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The Use of Descriptive Analytics to Improve Nursing Compliance with Bar Code Medication Administration in the Outpatient Setting

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ABSTRACT

Background: Bar Code Medication Administration (BCMA) has been shown to reduce medication errors and improve patient outcomes. The utilization of this technology-driven approach enhances patient care and has emerged as a potent strategy to decrease medication errors.

Purpose: This project aimed to examine the impact of descriptive analytics in improving BCMA compliance to reduce medication errors in acute outpatient settings.

Methods: In March 2021, baseline data revealed that overall BCMA compliance was 87%, with only 1 out of 20 outpatient units meeting the 95% benchmark. To enhance overall efficiency and effectiveness, our team took a multi-faceted approach, including streamlining the data file, involving nursing staff and leadership, and redesigning nursing workflows. Utilization of interactive pivot tables and slicers within the BCMA data file allowed for cogent conversations between nursing educators and staff to review areas of opportunity, barriers, override reasons, and technical reasons why medications could not be scanned.

Results: Initial analysis of the data revealed variability across each center, with over 700 overrides and a compliance of 87%. After the implementation of the revised data file in October 2021, BCMA compliance improved to 97%, with a greater than 50% reduction in override entries noted. The results of a dependent *t*-test showed a statistically significant 10.4% point increase in BCMA compliance in the post-implementation phase ($t[19] = -9.470, p < .001$).

Conclusions: Utilizing innovative data solutions for BCMA to bridge the gap between nursing education and practice can improve engagement, accountability, quality, and patient safety.

Keywords: Patient safety, BCMA, outpatient, leapfrog, medication administration compliance

INTRODUCTION

Medication errors continue to be a leading cause of adverse drug reactions and death in the United States (Tariq et al., 2023). A study conducted in a tertiary

care emergency department categorized the highest administration errors as occurring in the stages of prescribing (53.9%) and administering (34.8%) (Patanwala et al., 2010). As such,

healthcare organizations have implemented several safety nets to combat medication errors, such as bar code medication administration. Bar Code Medication Administration (BCMA) is an electronic verification process utilizing scanner technology to scan a patient's wristband and medications prescribed. This allows the nurse to verify and ensure the right medication is administered to the right patient, thus reducing the potential for patient harm. This method of verification ensures that allergies, route, dose, patient, and medication are correct before the medication is administered to the patient. However, BCMA is not fail-proof, as the margin for human error is not eliminated. Several variables, including high patient volume, lack of bedside computers with scanners, and limited mobile computers with scanners, hinder the use of BCMA. These variables may also delay patient throughput and discharge from the outpatient center. Interruptions and multitasking are common occurrences in clinical settings and have been shown to affect overall performance and increase the risk of error (Westbrook et al., 2018). These issues may contribute to nurses using the override scanning feature of BCMA.

Performance Improvement (PI) projects are vital for the continuous improvement toward zero harm to our patients. After conducting a value stream mapping of our process, we determined that BCMA was not being used appropriately due to the frequent use of override scanning. Furthermore, the current BCMA data file report did not allow further validation to pinpoint where the fallouts occurred. Utilizing data effectively can lead to substantial benefits by driving decision-making and providing insight for strategy development. Descriptive analytics is the use of data to identify a pattern or trend (Cote, 2021). Using descriptive analytics provides a multidimensional presentation of data output. It can assist in optimizing BCMA data to allow the identification of any fallouts. By collecting historical data and analyzing that data,

we could focus efforts on the areas requiring improvement. This PI project aimed to improve BCMA compliance to reduce medication errors by utilizing descriptive analytics.

