation of 15.8% ($F(7, 49)=2.5$, $p<.028$). The measure of *depression* was statistically significant in predicting older

Table 9.
Participant Responses to Adapted U.S.A.B.I.L.I.T.Y. Survey Items on Perceived Control and User Experience (*N*=210)

Item Number and Question	Strongly Agree *n*	%	Agree *n*	%	Neither *n*	%	Disagree *n*	%	Strongly Disagree *n*	%
1. An electronic personal health record (ePHR) is exactly what I need.	41	19.5	80	38.1	50	23.8	29	13.8	10	4.8
2. I am satisfied with the overall appearance of the ePHR.	35	16.7	98	46.7	60	28.6	12	5.7	5	2.4
3. I am satisfied with the audio of the ePHR.	17	8.1	49	23.3	126	60	14	6.7	4	1.9
4. I can successfully use the ePHR.	55	26.2	77	36.7	45	21.4	20	9.5	13	6.2
5. I would recommend an ePHR to a friend.	49	23.3	79	37.6	51	24.3	18	8.6	13	6.2
6. The ePHR is pleasant to use.	30	14.3	73	34.8	74	35.2	24	11.4	9	4.3
10. The ePHR gave me a feeling of control over my health.	29	13.8	66	31.4	78	37.1	30	14.3	7	3.3
11. I know what information I need and can access from the ePHR.	39	18.6	90	42.9	49	23.3	23	11.0	9	4.3
12. The information I received makes me feel in control.	27	12.9	84	40.0	68	32.4	22	10.5	9	4.3

adults' *performance* with ePHRs (*beta*=-.32, *p*<.037).

Discussion

This study examined facilitators and barriers to older adults' use of ePHRs. Overall, this study supported previous research findings by identifying relationships between individual factors and older adults' use of ePHRs. Findings suggest older adults are using or are interested in using ePHRs to help manage their health. A gap in the literature was identified related to the association between depression and loneliness and older adults' performance with ePHRs.

As participant age increased, the number of participants decreased (32% middle old, 17% old-old). Research findings suggest older adults are receptive to using ePHRs; however, older adults who are not as comfortable with technology may have different support needs to learn and use ePHRs (Son & Nahm, 2019). In this study, positive user experience with the ePHR was statistically significant to the older adult's intent to use ePHRs (*beta* = .50, *p*<.001). As younger adults who are technologically savvy start to age, the proportion of older adults using ePHRs is expected to grow in the future, so design of ePHRs with adult-friendly aspects should be considered (Son & Nahm, 2019).

Financial strain, lack of devices, and unreliable or limited internet access are potential barriers to older adults using ePHRs. Older adults are often on fixed incomes and may not be able to afford the high-speed internet that is often required for ePHRs to function effectively (Crouch & Gordon, 2019). Previous research has shown that low income is a social determinant of being an internet user (Crouch & Gordon, 2019), which can limit ePHR usage. As ePHRs use the internet as a platform, limited access to the internet is correlated with a lower usage rate of ePHRs. Consistent with previous research, the results of this study found a higher household income was associated with an increased likelihood of older adults' access and use of an ePHR. Although individuals with lower incomes may have less access to the internet, it is more likely that older adults own a smartphone with internet capability (Vogels, 2021). Healthcare organizations and ePHR developers should take into consideration a mobile interface for the ePHR. In addition, web-based resources should be easy to navigate and the content accessible to older adults who may have physical or computer skill deficits (Crouch & Gordon, 2019).

Education as a sociodemographic variable is influenced by other factors, such as income, occupation, and wealth (Fang et al., 2019). Individuals who have higher education levels often have greater access to technology and are more likely to use ePHRs (Fang et al., 2019). In addition, individuals with higher education levels often have a more positive perception of technology to access healthcare information to make decisions about their health (Lee et al., 2020). In this study, participants with a higher level of education were more likely to own a computer and to have more experience using a computer. As healthcare organizations and legislation continue to move forward with increasing ePHR access and use, investments

Table 10.
Frequencies of Participant ePHR Task Performance Ability (*N*=63)

ePHR Task	*n*	%
Log in		
Unable to perform	12	19.0
Significant assistance	2	3.2
Moderate assistance	5	7.9
Minimal assistance	6	9.5
Independent	38	60.3
Send message		
Unable to perform	5	7.9
Significant assistance	3	4.8
Moderate assistance	3	4.8
Minimal assistance	7	11.1
Independent	45	71.4
Read provider note		
Unable to perform	7	11.1
Significant assistance	1	1.6
Moderate assistance	2	3.2
Minimal assistance	3	4.8
Independent	50	79.4
Access lab results		
Unable to perform	3	4.8
Significant assistance	1	1.6
Moderate assistance	3	4.8
Minimal assistance	2	3.2
Independent	54	85.7
Review medications		
Unable to perform	2	3.2
Significant assistance	1	1.6
Moderate assistance	2	3.2
Minimal assistance	4	6.3
Independent	54	85.7
Log out		
Unable to perform	2	3.2
Significant assistance	1	1.6
Moderate assistance	5	7.9
Minimal assistance	13	20.6
Independent	42	66.7

should be made in staying connected with less affluent groups, including the older adult. Interventions could be developed and implemented to provide affordable internet access and devices to underserved populations, and to provide tailored and relevant training opportunities at convenient locations.

ePHRs have the potential to increase patient engagement in their health management, which can lead to improved patient outcomes (Hoogenbosch et al., 2018). However, older nonusers of ePHRs tend to be those with fewer chronic health conditions (Hoogenbosch et al., 2018). Limited knowledge or awareness of ePHRs is a barrier to ePHR use, as older adults may not have access to the benefits ePHRs can provide (Hoogenbosch et al., 2018). Results from this study indicate a majority of participants (79%) were aware of ePHRs, with approximately 55% of participants having used an ePHR previously. Prior research studies identify about 37% of older adults as being nonusers and unaware of ePHRs (Hoogenbosch et al., 2018), compared to 22% of nonusers in this study. Healthcare providers were the most likely group to inform older adults about the benefits of ePHRs, while only 11% of participants were informed by nurses. Healthcare professionals can have an influential role in patients' healthcare management. By integrating ePHR usage into daily care as well as providing support and training to older adults, healthcare providers can help increase ePHR use in the older adult population.

User experience and ease of navigating an ePHR are often facilitators that lead to increased usage. Individuals are more likely to adopt a new technology if it is perceived as useful, credible, and has obvious benefits (Portz et al., 2019). Prior studies have shown that older adults identify communication, access to lab results, and the ability to electronically refill prescriptions as the more important features within an ePHR (Portz et al., 2019). Similarly, results from this study identify the most commonly used ePHR feature was to review lab results (53.8%), communicate with the healthcare team (51.4%), and review medications or health history (41%). The features of messaging and lab results within an ePHR are often simple to use and easily understood, which can lead to improved communication between patient and provider and more seamless medication management (Portz et al., 2019). According to Portz and colleagues (2019), if older adults

Table 11.
Frequencies of Participant Time in Seconds to Complete ePHR Task

Time to Complete ePHR Task in Seconds	*n*	%
Task 1: Log on (*N*=52)		
<1	1	1.9
12	1	1.9
45	1	1.9
46	1	1.9
52	1	1.9
54	1	1.9
55	1	1.9
56	3	5.8
60	1	1.9
62	2	3.8
64	2	3.8
65	1	1.9
67	1	1.9
68	1	1.9
69	1	1.9
71	1	1.9
73	1	1.9
75	2	3.8
76	1	1.9
77	3	5.8
78	1	1.9
80	1	1.9
82	1	1.9
83	1	1.9
84	1	1.9
85	1	1.9
88	1	1.9
89	1	1.9
90	2	3.8
93	1	1.9
101	3	5.8
120	3	5.8
128	1	1.9
139	1	1.9
162	1	1.9
180	1	1.9
183	1	1.9
234	1	1.9
240	1	1.9
300	1	1.9

Table 11. *(continued)*
Frequencies of Participant Time in Seconds to Complete ePHR Task

Time to Complete ePHR Task in Seconds	*n*	%
Task 2: Send message (*N*=61)		
<1	3	4.9
2	7	11.5
3	6	9.8
4	3	4.9
5	4	6.6
6	3	4.9
7	6	9.9
8	3	4.9
9	1	1.6
10	1	1.6
11	2	3.3
13	1	1.6
15	4	6.6
21	1	1.6
22	1	1.6
24	1	1.6
26	1	1.6
30	1	1.6
32	1	1.6
35	1	1.6
57	1	1.6
78	1	1.6
89	1	1.6
117	1	1.6
120	3	4.9
160	1	1.6
180	1	1.6
300	1	1.6
Task 3: Read provider note (*N*=61)		
<1	1	1.6
1	5	8.2
2	4	6.6
3	4	6.6
4	6	9.8
5	9	14.8
6	2	3.3
7	4	6.6
8	9	14.8
10	3	4.9
12	1	1.6

