Emergency nurses' attitudes toward barcode medication administration

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Abstract

Background: Barcode medication administration (BCMA) has been widely implemented in the inpatient setting of hospitals throughout the United States, resulting in lower medication administration errors. Understanding nurses' attitudes toward BCMA in the Emergency Department (ED) may assist administrators with creating implementation strategies that will improve medication administration process turnaround time and remove barriers to use ensuring increased compliance and improved patient safety.

Methods: The aim of this descriptive research study was to identify Emergency Department nurses' attitudes towards acceptance of this technology, based on the Unified Theory of Acceptance and Use of Technology (UTAUT). Data collection was carried out using an online, cross-sectional survey of nurses (*n*=55) who were members of the National Emergency Nurses Association of Canada.

Results: The results demonstrated that two-thirds of those surveyed had approximately one year of experience with using BCMA technology. More positive attitudes were found in the following domains: behavioural intent, anxiety, and self-efficacy. Neutral attitudes were perceived regarding facilitating conditions, social influence, and effort expectancy. The most negative attitudes were expressed regarding attitude toward technology and performance expectancy.

Conclusions: The results of this study allow us to conclude that the ED nurse perceived BCMA as easy to master and use and not intimidating or anxiety producing; however, they do not perceive it as useful nor do they perceive it to improve their proficiency or productivity. It is recommended that future studies be conducted on larger samples and also on participants that have had more experience using this technology.

Keywords: *Barcode Medication Administration, Emergency Department, Medication Administration, Attitudes.*

Key Takeaways

- Using BCMA can decrease medication errors up to 90.4%.
- ED nurses need to acknowledge that BCMA is the gold standard of medication administration safety and work to incorporate it consistently in their workflow.
- Both leaders and staff need to work with the information technology group to determine ways to decrease medication administration time when using BCMA.
- Leadership support is paramount to the successful implementation and consistent use of BCMA.

Emergency Nurses' Attitudes Toward Barcode Medication Administration

In the barcode medication administration report by The Leapfrog Group (2018), approximately 7,000 deaths annually were attributed to medication errors. Adverse events associated with medication administration were among the primary causes of harm that result in additional days in a hospital and increasing healthcare costs (Keers, et al., 2013). A medication error is any preventable event that may cause or lead to inappropriate medication use or patient harm while the medication is in the control of the healthcare professional or consumer (National Coordinating Council for Medication Error Reporting and Prevention, 2020). Medication administration errors (MAEs) affect up to seven million patients a year at a cost to the healthcare system of $21 billion annually, and multiple organizations recommend actions be put in place to improve patient safety (Centers for Medicare & Medicaid Services [CMS], 2010; Federal Drug Administration [FDA], 2015; The Leapfrog Group, 2018).

Approximately 34% of medication errors occur during the administration phase and "less than two percent of these errors are intercepted before execution" (Voshall et al., 2013, p. 530). Errors such as wrong patient or wrong medication that occur at a patient's bedside can be attributed to many factors such as negligence, tiredness, lack of knowledge, intensity of patients' needs that often require multitasking or additional work, and even medication packaging (Harkanen et al., 2018). Many organizations recommend the use of two patient identifiers to verify a patient's identification alongside the use of barcode verification technology wherever possible (Institute for Safe Medication Practices, 2011; The Joint Commission, 2016; World Health Organization, 2007).

Barcode medication administration (BCMA) systems are defined as "electronic scanning systems that intercept medication errors at the point of administration" (Leapfrog Hospital Survey, 2018b, p. 1). This technology is used at the point-of-care prior to administering medication and ensures the five rights of medication administration are being followed (Leapfrog Hospital Survey, 2018b). Use of BCMA technology has shown to reduce the number of medication errors associated with the administration of medications by 54-86% and to reduce potential adverse drug events by 50.8% (Strykowski et al., 2013). BCMA use in an emergency department (ED) setting was reported by Bonkowski et al. (2013) to decrease medication administration error (MAE) rates from 6.3% to 1.2% with the wrong dose errors dropping by 90.4%, and in another study by Seibert et al. (2014) wrong dose error rates decreased to zero.

