

QUALITY IMPROVEMENT

Overcoming Bar Code Medication Administration Scanning Challenges in the Emergency Department

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Abstract

Background: Bar Code Medication Administration (BCMA) scanning is a globally accepted technology. However, many clinicians do not understand the requirements as a metric for nursing quality and safety behind the BCMA process. **Objective:** The aim of this Quality Improvement (Q.I.) project is to improve the BCMA scanning compliance, to identify the percentage of noncompliance, along with the numbers representing the percentage and to raise awareness of the challenges of using BCMA in the Emergency Department setting. **Methodology:** The Institute of Healthcare Improvement's Plan-Do-Study-Act (PDSA) cycle was used to plan, test, and observe the results of this Q.I. project. This report followed the Standards for Quality Improvement Reporting Excellence (SQUIRE V.2.0) publication guidelines. **Results:** Following a series of PDSA cycle implementations over an 18-month period, BCMA scanning rates for patients were increased to 93%, and medication scanning was increased to 94%, with an overall increase of 33% and 34%, respectively. Timely documentation improved by 18%, which accounted for a total of 96% compliance. **Conclusion and Recommendations:** Leadership involvement, nursing workflow monitoring of BCMA safety, as well as staff accountability and recognition, were crucial factors in improving the overall compliance rate. Suggestions to improve scanning safety include modifying the dashboard and highlighting the noncompliance scanning percentage along with actual numbers to raise awareness among clinicians. Organizations need to implement ongoing monitoring, continued training, and education, along with improvements and modifications.

Keywords: BCMA, BCMA report, BCMA challenges, medication safety, nurse leaders

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Medication errors are preventable and expensive human errors. A medication error is an error (of commission or omission) at any step along the pathway that begins when a clinician prescribes a medication and ends when the patient receives the medication (Agency for Healthcare Research and Quality [AHRQ], 2019). In the United States, medication errors result in an estimated 700,000 Emergency Department (E.D.) visits, 100,000 hospitalizations, 1.5 million adverse drug events (ADEs), and an estimated 7,000 deaths, costing almost \$21 billion each year (AHRQ, 2019). Medication errors can happen in any phase of the medication administration process, including prescribing, transcribing, dispensing, compounding, and administering. The Leapfrog Group (2020), a national non-profit organization that measures hospital performance, has reported that over 30% of medication errors occur during administration and 40% of the errors are preventable.

Implementation of health information technologies, such as Bar Code Medication Administration (BCMA) systems, are being considered as a major solution to address these challenges. The use of BCMA is recommended by The American Society of Health-System Pharmacists (2009) and the Healthcare Information and Management Systems Society (2013). BCMA, an electronic scanning system with preventive safety technology, has decreased or eliminated medication errors when safety steps are followed (Leapfrog Group, 2020; Mulac et al., 2021). Integrating BCMA with electronic medication administration record (eMAR) systems can translate details of medication administration orders, check algorithms, and provide real-time warnings and approvals for safe medication administration. BCMA technology automates the process of verification by scanning the barcode on the patient identification wristband followed by scanning the barcode on the medication, thus assisting nurses in confirming the five rights of medication administration: right patient, right medication, right dose, right route, right time, and right documentation (Mulac et al., 2021).

Hospitals have strongly supported BCMA implementation to improve medication administration safety (Leapfrog Group, 2020). The Leapfrog Group (2020) has recommended a 95% patient and medication scanning compliance rate for hospitals implementing BCMA technology. Nursing organizations such as the American Association of Critical Care Nurses (AACN, 2019) included a 95% BCMA scanning compliance rate as a quality outcome indicator to measure medication safety for the AACN Beacon designation. A study of BCMA and eMAR implementation in an academic medical center demonstrated a 41.1% reduction in errors in medication administration, with a 50.8% relative reduction in potential ADEs with significant financial cost savings (Leapfrog Group, 2020; Poon et al., 2010). A study conducted at The Mayo Clinic from 2008 to 2013 reported that medication administration errors decreased by 43.5% after introducing BCMA technology. It was also reported that medication errors decreased by 55.4% (Olson et al., 2018). A Quality Improvement (Q.I.) project conducted by Ho and Burger (2020) following a series of Plan-Do-Study-Act (PDSA) cycles

concluded that by improving the BCMA scanning rate (from 81% to 95%), the number of ADEs related to administration errors was decreased by 17% and opioid-related ADEs decreased by 2.6%. Along with improvements in preventing medication errors, there were significant annual cost savings.

