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**Improving Patient Safety and Emergency Department Staff Efficiency in Barcode
Medication Administration by Using the Rover™ Mobile Application**

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Abstract

BACKGROUND: The Emergency Department (ED) is one of the busiest areas in the hospital. Patients are often acute, and it can get chaotic at times. Such a complex environment requires an effective and efficient system to increase staff efficiency and elevate patient safety. Patient and medication scanning has been a continuing issue with the current barcoding process using the in-room scanners and workstations on wheels (WOWs). In reviewing the Barcode Medication Administration (BCMA) weekly audit report, scanner broken and scanner not available are the most frequently used reasons for not scanning patients and medications. Additionally, WOWs can be hard to find or move around in areas without built-in scanners, especially during busy times. Adding mobile devices with the Rover™ Application for scanning patients and medications can address the abovementioned problems. The global aim is to improve patient safety and ED staff efficiency in barcoding patients and medications using the Rover™ Mobile app.

METHODS: The Plan-Do-Study-Act (PDSA) was used for this quality improvement (QI) project. A pre-intervention survey was sent out to staff to evaluate the current barcoding process and determine the perceived usability of in-room scanners/WOWs using the modified Technology Acceptance Model (mTAM) by Lewis (2019). mTAM was used to measure staff agreement regarding the products' perceived usefulness (PU) and perceived ease of use (PEU). Similarly, a post-intervention survey was sent out a month after using the exact measurements. Qualtrics was used to analyze survey responses, including demographics, reasons for not scanning, frequency of use, and barriers to using the Rover™ app on mobile devices. Additionally, Qualtrics was used to compare the mean (M) and standard deviation (SD) of each of the twelve items in the mTAM. The specific aims include increasing staff's patient and

medication scanning compliance to 95% and above, decreasing occurrences of scanning noncompliance due to scanners broken and unavailable, and improving staff's perception of usefulness and ease of use with the Rover™ mobile app.

RESULTS: There was a substantial increase in the staff's perceived usefulness and ease of use with the Rover™ app on mobile devices. Perceived usefulness increased from a Mean of 3.73, SD of 1.09, Range 1-5 with the in-room scanners/WOWs to a Mean of 4.03, SD 1.17, Range 1-5 with the Rover™ app on mobile devices. Similarly, perceived ease of use increased from a Mean of 3.58, SD 1.28, Range 1-5 with the in-room scanners/WOWs to a Mean of 3.73, SD 1.29, Range 1-5 with the Rover™ app on mobile devices. In the first week of March, medication scanning compliance was 82%, and patient scanning compliance was 83%. With the addition of the Rover™ app on mobile devices, patient scanning compliance has peaked at 93-94%, while medication scanning stayed above 90% in most weeks. Concurrently, the reasons for not scanning per policy have also declined with using the Rover™ app. Before the intervention, the choice of scanner broken was provided 66 times, while scanner not available was the reason provided 262 times. In September, the scanner broken reason decreased to 31, and the scanner not available reason decreased to 78.

CONCLUSION: Although the desired benchmark of 95% for patient and medication scanning compliance was not achieved, the Rover™ app on mobile devices remarkably helped increase staff compliance with medication and patient scanning and has decreased the use of scanners broken and unavailable as reasons for not scanning. There are many external variables to consider, but most notably, having a clear use case for any QI initiative is integral. Unit leadership should set expectations and hold staff accountable for noncompliance. This QI project was instrumental in increasing staff efficiency with patient and medication scanning and

introducing the added features of the Rover™ app on mobile devices, including scanning lab specimens, secure chat, and Webex calling. The desired goal of 95% staff compliance would be easily achieved as more and more Rover™ app features are added, and staff become more adept in using and integrating the new technology into their daily care of patients.

Keywords: Rover™ app, mobile devices, barcode medication administration, scanner, workstations on wheels, staff efficiency, patient safety

Improving Patient Safety and Emergency Department Staff Efficiency in Barcode Medication Administration by Using the Rover™ Mobile Application

Mobile devices have been integral to advancing healthcare technology at the bedside. Ventola (2014) stated that mobile devices and applications allow healthcare professionals (HCPs) to make quick decisions with reduced errors, increase quality data management and accessibility, and improve practice efficiency and knowledge. Additionally, handheld devices provide clinicians with easy and timely access to information for more thorough documentation (Mickan et al., 2013). Clinicians find ease of use, quick interface, and adaptability critical in enhancing patient care. HCPs associate mobile devices with portability, quick access to information, ease of communication, and access to powerful apps for various purposes (Ventola, 2014). Innovative hardware gave rise to software development. Epic™ is the largest provider of electronic health records (EHR) in the United States (U.S.). Epic Rover™ is an Epic™ Mobile App that allows clinicians to record documentation and conduct barcode validation at the point of care, typically at the bedside (Healthcare I.T. Leaders, 2016). Epic Rover™ on handheld devices links seamlessly to the organization's existing Information Technology (I.T.) infrastructure to improve patient safety, increase ease of mobility, and quick transfer of data (Healthcare I.T. Leaders, 2016).

The microsystem of a facility in Northern New England successfully implemented Epic Rover™, with staff and patients embracing the technology well. Epic Rover™ is highly reliable, interoperable, and easily adaptable. Such proven efficacy necessitates expanding Rover™ technology to other areas. Adopting Epic Rover™ application to other units is integral as the organization lives up to its reputation as the best hospital for 2022 (U.S. News & World Report,

2022). This recognition speaks to the organization's mission to advance health through research, education, and clinical practice.

Problem Description

Epic Rover™ technology meets the need of the organization to increase efficiency with barcode medication administration (BCMA) for patient safety. Implementing this technology in areas with high patient volumes/medication administration and complex patients (e.g., Emergency Department) can significantly enhance clinician efficiency and patient safety. Cabilan et al., (2017) stated that areas like the fast-paced Emergency Department (E.D.) with short patient stays, high patient turnovers and frequent use of verbal orders have the most medication errors. Rover™ connects to Epic's central data repository in real-time, allowing clinicians easy and quick access to patient information (Healthcare I.T. Leaders, 2016). This innovative technology is cost-effective, patient-centric, and boosts efficiency with clinical workflows.

Barcode medication administration (BCMA) is a worthy feature of Epic Rover™. Currently, clinicians are using workstations on wheels (WOWs), which can be cumbersome and obtrusive to patients during medication administration, especially at night and during busy times. There are workstations in patient rooms, but they also present some spatial and system challenges. In the prior month's BCMA compliance report, the top reasons staff are not scanning patients and medications are either the scanner is broken or not available. Prior to the start of this project, there were 66 reports of broken scanners and 262 reports of unavailable scanners, selected as reasons for not scanning (See Appendix C). Based on information from the Helpdesk, there were 14 scanner-related issues in 2022, and the first quarter of 2023 has already generated 23 instances. Admittedly, the in-room wall scanners are over five years old and must be updated.

Inevitably, the current scanner setup could be improved. Often, scanners are not appropriately docked for varying reasons, resulting in scanners losing power and potentially falling and breaking. There are two workstations on wheels (WOWs) with scanners. However, with the increasing number of patients in the hallway, it can be extremely challenging to move this around, and often, the WOW is hard to find or not functioning (e.g., no power). This inefficiency potentially creates unsafe workarounds that might compromise patient safety (i.e., medication errors). Workarounds could lead to bypassing the BCMA process. This practice posits a significant risk to patient safety as it can result in a medication error (Morouse & Tyler, 2023). Sloss and Jones (2020) reported that 20-30% of medication errors occur at the time of administration. The BCMA staff compliance for March ranges from 81-87% (Medication scanning) and 83-87% (Patient scanning) (See Appendix B). The organization's benchmark is 95% combined patient and medication scanning compliance because even a single medication error can potentially result in devastating consequences. Tariq et al. (2022) reported that 7000 to 9000 people die in the U.S. due to medication errors. Furthermore, medication errors are the third leading cause of death in the United States, with an estimated 440,000 deaths annually (Baptiste et al., 2020). Epic Rover™ on mobile/handheld devices makes BCMA more efficient, ensures consistent staff compliance, and increases patient safety.

Available Knowledge

The E.D. is a fast-paced environment with high-acuity patients, and often, staff are presented with urgent or unsafe situations. Cabilan et al. (2017) stated that 62.7% of errors occur at the time of administration. Technology such as barcode medication administration can decrease these errors, especially in critical care areas like the E.D. Bonkowski et al. (2013) also asserted that the complexity and high potential for errors with medication administration in the

E.D. could get the most benefit with BCMA. In the aftermath of the *To Err is Human* publication in 1999, barcoding patients and medications at the point of care reduced medication error rates (Bates & Singh, 2018). Hutton, Ding, and Wellman (2021) stated that barcoding technology prevents errors of wrong dose, wrong drug, wrong patient, unauthorized drug, and wrong route in the hospital setting.