Table 11. *(continued)*
Frequencies of Participant Time in Seconds to Complete ePHR Task

Time to Complete ePHR Task in Seconds	*n*	%
Task 3: Read provider note (*N*=61) *continued*		
14	2	3.3
15	1	1.6
19	1	1.6
22	1	1.6
29	1	1.6
38	1	1.6
60	1	1.6
120	3	4.9
160	1	1.6
300	1	1.6
Task 4: Access lab results (*N*=61)		
1	13	21.3
2	23	37.7
3	8	13.1
4	5	8.2
5	1	1.6
7	1	1.6
8	1	1.6
18	1	1.6
22	1	1.6
42	1	1.6
60	1	1.6
120	3	4.9
160	1	1.6
300	1	1.6
Task 5: Review medications (*N*=61)		
1	15	24.6
2	20	32.8
3	7	11.5
4	6	9.8
5	2	3.3
6	2	3.3
10	1	1.6
13	1	1.6
28	1	1.6
60	1	1.6
120	3	4.9
160	1	1.6
300	1	1.6

Table 11. *(continued)*
Frequencies of Participant Time in Seconds to Complete ePHR Task

Time to Complete ePHR Task in Seconds	*n*	%
Task 6: Log out (*N*=61)		
1	1	1.6
2	2	3.3
3	6	9.8
4	7	11.5
5	5	8.2
6	3	4.9
7	1	1.6
8	1	1.6
9	1	1.6
10	2	3.3
11	3	4.9
12	1	1.6
13	3	4.9
15	1	1.6
16	1	1.6
17	1	1.6
19	1	1.6
20	2	3.3
21	1	1.6
24	1	1.6
25	1	1.6
30	2	3.3
31	1	1.6
32	1	1.6
41	1	1.6
45	1	1.6
48	1	1.6
50	1	1.6
58	1	1.6
60	1	1.6
83	1	1.6
120	3	4.9
160	1	1.6
300	1	1.6

engage with user-friendly features, an increased satisfaction with the ePHR may contribute to further engagement with other components. Therefore, healthcare providers should provide education on easy-to-use features and provide navigational support to older adults to increase ePHR usage.

Social support and encouragement can compel older adults' active engagement with ePHRs (Fang et al., 2019). Adults who need help from another person to use the internet or other web-based applications such as ePHRs were less likely to use them (Crouch & Gordon, 2019). Most participants in this study did not receive any help to learn how to use an ePHR (60.5%) and those who did received assistance from family members or friends (13.8%). Providing assistance and training opportunities to older adults can potentially increase their confidence with technology to maximize ePHR utilization (Lee et al., 2020).

Worldwide, depression occurs in 7% of the older adult population, though rates may not reflect the actual numbers affected, as mental health is often overlooked and untreated (World Health Organization, 2023). According to the CDC (2023), estimates of older adults with depression in community environments (<5%) is less than those requiring home care (13.5%) or hospitalization (11.5%). Information and communication technologies have been developed to facilitate interventions to improve the mental health of older adults (Haase et al., 2021).

Use of ePHRs by patients has been correlated with higher rates of depression treatment and decreases in depressive symptoms (Matthews et al., 2022). Between 1%-5% of older adults are diagnosed with depression, but many more may be undiagnosed (Hurley, 2024). Sixteen percent of older adult participants in this study scored 5 or higher on the GDS: Short Form (Sheikh & Yesavage, 1986). In addition, the regression analysis showed depression was the only significant variable of older adults' performance with ePHRs. The regression results support previous research, which demonstrated participants with depression were less likely to perform effectively with an ePHR. ePHR features such as messaging and scheduling are appealing to older adults with depression as they facilitate accessibility (Matthews et al., 2022). However, older adults with depression identified barriers to ePHR use, such as privacy concerns regarding the exchange of health information (Matthews et al., 2022). Additionally, older adults with depression were less likely to use an ePHR if there was no regular communication or if there was no perceived control over their health information (Matthews et al., 2022). ePHRs with usability concerns were identified as a barrier to older adults' usage (Matthews et al., 2022). One solution to overcome ePHR security concerns is to implement policies that guide both patient and provider exchange of healthcare information. Additionally, ePHRs can be designed to promote healthcare management by focusing on accessibility of the user interface.

Loneliness can have major implications on the health of older adults (National Poll on Health Aging, 2019). Social isolation is a risk factor for loneliness, which is associated with poor health outcomes, lower patient well-being, and higher mortality (Dahlberg, 2021). Prior to the COVID-19 pandemic, 34% of older adults reported feeling a lack of companionship, and 27% identified isolation (National Poll on Aging, 2019). Since the COVID-19 outbreak, loneliness has increased not just in older adults, but among the general public (Dahlberg, 2021). Older adult participants in this study scored an average of 36 on the UCLA Loneliness Scale Version 3 (Russell, 1996), indicating a moderate degree of loneliness. Total loneliness scores for the majority of participants (n=161) suggested a moderate to high degree of loneliness. Digital technology, including ePHRs, can positively impact older adults' perceived social support, leading to decreased feelings of social isolation (Byrne et al., 2021). Inclusion of screening tools for loneliness and isolation should be integrated into existing and future ePHRs (Perissinotto et al., 2019). By identifying older adults at risk or experiencing loneliness and isolation, guidelines and interventions can be developed to address this barrier.

Implications for Practice

Differences in ePHR use between older adult subgroups suggest that as age increases, use of ePHRs decreases. Older adults are less likely to adopt ePHRs as they age (Portz et al., 2019). Research suggests older adults are interested in using ePHRs, though they may not be as comfortable with technology (Son & Nahm, 2019). Physical changes associated with aging, such as visual impairments and decreased mobility, could make navigating ePHRs more difficult (Crouch & Gordon, 2019). To increase ePHR usability for older adults, it is recommended to obtain feedback from older adults when developing ePHRs (Dendere et al., 2019). Simple layouts with a clear, large font could be incorporated into ePHRs to improve accessibility to older adults with decreased visual acuity (Son & Nahm, 2019). Another important consideration is to present information using nonmedical descriptions and images (Son & Nahm, 2019) or to include a medical dictionary (Hoogenbosch et al., 2018) to increase older adults' understanding of medical language. Involvement of the end user during ePHR development and implementation addresses unique needs and abilities of the older adult (Nahm et al., 2020). Additionally, conducting evaluation of older adults' perspectives is imperative for future improvements in ePHR usability (Hoogenbosch et al., 2018).

Limitations

Study participants performed tasks with a sample ePHR account provided by a local provider group. However, because there is significant variability across ePHR systems, results may not be generalizable to all ePHR interfaces. Participants were not randomized, but were self-selected volunteers, making it difficult to generalize to a broader population. Participants with a strong or negative opinion of ePHRs may have been drawn to participate in the study, leading to results which may not be representative of the older adult population. Response bias may be present due to the use of self-reported instruments. In addition, results may have been impacted by the Hawthorne effect or survey burden. Race, ethnicity, and geographical location were not uniformly represented, again, influencing the generalizability of results to other locations or population groups. Due to COVID-19 restrictions requiring virtual recruitment and data collection, the sample may be biased against older adults with inconsistent internet or access to technology. In addition, recruitment challenges due to COVID-19 limited the number of participants who were able to participate in the ePHR task performance, leading to a small final sample size.

Conclusion

In summary, this study identifies several facilitators and barriers to older adults' performance with ePHRs. ePHRs can provide solutions to address healthcare challenges faced by older adults. This study demon-

strates that a considerable number of older adults are familiar with and use ePHRs. Importantly, older adults who use ePHRs tend to be highly satisfied with them, and plan to continue using them in the future. Understanding facilitators and barriers to older adults' performance with ePHRs could inform future informatics design. Partnering with providers, healthcare organizations, and developers of ePHRs can promote more user-friendly formats that appeal to older adults. A potential implication from this study is that including social technology and screening tools for depression and loneliness within ePHRs can reduce loneliness and associated health consequences. However, further research on the impact of loneliness and depression on older adults' performance with ePHRs should be considered. ◆

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References

Abdelrahman, N.D., Haque, R., Polverento, M.E., Wendling, A., Gotez, C.M., & Arnetz, B.B. (2021). Brain health: Attitudes towards technology adoption in older adults. *Healthcare, 9*(23), 1-7. https://doi.org/10.3390/healthcare9010023

Administration on Aging. (2020). *2020 profile of older Americans*. https://acl.gov/aging-and-disability-in-america/data-and-research/profile-older-americans

Bao, C., Bardhan, I.R., Singh, H., Meyer, B.A., & Kirksey, K. (2020). Patient-provider engagement and its impact on health outcomes: A longitudinal study of patient portal use. *MIS Quarterly, 44*(2), 699-723. https://doi.org/10.25300/MISQ/2020/14180

Bowles, K. H., Dykes, P., & Demiris, G. (2015). The use of health information technology to improve care and outcomes for older adults. *Research in Gerontological Nursing, 8*(1), 5-10. https://doi: 10.3928/19404921-21021222-01.