Challenges to BCMA Scanning Compliance

According to Ho and Burger (2020), BCMA scanning compliance issues occur due to multiple factors, including clinician workflow changes, staff accountability, cultural obstacles, and cost. Organizational and patient care unit related factors could impact the effectiveness of the BCMA technology in clinical practice (Ho & Burger, 2020). Staff resistance to implementing BCMA and eMAR was primarily due to poor communication, negative perception of the technology, and frustration dealing with malfunctioning software (Naidu & Alicia, 2019). Ho and Burger (2020) further described that BCMA scanning compliance rates also depended on optimizing clinical nurses' workflow, pharmacy workflow, and educational efforts. Strategies such as integrating scanning compliance goals into annual nursing strategic initiatives, providing departmental education, addressing scanning barriers, and discussing opportunities for improvement were reported to improve BCMA scanning rates (Ho & Burger, 2020). Additionally, adding BCMA technology in high-risk areas, such as the E.D. and intensive care units, can improve accountability, control of the supply chain, and set standards of care at a higher level of reliability (Lachman & Wilden, 2021).

Background

This project was conducted at a 247-bed community hospital which is part of the largest public health system in the Greater Metropolitan area of New York. The E.D. at this hospital serves more than 80,000 annual visits to one of the most diverse communities in New York. The E.D. clinical providers include 39 attending physicians, 34 advance practice providers which include nurse practitioners and physician assistants, 73 registered nurses (RNs), seven licensed practical nurses (LPNs), 46 patient care associates, 5 behavioral health associates, and 24 clerical associates.

The hospital has a fully implemented Epic electronic health record (EHR), BCMA capability, and utilizes automated medication dispensing cabinets throughout the hospital. BCMA scanning is required on all inpatient units, the E.D., perioperative units, and specific outpatient settings, such as hematology. All new hires, and faculty from affiliate schools of nursing, receive Epic EHR and BCMA training as part of their nursing orientation. The facility's Nursing Professional Practice Model emphasizes improvement in both facility and unit level metrics under the three pillars of quality, culture of safety, and care experience. The BCMA scanning goal at this hospital is set at $\geq 95\%$. BCMA scanning reports are in the form of percentage of medications and patients scanned per user, along with a report of unscanned medications. Since 2018, the inpatient unit scanning compliance was 95%, however, the E.D. compliance was 18%.

E.D. nursing leadership included BCMA scanning compliance as one of their Q.I. goals in 2018. During this period, hospital leadership addressed BCMA technology challenges and system issues by introducing Rover version 4.2, a handheld wireless device (refurbished iPhone), improving Wi-Fi connectivity in the E.D., increasing the number of Rovers, and improving the quality and efficiency of devices by upgrading the Rovers to the 9.2.2 advanced version. However, regardless of these improvement efforts, the E.D. BCMA scanning compliance rate remained under 40% in 2018. Although the E.D. compliance was low, the goal to reach 95% compliance, similar to the inpatient units, was perceived as an impossible goal due to the ongoing remodeling of the department and spatial constrictions. After reopening the new E.D. in 2019, the BCMA scanning compliance was revisited, as the quality gap between inpatient units and the E.D. was perceived as a threat to patient safety.

This particular hospital established a process to improve the BCMA scanning compliance by monitoring the BCMA dashboard. This process also included the nurse informaticist sending out a BCMA report quarterly, as well as a detailed analysis of the report to unit nurse managers for review. This initial report shared details of patient's identifiers, administering user, scanning status for patient and medications, reasons for not scanning, administered time, and recorded time. Nurse managers looked at the percentage of BCMA compliance and were comfortable with scanning rates of 90% to 95% in most inpatient units. The leadership staff were not aware of the actual numbers associated with a percentage figure on the dashboard. For example, if a unit had a 90% scanning compliance on the dashboard, it gave the impression that it was closer to achieving the desired scanning goal. This also means that scanning was ineffective 10% of the time, and nurses were working around the safe-use scan system to administer medications. This is an unacceptably low level of reliability for effective BCMA scanning. This 10% non-scanning could potentially account for an average of 5,000 non-scanned patient and medication administrations per month. Another challenge found was delays in documenting medication administration in real-time, which defeats the purpose of BCMA scanning.