Workarounds are "informal temporary practices for handling exceptions to normal procedures or workflow" (Van Der Veen et al., 2020, p. 2240). Miller et al. (2011) reported a median of 3 nursing workarounds per administration, which include failure to scan patients and medications and scanning barcodes once dosage has been removed. Van Der Veen et al. (2018) enumerated several factors contributing to workarounds, and it is worth noting that informal conversations with nurses cited a lack of education/training on the use of scanners, the computers on wheels are too large to move around, and these lead to workarounds becoming an accepted practice. As such, portable devices with scanning capabilities can be convenient in preventing workarounds (Baptiste et al., 2020). In addition, workarounds stem from ignoring/bypassing alerts (e.g., wrong medication, wrong patient, wrong dose, and wrong time) due to several factors (i.e., alarm fatigue, inappropriate alarms, no clinical significance) (Sloss & Jones, 2019).

It is imperative to trend and understand the frequency and reasons why nurses are bypassing BCMA and developing workarounds. Sloss and Jones (2019) stated that nursing workarounds minimize the benefits of BCMA and potentially increase rather than reduce risk in the medication administration process. It is incumbent on the nurse, as the sole user and the last line of defense, to use BCMA as designed without unsafe workarounds to prevent medication errors (Lichtner & Dowding, 2022). Nursing workarounds can be avoided by aligning technology with clinical workflows, designing clinically significant alarms, and enhancing

nursing engagement with the BCMA process. Staff need to be involved in the design, integration, and implementation of BCMA to foster buy-in and engagement. End-users tend to be disengaged when technology fails to meet their wishes and expectations, leading them to develop workarounds (Van Der Veen et al., 2020).

Habitual use of workarounds diminishes the safety-enhancing features of BCMA (Van Der Veen et al., 2018). End users need to understand how BCMA improves patient safety, with due recognition of its limitations, to make sound judgments and not practice harmful workarounds (Lichtner & Dowding, 2022). It is necessary to stress that BCMA is just a tool and should be used with critical thinking to advance patient safety.

Rationale

The success of Epic Rover™ in the organization's microsystem, as shown by their consistent >95% compliance rate, is a testament to the practical utility of this technology (See Appendix A). As the first unit in the organization to use the Rover™ app for Patient/Medication scanning, their data was used as an organizational baseline for this Q.I. project. It is crucial to implement this technology across the organization. The next logical step is launching this project in the Emergency Department (E.D.). The E.D. has higher patient volumes/medication administration and more complex patients requiring frequent rounds and monitoring. Portable mobile devices are relatively safer than WOWs as patients can be complex and potentially combative. As mentioned above, in-room scanners are unreliable and often reported as problematic. The two WOWs are also not as portable and have issues (e.g., heavy to move around, no power, often unavailable). These resulted in staff BCMA noncompliance with top reasons such as broken and unavailable scanners and practicing potentially unsafe system

workarounds. Admittedly, there are operational issues to consider, but the portability and ease of use of the Rover™ app on mobile devices can address current system and operational issues.

The Plan-Do-Study-Act (PDSA) framework was used for the project. In the Plan stage, a proposal was drafted to introduce the Rover™ app technology to one zone of the ED. Morouse and Tyler (2023) stated that testing and validating the process with user feedback is integral to successful implementation. Following the acceptance of the plan, feedback was obtained on using the in-room and WOW scanners, along with the staff's agreement on the technology's perceived usefulness and ease of use. Concurrently, lessons learned from the other microsystem and staff experience can guide the implementation of the E.D. Rover™ mobile app. This approach aligns with the PDSA framework to ensure interventions are well-suited and integrated into the existing workflow to ensure system optimization, staff engagement, and successful project implementation.

Lewin's Change Management Model (Burnes, 2020) guided interventions in undoing old habits and integrating new ones. Lewin's model addresses the three phases of change:

1. Unfreezing: to recognize that a change is needed
2. Moving: to implement and embrace the new workflow with the Rover™ app for BCMA
3. Refreeze: to ensure Rover™ for BCMA is constantly used by the staff, as shown in the weekly BCMA compliance report

It was important to seek feedback from staff on their current practices, identify challenges of the existing system, evaluate, and improve current standards of practice. Additionally, the weekly BCMA audits monitored staff patient/medication compliance and provided data on how frequently the Rover™ App on Mobile devices was used for BCMA.

Implementing Epic Rover™ in the Emergency Department was beneficial to the organization. The E.D. has a solid use case, highly engaged staff, and a supportive leadership team. This innovative solution helped improve clinician workflow, enhanced patient/staff satisfaction, and, most importantly, ensured patient safety. In addition, the E.D.'s success can support the integration of the Rover™ app on mobile devices in other critical areas (e.g., Intensive Care Units).

Evaluating Rover™ integration with current workflows is integral to mitigating potential gaps and ensuring successful implementation. This initiative required a multidisciplinary approach to review policies and standards and ensure staff accountability and compliance with continued analysis/monitoring of data for sustainability.

Specific Aims

The global aim of this project was to improve patient safety and Emergency Department staff efficiency in Barcode Medication Administration (BCMA) using the Rover™ mobile application. Through this new process, we expected to see an increase in patient and medication scanning compliance. It was essential to work on this now because a single medication error can potentially lead to patient harm, with devastating financial and operational consequences.

The specific aims of this project included increased individual staff barcode patient/medication compliance at 95% and above, decreased reports of scanners broken and unavailable as reasons for noncompliance to 0-5/week, and increased staff's level of agreement with perceived usefulness and ease of use with the Rover™ app on mobile devices (mTAM Mean scores of 3.5 and above) by the end of the fourth quarter of 2023.

Methods

Context

The metasystem is the most extensive hospital system in New Hampshire (N.H.). The macrosystem is the state's only academic medical center, and the microsystem provides primary and specialty care to the residents of N.H. and Vermont (Dartmouth Health, n.d.). The metasystem's mission is to advance health through research, education, clinical practice, and community partnerships, providing each person the best care in the right place, at the right time, every time (Dartmouth Health, n.d.). The metasystem strives to be innovative in healthcare technology, enhancing patient and clinician experience at the point of care. The metasystem's primary goals are enhancing patient safety and elevating patient care. The electronic medical record used by the metasystem is Epic™, which includes the Rover™ app technology. Incorporating Rover™ technology within the Epic system is the logical solution as it strengthens the metasystem's thrust to elevate patient safety and clinician efficiency.

The microsystem is a 42-bed Emergency Department (E.D.), Level 1 Trauma center averaging 30,000 patients annually with an average acuity of 2.80. The E.D. has an 88.8 total FTE covering clinical and operational staff. The E.D. has a combined (patient/medication) compliance rate in the 81st-87th percentile, with room for improvement (See Appendix B).

Cost Benefit Analysis

Rover™ technology for BCMA is an intelligent investment for the organization. Rover™ licensing/subscription cost has been acquired. However, it might require recurring yearly subscription fees. It is necessary to purchase additional phones and other accessories for the E.D. Staff training is integral to implementation success, and it is necessary to train unit leaders as they would be the drivers to sustain the use and adaptation of the new process. Equally important

is integrating Mobile Device Management (MDM) software to monitor and control updates and keep patient data safe and secure. Lastly, miscellaneous expenses will cover hardware repairs, ongoing maintenance, and staff re-training costs (See Appendix D).

Return on capital investment can be projected by looking at less likelihood of sentinel patient events relative to increased barcode medication administration compliance. The average cost per incidence of preventable harm is approximately \$ 58,776 (Bernazzani, 2015). That is a significant amount saved for the organization by avoiding patient harm and not incurring any denial of reimbursements or potential costs of litigations.

The interoperability, usability, and efficiency of Epic Rover™ technology meet the need of the organization to enhance patient safety and elevate patient care with increased BCMA compliance. In addition, adopting this technology will not create significant financial strain, as the Epic™ enterprise package already includes the initial acquisition cost. Lastly, with the addition of a new patient tower, it is integral that reliable systems are in place to ensure patient safety across patient encounters. Therefore, the Rover™ app on mobile devices can benefit patients and clinicians.

Interventions

Twenty-one (21) mobile devices with the Rover™ App were deployed to cover all R.N.s/Paramedics working at varying times of the day. Initially, only five phones (5) were available. However, 16 were acquired to complete 21 mobile Rover™ mobile phones. This number of phones was enough to cover all staff on shift and to have a few continuously charged left. In addition, every nurse/paramedic was provisioned for Rover™ access and trained on navigating the phone with a high emphasis on integrating the Rover™ App with the BCMA process.

There is a central docking station for all Rover™ phones within the nurses' station. So, each R.N./Paramedic coming on for their shift signed out a phone and kept it with them for the rest of their shift—a central monitor tracks which phone was signed out with which nurse/paramedic. At the end of their shift, they signed out, disinfected, and re-docked the phone into the docking station. Once re-docked, the system will wipe out the user/patient data, and the Rover™ mobile phones were kept charged and ready for the following staff.

An Informatics Nurse Specialist (INS) served as the project manager. He coordinated with ED Leadership, the Clinical Applications team, and the Senior Quality and safety specialist. In addition, all shift R.N. supervisors were trained (train the trainer) by the INS and were responsible for training their staff during their shifts. Once staff are confirmed to have met the educational requirement, they were held to the standards of BCMA compliance. Involving leadership in this stage fosters engagement, ownership, and unit accountability.