Byrne, K.A., Anaraky, R.G., Dye, C., Ross, L.A., Madathil, K.C., Knijnenburg, B., & Levkoff, S. (2021). Examining rural and racial disparities in the relationship between loneliness and social technology use among older adults. *Frontiers in Public Health, 9*, 723925. https://doi.org/10.3389/fpubh.2021.723925

Caboral-Stevens, M. (2015). *Theory development and pilot testing of a new survey instrument on usability by older adults* (Doctoral dissertation, City University of New York). https://academicworks.cuny.edu/gc_etds/535/

Caboral-Stevens, M., Whetsell, M.V., Evangelista, L.S., Cypress, B., & Nickitas, D. (2015). U.S.A.B.I.L.I.T.Y. framework for older adults. *Research in Gerontological Nursing, 8*(6), 300-306. https://doi.org/10.3928/19404921-20150522-02

Centers for Disease Control and Prevention (CDC). (2023). *Fast facts: Health and economic costs of chronic diseases*. https://www.cdc.gov/chronic-disease/data-research/facts-stats/

Chaffin, A.J., & Harlow, S.D. (2005). Cognitive learning applied to older adult learners and technology. *Educational Gerontology, 31*(4), 301-329. https://doi.org/10.1080/03601270590916803

Cotterell, N., Buffel, T., & Phillipson, C. (2018). Preventing social isolation in older people. *Maturitas, 113*, 80-84. https://doi.org/10.1016/j.maturitas.2018.04.014

Crouch, E., & Gordon, N. P. (2019). Prevalence and factors influencing use of internet and electronic health resources by middle-aged and older adults in a US health plan population: Cross-sectional survey study. *JMIR Aging, 2*(1), e11451. https://doi.org/10.2196/11451

Dahlberg, L. (2021). Loneliness during the COVID-19 pandemic. *Aging & Mental Health, 25*(7), 1161-1164. https://doi.org/10.1080/13607863.2021.1875195

Dendere, R., Slade, C., Burton-Jones, A., Sullivan, C., Staib., A., & Janda, M. (2019). Patient portals facilitating engagement with inpatient electronic medical records: A systematic review. *Journal of Medical Internet Research, 21*(4), e127779. https://doi.org/10.2196/12779

Depatie, A., & Bigbee, J.L. (2015). Rural older adult readiness to adopt mobile health technology: A descriptive study. *Online Journal of Rural Nursing and Health Care, 15*, 150-184. https://doi.org/10.14574/ojrnhc.v15i1.346

Fang, M.L., Canham, S.L., Battersby, L., Sixsmith, J., Wada, M., & Sixsmith, A. (2019). Exploring privilege in the digital divide: Implications for theory, policy, and practice. *The Gerontologist, 59*(1), e1-e15. https://doi.org/10.1093/geront/gny037

Finlay, J.M., & Kobayashi, L.C. (2018). Social isolation and loneliness in later life: A parallel convergent mixed-methods case study of older adults and their residential contexts in the Minneapolis metropolitan area, USA. *Social Science & Medicine, 208*, 25-33. https://doi.org/10.1016/j.socscimed.2018.05.010

Gray, J.R., Grove, S.K., & Sutherland, S. (2017). *Burns and Groves the practice of nursing research: Appraisal, synthesis, and generation of evidence* (8th ed.). Elsevier.

Haase, K.R., Cosco, T., Kervin, L., Riadi, I., & O'Connell, M.E. (2021). Older adults' experiences with using technology for socialization during the COVID-19 pandemic: Cross-sectional survey study. *JMIR Aging, 4*(2), e28010. https://doi.org/10.2196/28010

HealthIT.gov. (n.d.). *Health IT legislation.* https://www.healthit.gov/policy-researchers-implementers/health-it-legislation

Holman, H.R. (2020). The relation of the chronic disease epidemic to the health care crisis. *ACR Open Rheumatology, 2*(3), 167-173. https://doi.org/10.1002/acr2.11114

Hoogenbosch, B., Postma, J., de Man-van Ginkel, J. M., Tiemessen, N., van Delden, J., & van Os-Medendorp, H. (2018). Use and the users of a patient portal: Cross-sectional study. *Journal of Medical Internet Research, 20*(9), e262. https://doi.org/10.2196/jmir.9418

Hurley, K. (2024, April 29). *Depression in the elderly.* https://www.psycom.net/depression/depression-in-the-elderly

Kowal, P., & Dowd, J.E. (2001). *Definition of an older person. Proposed working definition of an older person in Africa for the MDS Project.* World Health Organization. https://doi.org/10.13140/2.1.5188.9286

Lee, O.E., Kim, D., & Beum, K. (2020). Factors affecting information and communication technology use and eHealth literacy among older adults in the US and South Korea. *Educational Gerontology, 46*(9), 575-586. https://doi.org/10.1080/03601277.2020179 0162

Matthews, E.B., Savoy, M., Paranjape, A., Washington, D., Hackney, T., Galis, D., & Zisman-Ilani, Y. (2022). Acceptability of health information exchange and patient portal use in depression care among underrepresented patients. *Journal of General Internal Medicine, 37*, 3947-3955. https://doi.org/10.1007/s11606-022-07427-2

McAlearney, A.S., Sieck, C.J., Hefner, J.L., Aldrich, A.M., Walker, D.M., Rizer, M.K., ... Huerta, T.R. (2016). High touch and high tech (HT2) proposal: Transforming patient engagement throughout the continuum of care by engaging patients with portal technology at the bedside. *JMIR Research Protocols, 5*(4), e221. https://doi.org/10.2196/resprot.6355

McMaughan, D.J., Oloruntoba, O., & Smith, M.L. (2020). Socioeconomic status and access to healthcare: Interrelated drivers for healthy aging. *Frontiers in Public Health, 8*, Article 231. https://doi.org/10.3389/fpubh.2020.00231

Nahm, E.-S., Zhu, S., Bellantoni, M., Keldsen, L., Charters, K., Russomanno, V., ... Smith, L. (2020). Patient portal use among older adults: What is really happening nationwide? *Journal of Applied Gerontology, 39*(4), 442-450. https://doi.org/10.1177/0733464818776125

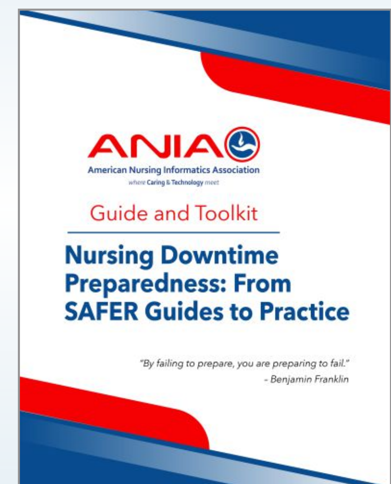
National Poll on Healthy Aging. (2018). *Logging in: Using patient portals to access health information.* https://www.healthyagingpoll.org/