Objectives

The primary objective of this Q.I. project was to improve the BCMA scanning compliance in the E.D. following the PDSA methodology. The secondary objective of this Q.I. project was to identify the depth of noncompliance figures behind the dashboard numbers and raise awareness of the challenges of using the BCMA.

Patient Confidentiality

This manuscript complies with the Health Insurance Portability and Accountability Act (HIPAA). The authors did not utilize patient identifiers such as names, social security numbers, telephone numbers, email addresses, street addresses, or any other demographic information. All reported data are in aggregate and comply with the health systems' confidentiality policies. All data and spreadsheets are saved in the health systems approved share point site and are password protected. The data tables and

graphs are reviewed and approved by the Office of Research Administration at the health system corporate office.

Methods

A systematic method for performance improvement is the PDSA model, which tests the effectiveness of small changes before widespread implementation. The Institute of Healthcare Improvement (IHI, 2017) advocates for PDSA cycles to plan, test, observe the results of an intervention, and act based on the study results. The PDSA methodology was used in this Q.I. project to test changes over time, determine how new practices lead to an improvement, assess the magnitude of the improvement, and evaluate any change-associated unanticipated effects.

Rapid PDSA cycles were developed based on feedback from nurse leaders. An initial meeting was held with the directors of the E.D., pharmacy, nursing education, nursing quality, and the nurse informaticist to discuss medication safety challenges and quality improvement initiatives. A focus group meeting was held with ED RNs and LPNs on both shifts to identify BCMA scanning and compliance challenges. During these meetings, hospital and E.D. scanning compliance goals and patient safety were emphasized, and nurses were encouraged to communicate any potential challenges as they adopt BCMA scanning workflow in their medication administration process. For this Q.I. project, data on patient and medication scanning compliance and timely administration of medication were collected in six-month intervals beginning September 2019 and ending February 2021. These reports followed the Standards for Quality Improvement Reporting Excellence (SQUIRE V.2.0) publication guidelines (Ogrinc et al., 2016).

PDSA Cycle One (September 2019-February 2020)

The Q.I. team identified hospital executive leadership engagement and support as crucial factors for this project's success. A standard process and workflow for E.D. nursing staff were created to improve staff accountability for BCMA scanning compliance. The nurse informaticist, in collaboration with the Epic reporting and analytic team, created a meaningful scanning and compliance report for nurse managers. This modified report included metrics such as the total number of medication administrations by each staff in a given period, the total number of scanned medications, the total number of unscanned medications and the reasons for not scanning, the total number of patients scanned, the total number of unscanned patients and the reason for not scanning, the number of late administrations, and the number of delayed or late documentations. Before this modified process, E.D. nursing leadership was provided access to the detailed BCMA spreadsheet report, which included metrics such as scanning compliance for patients and medications. However, monitoring these metrics was suboptimal, and the scanning compliance remained less than 50%.

Two significant findings from the E.D. nurses focus group meeting were that nurses were unaware that barcode scanning compliance was a Q.I. goal and that the BCMA system was not well understood by these nurses as they continued to use workarounds to document medication administration. The nurse informaticist collaborated with the E.D. leadership to develop

a monitoring process to track compliance weekly. As the E.D. was recruiting a nurse educator for this Q.I. project, a designated LPN was identified and trained on BCMA reports and monitoring metrics. The weekly BCMA reports provided an overview of the scanning compliance and noncompliance with medication administration details for each R.N. and LPN. Information from this report was added to the E.D. visual management board every week for transparency and to display performance improvement. The scanning metrics also became a standing agenda item for the E.D. Daily Management System (DMS) huddle every Monday with multidisciplinary team members. This report was also emailed to each E.D. nurse by the nurse manager. By the end of February 2020, the BCMA scanning data was moving in a positive direction from 51% (September 2019) to a 65% monthly medication scanning rate for 13,755 medications administered. However, 35% of the monthly unscanned figure accounted for 7,436 medications.