The INS completed the weekly rounding during the Pilot phase, gathered staff feedback, reinforced education, addressed potential challenges, and identified strategies to improve the implementation plan. In addition, the INS collaborated with the analytics team to establish baseline data and identify challenges using the weekly BCMA compliance report.

Study of the Interventions

A weekly BCMA report tracks the department's staff compliance and reasons for noncompliance. There are gaps identified in the current setup. The two workstations on wheels (WOWs) can be challenging to move around and must be charged for frequent use. Additionally, more than two WOWs are needed as patients are often in hallway beds due to overcrowding. Securing a WOW and moving it around a crowded ED can be daunting, leading to a possible BCMA workaround. The built-in scanners in patients' rooms are over five years old, and there

are several reports where those scanners have been problematic. Moreover, the setup of the current scanners could be improved.

As mentioned, having the Rover™ app for BCMA on mobile devices improves patient safety and ED staff efficiency. In addition, the portability and convenience of the Rover™ app on mobile devices can address the challenges stated above. Most importantly, this innovative technology can enhance timely medication administration. Inevitably, there will be a decrease in the use of "scanner not available" or "scanner broken" as reasons for noncompliance. Staff feedback can confirm the portability, convenience, and ease of use of the Rover™ App on Mobile devices.

The Donabedian Model states that an established structure leads to effective processes that yield high-quality outcomes (LoPorto, 2020). As such, it is imperative to evaluate these domains, identify areas of improvement, and evaluate outcome measures relative to the intervention. Introducing a new technology requires a standardized process, staff training and education, and policies and procedures that outline expectations. Staff must be provisioned and consistently use the Rover™ app to scan patients and medications during their shifts. Unit leadership must ensure staff are engaged with the new structure and adhere to the standardized processes.

Measures

BCMA Compliance Measure

Consistent with the Donabedian model, a detailed evaluation and enhancement of the current structure and processes leads to high-quality outcomes and maximizes the expected results of the interventions. The BCMA audit tool is an organization-specific tool that monitors staff compliance and is sent to unit leaders weekly. The tool evaluates staff's combined patient

and medication compliance, and to be deemed compliant, both medication and patient compliance should be at 95% and above. Patient and medication scanning compliance were computed by dividing the number of administrations with medications and patients scanned by the total number of administrations requiring medication and patient scanning. The report also provides a department summary by date and a summary by medication not scanned, focusing on scanner broken and unavailable as reasons for not scanning. Lastly, the report also provides the no. of times the Rover™ app has been used for patient and medication scanning. It is imperative to establish the frequency of usage of the Rover™ app and determine if it has contributed to increased staff scanning compliance.

Staff Survey

The pre-intervention survey asked about respondents' years of experience, level of education, years of using BCMA, and use of “scanner not available” and “scanner broken” as reasons for not scanning. Post-intervention asked about the respondent’s frequency of use of the Rover™ mobile app and if there were any barriers identified to using the app. Additionally, qualitative data were gathered by asking respondent’s comments, suggestions, and thoughts on both technologies.

The 12-item Modified Technology Model (mTAM) was included in pre- and post-intervention surveys. The Technology Acceptance Model, as introduced by Davis in 1989, looks at two determinants that influence system use: (1) perceived usefulness is defined as “the degree to which a person believes that using a particular system would enhance his or her job performance, and (2) perceived ease of use refers to “the degree to which a person believes that using a particular system would be free of effort” (Davis, 1989, p. 320). Davis (1989) investigated and validated the scale in 2 studies with .97 Cronbach alpha reliability for perceived

usefulness in study 1 and .98 in study 2: .91 reliability for ease of use in study 1 and .94 in study 2, confirming the scale’s psychometric strength (p.320). For this project, the modified TAM (mTAM), as introduced by Lewis (2019), will be utilized (See Figure 1). Lewis (2019) manipulated the item formats of the original TAM from assessment of likelihood to agreement, with numeric numbers arranged from left to right with increasing agreement [Strongly Disagree (1) – Strongly Agree (5)]. According to Sauro (2010), the small benefit of using a 7-point Likert scale can only be realized if there are less than ten response items and a large sample size. For this project, there’s 12 response items with a small sample size, so a 5-point Likert scale was used. A 5-point Likert scale makes it easier for staff to complete the survey with a QR code on their mobile devices.

Figure 1.
Modified Technology Acceptance Model (mTAM)

The Technology Acceptance Model (TAM) is designed to give you an opportunity to rate this product's usefulness and ease-of-use.

To as great an extent as possible, think about all the tasks that you do with the product while you answer these questions.

Please read each statement and indicate how strongly you agree or disagree with the statement. Please read the statements carefully, but don't spend a lot of time on each item -- your first impression is fine.

Note that for this questionnaire (TAM), all items have a positive tone so greater levels of agreement (to the right of the scale) indicate a better user experience.

1. Please indicate the extent to which you agree with the following statements where 1 = Extremely disagree and 7 = Extremely agree.

	1	2	3	4	5	6	7
1. Using this product in my job enables me to accomplish tasks more quickly than other products in its class.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2. Using this product improves my job performance.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3. Using this product in my job increases my productivity.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4. Using this product enhances my effectiveness on the job.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
5. Using this product makes it easier to do my job.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
6. I have found this product useful in my job.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
7. Learning to operate this product was easy for me.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
8. I found it easy to get this product to do what I want it to do.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
9. My interaction with this product has been clear and understandable.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
10. I found this product to be flexible to interact with.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
11. It was easy for me to become skillful at using this product.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
12. I found this product easy to use.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Note: A 5-point Likert scale was used instead of 7.

The pre-intervention survey was used to establish respondents' general characteristics, their experiences, and challenges with BCMA using in-wall portable scanners. The post-intervention survey aims to determine the same respondent's level of acceptance of using the Rover™ mobile app, any barriers to using it, and see if it increases patient and medication scanning compliance.

Analysis

The weekly BCMA data will be analyzed descriptively, noting frequency and percentages. Similarly, descriptive analysis will be used to note the frequency and percentages of categorical data pre/post-intervention survey (i.e., years of experience, level of education, etc.). For Likert-style items, descriptive analysis using mean, SD, and range will be used pre/post-intervention. The survey's final question asked for comments, suggestions, and thoughts regarding using the in-room scanners/WOWs and the Rover™ mobile app post-intervention. These qualitative data will be analyzed to identify patterns and themes.

Ethical Considerations

E.D. leaders informed staff about the project and the need to monitor compliance. Nursing supervisors addressed reasons for noncompliance to ensure consistency and sustainability. Similarly, it is imperative to regularly evaluate staff acceptance of new technology to ensure continued use and adoption. E.D. leadership assumed full responsibility for monitoring weekly staff patient/medication scanning compliance and addressing identified barriers as they arise. As much as all staff are held accountable for their practice, monitoring compliance is non-punitive and can identify system issues, enhance current workflow, and foster patient safety.

There is no identifiable patient information on the compliance report. Monitoring tools and Helpdesk reports provide occurrences and reporting frequency without identifiable patient

data. Similarly, the pre/post-intervention survey has no identifiable staff or patient information. The UNH participant consent template was used to inform the participants and gather participant agreement. There is no conflict of interest as the Rover™ app is part of the Epic enterprise, and the organization already has the license for its use.

Two University of New Hampshire (UNH) nursing faculty members and Dartmouth Hitchcock's Institutional Review Board (IRB) have reviewed this proposal. It is determined to be a quality improvement project and was exempt from a full IRB review.

Results

Results

Evolution of the Intervention

Five Rover™ phones were first piloted in one of the ED Zones (Zone D). Zone D has five telemetry beds, and Rover™ phones were initially used to communicate critical telemetry alarms to nursing staff. As staff started exploring and familiarizing themselves with the features of the Rover™ phones, a barcode scanning feature was added. A new barcode patient/medication scanning process was established. All ED staff (RNs/Paramedics) were provisioned to use the Rover™ mobile phone. Feedback on the new scanning process was sought from staff who have used it. Some process iterations were done, and then the final workflow was established. Subsequently, additional Rover™ phones were deployed, totaling 21 for the whole ED. Unit Supervisors and charge nurses were first trained, then helped train/educate the rest of the ED staff. ED leadership emailed all staff notifying them of the new process, with a reference guide attached. A hard copy of the reference guide was also placed near the docking station for quick reference. This new process was also added to the new hire (including travel nurses) curriculum to avoid potential knowledge gaps. Most importantly, regular rounding to

support staff and constant collaboration with the unit leadership team was essential to engaging staff and developing new habits. A timeline of the project is shown in Figure 2 below.