METHODS

Initial Steps

Our organization is a non-profit healthcare system in South Florida. This project focused on 20 of our urgent care outpatient centers. As part of the organization's journey to high reliability, the goal was to develop methods to visualize data in a more structured three-dimensional view to help identify specific opportunities for BCMA compliance improvement. In January 2021, the team learned that several outpatient centers utilized differing criteria for excluding, collecting, and reporting data relating to unscanned medications or patients, such as excluding patients from the denominator due to staffing shortages or physician non-compliance. In March 2021, the data file was revised to incorporate descriptive analytics. The first step in the process of utilizing descriptive analytics was to centralize the data collection process to a data steward and create a single criterion for exclusion—only cases of unscanned medications or patients during technology downtime would be excluded. This crucial step allowed for the standardization of the data collection process and the removal of bias related to the exclusions. Following centralization, historical data were obtained to create a baseline. The second step was to identify key performance indicators to guide data extraction and its display on the dashboard. The team created a descriptive analytics report using Microsoft Excel with multiple tabs and interactive pivot tables. The raw data was imported from an automated database into the monthly outpatient services BCMA Site Compliance report each month. The team ensured that all data was validated and corresponded to each site accordingly. Site leaders could navigate and review the report for spe-

cific site metrics and individual metrics for each clinical staff member's compliance rate.

Search for the Best Practice

The Leapfrog Group is a national not-for-profit organization that assigns letter grades to hospitals based on patient safety and reports information publicly to consumers (Austin et al., 2022). Public reporting by the Leapfrog Group enables consumers to make informed decisions when seeking healthcare and mitigates potential injuries and errors in the healthcare setting. The Leapfrog Group developed an expert panel to identify best practices related to the implementation and use of BCMA in hospitals. The panel was charged with reviewing best practices and developing the framework for Leapfrog's BCMA standard. The BCMA standard set by the panel focuses on four domains. The first domain of the standard relates to the implementation of BCMA technology in the hospital, the second domain focuses on BCMA utilization, the third domain focuses on decision support systems for BCMA, and the fourth domain focuses on BCMA monitoring, compliance, and potential barriers to BCMA compliance. Our goal was for all the sites to reach the Leapfrog standard of a 95% compliance rate.

Educating Outpatient Site Nurses

In May 2021, nursing educators created targeted education for the nursing staff, focusing on Leapfrog's fourth domain: monitoring, compliance, and potential barriers to BCMA compliance. Educational objectives and goals included increasing BCMA compliance by nursing staff and improving knowledge related to medication safety. Educators also reviewed override reasons with nurses and held small group discussions to examine barriers to BCMA implementation. The most discussed barrier amongst staff and educators was the patient volume of the site and the limitation of on-site equipment. Knowledge of these barriers was considered when providing

feedback during on-site rounding. For sites that had near ranges of 94% reflecting "caution or action needed," our dedicated quality educators, site leadership, PI team, and pharmacy team worked side by side to identify opportunities and initiate action plans to mitigate the concerns.

Ethical Considerations

Per the organization's policy, this PI project did not meet the criteria for human subjects research and, therefore, did not require approval from its Institutional Review Board.

RESULTS

In March 2021, the cumulative average of BCMA compliance was 87% across the 20 outpatient centers, with only one outpatient center meeting the goal of 95% (Table 1). The centers had a total of 702 overrides (including patient and medication scanning) (Figure 1) and 1,299 unscanned medications (Table 2). After the project in October 2021, 18 out of the 20 outpatient centers met the goal of 95% compliance, with a cumulative average of 97% (Table 3). There was a reduction in overrides ($n = 218$), representing a 70% decrease (Figure 2). In addition, there was a 73% decrease in medications not scanned ($n = 345$) (Table 4). Our objective to reach beyond the 95% benchmark was successfully achieved, and the feedback related to the accessibility and detailed data file was overwhelmingly positive. The outpatient centers have been able to maintain compliance above 95% since the end of the project. Furthermore, the results of a dependent t -test to examine percent compliance across all 20 outpatient centers showed a statistically significant difference in compliance between pre-implementation and post-implementation [$t(19) = -9.470, p < .001$] (Table 5). Pre-implementation and post-implementation percent averages were 86.41% ($SD = 5.81$) and 96.44% ($SD = 1.77$), respectively, yielding a mean difference of 10.30% ($SD = 4.74$). Throughout this PI

project, there were no unintended consequences or missing data.