PDSA Cycle Two (March 2020-August 2020)

While PDSA Cycle Two was in progress, the coronavirus disease of 2019 (COVID-19) pandemic added medication safety challenges in this healthcare setting. As the epicenter of COVID-19, this facility's E.D. provided care to more than 100,000 patients in 2020. During the peak of the COVID-19 pandemic, the overall BCMA compliance in the E.D. dropped to 30%, while the inpatient unit's scanning compliance remained between 88% to 96%. The hospital executive team verbalized increasing concerns over the low scanning compliance rate in the E.D. As a result, a meeting consisting of E.D. nursing leadership, the chief nursing officer (CNO), the chief operating officer, the E.D. pharmacist, the nurse educator, and the nurse informaticist was held to determine metrics to track performance, identify gaps in the workflow, as well as discuss the limitation of current reporting tools and the accountability of frontline nurses. Based on the above discussions with executive leadership, there was a commitment from E.D. nursing to improve BCMA scanning rates. The E.D. leadership continued to review the BCMA scanning data for each nurse, and E.D. nurse leaders reinforced the need to improve BCMA scanning compliance during the daily morning briefs. It became imperative to identify low performers and redesign the workflow process to overcome their barriers to success. One recommendation that resonated with the nurse leaders in improving the scanning compliance goal to 95% was to purposefully involve the E.D. nurses in a shared decision-making process. As a result, BCMA scanning compliance data became a standing quality indicator at the monthly E.D. council meeting, monthly nursing Q.I. meeting, and monthly pharmacy and therapeutic meetings. At the conclusion of PDSA Cycle Two, the BCMA monthly scanning rate increased to 64% with 9,722 scanned medications, while 36% of unscanned medications accounted for 5,400 administrations.

PDSA Cycle Three (September 2020-February 2021)

The involvement of the CNO and other executive leadership in the compliance monitoring process significantly influenced the appropriate implementation of BCMA workflow. The nursing leadership team communicated the need to improve E.D. BCMA

scanning compliance to the E.D. nurses. During this phase, the team continued efforts to reach the set goal for scanning compliance. Timely administration and real-time documentation were also included as monitoring metrics. The E.D. nurse educator identified opportunities for education and process improvement with direct observation. Timely administration and real-time documentation were also included as monitoring metrics. The active involvement of the E.D. nurse educator facilitated the understanding and engagement of the frontline staff in this Q.I. initiative. The E.D. educator created an educational plan which included a one-on-one meeting with each staff who had adherence issues. One of the major goals of the intense educational effort was to ensure that the nursing staff followed the designed technology workflow without creating workarounds. The educator addressed their educational gaps, reinforced correct scanning workflow, and the utilization of Rovers. The E.D. educator also created a group email and text message platform to inform staff nurses of daily updates and reminders. Information sharing also occurred through a hospital-approved virtual platform. The weekly BCMA reports provided patient and medication scanning compliance and noncompliance details for each staff nurse. The nurse manager analyzed each nurse's medication scanning rate performance and identified individuals outside of the scanning goal. When compliance fell below the required goal, the nurse manager met with the nurse involved and developed an individual action plan to reach the compliance goal.

At this phase in the improvement activities, the E.D. leadership sought to celebrate the overall success of this project. Each staff member who showed an improvement in scanning was recognized at the weekly ED DMS huddles. E.D. nursing leadership, along with the director of services, appreciated the effort by the nurse educator and rewarded staff members who had improved compliance with a monthly luncheon celebration. At the conclusion of PDSA Cycle Three, the monthly scanning rate increased to 96% for 14,091 medications, while 4% of unscanned medications accounted for 621 administrations.

Results

The Q. I. project achieved its primary and secondary objectives. The primary objective was to improve the BCMA scanning compliance in the E.D. This was achieved throughout the three PDSA cycles, which included a redesigned workflow, addressing challenges in the current process, and intense educational efforts. The secondary objective of this Q.I. project was to identify the depth of noncompliance figures behind the dashboard numbers and to raise awareness among the nursing staff. This was achieved by discussing and demonstrating the figures associated with the percentage of noncompliance and the total number of medication administrations. The monthly average scanning compliance for 18 months is shown in Figure 1.