Figure 2.
Project Timeline



Process, Measures, and Outcomes

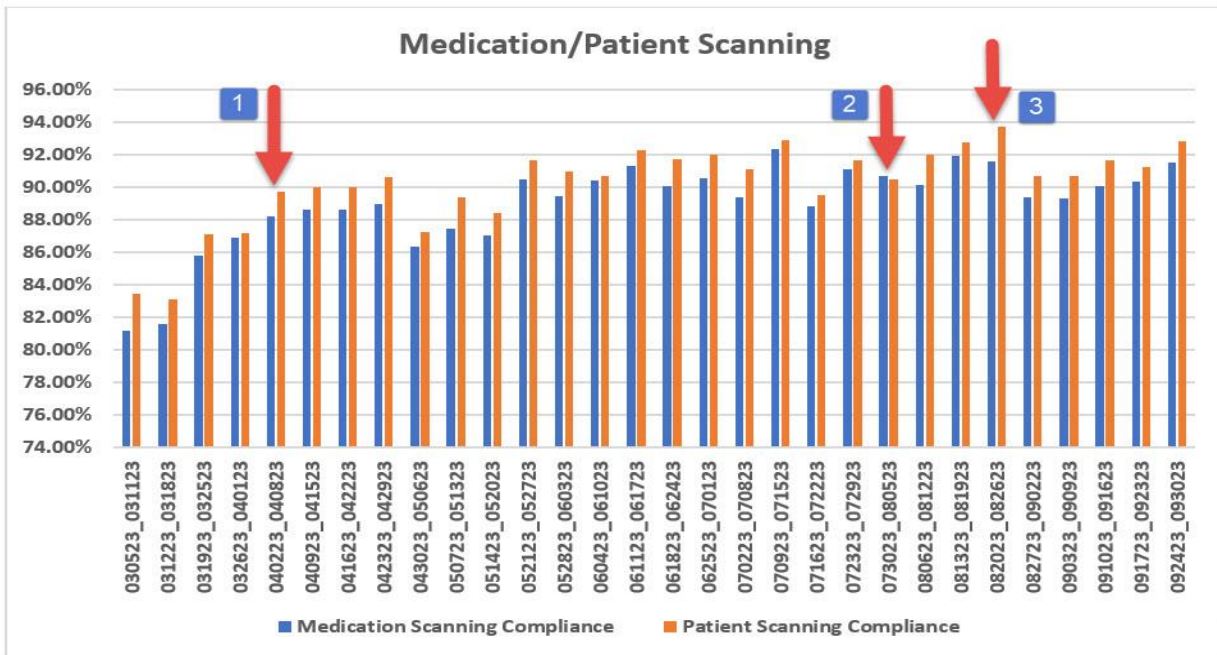
Unit leaders set staff expectations to align the new process with established unit standards. Staff compliance is monitored weekly with the BCMA audit report. For staff to be deemed compliant, patients and medication should be scanned 95% of the time. All staff are sent a quarterly scorecard, which includes BCMA compliance, to make them aware of their performance and a way to foster accountability.

The above metrics are used to evaluate if introducing the Rover™ BCMA technology enhances staff compliance and minimizes the use of “scanner broken” and “scanner not available” as reasons for not scanning patients and medications. Additionally, determining the frequency of use of the Rover™ app in scanning patients and medications can ascertain staff engagement and adoption of the new technology.

As noted in Figure 3, Rover™ app scanning was started on April 1st, 2023 (**Arrow 1**), with just five mobile phones. It was piloted in Zone D, but all staff were provisioned and

educated on its use. At this time, the five Rover™ phones served as extra devices for use in areas with no in-room or broken scanners. Daily unit rounding with device demonstration and one-on-one conversations with staff on shift. All unit supervisors were trained and channeled the education to staff on their respective shifts. The graph shows that medication and patient compliance improved over the coming months. On August 2, 2023 (**Arrow 2**), 16 mobile phones with the Rover™ app were added, slightly increasing patient scanning compliance. August 24, 2023 (**Arrow 3**), an email from the unit leadership was sent out to all staff encouraging the use of the Rover™ phones during their shift. That week showed medication scanning compliance at 91% and patient scanning compliance at 94%, which was the closest to our desired goal of 95%. Combined medication and patient scanning compliance has stayed above the 90th percentile for most of September, with patient scanning peaking at 93% in the last week.

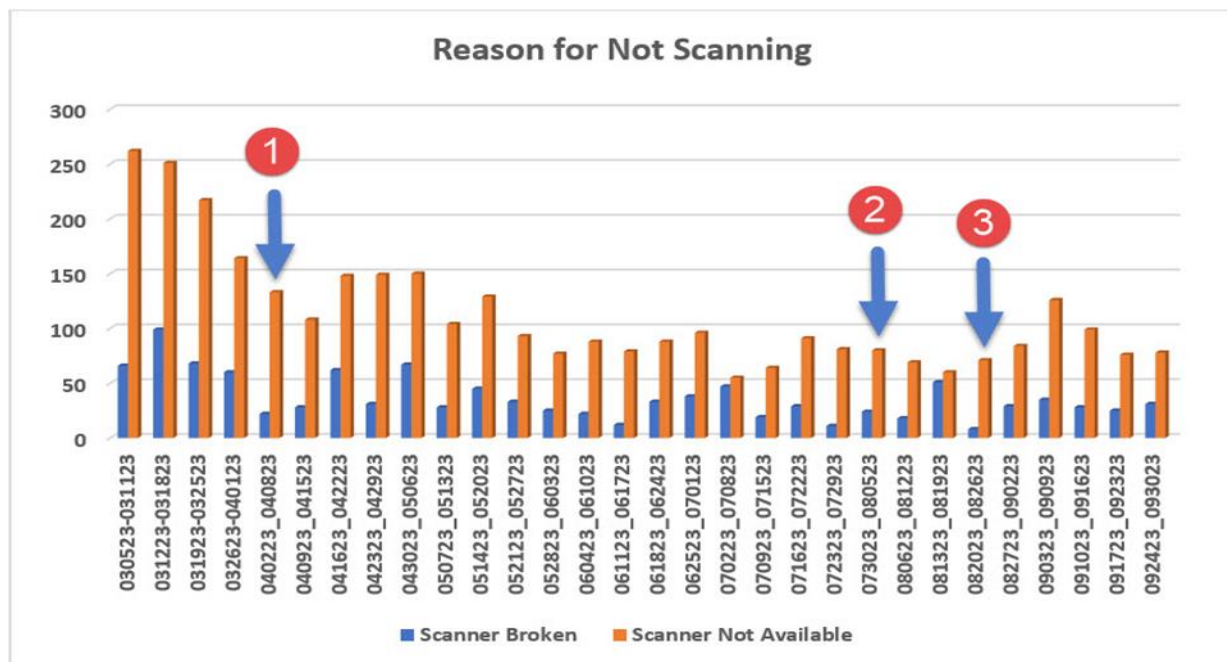
Figure 3.
Medication/Patient Scanning Compliance



Based on the weekly audit report, the main reasons selected for not scanning patients and medications include scanner broken or scanner unavailable. The addition of the Rover™ app on mobile devices to scan patients and medications decreased the use of the above-stated reasons, as seen in the graph below (See Figure 4). As stated above, five mobile devices with the Rover™ app were initiated on April 1st, 2023 (**Arrow 1**). Sixteen mobile devices were added on August 2, 2023 (**Arrow 2**). Then, unit leadership sent an email encouraging the use of mobile devices to scan patients and medications on August 24, 2023 (**Arrow 3**).

Overall, introducing the Rover™ app on mobile devices has improved staff compliance with patient and medication scanning and decreased the use of broken and unavailable scanners as reasons for not scanning. Similar milestones were highlighted (**Arrows 1-3**) to correlate decreases in using the above reasons for not scanning. The last week of September showed “scanner broken” at 31 (down from 66 in March) and “scanner not available” at 78 (down from 262 in March).

Figure 4.
Reasons for Not Scanning



Survey Results

A pre/post-intervention survey was done with questions about demographic data, reasons for not scanning, frequency and barriers to using the Rover™ app on mobile devices, and the modified Technology Acceptance Model (TAM4). The demographic data included years of nursing experience, level of education, and years of experience with BCMA. A pre-intervention survey was sent out to ED staff on August 4, 2023, and a post-intervention survey was sent on October 2, 2023. A total of 26 participants responded to the pre-intervention survey, and a total of 36 participants to the post-intervention survey. The Pre-Intervention demographic data distribution of the participants is presented in Table 1. Most of the respondents in the pre-intervention survey have more than ten years of experience (50%) and have bachelor’s degrees (62%). Most notably, participants have a wide range of experience with barcode medication administration. About 85% of the respondents selected “sometimes” or “about half the time” when asked about broken scanners or not being available as reasons for not scanning. Post-intervention categorical data shows the frequency and barriers to using the Rover™ app on mobile devices. Some respondents declined to answer some questions, which was reflected by adding that option to maintain the total sample and percentages (see Table 1).

Table 1.
General Characteristics

<u>General Characteristics</u>	<u>Total Sample (N=26) n (%)</u>
Years of Experience	
Less than 1 yr.	0 (0)
1-2 yrs	4 (15.38)
3-5 yrs	4 (15.38)
6-10 yrs	5
>10 yrs	(19.23)
	13
	(50)
Level of Education	
Associate	6 (23.08)

Bachelor’s Degree	16 (61.54)
Master’s Degree	2 (7.69)
Doctoral Level	0 (0)
Licensed Practical Nurse	0 (0)
EMT-P	2 (7.69)
How Long Using BCMA	
<1 yr.	3 (11.54)
1-2 yrs.	8 (30.77)
3-5 yrs.	7 (26.92)
6-10 yrs.	6 (23.08)
>10 yrs	2 (7.69)
Scanner Not Available	
Never	1 (3.85)
Sometimes	15 (57.69)
About Half the Time	7 (26.92)
Most of the time	2 (7.69)
Always	0(0)
Declined to answer	1(3.85)
Scanner is Broken	
Never	0 (0)
Sometimes	20 (76.92)
About Half the Time	5 (19.23)
Most of the time	1 (3.85)
Always	0 (0)

The post-intervention survey showed that most respondents (86%) used the Rover™ app to scan patients and medications, with 75% of them reporting using the Rover™ App “sometimes” (53%) and “about half the time” (22%). When asked about barriers to using the Rover™ app, 25% reported it is cumbersome to carry an additional phone, while 39% declined to answer (See Table 2).