reports-more/report/logging-using-patient-portals-access-health-information
National Poll on Healthy Aging. (2019). *Loneliness and health.* https://www.healthyagingpoll.org/reports-more/report/loneliness-and-health
Oh, S.S., Kim, K.-A, Kim, M., Oh, J., Chu, S.H., & Choi, J. (2021). Measurement of digital literacy among older adults: Systematic review. *Journal of Medical Internet Research, 23*(2), e26145. https://doi.org/10.2196/26145
Patomella, A.-H., Kottorp, A., Malinowsky, C., & Nygard, L. (2011). Factors that impact the level of difficulty of everyday technology in a sample of older adults with and without cognitive impairment. *Technology and Disability, 23*(4), 243-250. https://doi.org/10.3233/TAD-2011-0331
Perissinotto, C., Holt-Lunstad, J., Periyakoil, V.S., & Covinsky, K. (2019). A practical approach to assessing and mitigating loneliness and isolation in older adults. *Journal of the American Geriatrics Society, 67*(4), 657-662. https://doi.org/10.1111/jgs.15746
Portz, J.D., Bayliss, E.A., Bull, S., Boxer, R.S., Bekelman, D.B., Gleason, K., & Czaja, S. (2019). Using the technology acceptance model to explore user experience, intent to use, and use behavior of a patient portal among older adults with multiple chronic conditions: Descriptive qualitative study. *Journal of Medical Internet Research, 21*(4), e11604. https://doi.org/10.2196/11604
Price-Haywood, E.G., Harden-Barrios, J., Ulep, R., & Luo, Q. (2017). eHealth literacy: Patient engagement in identifying strategies to encourage use of patient portals among older adults. *Population Health Management, 20*(6), 486-494. https://doi.org/10.1089/pop.2016.0164
Rosenberg, L., Kottorp, A., Winblad, B., & Nygard, L. (2009). Perceived difficulty in everyday technology use among older adults with or without cognitive deficits. *Scandinavian Journal of Occupational Therapy, 16*(4), 216-226. https://doi.org/10.3109/11038120802684299
Russell, D.W. (1996). UCLA Loneliness Scale (Version 3): Reliability, validity, and factor structure. *Journal of Personality Assessment, 66*(1), 20-40. https://doi.org/10.1207/s15327752jpa6601_2
Sheikh, J.I., & Yesavage, J.A. (1986). Geriatric depression scale (GDS): Recent evidence and development of a shorter version. *Clinical Gerontologist, 5*(1-2), 165-173. https://doi.org/10.1300/J018v05n01_09
Son, H., & Nahm, E.-S. (2019). Older adults' experience using patient portals in communities: Challenges and opportunities. *CIN: Computers, Informatics, Nursing, 37*(1), 4-10. https://doi.org/10.1097/CIN.0000000000000476
Vogels, E.A. (2021, June 22). *Digital divide persists even as Americans with lower incomes make gains in tech adoption.* https://www.pewresearch.org/fact-tank/2021/06/22/digital-divide-persists-even-as-americans-with-lower-incomes-make-gains-in-tech-adoption
Wildenbos, G.A., Peute, L., & Jaspers, M. (2017). Facilitators and barriers of electronic health record patient portal adoption by older adults: A literature study. In R. Randell, R. Cornet, C. McCowan, N. Peek, & P.J. Scott. (Eds.), *Studies in health technology and informatics* (pp. 308-312). https://doi.org/10.3233/978-1-61499-753-5-308
Wolff, J.L., Dukhanin, V., Burgdorf, J.G., & DesRoches, C.M. (2022). Shared access to patient portals for older adults: Implications for privacy and digital health equity. *JMIR Aging, 5*(2), e34628. https://doi.org/10.2196/34628
World Health Organization. (2023, March 31). *Depressive disorder (depression).* https://www.who.int/news-room/fact-sheets/detail/depression

Nursing Downtime Preparedness: From SAFER Guides to Practice

Even when we are prepared, downtimes are disruptive, and if an organization is unprepared, they can be chaotic and unsafe. Nursing represents the largest group utilizing the electronic health record to care for patients.

This guide from the American Nursing Informatics Association (ANIA) is a valuable resource that provides timely and important information as well as tools to help organizations prepare for both planned and unplanned downtimes using the SAFER Guides as a model. Nursing is the focus, but the tools can be used as a starting point for other departments as well. Many tools can be used and modified as needed by organizations to meet their specific requirements.



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Strategic Stewards: Core Teams and Knowledge Maintenance

Stacey Hamilton Hanna, Saiqua Nooreen, and Megan Reichert

Knowledge maintenance is a crucial process to facilitate evidence-based practice and should be completed at regular intervals. One healthcare institution found the presence of a core team plus interdisciplinary collaboration effective for completing knowledge maintenance of regionally owned order sets.

Keywords: knowledge maintenance, order sets, interdisciplinary, teamwork, collaboration

Knowledge maintenance (KM) and knowledge management are synonymous terms that are used to define the process where clinical knowledge is generated, shared, and maintained within an electronic health record (EHR) environment (Sittig et al., 2011). In the realm of clinical informatics (CI), the discussion around KM is paramount, as it directly impacts the quality and efficacy of healthcare systems (Idemoto et al., 2016).

The management and sustenance of knowledge within these systems are critical for ensuring accurate, up-to-date, and reliable information for healthcare professionals (Li et al., 2019). One key aspect to consider is the dynamic nature of medical knowledge. In health care, new research findings, treatment protocols, and technological advances emerge regularly (Dardis & McBride, 2022). Thus, a robust KM strategy should be in place to continually update and integrate these developments into existing EHR platforms (Idemoto et al., 2016). Failure to do so may lead to outdated practices, potentially compromising patient care (Amato et al., 2017).

Furthermore, the interoperability of healthcare information systems plays a crucial role in KM. Seamless integration among different platforms and databases is essential to ensure that relevant knowledge is accessible across the healthcare continuum. This fosters collaboration among healthcare professionals and enables comprehensive patient care by providing a holistic view of a patient's medical history and treatment plans (Torab-Miandoab et al., 2023).

The discussion also extends to the challenges associated with KM. Security and privacy concerns must be rigorously addressed to protect sensitive patient information. In addition, the cost and resources required for regular updates and system enhancements pose financial challenges for healthcare institutions (see Figure 1).

Background and Setting

The authors are part of a CI team that serves the greater Sacramento, California, market, which includes six acute care hospitals, one long-term care facility, and several ambulatory clinics. The Sacramento market is a subset of a broader nationwide enterprise. The enterprise has created more than 2,500 order sets in total, spread across three separate geographical domains. Each domain utilizes a distinct version of the EHR. An order set is a bundle of disease- or procedure-specific service requests that are needed during hospitalization, such as medications, labs, and rehabilitative therapy (Wells & Loshak, 2019). Some order sets are Admission order sets, meaning they are meant to be a comprehensive list of orders for a particular disease or procedure. Other order sets are Quick-Pick, which means they address only one disease process and are often used in conjunction with an Admission order set. Individual facilities can choose which order sets are virtually visible and which are not. Some order sets were created by, and are maintained by, the national CI team; in particular, those order sets with high usage. A smaller subset of order sets was created by local markets. A cadence and process for locally owned order set KM was not yet established.

In 2021, the national CI team shifted the duty of KM to the market that created those order sets. Fifteen order sets have been created by the Sacramento market and all were due for maintenance. Total usage of each order set and identification of highest-user prescribing providers was provided by the Sacramento CI Data Analyst. A Responsibility, Accountable, Consulted, Informed (RACI) matrix was provided to the Sacramento CI team from the national CI team; it is visually dense and an internal document. While it listed high-level tasks, the Sacramento team discovered several nuances to the KM undertaking. A process was created to more effectively approach each order set update (see Figure 2). The process has evolved due to changes in staffing; initially it was pharmacy informaticists who input their suggestions before prescribing providers input their suggestions. Now, physicians input their suggestions before sending the mock-up to the pharmacy. The Sacramento market also consolidated from two staff pharmacy informaticists to one due to resource constraints across the enterprise.

Additional Process Pearls

Privacy and security requirements in the modern age can be experienced as a challenge to ad hoc specialists during KM. Some providers prefer not to use, and are not provisioned for, an enterprise email account. Collaborative documents created internally cannot be shared with external parties. Thus, color-coded mock-ups; the Situation, Background, Assessment, Recommendation (SBAR); and original order sets must be downloaded and sent as email attachments. This workaround can lead to the circulation of multiple drafts, creating confusion among core team members. The authors' solution is to collect feedback from subject matter experts (SMEs) via email or teleconference meetings. Access to edit the color-coded mock-up is granted only to the pharmacy informaticist and CI in order to preserve the integrity of the mock-up.