DISCUSSION

The results of this project showed that the 95% benchmark compliance rate was cumulatively achieved for 18 of the outpatient centers. These results are further supported by the statistically significant 10.4% point increase in BCMA compliance in the post-implementation phase. The user non-compliance dashboard was rapidly developed, resulting in a 45% reduction in non-compliant scanners within 10 weeks and an 81% reduction in 23 weeks. In response to reaching the benchmark, the outpatient teams were challenged to outperform themselves. Our executive leaders encouraged our site leaders to increase the benchmark to 98%. The purpose of this challenge was to provide positive encouragement for exceeding the 95% Leapfrog benchmark to raise the bar for preventing medication errors, thus supporting the organization's journey to high reliability and zero patient harm (Ho & Burger, 2020). This aim has resulted in healthcare organizations that engaged accountability from nursing to leadership on the safety nature of the BCMA report and the descriptive analytics it can provide (Van Ornum, 2018). Leapfrog's BCMA standard offers a comprehensive guide outlining best practices for the secure administration of medications at the bedside. This has proven successful at facilities that have elected to participate in the Leapfrog hospital survey (Austin et al., 2022). As of April 2023, 100% of our outpatient centers have met the 98% benchmark. Each site continues to conduct its own PI projects with the self-identification of non-compliant teammates and the development of nurse-specific action plans.

One of the greatest benefits of an automated data file is the ability to replicate the tool for additional outpatient centers. At this time, we have extended the use of the descriptive analytics data tool to eight other outpatient centers

within the organization (e.g., off-campus emergency departments, express care centers, and infusion centers). These centers have also reported improved BCMA compliance and reduced medication overrides. Outside of BCMA, our team has implemented the use of descriptive analytics for several other metrics, such as medication history collection, pain assessment, and fall screening.

As discussed previously, barriers were identified throughout the project, leading to recommendations from our team. One alarming barrier was the lack of access to scanners. We recommended that each nurse have their own workstation on wheels with a scanner available. This would prevent forced overrides and unscanned medications by eliminating the need to override due to scanner inaccessibility. Additionally, bedside documentation is currently being piloted at one of our outpatient centers; each workstation is equipped with its own scanner. This is a pivotal step as we continue to move toward high reliability and zero patient harm in our outpatient centers.

CONCLUSION

This PI project highlights the importance of medication safeguards, such as BCMA. It also demonstrates the value behind the use of descriptive analytics to represent the data in a way that has a positive impact on compliance. Some gaps were also identified, such as the need to have sufficient on-site equipment to aid in the use and compliance of BCMA. We discovered throughout this project that lack of equipment discourages nursing staff from using the BCMA medication safeguard. Lack of equipment interrupts the normal workflow by delaying medication administration until a scanner is available, leading to medication overrides and unscanned medications. By using descriptive analytics, we reached and surpassed the goal of achieving the Leapfrog benchmark of 95% BCMA compliance. Lastly, we have collaborated and continue to collabo-

rate with outpatient center site leadership to encourage the provision of necessary equipment as we continue to strive for high reliability and zero patient harm related to medication administration.

DECLARATION OF INTEREST

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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Table 1

Pre-Implementation: BCMA "Pivot Summary" Tab for March 2021 (N = 10,823)

Outpatient Site	Medication Administered		Patient Scanned		Medication Scanned		BCMA Compliance	
	<i>n</i>	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	
All Outpatient Sites	10,823	10,104	93	9,524	88	9,447	87	
Outpatient 1	1,071	987	92	944	88	941	88	
Outpatient 2	436	413	95	406	93	401	92	
Outpatient 3	446	442	99	383	86	383	86	
Outpatient 4	376	372	99	338	90	338	90	
Outpatient 5	293	274	94	260	89	256	87	
Outpatient 6	1,282	1,206	94	1,152	90	1,146	89	
Outpatient 7	976	798	82	716	73	713	73	
Outpatient 8	397	392	99	332	84	331	83	
Outpatient 9	411	405	99	396	96	395	96	
Outpatient 10	147	132	90	124	84	124	84	
Outpatient 11	376	350	93	328	87	326	87	
Outpatient 12	1,457	1,382	95	1,341	92	1,341	92	
Outpatient 13	162	135	83	127	78	125	77	
Outpatient 14	406	397	98	381	94	375	92	
Outpatient 15	1,308	1,222	93	1,192	91	1,167	89	
Outpatient 16	395	366	93	326	83	324	82	
Outpatient 17	131	128	98	104	79	103	79	
Outpatient 18	209	196	94	186	89	180	86	
Outpatient 19	242	212	88	206	85	198	82	
Outpatient 20	302	295	98	282	93	280	93	

Note. The "Pivot Summary" tab is an overall roll-up of all the sites and their percentage.