Table 2.
Use of the Rover™ App

<u>Post-Intervention Categorical Data</u>	<u>Total Sample (N=36) n (%)</u>
Scanning with Rover™ App	
(N=34)	31(86.11)
Yes	3(8.33)

No	2(5.56)
Declined to answer	
Frequency of using the Rover™ App	0(0)
Never	19(52.78)
Sometimes	8(22.22)
About Half the time	2(5.56)
Most of the time	1(2.78)
Always	6(16.67)
Declined to answer	3(8.33)
Barriers to Using the Rover™ App	3(8.33)
It is not required.	9(25)
I don't know how to use it	
It is cumbersome to carry an additional phone.	6(16.67)
Signing in issue	1(2.78)
Prefer not to answer	14(38.89)
Declined to answer	

The modified TAM (TAM4), as compared by Lewis (2019) with other perceived usability measurements (e.g., SUS, UMUX-Lite), was used to measure technology acceptance. Specifically, mTAM was used to determine the perceived usefulness (PU) and perceived ease of use (PEU) of the data logic scanner and the Rover™ App on mobile devices. mTAM (TAM4) was preferred because the focus was on agreement ratings and rating the experience of actual use (Lah, Lewis, & Sumak, 2020). mTAM items with mean (M), standard deviation (SD), and range are displayed for both the Data Logic scanner and the Rover™ app in Table 3. Respondents reported that when compared to the in-room scanner/WOW, using the Rover™ app increases their productivity (mean of 3.38 to 3.67) and makes it easier for them to do their job (mean increased from 3.5 to 3.73). Although learning to operate the product was a challenge (mean decreased from 4.04 to 3.86), and it takes time for them to be skillful (mean decreased from 3.73 to 3.6), respondents still reported the product gets the job done (mean increased from 3.23 to 3.67) and is flexible to interact with mean increased from 3 to 3.72. Operational definitions of

Perceived Usefulness (PU) and Perceived ease of use (PEU) with scoring are presented in Table 4.

Table 3.
Technology Acceptance Model Comparison between Data Logic Scanner and the Rover™ App

<u>Variable</u>	<u>M</u>	<u>Pretest</u> <u>SD</u>	<u>Range</u>	<u>M</u>	<u>Posttest</u> <u>SD</u>	<u>Range</u>
<u>Perceived Usefulness</u>						
PU1. Using this product in my job enables me to accomplish tasks more quickly than other products in its class.	3.04	1.16	1-5	3.63	1.40	1-5
PU2. Using this product improves my job performance.	3.73	1.02	1-5	3.77	1.28	1-5
PU3. Using this product in my job increases my productivity.	3.38	1.27	1-5	3.67	1.40	1-5

PU4. Using this product enhances my effectiveness on the job.	3.77	1.15	1-5	3.77	1.36	1-5
	3.5	1.15	1-5	3.73	1.34	1-5
PU5. Using this product makes it easier to do my job.	3.73	1.09	1-5	4.03	1.17	1-5
PU6. I have found this product useful in my job.	4.04	1.13	1-5	3.86	1.36	1-5
<u>Perceived Ease-of-Use</u>						
PEU1. Learning to operate this product was easy for me.	3.23	1.15	1-5	3.67	1.30	1-5
PEU2. I found it easy to get this product to do what I want it to do.	3.65	1.17	1-5	3.79	1.24	1-5
PEU3. My interaction with this product has been clear and understandable.	3.00	1.27	1-5	3.72	1.17	1-5
	3.73	1.09	1-5	3.60	1.31	1-5
PEU4. I found this product to be flexible to interact with	3.58	1.28	1-5	3.73	1.29	1-5
PEU5. It was easy for me to become skillful at using this product.						
PEU6. I found this product easy to use						

It is clear from the results that the Rover™ app on mobile devices scored higher based on user agreement and experience of actual use. Most notably, perceived usefulness increased from

3.73 to 4.03, and perceived ease of use increased from 3.58 to 3.73 pre/post-intervention (highlighted in red). The overall mTAM score also increased from 3.5 to 3.75. It is understood that the new technology needs time to get adjusted and become skillful. Given the limited period that the product has been used, along with other challenges that the department was facing at the time of implementation (i.e., change in leadership, lots of new hires/travelers, etc.), it can be inferred that the new technology was perceived to be useful, and ease of use expected to improve over time.

Table 4. Technology Acceptance Model (TAM) Operational Definition and Pre/Post-test Scores

Construct	Operational Definition	Scoring
<u>Perceived Usefulness (PU)</u>	the extent to which a person believes using the system will enhance job performance. (Venkatesh & Davis, 2000)	$PU = \text{Average (PU1, PU2, PU3, PU4, PU5, PU6)}$ <p style="text-align: center;"><u>Pretest</u></p> $= \text{Average (3.04, 3.73, 3.38, 3.77, 3.5, 3.73)}$ $= 21.15/6$ $= \mathbf{3.5}$ <p style="text-align: center;"><u>Posttest</u></p> $= \text{Average (3.63, 3.77, 3.67, 3.77, 3.73, 4.03)}$ $= 22.6/6$ $= \mathbf{3.8}$
<u>Perceived ease of use (PEU)</u>	the extent to which a person believes that using the system will be free of effort (Venkatesh & Davis, 2000)	$PEU = \text{Average (PEU1, PEU2, PEU3, PEU4, PEU5, PEU6) - 1} (100/6)$ <p style="text-align: center;"><u>Pretest</u></p> $= \text{Average (4.04, 3.23, 3.65, 3.00, 3.73, 3.58)}$ $= 21.23/6$ $= \mathbf{3.5}$

		<u>Posttest</u> = Average (3.86, 3.67, 3.79, 3.72, 3.60, 3.73) = 22.37/6 = 3.7
<u>Overall mTAM Score</u>	The mean of PU and PEU (PU + PEU/2)	Data Logic = 3.5 + 3.5 / 2 = 3.5 Rover™ App = 3.8 + 3.7 / 2 = 3.75

The overall mTAM scores showed that respondents rated both the Data Logic scanner and the Rover™ App between “neither agree nor disagree” and “somewhat agree” categories (3-4 Levels of Agreement in a 5-point Likert scale). The Rover™ app is leaning more towards the “somewhat agree” category, which is expected considering the intervention timeline.

Participant Comments, Suggestions, and Thoughts

Respondents were asked to share additional comments about using the Data Logic scanner and the Rover™ app on mobile devices to support the above assertions further.

Pertinent words were selected and placed in a word cloud, as presented in Figures 5 and 6.