The Sacramento CI team also identified some markets that chose not to have select order sets virtually visible at their location. The reasons for this can vary; for example,

Figure 1.
History of Knowledge Maintenance (KM) Experienced at One Healthcare Organization

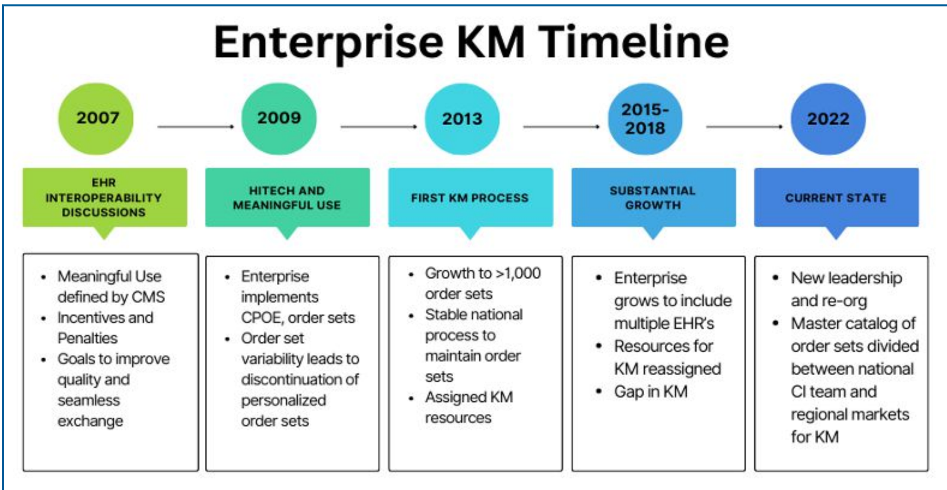
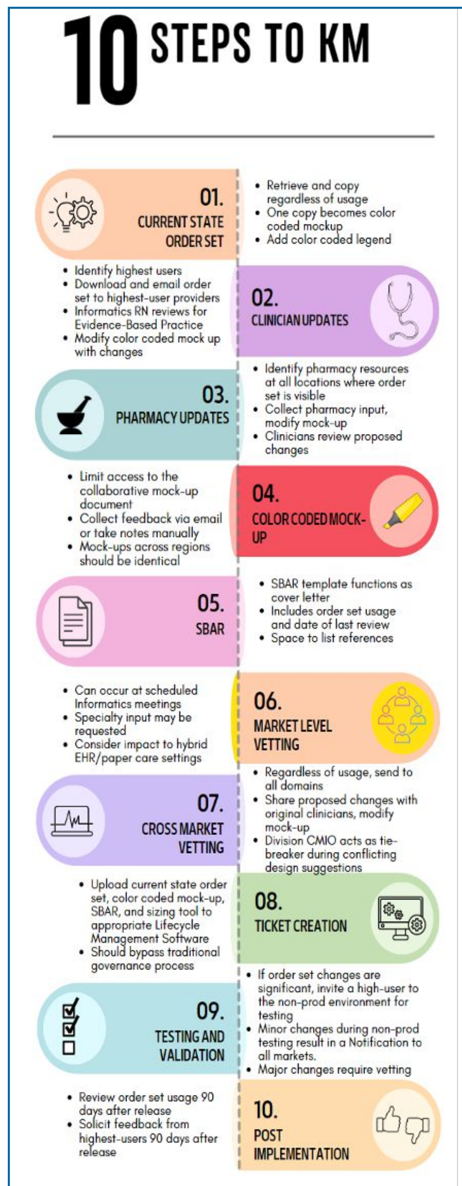


Figure 2.
Infographic Depicting the Process Created to Facilitate Market-Owned Knowledge Maintenance (KM)



relevance, such as regions that do or do not experience endemic conditions, clinical practice variations due to variances in local culture or policies, and functionally duplicative order sets. However, markets that chose not to utilize an order set were not exempt from wanting to participate in the vetting process. These no-use markets expressed the desire to participate in the design process in the event that they later choose to utilize the selected order set. In response, the Sacramento CI team embedded this junction into the final process.

Clinicians endure heavy workloads and competing priorities (Chang et al., 2018). Engaging SMEs to participate in KM can be difficult due to their busy schedules. Anecdotally, approximately five specialists communicated that they were too busy to provide input on order sets of which they were high users. Eight emails total, plus accompanying phone calls to SMEs went unanswered. One provider withdrew engagement midway, and a second SME agreed to finish KM on the selected order set. Clinicians are not provided additional monetary incentives to participate in KM, which adds to the challenge. At the time of publication, the Sacramento CI team has completed KM on six order sets, opted to retire one order set, and has three order sets actively undergoing maintenance. The KM initiative began in the first quarter of 2022.

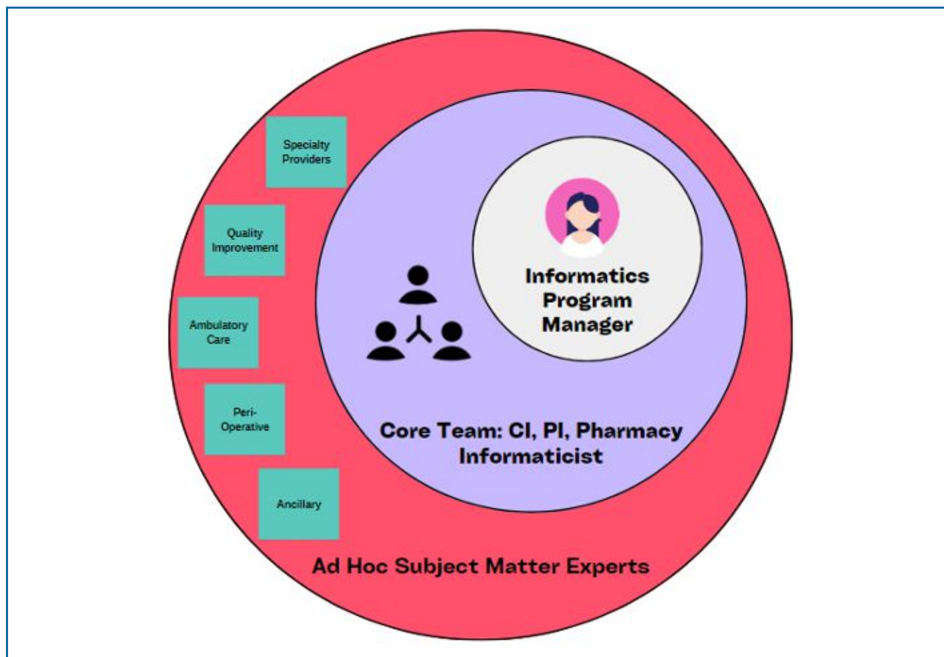
Interdisciplinary Teamwork

Figure 3 was created to demonstrate the core team and associated SMEs. Ad hoc SMEs are distinct from one another yet categorically similar in their unique contribution to the maintenance of order sets. The core team members are closely connected, communicating frequently, and dependent on each other for success. The Informatics Program Manager holds a unique perspective: enmeshed and providing process guidance while remaining outside of clinical recommendations.

Informatics Program Manager

In the Sacramento market, the informatics program manager plays a crucial role in overseeing and managing the development, implementation, and maintenance of the informatics programs within an organization. While the program manager holds a key position in the KM process, it is the core team, comprising various stakeholders, that undertakes the bulk of KM work. For this article, the program manager was tasked with creating,

Figure 3.
Infographic Depicting the Core Team and Subject Matter Experts



implementing, and shepherding a new KM program for order sets assigned to the Sacramento CI market. Relying on previous KM work done in the market, the program manager has a specific understanding of the core team in KM of order sets: the CI registered nurse (RN), pharmacy informaticist, and physician informaticist.

Initially, the program manager assembled the core team through a phased approach, involving facility-specific CI RNs and physician informaticists who were tasked with order set maintenance based on facility order set usage patterns. However, this initial workflow underscored the imperative for a dedicated CI RN and a physician informaticist to guide KM efforts, irrespective of facility-based utilization. Facility-based CI RNs are integral in day-to-day facility operations and are assigned a myriad of tasks. Due to prioritizing facility needs with KM, the initial order set review was months in process, with marginal forward movement. This facility-based KM assignment trial revealed that integrating KM responsibilities into the existing roles of CI RNs was too great a burden on time. The program manager recognized the need for a strategic shift and pivoted planning and process strategies toward establishing a single ownership team — the core team.

The core team included the following defined stakeholders: CI RN, pharmacy informaticists, and physician informaticists. With the core team now in place, the program manager assumed specific responsibilities, including the delineation of process workflows through methodologies such as the RACI, swimlane process maps, and SBAR templates. Furthermore, the program manager defined the scope of KM at the market level, facilitated KM meetings, fostered collaboration among team members, and provided regular updates on market-based KM progress to both local and national stakeholders.