For BCMA technology to be successful, nurses must accept it and use it appropriately. Influences that were found to increase acceptance of BCMA included improved job performance, increased productivity, enhanced speed and effectiveness of work, and improved patient and medication identification (Marini, et al., 2010; Sheikhtaheri & Saravani-Aval, 2018; Taliercio et al., 2014). Barriers to acceptance include decreasing job efficiency mostly due to increased time involved in medication administration (Glover, 2013); however, a study by Hurley et al. (2007) reported that although nurses found BCMA to be time consuming, they acknowledged that BCMA was the safest process for their patients and reported it as time well spent. Therefore, despite some barriers, if BCMA is perceived as useful, easy to use, and if improved patient safety is the outcome, the technology is more likely to be accepted and consistently used (Ketikidis et al., 2012; Hurley et al., 2007).

Barcode medication administration has been introduced into many healthcare areas; however, limited research on its use in the ED environment or ED nurses' attitudes toward BCMA exists. Emergency department nurses' acceptance of the technology is a major factor in the success of BCMA. Understanding ED nurses' attitudes toward this technology may provide administrators with knowledge on barriers to use, which can be used when implementing strategies to improve processes to decrease workarounds, increase compliance, and improve nurses' attitudes towards BCMA. The purpose of this quantitative descriptive study was to determine the attitudes regarding acceptance of BCMA, among ED nurses who currently use the technology.

Method

Study Design and Participants

This study used a cross-sectional, survey design. Data were collected via a survey that was created in SurveyMonkey® and e-mailed to members of the National Emergency Nurses Association of Canada (NENA). Registered nurses who work in an emergency department environment and use BCMA technology as a part of their current workflow were included, all others excluded.

Survey Instrument

A validated tool, the Unified Theory of Acceptance and Use of Technology (UTAUT) questionnaire, created by Venkatesh et al. (2003) and adapted by Spil and Schuring (2006), was used. The tool contains 32 attitude questions related specifically to technology acceptance and use. The survey comprised of 38 questions in total. There were six socio-demographic questions (age, gender, years of experience, etc.), which also included a question on which country the participant currently works in because NENA has an international membership. The 32 UTAUT questions were measured in the following eight domains: performance expectancy [PE] (4 items), effort expectancy [EE] (4 items), attitude towards technology [ATT](5 items), social influence [SI](4 items), facilitating conditions [FC] (4 items), self-efficacy[SE] (4 items), anxiety [ANX](4 items), and behavioural intention to use the system[BI] (3 items). These questions were anchored on a five-point Likert scale with scores assigned as follows: 1= strongly agree, 2 = agree, 3 = neutral, 4 = disagree, and 5 = strongly disagree. For this research BCMA was substituted for "the system" and, as the aim is to study attitudes toward acceptance in nurses presently using the system, questions written in a prospective manner have been changed to actual tense. The original question "using the system is a bad/good idea" has been broken into two questions "using BCMA is a good idea" and "using BCMA is a bad idea" as there is no way to represent an answer to the question as it is currently written when using a Likert scale.

Data Analysis

All data were entered into the IBM Statistical Package for the Social Science (SPSS), version 25.0 for analysis. The socio-demographic and attitude questions were analyzed using descriptive analytics of frequencies and percentages. Composite scoring was calculated for each of the eight domains by examining the internal consistency of each of the items in each domain with Cronbach's alpha. Alpha levels greater than 0.60 were considered acceptable (Gliem & Gliem, 2003). If the internal consistency was acceptable, a composite score was created for the domain by computing a mean score for all of the items in the domain. If the coefficient alpha could not be improved by removing items, a composite score was not created for the domain and items were considered for individual analysis. For each composite score, normality was examined with a Shapiro-Wilks test with an alpha level set at 0.05, and descriptive statistics, including means and standard deviations, were produced. For those domains where scores were not normally distributed, median, minimum and maximum are reported as outcomes, means and standard deviations are reported for normally distributed domains.