Figure 5.
Word Cloud for Comments about the Data Logic Scanner

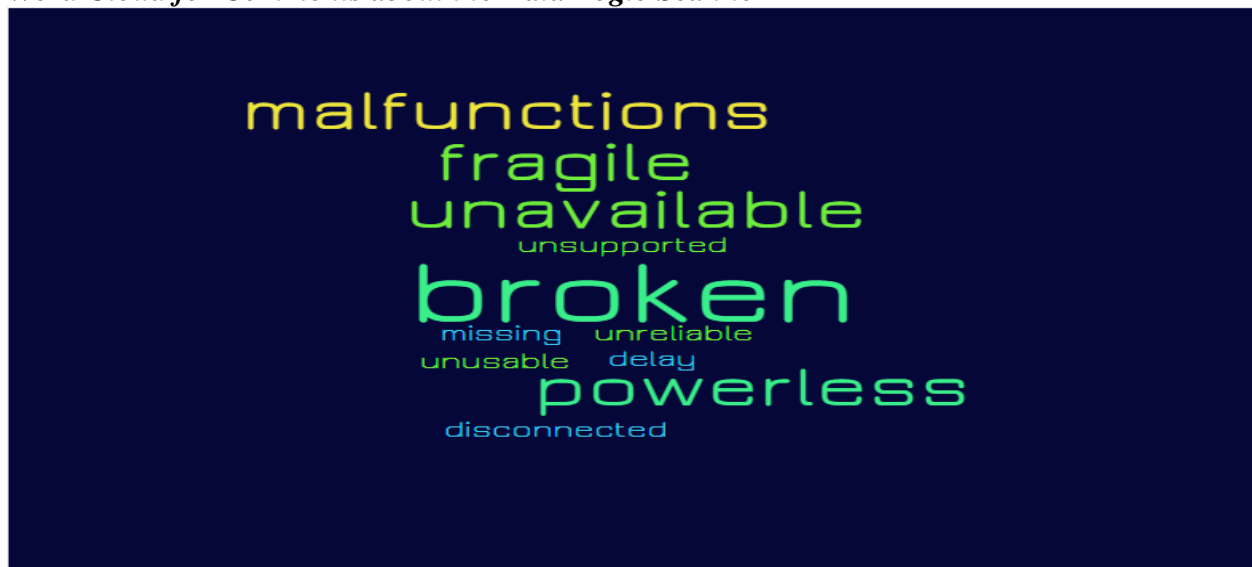
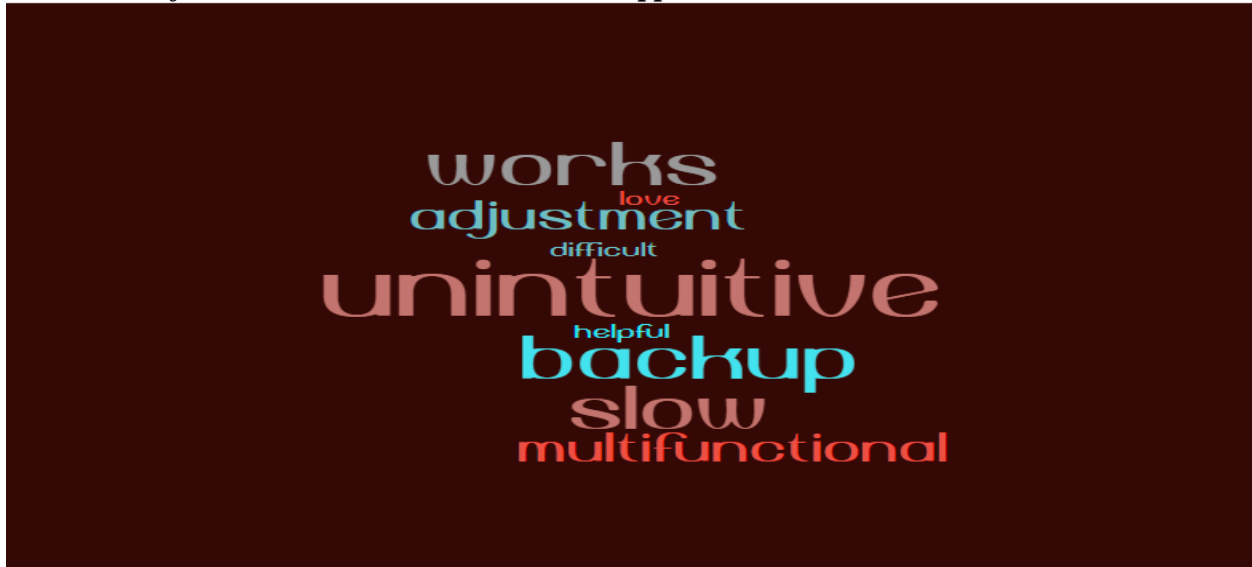


Figure 6.***Word Cloud for Comments about the Rover™ App on Mobile Devices***

As noted in word cloud images, the words with the larger font were repeated by participants as a common theme. Thus, the predominant theme for using the Data Logic Scanner was “broken,” “unavailable,” “malfunctions,” “powerless,” and “fragile.” In contrast, the predominant theme for the Rover™ mobile app was “unintuitive,” “works,” “backup,” “slow,” “adjustment,” and “multifunctional.” These comments suggest that the gold standard is the traditional handheld BCMA scanner and that the device’s functionality merits further investigation.

Discussion

Summary

Key Findings

Before this project, the ED staff’s patient and medication compliance was in the low 80th percentile (patient scanning compliance at 83% and medication scanning compliance at 81%). This is such a concern as 20-30% of medication errors occur at the time of administration (Sloss & Jones, 2020). Poor compliance would lead to a potential increase in medication errors. The

global aim of this project was to utilize the Rover™ mobile application to improve patient safety and enhance staff efficiency by scanning patients and medications. As mentioned earlier, the specific aims of this project included increased individual staff barcode patient/medication compliance at 95% and above, decreased reports of scanners broken and unavailable as reasons for noncompliance to 0-5/week, and increased staff's level of agreement with perceived usefulness and ease of use with the Rover™ app on mobile devices (mTAM Mean scores of 3.5 and above) by the end of the fourth quarter of 2023.

Most notably, patient scanning compliance peaked at 94% in the last week of August when unit leadership emailed to staff, encouraging them to use the Rover™ mobile app. At the end of September, medication scanning compliance was at the 90th percentile, and patient scanning compliance was at 93%. Reports of broken scanners and unavailable as reasons for not scanning decreased with scanners broken from 66 to 31, and scanners not available from 262 to 78. The overall mTAM scores showed that respondents rated both technologies between the “neither agree nor disagree” and “somewhat agree” categories (3-4 levels of agreement on a 5-point Likert scale). The Rover™ mobile app was rated more towards the “somewhat agree” category with a mean of 3.75, suggesting a greater perception of usefulness and ease of use than the Data Logic scanner.

Interpretation

As much as the availability of the Rover™ App on Mobile devices increased staff medication/patient compliance, there is still a need to hold staff accountable for their practice. Clearly, when unit leadership reminded and encouraged staff to use the Rover™ mobile app, it resulted in the highest patient scanning compliance at 94%. Presumably, despite the added benefit of having the Rover™ mobile app as a backup option, many staff still have poor

compliance in medication and patient scanning, failing to reach the benchmark of 95%. The use of broken scanners and not available as reasons for not scanning is still significant. Relatively, there is poor usage of the Rover™ app on Mobile devices. This can be attributed to the Rover™ mobile app being “difficult” and “unintuitive,” as reported, and staff’s preference to use the traditional handheld scanner if available and functional. This certainly warrants further investigation.

Based on staff feedback from the survey, it is clearly understood that in-room scanners/WOWs are preferred. Still, it is often found broken or unavailable for various reasons (i.e., computer, keyboard, mouse issues, not docked properly, no charge, etc.). The Rover™ app on mobile devices can be a great alternative and an excellent addition to in-room scanners/WOWs. However, some find it cumbersome to carry, unintuitive, or hard to navigate.

Staff compliance with scanning patients and medications has markedly improved from March to September. Although the desired goal of 95% was not achieved, it is worth noting that there is a consistent upward compliance trend every week. Keeping staff supported and engaged is integral to sustaining buy-in and adopting the new technology. Leadership engagement is integral to successful adoption and implementation. Staff is more likely to adhere to a new process if they are included in the design process, have met the educational requirements, and have set expectations to hold them accountable. Van der Veen et al. (2018) reported that staff bypass the BCMA process due to lack of training/education with scanner use and the workstation on wheels being too heavy to move around. Being available for support and answering staff questions helps address the knowledge gap and foster engagement. Moreover, it is vital to have a clear integration of technology with clinical processes. Portable devices for scanning patients and medications negate the need for the workstation on wheels. Moreover, portable devices

enable staff to easily access patient information for thorough documentation (Micken et al., 2013). However, staff need to recognize technological limitations, but they should not undermine the benefit of BCMA for patient safety (Lichtner & Dowding, 2022). Baptiste et al. (2020) asserted that the convenience of portable devices with scanning capabilities can prevent workarounds. Still, technology should be used as designed to maximize its benefits (Lichtner & Dowding, 2022). Staff patient and medication scanning compliance could reach 95% and above with continued use, leadership engagement, and regular compliance monitoring. By doing so, staff workarounds can be prevented, resulting in a potential decrease in medication errors.

It was anticipated that staff would be mandated to sign out the mobile devices at the beginning of their shift and use them for scanning patients and medications along with the added Rover™ app features such as secure chat, Webex calling, and scanning lab labels. Such leadership push fosters staff patient and medication scanning compliance. Understandably, it is imperative to establish use cases of a new tool and that without it, staff cannot perform based on established standards of care. Keeping the in-room/WOW scanners functional and having the Rover™ mobile phones as an alternative ensures that staff has all the tools necessary to comply with the BCMA process. Over time, as staff becomes more accustomed to using the Rover™ mobile phone, with added features, Rover™ mobile phone might become the preferred technology in scanning patients and medications and other features that improve staff efficiency and patient safety.

Costs and Strategic Trade-offs, Including Opportunity Costs

The Rover™ app on mobile devices did not incur any charges for the organization. Licensing cost was already paid, and the additional sixteen mobile devices were repurposed from a different unit. No other paid time for staff was incurred. Training and education were rolled

out via email, regular staff meetings, and just-in-time education/demonstration with the INS, unit supervisors/charge nurses. There were no opportunity costs as in-room data logic scanners were still in place with the two workstations on wheels (WOWs). The merging of the two processes enabled staff to have readily available resources to simplify scanning patients and medications, thereby increasing compliance. Although signing out a “Rover™ phone” was not mandated by unit leadership, it was expected that staff adhere to the standard scanning process for patient safety. Such availability of scanners should deter staff from using “scanner broken” and “scanner not available” as reasons for not scanning patients and medications.