CI Registered Nurse (CI RN)

The CI RN in the Sacramento market was uniquely positioned to begin the KM process for market-owned order sets because she serves informally as a floating CI RN to the six acute care hospitals in Sacramento. Without ongoing, facility-based responsibilities, the CI RN was able to formally dedicate time to KM. The CI RN served as the primary contact and key communicator among team members and partnered with the regional data analyst to validate order set usage and highest users. The CI RN contacted and engaged with SMEs, which sometimes included many months of deliberation regarding order set updates. SMEs were asked clarifying questions, technical feasibility inquiries were sent to the technical team, and hospital rules and regulations were examined. Even minute changes to the language of individual orders were carefully considered. The CI RN reviewed all orders outside of medications to incorporate evidence-based updates, as the integration of evidence-based practice within informatics, facilitated by individuals such as the dedicated CI RN, leads to enhanced patient outcomes (Dardis & McBride, 2022). The effective approach to KM is rooted in thoroughness and attention to detail, not speed (Dardis & McBride, 2022).

Physician Informaticists

Along with the technical resources, physicians play an integral part in providing expertise as SMEs, as well as physician informaticists in this market who act as liaisons between the practitioners and the technical experts. Physicians play a pivotal role in the KM of EHRs, contributing to the seamless integration of medical knowledge into these digital systems (Idemoto et al., 2016). Physician informaticists act as a bridge between healthcare practitioners and information technology (IT). Their unique understanding of both the clinical and informatics domains positions them to translate medical knowledge into formats that are compatible with EHR systems. This ensures that data within EHRs accurately reflects the latest medical insights, treatment protocols, and research findings. Physician informaticists, beyond possessing clinical and technical proficiency in EHRs, may function as SMEs, depending on the scope of order set KM. Within our market processes, physician informaticists play a pivotal role as intermediaries, facilitating engagement with clinical SMEs. Moreover, they serve as peer-to-peer advocates, ensuring that order sets remain finely tuned and reflective of best practices.

Pharmacy Informaticist

As a multidisciplinary core team member, the pharmacy informaticist is required to possess expertise in pharmacy best practices, remain up to date on all state and federal guidelines, be knowledgeable in IT, including data management, and understand the complexity of healthcare delivery. Pharmacy informaticists also should have direct insight into facility-based formularies, approved medications, and EHR pharmacy build tools. The intricate and specialized realms of pharmacy informatics are indispensable, particularly since other members of the core team might lack access to such expertise. The market-level KM process includes a pharmacy informaticist to review all pharmacological updates requested by clinical SMEs. This review includes validating formulary availability, state and federal guidelines, and the involvement of best prac-

tice guidelines. This review is conducted with facility pharmacy departments and coordinated with national pharmacy team members as needed. It is important to note that during our KM work, the Sacramento market was part of downsizing within CI departments nationally. Part of the national strategy was to align all pharmacy informatics teams; this meant the Sacramento CI team was reduced from having two pharmacy informaticists to a single pharmacy informaticist.

Subject Matter Experts

KM pivots around SMEs; their input is essential. The Sacramento CI team requested participation from specialists, such as wound care nurses, radiology and lab technicians, operating room schedulers, respiratory therapists, quality improvement, and many other specialty providers. Each order set facilitates the care of a unique patient population and therefore requires tailored care through each included order. Although SMEs can take several days or weeks to respond to emails or phone calls, it is necessary to wait for their input. The success of KM hinges on the invaluable wisdom and experience of SMEs regarding how orders are worded, the flow of patients throughout the hospital, hybrid EHR/paper-based departments, regulatory and compliance considerations, and best practices.

Challenges

The process of KM encountered several formidable challenges in the Sacramento market. First, the sheer size and complexity of the healthcare system poses a significant hurdle. Navigating through vast networks of data and diverse stakeholders requires meticulous attention and strategic coordination. Resource allocation emerges as another pressing concern, as the demand for skilled personnel, technical infrastructure, and financial resources often exceeds the available supply (Papanicolas et al., 2018). Time constraints further compound these challenges for team members who must balance their responsibilities amid competing priorities. Moreover, the utilization of differing EHR versions presents a unique set of obstacles, necessitating interdisciplinary collaboration and a comprehensive understanding of various specialized areas. Cost considerations loom large, as investments in cutting edge technologies and ongoing training programs strain organizational budgets (Turner et al., 2023). Lastly, the dynamic nature of health care adds a layer of complexity, requiring continuous adaptation and innovation to keep pace with evolving trends, changes in state and federal healthcare regulations, and patient needs. Addressing these challenges demands a holistic approach, integrating strategic planning, resource optimization, and a steadfast commitment to advancing KM in healthcare informatics.

Future State

Looking forward, the trajectory of KM in the Sacramento market is poised for significant advancements in several key areas. First, there will be a heightened emphasis on turnaround time tracking, utilizing sophisticated data analytics and real-time monitoring tools to streamline processes and enhance efficiency throughout healthcare systems. By implementing robust tracking mechanisms, organizations can better manage workflows, leading to improved patient outcomes and resource allocation (Helminski et al., 2022). Moreover, there will be a concerted effort to enhance post-implementation evaluation strategies, facilitating more comprehensive assessments of the effectiveness of informatics solutions and their impact on clinical practice. This will enable healthcare providers to refine and optimize their informatics strategies continuously, fostering ongoing improvement in patient care delivery.

Furthermore, the integration of artificial intelligence (AI) technologies will play a pivotal role in shaping the future of computerized provider order entry overall (Bates et al., 2021). Through the seamless integration of AI-driven algorithms and predictive analytics, healthcare organizations can harness the power of data to generate actionable insights and support informed decision-making (Landi, 2024). This integration will not only enhance the efficiency and effectiveness of KM processes, but also pave the way for more personalized and proactive approaches to patient care, ultimately driving innovation and improving health outcomes on a broader scale.

Conclusion

Effective KM is indispensable for delivering high-quality and timely patient care. The discussion highlighted the need for dynamic systems that can adapt to the evolving landscape of medical knowledge, emphasizing the importance of interoperability, security, and resource allocation in achieving successful KM within informatics. While challenges were encountered during the KM process, the positive impact to end users was significant. Updates to order sets reflected pertinent updates to patient care orders, fostering trust between clinicians and the EHR. The core team modeled interdisciplinary collaboration and perseverance while implementing the new KM process. ◆

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References

Amato, M.G., Salazar, A., Hickman, T.-T., Quist, A.J.L., Volk, L.A., Wright, A., ... Schiff, G.D. (2017). Computerized prescriber order entry-related patient safety reports: Analysis of 2522 medication errors. *Journal of the American Medical Informatics Association*, *24*(2), 316-322. https://doi.org/10.1093/jamia/ocw125

Bates, D.W., Levine, D., Syrowatka, A., Kuznetsova, M., Craig, K.J.T., Rui, A., ... Rhee, K. (2021). The potential of artificial intelligence to improve patient safety: A scoping review. *NPJ Digital Medicine*, *4*(1), Article 54. https://doi.org/10.1038/s41746-021-00423-6

Chang, B.P., Gallos, G., Wasson, L., & Edmondson, D. (2018). The unique environmental influences of acute care settings on patient and physician well-being: A call to action. *Journal of Emergency Medicine*, *54*(1), e19-e21. https://doi.org/10.1016/j.jemermed.2017.08.092

Dardis, M., & McBride, S. (2022). Physician learning preferences: A doximity report. https://press.doximity.com/reports/physician-learning-report-2022.pdf

Helminski, D., Kurlander, J.E., Renji, A.D., Sussman, J.B., Pfeiffer, P.N., Conte, M.L., ... Landis-Lewis, Z. (2022). Dashboards in health care settings: Protocol for a scoping review. *JMIR Research Protocols*, *11*(3), e34894. https://doi.org/10.2196/34894

Idemoto, L., Williams, B., & Blackmore, C. (2016). Using lean methodology to improve efficiency of electronic order set maintenance in the hospital. *BMJ Open Quality*, *5*(1), u211725.w4724. https://doi.org/10.1136/bmjquality.u211725.w4724

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A Day in the Life of an Informatics Nurse

More Than a Cost Center: Examining the Return on Investment of Nursing Informatics

Marc Perkins-Carrillo and Nedlyne Monestime

Nurse informaticists' workflow analysis, redesign, and implementation of technology solutions improve financial outcomes. This article summarizes the economic benefits that nursing informatics contribute to the health system. These contributions strengthen the need for continued growth of informatics teams.

Keywords: informatics, nursing, clinical, nurse informaticist, return on investment

Since the recognition of nursing informatics (NI) in 1992, it has played a significant and evolving role in improving health outcomes, electronic health record (EHR) adoption, workflow improvements, and information sharing (Garcia-Dia, 2021). NI integrates nursing science, computer science, and information science to manage and communicate data, information, knowledge, and wisdom into nursing practice (American Nurses Association, 2023) while also working with information management and data science or analysts to analyze data and transform data into crucial information, knowledge, and wisdom.