Results

Fifty-five nurses participated in the study; the demographic details of the sample are outlined in Table 1. The majority of the sample worked in Canada (98.2%) with one respondent from the United States of America (1.8%). Females represented the majority of respondents at 78.2% with 21.8% being male. The largest category of respondents was in the 31–40- and 41–50-year-old age ranges, totalling 61.8%. A majority of respondents reported more than 5 years of experience in the ED (70.9%) and low levels of BCMA use, with the largest group having one year or less of experience with this technology (67.3%). Approximately 64% of respondents reported BCMA was mandatory in their work environment.

A summary of the reliability analysis is provided in Table 2. Most of the domains, including PE, EE, SI, SE, ANX, and BI yielded a coefficient alpha > 0.60. Domains ATT and FC had coefficient alphas less than 0.70. Removal of one item improved the alpha for the ATT domain from 0.43 to 0.84; however, for the FC domain, removal of items did not improve internal consistency so only individual item responses are displayed (Table 3). The distributions of data (Table 4) in the EE, ATT, and SI domains did not differ significantly from normal (p>0.05). The means for these domains ranged from 2.7-3.5, implying that those in the sample were generally between agreement to disagreement with the idea that BCMA is easy to learn and use, that they were influenced by peers or leaders, and that working with BCMA was fun or a good idea. The distributions of the data in PE, SE, ANX, and BI domains were not normally distributed (p=0.05). The highest-ranking domains in this group were BI (2.0) and SE (2.25) implying that those in the group were agreeable to using BCMA in the future, and reported positive association with being capable to use the system if using the available support.

Table 1: Demographics of the questionnaire respondents		
Demographic	**Frequency**	**Percent**
Age Group		
21-30	9	16.4
31-40	19	34.5
41-50	15	27.3
51-60	9	16.4
>60	3	5.5
Gender		
Female	43	78.2
Male	12	21.8
No. of years-ED		
0-1	3	5.5
2	1	1.8
3	7	12.7
4	3	5.5
5	2	3.6
>5	39	70.9
No. of years -BCMA		
0-1	37	67.3
2	5	9.1
3	6	10.9
4	3	5.5
5	0	0.0
>5	4	7.3
BCMA Mandatory		
Yes	35	63.6
No	20	36.4
Country		
Canada	54	98.2
USA	1	1.8
Note. No. of years- ED= your number of years' experience as a nurse in the emergency department; No. of years-BCMA = your number of years' experience with BCMA		

Table 2: Reliability Analysis (*n*=55)		
Domain	**Cronbach's Alpha**	**Number of Items**
Performance Expectancy	0.797	4
Effort Expectancy	0.877	4
Attitude Toward Technology	0.840	4
Social Influence	0.751	4
Self-Efficacy	0.790	4
Anxiety	0.887	4
Behavioural Intention	0.936	3

The domains that rated lowest in this group were ANX and PE with medians of 3.25 and 4.25, respectively. These results reflect on average that the sample typically did not agree that BCMA was useful or enabled them to improve efficiency or productivity; however, the group reported neutral to disagreement responses that working with BCMA caused anxiety.

In the FC domain, the results indicate that those in the sample agreed or were neutral toward the attitudes within the domain (Table 4). Approximately 41.8% (*n*=23) agree they have the necessary resources to use the system, 60.0% (*n*=33) agree they have the necessary knowledge, 50.9% (*n*=28) are neutral for the proposition that the system is not compatible with other systems in use, and 40.0% (*n*=22) agree that there is assistance available when system difficulties arise.

Discussion

The objective of this study was to identify ED nurses' attitudes towards BCMA technology using descriptive analysis. Based on the data provided by the 55 respondents, the participants were mostly female and the majority (*n*=34) were within the 31–40- and 41–50-year-old ranges. These groups are congruent with the 2017 National Nurses Workforce survey that reported that although the median age of a registered nurse is 53 years of age, 39.5% of the nursing population is in the 30–50-year age range. It also reported that 90.9% of the nursing workforce are female (Smiley et al. 2018). Our participant base had many years' experience in the ED environment but reported minimal experience with BCMA technology. This lack of experience may be attributed to the limited deployment in this environment of complete electronic medical record systems that enable BCMA technology (Bonkowski et al., 2013).