Limitations

Implementing this project during the summertime was challenging due to various reasons. The department has a high patient volume; there was a change in leadership and an influx of new hires/travelers. As such, it created a degree of complexity with training and education. Additionally, when the unit is understaffed, it is hard to gather all the staff in one place for training and education. Also, with the department in its busy season, finding time to train staff while working is difficult. Starting with five phones and trialing the new process in one of the zones in the ED provided opportunities to enhance individual staff training. Moreover, since it took several weeks to complete the requisition of additional Rover™ phones, the new process was not wholly launched to the rest of the department. However, such a delay provided more time to educate and train staff, including new hires/travelers. Constant collaboration with unit leadership and charge nurses helped promote the new workflow and keep staff engaged.

Conclusions

The initial goal was to utilize the Rover™ app on mobile devices to scan patients and medications. However, with in-room scanners and WOWs still available, staff are not inclined to sign out a Rover™ phone unless they have patients in areas without built-in scanners (e.g., hallways). Moreover, with limited features in the Rover™ mobile phone, staff find carrying an additional device unnecessary, especially if they have a much more convenient option.

After this project, unit leadership sent an email to staff mandating everyone to sign out a “Rover™ phone” at the beginning of their shift. Relatively, this resulted in an increased utilization of the Rover™ phones. Moreover, additional features were added to the Rover™ phones (e.g., Webex calling and scanning lab specimens), which enticed staff to sign out and use it for the stated purposes. Most importantly, unit leadership now holds staff accountable for their compliance rates. This provided staff awareness and fostered increased usage of the new technology. Reaching the desired benchmark at 95% and above can be achieved by leadership taking ownership of the process, ensuring staff are trained and supported, having all the resources/tools to scan patients/medications, and providing safe, timely, efficient, effective, quality patient care.

Funding

This project was made possible by the continued support of the ED director, manager, unit supervisors, and the MHMH ED staff. The “Rover™ phones” provision was made possible by establishing a solid use case supported by the Quality and Safety department and expedited action by the hardware and IT team.

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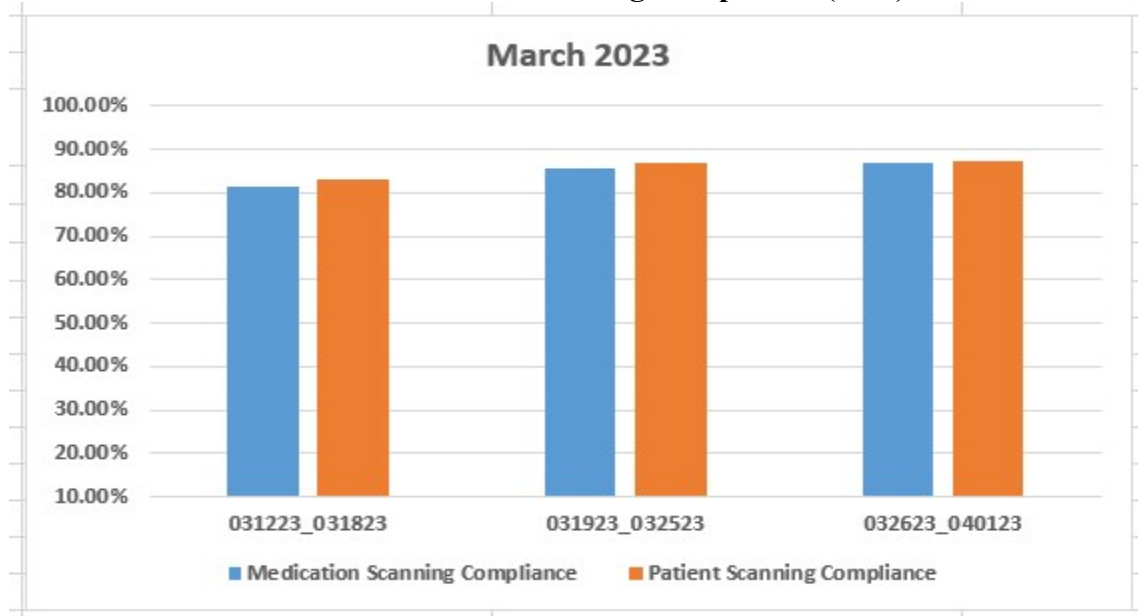
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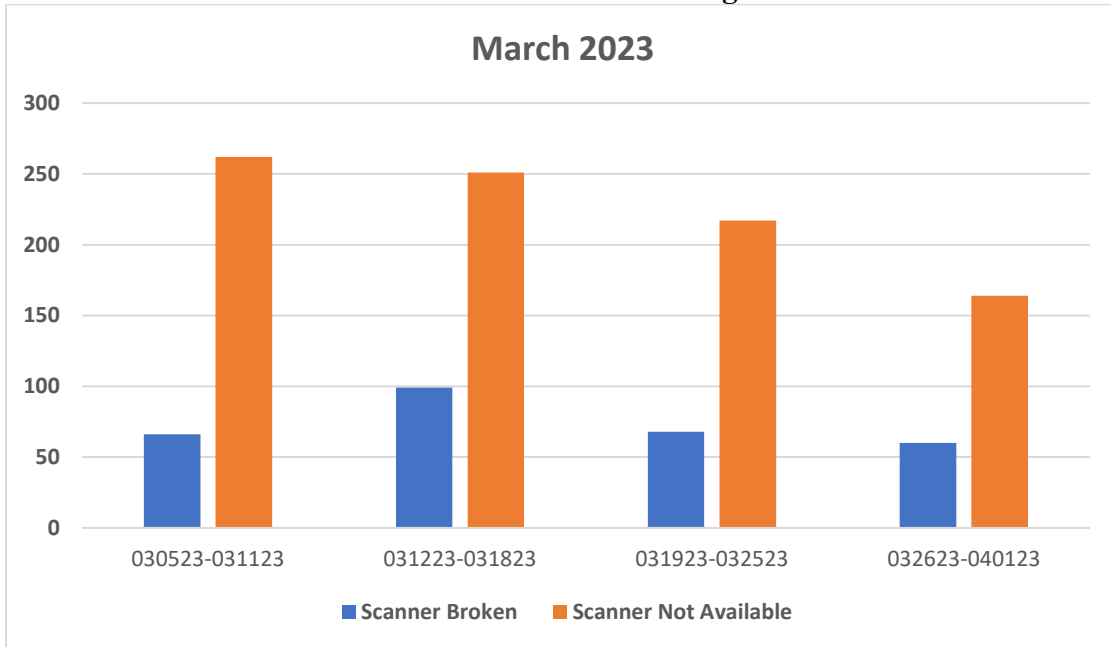
**Appendix A
Combined Scanning Compliance (Microsystem)**



Appendix B
Medication/Patient Scanning Compliance (E.D.)



Appendix C
Reasons for not Scanning



**Appendix D
Budget Proposal**

Hardware/Software	Facilities Prep
iPhone 13 x 8 pcs @ \$700/pc = \$ 5,600	IT Infrastructure (build, provisioning, etc.) - Done
iPhone 13 case 8 pcs @ 60/pc = \$ 480	Train The Trainer/Super User = No Expense: Training incorporated in regular staff work/meeting hours
Epic Rover™ Licensing Subscription = Paid Up (Standard Customization with 3-5 systems integration)	Implementation Expenses (OT, Consultant Fees, Extra Staffing, Go Live Technical Support) = No Expense: Part of regular work hours
Mobile Device Management (Manage, Deploy, & Update Devices) = TBD: Initial cost paid but might require recurring fees	Ongoing Implementation/Maintenance/Evaluation Expenses (TBD)
	Miscellaneous/Overhead Expenses: TBD (To Be Determined)
Total Estimated Cost	<u>\$6,080</u>

Appendix E **Pre-Intervention Survey**

Q1 Dear nursing/paramedic staff,

I am a doctoral nursing student at the University of New Hampshire (UNH), working on a quality improvement (QI) project to improve patient safety and emergency department staff efficiency in barcode medication administration (BCMA). By participating in this survey, you are participating in this QI project.

A project description and information are provided to help you decide if you want to participate.

You should:

- Read the information carefully, and ask me or my faculty advisor any questions, particularly if you need help understanding something.
- Only agree to participate once all your questions have been answered, or you are sure you want to.
- Understand that your participation in this project involves completing a survey that will take about 10 minutes.
- Understand that the potential risks of participating in this project are minimal.

You must be 18 to participate in this project and a current (full-time, per diem, traveler) nursing/paramedic at Dartmouth Hitchcock Emergency Department (ED).

If you agree to participate in this project after reading this document, you will be asked to participate in a survey that will take approximately 10 minutes. You will not be paid to participate in this project.

You should complete this survey only once. I may exclude your data if I determine that you still need to meet the eligibility criteria for the project. For questions about eligibility, don't hesitate to contact me (information provided at the end of the form).

As a participant in this project, you may benefit from any changes in the program or process being reviewed. Further, the information may help guide interventions to improve ED staff efficiency and enhance patient safety.

Taking part in this project is entirely voluntary. You may choose not to take part at all. If you agree to participate, you may refuse to answer any question. If you change your mind, you may stop participating at any time. Any data collected during your participation will remain part of the project records. If you decide not to participate or stop participating at any time, you will not be penalized.

I plan to maintain the confidentiality of all data and records associated with your participation in this project. Due to the low number of respondents, I do not ask for individually identifiable information in this survey to protect your identity. Responses are anonymous. As a reminder, any communication via the Internet poses minimal risk of a breach of confidentiality.