Figure 1

Monthly Average Patients and Medications Scanning Compliance 09-2019 to 02-2021

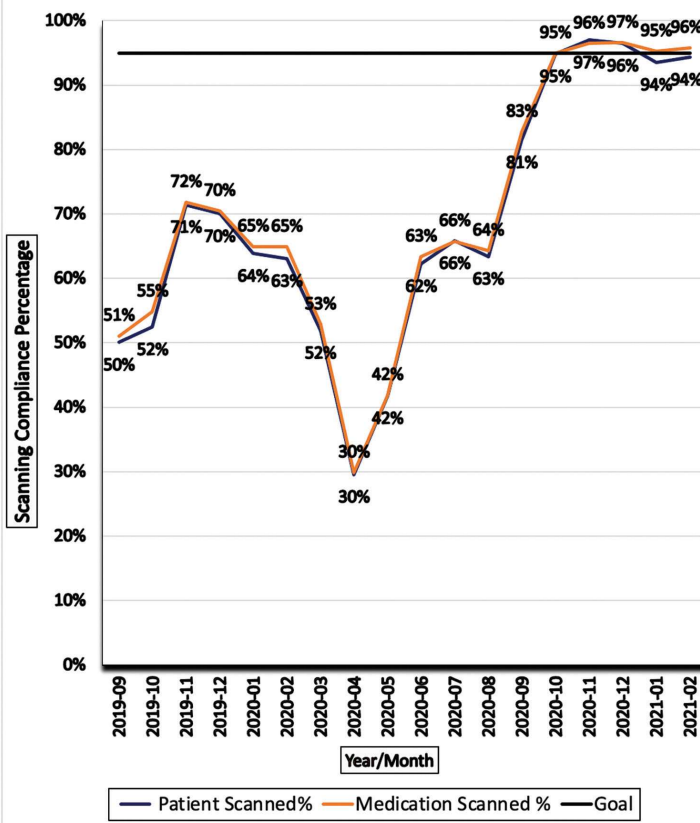


Table 1 reflects the six-month average of the total number of patients and medications scanned or not, as well as the total number of medication administrations documented in relation to the 30-minute timely window for all three PDSA cycles.

Table 1

Scanning Compliance Data for Patients, Medications, and Timely Documentation During Three PDSA Cycles

Patient Scanning Status	PDSA Cycle One (September 2019 to February 2020)	PDSA Cycle Two (March 2020 to August 2020)	PDSA Cycle Three (September 2020 to February 2021)
Patient Scanned	79,387 (62%)	51,082 (50%)	84,328 (93%)
Patient Not Scanned	48,537 (38%)	50,714 (50%)	6,369 (7%)
Total Patients	127,924	101,796	90,697
Medication Scanning Status	PDSA Cycle One	PDSA Cycle Two	PDSA Cycle Three
Medication Scanned	80,902 (63%)	51,649 (51%)	84,984 (94%)
Medication Not Scanned	47,022 (37%)	50,147 (49%)	5,713 (6%)

Total Medications	127,924	101,796	90,697
Timely Documentation	PDSA Cycle One	PDSA Cycle Two	PDSA Cycle Three
Documented within 30 minutes of administration	105,039 (82%)	79,882 (78%)	86,776 (96%)
Documented after 30 minutes of administration	22,885 (18%)	21,914 (22%)	3,921 (4%)
Total Documented	127,924	101,796	90,697

The baseline scanning compliance for both patients and medication were 62% and 63%, respectively, during PDSA Cycle One. Although E.D. leadership continuously monitored the metrics during this period, the improvement was limited to 60%. During this period, the E.D. nurses administered 127,924 medications; of those, 47,022 were administered without scanning (63% medications scanned; 37% unscanned). As improvements were in progress, the hospital was faced with the challenges related to the COVID-19 pandemic. The global and local response to the COVID-19 pandemic, coupled with staffing and supply chain challenges, slowed down PDSA Cycle Two. At the peak of COVID-19, scanning compliance for both patients and medications dropped to 30%. Following improvement efforts, the average scanning compliance for patients and medications in PDSA Cycle Two improved to 50% and 51%, respectively. During this period, the E.D. nurses administered 101,796 medications, and of those, 50,147 were administered without scanning (51% medications scanned; 49% unscanned). The most significant improvement was seen during PDSA Cycle Three, where patient scanning compliance increased to 93% and medication scanning increased to 94%, with an overall increase of 33% and 34%, respectively. At this time, the E.D. nurses administered 90,697 medications, and of those, 5,713 were administered without scanning (94% medications scanned; 6% unscanned). Figure 2 shows the six-month averages of patients' scanning compliance and noncompliance for all three PDSA cycles.