Table 2*Pre-Implementation: BCMA "Medications not Scanned" Tab for March 2021 (N = 1,299)*

Medications Not Scanned	Total
Lidocaine	187
Ceftriaxone	173
Mupirocin topical	145
Bacitracin topical	92
Aspirin	70
Sodium Chloride 0.9% intravenous solution	53
Fluorescein ophthalmic	51
Proparacaine ophthalmic	46
Acetaminophen	45
Ibuprofen	41
Ondansetron	35
Ophthalmic irrigation, extraocular	33
Ketorolac	28
Tetanus/diphth/pertuss (Tdap) adult/adol	24
Alprazolam	20
Albuterol	17
Famotidine	16
Benzoin topical	16
Methylprednisolone	15
Lidocaine-epinephrine	15
Lidocaine topical	15
Ciprofloxacin otic	14
Ciprofloxacin ophthalmic	13
Magnesium hydroxide/aluminum hydroxide/ simethicone	12
Silver Sulfadiazine topical	11
Dicyclomine	11
Docusate	10
Lidocaine/epinephrine/tetracaine topical	9
Diphenhydramine	8
Carbamide peroxide otic	8
Orphenadrine	8
Erythromycin ophthalmic	7
Prednisolone	7
Ipratropium	5
Lactated Ringers Injection intravenous solution	4
Phenylephrine nasal	3
Silver nitrate topical	3
Clonidine	3
Metoclopramide	3
Epinephrine	3
Azithromycin	2
Meclizine	2
Dexamethasone	2
Potassium bicarbonate-potassium chloride	2
Penicillin G benzathine	1
Tranexamic acid	1

Pentafluoropropane-tetrafluoroethane topical	1
Levofloxacin	1
Morphine	1
Potassium chloride	1
Insulin regular	1
Ammonia	1
Tetanus-diphth toxoids (Td) adult/adol	1
Prednisone	1
Cyclobenzaprine	1
Gelatin hemostatic	1

Note. The "Medications not scanned" tab is a list of medications that were not scanned by clinicians. This list was given to the pharmacy team for further evaluation.

Table 3

Post-Implementation: BCMA "Pivot Summary" Tab for October 2021 (N = 11,583)

Outpatient Site	Medication Administered		Patient Scanned		Medication Scanned		BCMA Compliance	
	n		n	%	n	%	n	%
All Outpatient Sites	11,583		11,441	99	11,238	97	11,220	97
Outpatient 1	1,057		1,045	99	1,040	98	1,039	98
Outpatient 2	445		441	99	434	98	433	97
Outpatient 3	565		563	100	558	99	558	99
Outpatient 4	490		484	99	475	97	474	97
Outpatient 5	384		383	100	378	98	378	98
Outpatient 6	1,278		1,271	99	1,233	96	1,231	96
Outpatient 7	883		854	97	841	95	838	95
Outpatient 8	476		469	99	456	96	452	95
Outpatient 9	591		584	99	584	99	582	98
Outpatient 10	210		203	97	200	95	199	95
Outpatient 11	443		437	99	433	98	432	98
Outpatient 12	1,362		1,355	99	1,338	98	1,337	98
Outpatient 13	190		189	99	179	94	179	94
Outpatient 14	323		319	99	307	95	307	95
Outpatient 15	1,210		1,194	99	1,180	98	1,180	98
Outpatient 16	491		480	98	465	95	465	95
Outpatient 17	207		204	99	193	93	193	93
Outpatient 18	286		279	98	274	96	274	96
Outpatient 19	371		367	99	352	95	352	95
Outpatient 20	321		320	100	318	99	317	99

Table 4

*Post-Implementation: BCMA "Medications not Scanned" Tab for October 2021
(N = 345)*