The evidence of this study reveals that the group had the common opinion that the attitudes outlined in EE, SE, SI, FC, and BI were positive towards acceptance of BCMA technology; with the ANX domain a positive negative was reported, that is the group reported they disagreed that BCMA technology caused anxiety. However, the group reported that attitudes outlined in the PE and ATT domains were not positive towards acceptance of the technology.

The results of this study for the SI domain (mean 2.70) are interesting as most of the participants specified they had only been using the system for approximately one year. This implies that implementation had been recent and implementations usually entail multiple educational sessions, hands-on training, go-live support such as dedicated technical teams, staff super-users, and post go-live support for optimization of the computer-based system. Recent adoption also means that there is leadership support in the use of the technology. So one would expect stronger agreement for the attitudes in this domain.

Approximately 64% (*n*=35) of the sample stated it was mandatory to use BCMA in their department; however, the majority of the participants (*n*=51) reported that they strongly agreed, agreed, or were neutral about their intent to use the system in the future. This denotes that a portion of the sample was willing to use the technology despite it being voluntary. It has been reported that the freedom of choice to use technology has had a positive effect on the intention to use it. In settings where BCMA utilization is voluntary, it would benefit administrators to identify staff members who willingly use this technology, and have positive attitudes regarding its use and train them to be advocates for the technology. This could improve compliance and decrease workarounds, which can impede patient safety (Kijssanayotin et al., 2009).

Unlike other studies (Alam et al., 2018; Holtz & Krein, 2011; Liu et al., 2015; Vollmer et al., 2016), the current research demonstrated that the nurses' attitudes toward the technology were not positive toward performance expectancy. However, this is not an unexpected result as this domain speaks to how useful the system is and how it improves proficiency and productivity (Venkatesh et al., 2003). The ED is a fast-paced dynamic environment and, as mentioned previously, some studies have reported that more time is spent on

Table 3: Frequency scores of items (*n*=55)