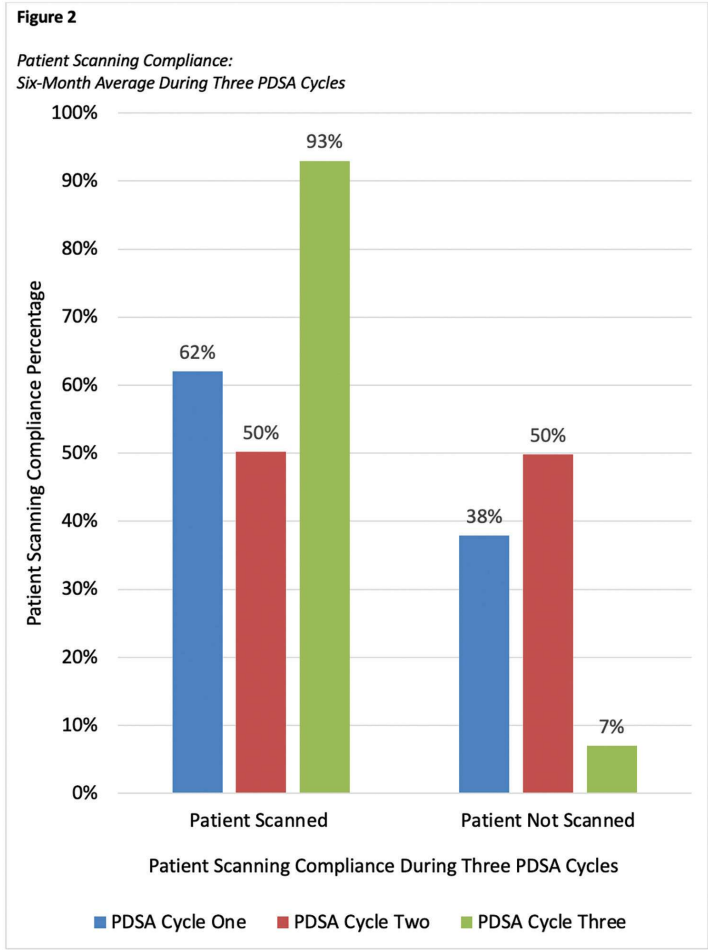


Figure 3 shows the six-month averages of medication scanning compliance and noncompliance for all three PDSA cycles.