Medications Not Scanned	Total
Ceftriaxone	51
Bacitracin topical	36
Lidocaine	24
Mupirocin topical	23
Sodium Chloride 0.9% intravenous solution	23
Fluorescein ophthalmic	16
Acetaminophen	14
Carbamide peroxide otic	14
Ibuprofen	14
Ondansetron	11
Aspirin	10
Proparacaine ophthalmic	10
Benzoin topical	10
Ophthalmic irrigation, extraocular	9
Gelatin hemostatic	8
Dexamethasone	7
Potassium chloride	6
Ketorolac	6
Ciprofloxacin otic	5
Diphenhydramine	5
Silver nitrate topical	4
Docusate	3
Epinephrine	3
Erythromycin ophthalmic	3
Influenza virus vaccine, inactivated	3
Lidocaine topical	3
Phenylephrine nasal	3
Lidocaine/epinephrine/tetracaine topical	3
Lidocaine-epinephrine	2
Famotidine	2
Silver Sulfadiazine topical	2
Albuterol	2
Tranexamic acid	2
Ciprofloxacin ophthalmic	1
Methylprednisolone	1
Acetaminophen-codeine	1
Penicillin G benzathine	1
Dicyclomine	1

Nitroglycerin	1
Hydrocodone-acetaminophen	1
Ipratropium	1

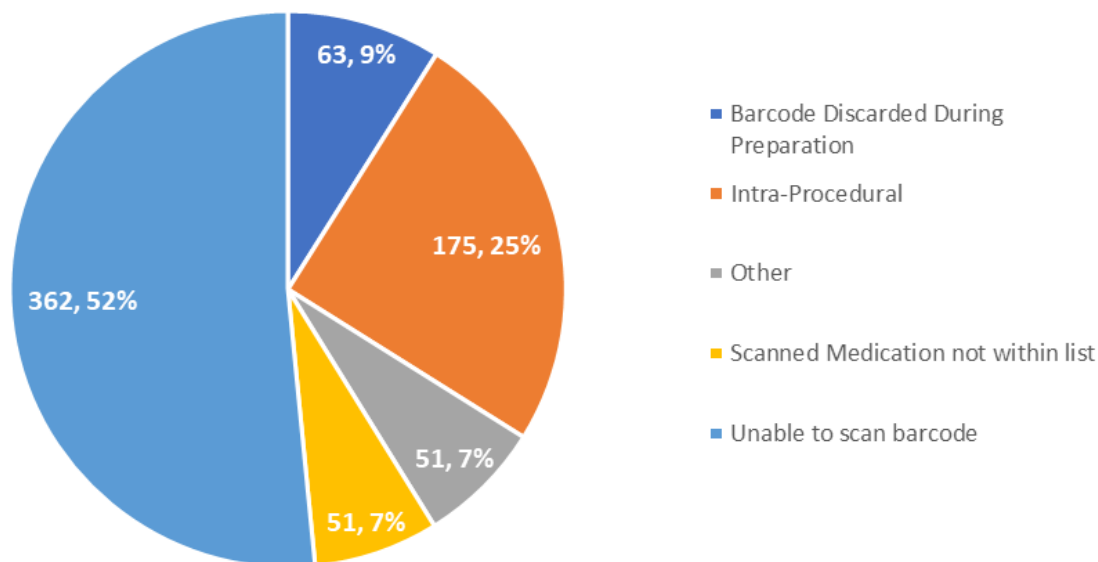
Table 5

Comparison of Means for BCMA Overall Compliance Pre- and Post-Implementation

	Pre		Post		t(19)	p value	Cohen's d
	M	SD	M	SD			
Percent Compliance	86.41	5.81	96.44	1.77	-9.470	< .001	4.74

Figure 1

Pre-Implementation: BCMA "Top 5 Override Reasons" Tab – March 2021, n, %



Note. The "Top 5 Override Reasons" tab has a visual representation of the top 5 override reasons for not being able to scan a medication.

Figure 2

Post-Implementation: BCMA "Top 5 Override Reasons" Tab – October 2021, n, %