Item	Question	1 Strongly Agree	2 Agree	3 Neutral	4 Disagree	5 Strongly Disagree	Mean	SD
PE1	I find BCMA useful in my job	4 (7.3%)	**14 (25.5%)**	**14 (25.5%)**	10 (18.2%)	13 (23.6%)	3.25	1.280
PE2	Using BCMA enables me to accomplish more tasks more quickly	1 (1.8%)	3 (5.5%)	11 (20.0%)	9 (16.4%)	**31 (56.4%)**	4.20	1.061
PE3	Using BCMA increases my productivity	2 (3.6%)	3 (5.5%)	11(20.0%)	11 (20.0%)	**28 (50.9%)**	4.09	1.127
PE4	If I use BCMA, I increase my chances of getting a raise	0 (0.0%)	1 (1.8%)	9 (16.4%)	4 (7.3%)	**41 (74.5%)**	4.55	0.835
EE1	My interaction with BCMA is clear and understandable	8 (14.5%)	**25 (45.5%)**	12 (21.8%)	5 (9.1%)	5 (9.1%)	2.53	1.136
EE2	It was easy for me to become skillful at using BCMA	9 (16.4%)	**16 (29.1%)**	**16 (29.1%)**	9 (16.4%)	5 (9.1%)	2.73	1.193
EE3	I find BCMA easy to use	5 (9.1%)	**16 (29.1%)**	9 (16.4%)	11 (20.0%)	14 (25.5%)	3.24	1.360
EE4	Learning to operate BCMA was easy for me	8 (14.5%)	**27 (49.1%)**	9 (16.4%)	8 (14.5%)	3 (5.5%)	2.47	1.086
ATT1	Using BCMA is a good idea	10 (18.2%)	**21(38.2%)**	11(20.0%)	7 (12.7%)	6 (10.9%)	2.60	1.241
ATT2	Using BCMA is a bad idea	5 (9.1%)	9 (16.4%)	14 (25.5%)	**16 (29.1%)**	11 (20.0%)	3.35	1.236
ATT3	BCMA makes work more interesting	0 (0.0%)	3 (5.5%)	**20 (36.4%)**	15 (27.3%)	17 (30.9%)	3.84	0.938
ATT4	Working with BCMA is fun	0 (0.0%)	2 (3.6%)	15 (27.3%)	17 (30.9%)	**21 (38.2%)**	4.04	0.902
ATT5	I like working with BCMA	2(3.6%)	8 (14.5%)	12 (21.8%)	16 (29.1%)	**17 (30.9%)**	3.69	1.169
SI1	People who influence my behaviour think that I should use BCMA	8 (14.5%)	17 (30.9%)	**19 (34.5%)**	7 (12.7%)	4 (7.3%)	2.67	1.106
SI2	People who are important to me think I should use BCMA	4 (7.3%)	14 (25.5%)	**25(45.5%)**	7 (12.7%)	5 (5.0%)	2.91	1.023
SI3	The senior management of our Emergency Department have been helpful in the use of BCMA	5 (9.1%)	**20 (36.4%)**	10 (18.2%)	13 (23.6%)	7 (12.7%)	2.95	1.224
SI4	In general, the organization has supported the use of BCMA	15 (27.3%)	**19 (34.5%)**	14 (25.5%)	4 (7.3%)	3 (5.5%)	2.29	1.117
FC1	I have the resources necessary to use BCMA	5 (9.1%)	**23 (41.8%)**	12 (21.8%)	7 (12.7%)	8 (14.5%)	2.82	1.219
FC2	I have the knowledge necessary to use BCMA	11(20.0%)	**33 (60.0%)**	9 (16.4%)	0 (0.0%)	2 (3.6%)	2.07	0.836
FC3	BCMA is NOT compatible with other systems I use	2 (3.6%)	8 (14.5%)	**28 (50.9%)**	14 (25.5%)	3 (5.5%)	3.15	0.870
FC4	A specific person or group is available for assistance with system difficulties	1 (1.8%)	**22 (40.0%)**	15 (27.3%)	12 (21.8%)	5 (9.1%)	2.96	1.036
SE1	I could complete a job or task using BCMA if there was no one around to tell me what to do as I go	17 (30.9%)	**21(38.2%)**	9 (16.4%)	7 (12.7%)	1 (1.8%)	2.16	1.067
SE2	I could complete a job or task using BCMA if I could call someone for help if I got stuck	13 (23.6%)	**21(38.2%)**	15 (27.3%)	5 (9.1%)	1 (1.8%)	2.27	0.990
SE3	I could complete a job or task using BCMA if I had a lot of time to complete the job for which the software was provided	17 (30.9%)	**24 (43.6%)**	13 (23.6%)	0 (0.0%)	1 (1.8%)	1.98	0.850
SE4	I could complete a job or task using BCMA if I had just the built-in help facility for assistance	9 (16.4%)	14 (25.5%)	**23 (41.8%)**	8 (14.5%)	1 (1.8%)	2.60	0.993
ANX1	I feel apprehensive about using BCMA	4 (7.3%)	14 (25.5%)	10 (18.2%)	**19 (34.5%)**	8 (14.5%)	3.24	1.201
ANX2	It scares me to think I could lose a lot of information using BCMA by hitting the wrong key	3 (5.5%)	12 (21.8%)	10 (18.2%)	**20 (36.4%)**	10 (18.2%)	3.40	1.180
ANX3	I hesitate to use BCMA for fear of making mistakes I cannot correct	4 (7.3%)	7 (12.7%)	12 (21.8%)	**23 (41.8%)**	9 (16.4%)	3.47	1.136
ANX4	BCMA is somewhat intimidating to me	1(1.8%)	3 (5.5%)	15 (27.3%)	**26 (47.3%)**	10 (18.2%)	3.75	0.886
BI1	I intend to use BCMA in the next month	18 (32.7%)	**19 (34.5%)**	14 (25.5%)	2 (3.6%)	2 (3.6%)	2.11	1.031
BI2	I predict I will use BCMA in the next 6 months	15 (27.3%)	**22 (40.0%)**	14 (25.5%)	1 (1.8%)	3 (5.5%)	2.18	1.038
BI3	I plan to use the system in the next 12 months	16 (29.1%)	**22 (40.0%)**	13 (23.6%)	1 (1.8%)	3 (5.5%)	2.15	1.044