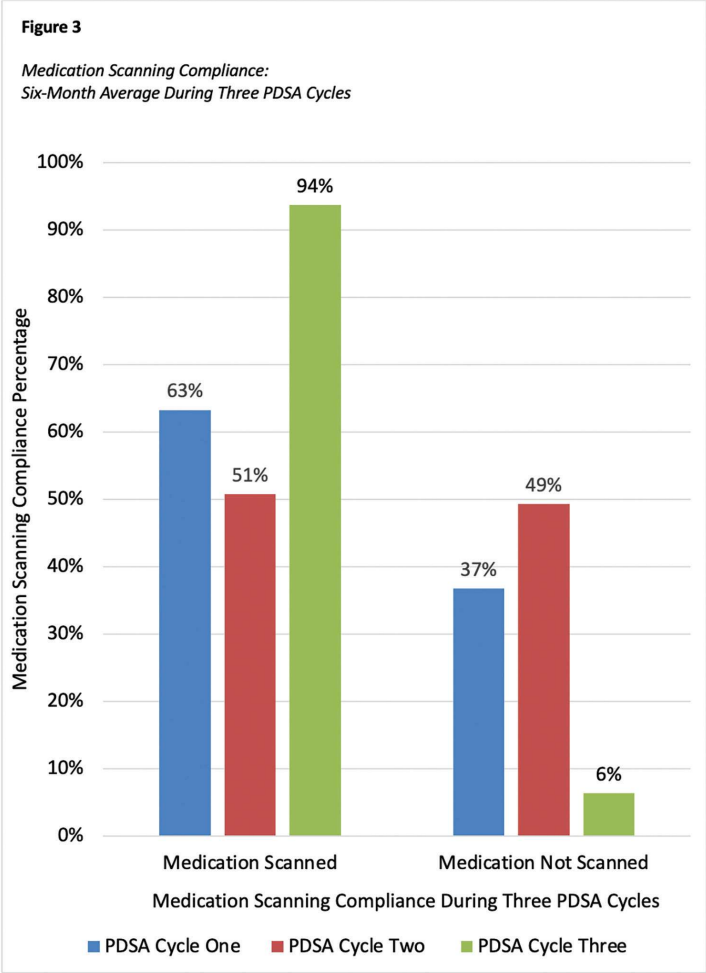
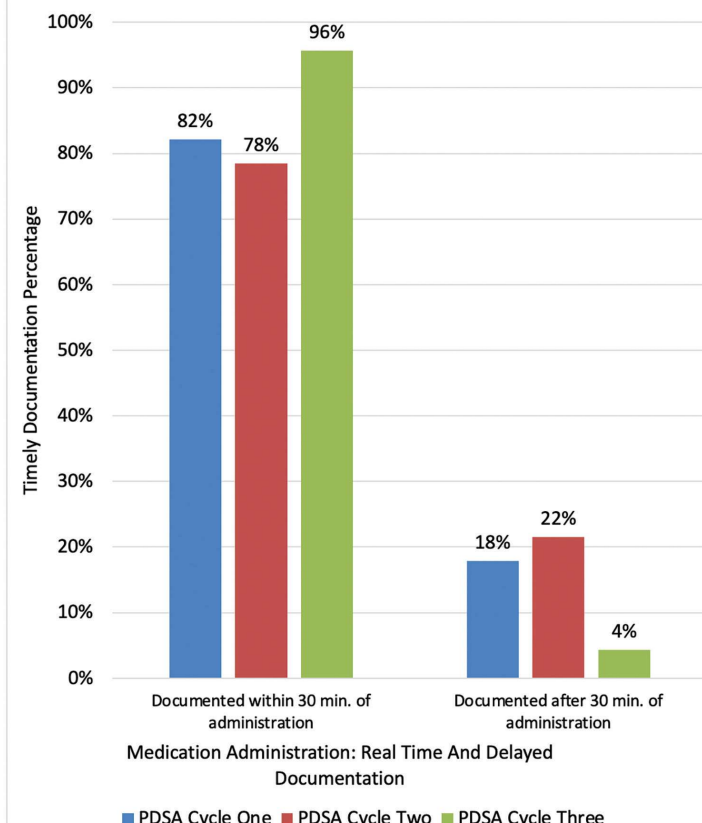


Figure 4 shows the six-month averages of timely documentation compliance and noncompliance for all three PDSA cycles. Timely documentation was defined as completing patient and medication BCMA scanning and documentation of administration details within 30 minutes of the first scanning action.

Figure 4

*Timely Documentation:
Six-Month Average During Three PDSA Cycles*



Discussion

Over the 18 months that this Q.I. project was conducted, the E.D. was the only unit at the facility with a low BCMA scanning compliance rate. The sense of urgency to address this issue and the need for change were communicated to all nursing staff through focus group meetings, daily unit briefings, and education. Executive leadership's involvement, nurse leaders' ownership of the project, frontline staff accountability, addressing the gaps, and weekly dashboard displays were successful strategies in improving BCMA scanning compliance in the E.D. Early et al. (2011) observed similar strategies and results at an academic medical center as these authors reported a 15% improvement in scanning compliance after implementing a culture of safety campaign. As with this Q.I. project, Early et al. (2011) also noted that strong executive leadership support was a crucial factor in their success. A systematic review by Parand et al. (2014) reported that essential factors of success in establishing goals and strategies to improve quality lies with leadership activities such as engaging in and promoting a Q.I. culture, driving improvement through goal setting, providing feedback, and managing organizational resources for quality. Similar strategies implemented at this facility's E.D. included nurse leaders' ownership of the project and the need to support individual nurses through goal setting.