EHR systems implemented in collaboration with assistance from nurse informaticists have enhanced data documentation, cost savings, and communication as well as improved care and patient safety. NI is often seen by healthcare leaders as simply a cost center as the money and efficiencies gained are realized by other divisions within the organization. Savings or financial gains garnered by NI can be defined as soft or hard dollars. Hard dollar gains are generally considered actual money savings or increases for an organization, whereas soft dollars are generally gained efficiencies. This article aims to highlight the return on investment garnered by NI to help facilitate discussion with leadership for the expansion of NI teams.

Better Documentation: Data Accuracy and Time Savings

Digitization has helped nurses and healthcare centers to record, store, and retrieve patient and hospital data cost-effectively. Traditionally, nurses and providers recorded patient data on paper forms, which limited the amount of data taken and increased the likelihood of mistakes (Farokhzadian et al., 2020). The work that NI has done with patient-entered data has led to reduced nursing documentation burden and made information readily available (Moore et al., 2020). NI has helped save the time needed to code or decode patient data using standard code sets such as SNOMED, LOINC, and ICD-10 (Moen et al., 2020).

NI has enhanced data accessibility by all authorized clinical and non-clinical staff. Nurse informaticists work with customers, ensuring they have the correct level of access within the EHR. The accessibility of data is crucial for timely patient care decisions; the inability to access it may delay care. A review of delays in care at the U.S. Veterans Affairs Health Care System found the inability to access data was one of the major causes of delayed action on diagnostic study results (Powell et al., 2020).

A phrase often heard when discussing the EHR is "one more click." Nursing documentation is inundated with clicks for data entry. The Carolinas HealthCare System identified this as a problem and, with the help of NI, eliminated 18 million clicks and gave nursing back 35,000 hours for direct patient care (Davis, 2017). The team also reduced third-party software costs, saving the organization $60,000 by implementing new screening tools.

Enhancing the Quality and Efficiency of Health Care and Services

Farokhzadian and colleagues (2020) suggest NI has a significant impact on reducing medical errors, which have far-reaching financial implications on the hospital and the reputation of the hospital, doctors, and nurses. NI-developed tools aid in the accurate and secure provision of data, which in turn reduces clinical risks and errors (Agrawal, 2019). The United States records about $17 billion in medical costs attributed to misdiagnoses and wrong drug prescriptions. Medical errors result in over 100,000 deaths annually and thousands of readmissions (Uitvlugt et al., 2021). Most of these errors are said to be caused by incorrect data entry and negligence. Uitvlugt and colleagues (2021) argue that about 16% of admissions are readmissions from medical errors, of which 40% are potentially preventable readmissions.

Burnie and Vining (2021) found that nurse informaticists working with multidisciplinary teams, including lab specimen technicians and nurses, reduced workflow variations, which resulted in a reduction of repeat testing and overuse of medications and supplies. They found a 1.5% reduction in contamination rates, which resulted in nearly $2 million in savings for the organization. These figures do not account for patient satisfaction and organization reputation damage due to health grade reporting on sites such as Medicare Hospital Compare or LeapFrog health ratings.

Workflow enhancements and quick accessibility of data for care delivery enhance nurses' and providers' satisfaction and confidence, leading to improved productivity levels (Farokhzadian et al., 2020). This increased productivity and better staffing allocation impact a hospital's financial aspect with more patient visits and increased revenue. An example of a hard dollar savings to having the right information available, such as test results, is the potential to discharge a patient earlier, thus allowing for another patient admission.

Facilitating Communication Management in the Technological Environment

One of the significant benefits of NI is enhancing communication within and outside the hospital. Accurate and timely transmission of information and communication are necessary in healthcare settings (Bartos et al., 2022). Federal government programs such as the Merit-based Incentive Payment System (MIPS) introduced by the Centers for Medicare and Medicaid Services (CMS) have enhanced intra-organizational information flow, especially among hospitals, registries, and regulatory agencies. These complex requirements are translated into both clinical and electronic documentation practices by NI.

Governmental regulations require the sharing of patient data, and NI plays a pivotal role in ensuring compliance and protection of patient information. These regulations have promoted data shareability, allowing providers access to patient diagnostic and laboratory tests and previous treatments performed at other organizations. NI enhances the delivery and continuity of care. Health information sharing across organizations enhances timesaving, mitigates care and treatment delays, and reduces the cost of test duplication. In a review of the literature, Reis and colleagues (2017) found that NI plays a vital role in health data interoperability, thus reducing costs by eliminating duplicate testing and other healthcare resource utilization.

Telemedicine, or telehealth, is one of the fastest growing sectors in health care, with much of this growth required due to the COVID-19 pandemic. While most consider telehealth a recent addition, this virtual care model has been used in health care since the late 1950s and 1960s (Hyder & Razzak, 2020). NI continues to play a critical role in implementing and refining telehealth by designing effective systems that benefit patient-family and patient-nurse/provider relationships. These virtual care programs help improve communication with patients remotely, thus increasing trust and convenience of care. Telehealth can reduce costs by decreasing 30-day readmission rates through virtual consults (Mattout & Yesilada, 2024).

Improving Resource Management

With nursing shortages reaching critical levels in the United States, the focus of NI is on workflow and technology optimization. To overcome the risks associated with information technology systems, the goal should be to support practice improvement and not the reduction of staffing (Weber et al., 2022) – a focus on soft dollars versus hard dollars. Efficient workflows and technology solutions result in greater nurse satisfaction and lower turnover rates, which help the overall financial status of the organization.

Remote working accelerated during the COVID-19 pandemic. NI worked with partners in information technology to implement remote communication tools such as Zoom or Microsoft Teams to facilitate this shift in work requirements. In hospitals, even when services offered are face-to-face, some personnel, such as billing specialists and scheduling teams, can work from home.

Data-Driven Decision-Making

NI aids nurses in delivering evidence-based and patient-centered care. Improved care delivery is facilitated using clinical decision support (CDS) tools. Nurse informaticists work closely with clinical experts to design CDS rules to guide clinical staff in providing appropriate care. These assisted decision prompts enhance clinical workflows, allowing more efficient and effective care (Bartos et al., 2022; Farokhzadian et al., 2020). Nurse informaticists help reduce redundancy by eliminating repetitive tests or tasks, diagnosis, and registration of returning patients (Shrank et al., 2019). Shrank and colleagues argue that failure of care coordination, administrative complexity, fraud and abuse, overtreatment or low-value care, failure of care delivery, and pricing failure amount to waste as they are a financial cost. They found that the United States records annual wasted expenditures of $760-$935 billion. Notably, lack of coordination led to $38.2 billion in waste expenditure, while overtreatment or low-value care waste cost was $12.8-$28.6 billion (Shrank et al., 2019). However, some of this waste can be reduced with NI as repetitive and unnecessary procedures can be reduced or even eliminated.

Improving Performance Management

In 2022, partnering with the revenue integrity team, the Moffitt Cancer Center clinical informatics team developed work-flows to capture non-operating room anesthesia (NORA) charges without providers having to perform extra work. The nurse informaticists performed current state workflow assessments and engaged billing specialists to develop a workable solution. The design specifications were provided to the clinical systems team to build charge capture from documentation performed by the clinical staff within the EHR. The NI education team assisted with training materials and staff education. The revenue integrity team remained engaged and monitored charge capture during and after implementation. The teams were able to capture approximately $3 million in gross charges, resulting in an annualized net revenue of approximately $900,000 for the organization (J. Chalarca, personal communication, January 13, 2022).

NI helps identify inefficiencies in healthcare practice, workflows, and operations. A literature review found that NI teams partnered with an infusion pump manufacturer to integrate pump data into the EHR. Bartos and colleagues (2022) attained a 27% reduction in fluid overrides after the integration of smart pumps into the EHR. They also realized a 30-day increase in net charges of 39%, resulting in a net revenue of approximately $17,000.