Note. Results reported as N(%). PE=Performance Expectancy, EE=Effort Expectancy, ATT=Attitude Toward Technology, SI=Social Influence, FC= Facilitating Conditions, SE= Self-Efficacy, ANX= Anxiety, BI=Behavioural Intent, SD= Standard Deviation

Table 4: *Composite scores of domains*						
Domain	**Mean**	**SD**	**Median**	**Min**	**Max**	***p* value**
Performance Expectancy			4.25	2.00	5.00	≤ 0.05
Effort Expectancy	2.74	1.02				> 0.05
Attitude Toward Technology	3.50	0.60				> 0.05
Social Influence	2.70	0.84				> 0.05
Self-Efficacy			2.25	1.0	5.00	≤ 0.05
Anxiety			3.75	1.25	5.00	≤ 0.05
Behavioural Intent			2.00	1.00	5.00	≤ 0.05
Note. SD= Standard Deviation, Min=Minimum, Max=Maximum, *p* value for Shapiro Wilk Test of Normality.						

medication administration tasks when using BCMA technology. One explanation for this is the increase in steps needed to complete medication administration workflow when using this technology (Glover, 2013). Therefore, less favourable perceptions of proficiency and productivity may be related to additional time spent on medication administration tasks when using BCMA.

Finally, the results for ATT domain suggest that the participants did not like working with the system. Usually, if a technology improves job performance or increases productivity, attitudes toward the technology are more positive. However, as reported in this study there was not a positive attitude reported on this domain, which is reflected in the low performance expectancy results; this is consistent with the results reported by Ayatollahi et al. (2013). Attitude toward technology has also been reported to have an effect on behavioural intent to use the technology (Dulle & Minishi-Majanja, 2011), yet this study has shown that the attitudes toward the technology did not have a major effect on the attitudes of behavioural intent to use it. Examining the data with correlational analysis may help to explain these phenomena.

Limitations

This study has several limitations. First, the sample for this study was small, limiting its generalizability to a larger population. Our targeted population was ED nurses who used BCMA technology and it is recognized that a limited number of hospitals have yet to implement this technology. This sample was drawn from one organization and participation was limited to those members only. Therefore, it may be that ED nurses who did not belong to this organization could have other attitudes towards BCMA technology. Another limitation was the level of experience participants had with the technology; a majority of the sample had less than one year of experience with the technology, and recent adoption may have influenced perceptions.

Implications and Recommendations

This study provides administrators with the knowledge that ED nurses generally believe that BCMA is easy to use, and had confidence in the system. Some important questions were raised such as: (1) Is there enough organizational support one-year post implementation to ensure compliance with utilization? (2) Is there a way to decrease medication administration time in the ED environment when using this technology, which may improve proficiency?

Finally, this study utilized a descriptive design. Therefore, inferences about relationships between attitudes and other factors, such as tenure in the nursing field and voluntariness of BCMA use, were not explored in this research. Further studies are recommended to replicate the results with either increased professional organizational involvement or involvement of other settings and samples, to understand the similarities and differences regarding attitudes toward BCMA technology among nurses.

Conclusion

BCMA technology is not widely used in the ED so there is minimal literature on ED nurses' attitudes toward BCMA. The current research is a first step in understanding ED nurses' attitudes toward BCMA technology. The results of this study allow us to conclude that BCMA is perceived as easy to master and use and is not intimidating nor does it cause anxiety when being used. However, it was not perceived as useful for the ED nurse nor does it improve their proficiency or productivity. To better understand ED nurses' acceptance of BCMA technology, more research is needed using both qualitative and quantitative methods.

About the authors

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