Another study at a 175-bed community hospital by Van Ornum (2018) found that refining the BCMA report and clinical workflows,

as well as engaging nurse leaders and supporting individual nurses' accountability, allowed the facility to achieve optimal scanning compliance, increasing from a scan rate of 95% to 98%. Similar to Van Ornum's (2018) approach, end-user accountability in our Q.I. project was established through education, recognition, coaching, and counseling, which contributed to the overall increase in compliance. The transparency of this project further challenged the E.D. staff nurses to utilize opportunities for improvement, as well as comply with the E.D. performance improvement goals. The importance of medication administration with BCMA technology became an important topic in new hire orientation and annual competency training of nursing staff. Adhering to the BCMA scanning goal is now an expectation among E.D. nurses and leaders at this facility.

Following the 18 months of this Q.I. project period, team members identified challenges with Rover, such as loss and underreported malfunctioning of these devices to the Information Technology (I.T.) department. To further address these challenges, staff nurses proposed a modified workflow by assigning a staff nurse every shift to monitor Rover usage and report malfunctions to the I.T. department. These nurses were instrumental in maintaining adequate working devices on the unit, which substantially improved the scanning compliance rate. This improvement was sustained following PDSA Cycle Three, as data from March 2021 to August 2021 demonstrated that the BCMA scanning compliance rate remained above 92%.

Each PDSA cycle was a lesson learned in improving the overall BCMA scanning processes. In the E.D., the BCMA scanning compliance rates improved by 31% post PDSA cycle implementation. In the PDSA Cycle Three phase of this project, the patient and scanning compliance increased to 93% and 94%, respectively. However, E.D. leadership targeted BCMA compliance rate of 95% or greater as a goal for individual nurses, and incorporated this into nurses' annual performance evaluation to further minimize medication administration errors.

These findings offer opportunities for shared decision-making between nurse leaders, clinical nurses, and other process owners to identify opportunities for improving BCMA scanning rates and sustaining compliance. It is important to note that using the metric of BCMA scanning rates can potentially put undue pressure on nurses to develop workarounds. It is recommended that ongoing real-time observations must be conducted to solicit E.D. nurses' feedback and address the challenges that lead to workarounds. It is also suggested that units preparing to improve BCMA scanning compliance rates implement this using a series of PDSA improvement cycles.

Limitations

Quality improvement projects require an investment of time and effort. A limitation of this project was the use of convenience sampling of nurses from only one unit (E.D.) at one community hospital. More BCMA usage Q.I. projects based on current evidence versus current practice are needed using a larger sample size of nurses across other E.D.s within and beyond a particular health system. Not having the support and expertise required for BCMA report development and refinement is another limitation. The availability of a board-certified nurse informaticist

contributed to the creation of weekly dashboard reports along with meaningful updates provided to E.D. nursing leadership. Facilities may consider employing a full-time nurse informaticist to provide ongoing support to evaluate existing workflow issues with medication administration scanning. Additionally, future projects can include assessing the educational impact of nursing quality metrics and soliciting feedback from nursing staff through surveys.

Conclusion

Although BCMA scanning is a globally accepted technology, many clinicians do not know the rationale behind the safety nets of the BCMA process. This article outlined our efforts to streamline the BCMA process for nurses in the E.D. setting. Adopting this process requires diligent efforts to redefine workflows and nurses' responsibilities through shared decision-making and educational support. The findings of our study suggest that the percentage of BCMA scanning compliance data must be analyzed and displayed, along with the total number of medication administrations, patients and medications scanned, representing the percentage for meaningful dashboard reports. For example, in this Q.I. project, 6% of unscanned medications may be interpreted as a small percentage. However, 6% represents a significant number of 5,713 administrations. Adherence to real-time documentation of all medication administrations using BCMA technology, except in emergencies, eliminates the potential for errors during administration. Ongoing monitoring and real-time feedback can increase clinicians' awareness about BCMA and further enhance patient safety. A BCMA compliance of 100% is achievable with continued focus on nursing workflow.

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