Conclusion

The cost-saving or economic aspects of NI are often overlooked, as many tend to focus on the cost center's salaries and expenses without the revenue savings or generation tied directly to the NI department. NI helps reduce medical errors, paper consumption, and waste related to repetitive activities and enhances worker satisfaction. With help from NI, patients can get appropriate, timely, and cost-effective care. Organizations with robust NI and data analysis tools can improve care quality and patient safety by offering personalized, patient-centered care while reducing costs. The ability of NI to optimize workflows and enhance charge capture and cost avoidance is valuable to all healthcare centers and warrants significant investments. ◆

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References

Agrawal, A. (2019). Medication errors: Prevention using information technology systems. *British Journal of Clinical Pharmacology*, *67*(6), 681-686. https://doi.org/10.1111/j.1365-2125.2009.03427.x

American Nurses Association. (2023, July 5). *What is nursing informatics*. https://www.nursingworld.org/content-hub/resources/nursing-resources/nursing-informatics

Bartos, D., Vitoux, R.R., Schuster, C., & Curtin, C.R. (2022.). Outcomes from a smart infusion pump and electronic health record integration: Improved patient safety, nursing efficiency, and return on investment. *Journal of Informatics Nursing*, *7*(3), 13-19. https://library.ania.org/p/a/outcomes-from-a-smart-infusion-pump-and-electronic-health-record-integration-improved-patient-safety-nursing-efficiency-and-return-on-investment-10593

Burnie, J., & Vining, S. (2021). Clinical nurse specialist practice: Impact on emergency department blood culture contamination. *Clinical Nurse Specialist*, *35*(6), 314-317. https://doi.org/10.1097/nur.0000000000000634

Davis, J. (2017, March 27). How nursing informatics helped Carolinas HealthCare eliminate 18 million clicks. *Healthcare IT News*. https://www.healthcareitnews.com/news/how-nursing-informatics-helped-carolinas-healthcare-eliminate-400000-clicks

Farokhzadian, J., Khajouei, R., Hasman, A., & Ahmadian, L. (2020). Nurses' experiences and viewpoints about the benefits of adopting information technology in health care: A qualitative study in Iran. *BMC Medical Informatics and Decision Making*, *20*, Article 240. https://doi.org/10.1186/s12911-020-01260-5

Garcia-Dia, M.J., (2021). Nursing informatics: An evolving specialty. *Nursing Management,52*(5), 56. https://doi.org/10.1097/01.NUMA.0000743444.08164.b4

Hyder, M.A., & Razzak, J. (2020). Telemedicine in the United States: An introduction for students and residents. *Journal of Medical Internet Research, 22*(11), e20839. https://doi.org/10.2196/20839

Mattout, W., & Yesilada, F. (2024). Revolutionizing healthcare finances: Navigating the impact of innovative technologies on medical claims cost containment in the MENA region. *Economics and Business Quarterly Reviews,* 7(1), 41-54. https://doi.org/10.31014/aior.1992.07.01.558

Moen, H., Hakala, K., Peltonen, L.-M., Suhonen, H., Ginter, F., Salakoski, T., & Salantera, S. (2020). Supporting the use of standardized nursing terminologies with automatic subject heading prediction: A comparison of sentence-level text classification methods. *Journal of the American Medical Informatics Association* , *27*(1), 81-88. https://doi.org/10.1093/jamia/ocz150

Moore, E.C., Tolley, C. L., Bates, D.W., & Slight, S.P. (2020). A systematic review of the impact of health information technology on nurses' time. *Journal of the American Medical Informatics Association*, *27*(5), 798-807. https://doi.org/10.1093/jamia/ocz231

Powell, L., Sittig, D.F., Chrouser, K., & Singh, H. (2020). Assessment of health information technology-related outpatient diagnostic delays in the US Veterans Affairs health care system: A qualitative study of aggregated root cause analysis data. *JAMA Network Open*, *3*(6), e206752. https://doi.org/10.1001/jamanetworkopen.2020.6752

Reis, Z.S.N., Maia, T.A., Marcolino, M.S., Becerra-Posada, F., Novillo-Ortiz, D., & Ribeiro, A.L.P. (2017). Is there evidence of cost benefits of electronic medical records, standards, or interoperability in hospital information systems? Overview of systematic reviews. *JMIR Medical Informatics*, *5*(3), e26. https://doi.org/10.2196/medinform.7400

Shrank, W.H., Rogstad, T L., & Parekh, N. (2019). Waste in the US health care system. *JAMA*, *322*(15), 1501-1509. https://doi.org/10.1001/jama.2019.13978

Uitvlugt, E.B., Janssen, M.J.A., Siegert, C.E.H., Kneepkens, E.L., van den Bemt, B.J.F., van den Bemt, P.M.L.A., & Karapinar-Çarkit, F. (2021). Medication-related hospital readmissions within 30days of discharge: Prevalence, preventability, type of medication errors and risk factors. *Frontiers in Pharmacology*, *12*, 567424. https://doi.org/10.3389/fphar.2021.567424

Weber, P., Peltonen, L.-M., & Junger, A. (2022). The essence and role of nurses in the future of biomedical and health informatics. *Studies in Health Technology and Informatics*, *300*, 164-176. https://doi.org/10.3233/shti220948

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Landi, H. (2024, March 15). *HIMSS24: Oracle Health builds out generative AI tools in its quest to 'eliminate clicks' for clinicians*. Fierce Healthcare. https://www.fiercehealthcare.com/ai-and-machine-learning/himss24-oracle-builds-out-generative-ai-tools-its-quest-eliminate-clicks

Li, R.C., Wang, J.K., Sharp, C., & Chen, J.H. (2019). When order sets do not align with clinician workflow: Assessing practice patterns in the electronic health record. *BMJ Quality & Safety, 28*(12), 987-996. https://doi.org/10.1136/bmjqs-2018-008968

Papanicolas, I., Woskie, L.R., Jha, A.K. (2018). Health care spending in the United States and other high-income countries. *JAMA, 319*(10), 1024-1039. https://doi.org/10.1001/jama.2018.1150

Sittig, D.F., Wright, A., Meltzer, S., Simonaitis, L., Evans, R.S., Nichol, W.P., ... Middleton, B. (2011). Comparison of clinical knowledge management capabilities of commercially-available and leading internally-developed electronic health records. *BMC Medical Informatics and Decision Making*, *11*, Article 13. https://doi.org/10.1186/1472-6947-11-13

Torab-Miandoab, A., Samad-Soltani, T., Jodati, A., & Rezaei-Hachesu, P. (2023). Interoperability of heterogeneous health information systems: a systematic literature review. *BMC Medical Informatics and Decision Making*, *23*, Article 18. https://doi.org/10.1186/s12911-023-02115-5

Turner, A., Miller, G., & Lowry, E. (2023, October 4). *High U.S. health care spending: Where is it all going?* The Commonwealth Fund. https://www.commonwealthfund.org/publications/issue-briefs/2023/oct/high-us-health-care-spending-where-is-it-all-going

Wells, C., & Loshak, H. (2019). *Standardized hospital order sets in acute care: A review of clinical evidence, cost-effectiveness, and guidelines.* Ottawa: Canadian Agency for Drugs and Technologies in Health. https://www.ncbi.nlm.nih.gov/books/NBK546326

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Dr. Virginia Saba Memorial Keynote Address

Nursing IS Connected: Connecting Nursing Informatics to the Digital Innovation Future of Health Care

Lauren Bergens

Lxchelle Arceneaux

Lauren Bergens, DNP, RN
Lxchelle Arceneaux, DNP, MPH, BSN, BS, RN, NI-BC

Dr. Lauren Bergens and Dr. Lxchelle Arceneaux will discuss the importance of connecting nursing informatics to the digitally innovative future of health care, including enhanced patient safety and promotion of ease of practice.

General Keynote Address

Hacking Health Care: Building Missing Infrastructure with the People We Serve

Danny van Leeuwen

Danny van Leeuwen, MPH, RN, OPA

Danny van Leeuwen will focus on how patients and caregivers are hacking a healthcare system that doesn't work for them – they need a system that provides them with actionable information and truly includes them in both research and decision-making. Danny shares methods to promote vital collaboration among stakeholders, including community members and nurse informaticists, to effectively implement solutions, reduce non-adherence, and ensure sustained adoption.

Endnote Address

What's Next in Artificial Intelligence

Jason Thrift

Jason Thrift, PhD, RN, CHSE

Artificial intelligence is revolutionizing various aspects of healthcare delivery. Dr. Jason Thrift will explore what's next in artificial intelligence and how, with a solid understanding of artificial intelligence, nurses can leverage its potential benefits to deliver high-quality, patient-centered care. Focus will include current trends for artificial intelligence in healthcare delivery; new interventions for patient care such as current research in virtual reality, x-rays, and simulation; and context for future interactions of artificial intelligence in the delivery of care.

For complete conference schedule and registration details, visit
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Obarzanek, L., & Pieper, B. (2020). The use of equine-assisted programs for nontraditional undergraduate clinical pediatric experiences. *Teaching and Learning in Nursing, 15*(2), 145-151. https://doi.org/10.1016/j.teln.2020.01.002

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