To help protect the confidentiality of your information, I will store data on the USNH IT secure cloud storage. Only I and my faculty advisor, Dr. Pamela Kallmerten, can access the data. Data, even de-identified, will not be used for future projects. I will report the de-identified data in an educational paper that will be available via the UNH Scholar's Repository. I may share the aggregate results with the organization. The results may be used in reports, presentations, and publications for educational purposes only.

If you have any questions about this project or would like more information before, during, or after the project, don't hesitate to contact me at the information provided below. If you have questions about your role as a participant, you may contact Dr. Pamela Kallmerten at UNH to discuss them via email (pamela.kallmerten@unh.edu), or you can call her at (603) 387-3340. I appreciate your consideration.

Sincerely,

Ian B. Kirit
ik1047@usnh.edu
603-443-7782

Do you agree to participate in this project?

Yes (3)

No (4)

Skip To: End of Survey If Dear nursing/paramedic staff, I am a doctoral nursing student at the University of New Hampshire... = No

Q2 How many years of clinical nursing/paramedic experience?

- Less than 1 year (1)
 - 1-2 years (2)
 - 3-5 years (3)
 - 6-10 years (4)
 - More than 10 years (5)
-

Q3 What is your highest level of nursing/paramedic education?

- Associate Degree (1)
 - Bachelor Degree (2)
 - Masteral Degree (3)
 - Doctoral Level (4)
 - Professional Education as a Licensed Practical Nurse (5)
 - Professional Education as an EMT-P (6)
-

Q4 How long have you used barcode medication administration (BCMA)?

- Less than 1 year (1)
 - 1-2 years (2)
 - 3-5 years (3)
 - 6-10 years (4)
 - More than 10 years (5)
-

Q5 How often do you encounter situations when "Scanner is not available" when administering medications?

- Never (1)
 - Sometimes (2)
 - About half the time (3)
 - Most of the time (4)
 - Always (5)
-

Q6 How often do you encounter situations when "Scanner is Broken" when administering medications?

- Never (1)
 - Sometimes (2)
 - About half the time (3)
 - Most of the time (4)
 - Always (5)
-

Q7 The Technology Acceptance Model (TAM) is designed to give you an opportunity to rate the In-room/WOW data logic scanner's usefulness and ease of use.

To as great an extent as possible, consider all the tasks you do with the BCMA technology while answering these questions.

Please read each statement and indicate how strongly you agree or disagree with the statement.

Please read the statements carefully, but don't spend much time on each item -- your first

impression is fine.

	Strongly disagree (1)	Somewhat disagree (2)	Neither agree nor disagree (3)	Somewhat agree (4)	Strongly agree (5)
1. Using the current in room/Workstation on Wheels (WOW) scanner in my job enables me to accomplish tasks more quickly than other products in its class. (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2. Using the in-room/WOW scanner improves my job performance. (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3. Using the in-room/WOW scanner in my job increases my productivity. (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3 Using the in-room/WOW scanner enhances my effectiveness on the job. (4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
5. Using the in-room/WOW scanner makes it easier to do my job. (5)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
6. I have found the in-room/WOW scanner useful in my job. (6)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
7. Learning to operate the in-room/WOW scanner was easy for me. (7)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

8. I found it easy to get the in-room/WOW scanner to do what I want it to do. (8)

9. My interaction with the in-room/WOW scanner has been clear and understandable. (9)

10. I found the in-room/WOW scanner to be flexible to interact with. (10)

11. It was easy for me to become skillful at using the in-room/WOW scanner. (11)

12. I found the in-room/WOW scanner easy to use. (12)

Q8 Please write any comments, or suggestions, or share any thoughts you might have regarding the current barcode medication administration process using the in-room/workstation on wheels scanner.

Appendix F
Post-Intervention Survey

Q1 Dear nursing/paramedic staff,

I am a doctoral nursing student at the University of New Hampshire (UNH), working on a quality improvement (QI) project to improve patient safety and emergency department staff efficiency in barcode medication administration (BCMA). By participating in this survey, you are participating in this QI project.

A project description and information are provided to help you decide if you want to participate.

You should:

- Read the information carefully, and ask me or my faculty advisor any questions, particularly if you need help understanding something.
- Only agree to participate once all your questions have been answered, or you are sure you want to.
- Understand that your participation in this project involves completing a survey that will take about 10 minutes.
- Understand that the potential risks of participating in this project are minimal.

You must be 18 to participate in this project and a current (full-time, per diem, traveler) nurse/paramedic at Dartmouth Hitchcock Emergency Department (ED).

If you agree to participate in this project after reading this document, you will be asked to participate in a survey that will take approximately 10 minutes. You will not be paid to participate in this project.

You should complete this survey only once. I may exclude your data if I determine that you still need to meet the eligibility criteria for the project. For questions about eligibility, don't hesitate to contact me (information provided at the end of the form).

As a participant in this project, you may benefit from any changes in the program or process being reviewed. Further, the information may help guide interventions to improve ED staff efficiency and enhance patient safety.

Taking part in this project is entirely voluntary. You may choose not to take part at all. If you agree to participate, you may refuse to answer any question. If you change your mind, you may stop participating at any time. Any data collected during your participation will remain part of the project records. If you decide not to participate or stop participating at any time, you will not be penalized.

I plan to maintain the confidentiality of all data and records associated with your participation in this project. Due to the low number of respondents, I do not ask for individually identifiable information in this survey to protect your identity. Responses are anonymous. As a reminder, any communication via the Internet poses minimal risk of a breach of confidentiality.

To help protect the confidentiality of your information, I will store data on the USNH IT secure cloud storage. Only I and my faculty advisor, Dr. Pamela Kallmerten, can access the data. Data, even de-identified, will not be used for future projects. I will report the de-identified data in an educational paper that will be available via the UNH Scholar's Repository. I may share the aggregate results with the organization. The results may be used in reports, presentations, and publications for educational purposes only.

If you have any questions about this project or would like more information before, during, or after the project, don't hesitate to contact me at the information provided below. If you have questions about your role as a participant, you may contact Dr. Pamela Kallmerten at UNH to discuss them via email (pamela.kallmerten@unh.edu), or you can call her at (603) 387-3340. I appreciate your consideration.

Sincerely,

Ian B. Kirit
ik1047@usnh.edu
603-443-7782

Do you agree to participate in this project?

Yes (3)

No (4)

Skip To: End of Survey If Dear nursing/paramedic staff, I am a doctoral nursing student at the University of New Hampshire... = No

Q2 Have you scanned patients and/or medications using the Rover™ App on a Mobile Device?

Yes (1)

No (2)

*Skip To: End of Survey If Have you scanned patients and/or medications using the Rover App on a Mobile Device? =
No*

Q3 How frequently do you use the Rover™ App on a mobile device to scan patients and medications?

- Never (1)
 - Sometimes (2)
 - About half the time (3)
 - Most of the time (4)
 - Always (5)
-

Q4 What is preventing you from using the Rover™ App on a mobile device to scan patients and medications (Select All That Apply)?

- It is not required (1)
 - I don't know how to use it (2)
 - It is cumbersome to carry an additional phone (3)
 - Signing in issue (4)
 - Prefer not to answer (5)
-

Q5 If there is a reason that was not listed in the previous question, please write it here.

Q6 The Technology Acceptance Model (TAM) is designed to give you an opportunity to rate the Rover™ App on a Mobile Device's usefulness and ease of use.

To as great an extent as possible, consider all the tasks you do with the Rover™ App technology on a mobile device while answering these questions.

Please read each statement and indicate how strongly you agree or disagree with the statement.

Please read the statements carefully, but don't spend much time on each item -- your first

impression is fine.

	Strongly disagree (1)	Somewhat disagree (2)	Neither agree nor disagree (3)	Somewhat agree (4)	Strongly agree (5)
1. Using the Rover™ App on a Mobile Device for scanning patients and medications in my job enables me to accomplish tasks more quickly than other products in its class. (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2. Using the Rover™ App on a mobile device to scan patients and medications improves my job performance. (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3. Using the Rover™ App on a mobile device to scan patients and medications in my job increases my productivity. (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3 Using the Rover™ App on a mobile device to scan patients and medications enhances my effectiveness on the job. (4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

5. Using the Rover™ App on a mobile device to scan patients and medications makes it easier to do my job. (5)

6. I have found the Rover™ App on a mobile device to scan patients and medications useful in my job. (6)

7. Learning to operate the Rover™ App on a mobile device to scan patients and medications was easy for me. (7)

8. I found it easy to get the Rover™ App on a mobile device to do what I want it to do. (8)

9. My interaction with the Rover™ App on a mobile device has been clear and understandable. (9)

10. I found the Rover™ App on a mobile device to be flexible to interact with. (10)

11. It was easy for me to become skillful at using the Rover™ App on a mobile device to scan patients and medications. (11)

12. I found the Rover™ App on a mobile device easy to use. (12)

Q7 Please write any comments or suggestions or share thoughts regarding the barcode medication administration process using the Rover™ app on a mobile device.

End of Block: Default Question Block
