"Nurses Don't Hate Change"

Survey of nurses in a neonatal intensive care unit regarding the implementation, use and effectiveness of a bar code medication administration system

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Abstract

A bar code medication administration (BCMA) system reduced preventable adverse drug events (ADEs) by 47% in our neonatal intensive care unit (NICU). However, it is often expected that providers will not welcome technological change. Two years after BCMA system implementation, we studied the perceptions of nurses in our NICU to better understand their opinions about patient safety, use, acceptance and occupational effects of the new technology. Forty-six nurses (median age <30 years) completed a 30-item questionnaire. Most nurses reported comfort using the system within two weeks. The majority believed that the system had prevented a medication error or ADE, although they were aware that medication errors persisted and workarounds occurred. Most reported that medication administration required more time with the BCMA system, but they believed that the alerts, which most reported occurred with ≤25% scheduled administrations, were not excessive. Over half of the nurses felt that the new system improved job satisfaction and increased professionalism. Although overall stress levels were moderate, nurses reported greater stress resulting from computer breakdowns than from other situations. Nurses reported strong support from supervisors, physicians and hospital administrators. These nurses were adaptive to the new technology when they believed it increases patient safety, nursing professionalism and job satisfaction and when they were supported by colleagues.

In 2006, we investigated the effectiveness of a bar code medication administration (BCMA) system in reducing preventable adverse drug events (ADEs) in a neonatal intensive care unit (NICU) (Morriss et al. 2009). The study was a prospective cohort study in which the end points were clinical processes and patient outcomes, most importantly, preventable ADEs. The implementation of the BCMA system reduced preventable ADEs by 47%, adjusted for the number of doses of medication administered per patient per day.

In patient safety research studies, multiple study methods and end points are advocated (Brown et al. 2008). To capture additional end points regarding the BCMA intervention, we

conducted a survey of the nursing staff who worked in the NICU prior to and after the BCMA system implementation. Our aim was to obtain information on intervening variables regarding the BCMA system, such as nurses' opinions and attitudes about the change in medication administration process, as well as measures of their fidelity to the intervention, such as workarounds. This is a report of the survey results and how they compare with and augment the results of the BCMA system effectiveness study.

Almost all respondents stated that the system helped them avoid making a medication error, and most reported that the system helped them avoid an ADE.

Methods

The study setting was a 36-bed NICU in the University of Iowa Children's Hospital, a component of the University of Iowa Hospitals and Clinics. The NICU is staffed by nurses with various levels of formal nursing training. Medications are administered by registered nurses or licensed practical nurses who have completed a pediatric-specific medication instructional module and passed pediatric and NICU-specific medication tests. All staff must also complete an annual medication instructional module and pass a computer-based test. The intervention BCMA system is described elsewhere (Morriss et al. 2009).

To prepare for the advent of the new system, nurses attended a required 3.5-hour didactic training session and were assisted by "super-users" in hands-on use of the system for two weeks. The BCMA system employs tools to help a nurse organize workflow, including a scheduling mechanism for dosing, prompts for upcoming scheduled medication doses, alerts when an aspect of the intended administration of a medication is erroneous and displays of omitted scheduled doses. Personnel administering medications can override the alerts.

We developed a 30-item survey instrument that included 10 items selected from the 34-item Nursing Stress Scale (Gray-Toft and Anderson 1981). These items were included to assess occupational psychosocial stress resulting from the breakdown of a computer, fear of making a mistake in treating a patient, feeling inadequately trained for expected tasks and uncertainty regarding the operation and functioning of specialized equipment, compared with other situations.

We invited the 104 nurses employed in the NICU to respond to the survey, which was presented electronically using WebSurveyor. Participation was voluntary and anonymous. The survey instrument was made available to respondents for four weeks in June–July 2008, approximately two years after the system's implementation. The study was approved by the University of Iowa Institutional Review Board.

Results

Characteristics of participating nurses are presented in Table 1.

Table 1. Characteristics of participants responding to survey

	n (%)
Nurses responding of 104 working in NICU	46 (44.2)
Age (yr)	
20–35	27 (58.7)
36–50	16 (34.8)
51–65	3 (6.5)
NICU experience (yr)	
<1	6 (13.0)
1–3	17 (37.0)
>3	23 (50.0)
Worked in NICU before BCMA system was installed	32 (69.6)

BCMA = bar code medication administration; NICU = neonatal intensive care unit.

Learning to Use the System

Only two weeks or less of use were required for 62% (28 of 45) of the nursing staff to feel comfortable using the system. Of those who took four or more weeks to feel comfortable with the system, most (five of seven) were age 40 years or older and had worked in the NICU more than three years.

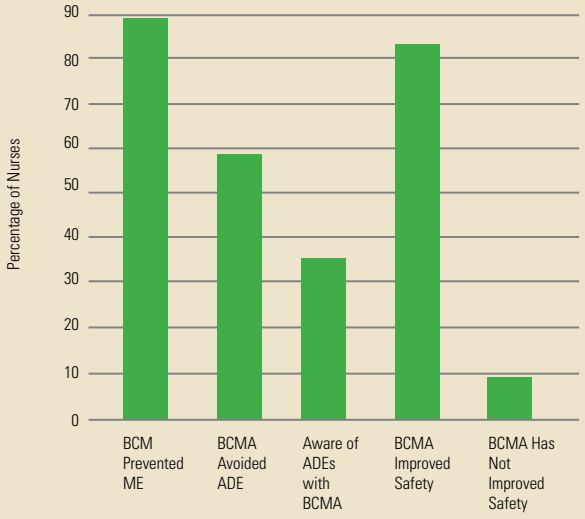
Nurses' Opinions of Effectiveness of the BCMA System

Almost all respondents stated that the system helped them avoid making a medication error, and most reported that the system helped them avoid an ADE. Overall, most were of the opinion that the BCMA system improved patient safety and thought that the system had a "good" effect on patient safety (Figure 1).

Nurses' Opinions of the Alerts Issued by the System

During the effectiveness study, alerts were generated for 31% of scheduled medication administrations. Of the 46 responding nurses working in the NICU in 2008, 44 estimated that alerts occurred in one quarter of scheduled medication administra-

Figure 1. NICU nurses indicating opinions about the effectiveness of the BCMA system



ADE = adverse drug event; BCMA = bar code medication administration; ME = medication error; NICU = neonatal intensive care unit.

tions or less. The effectiveness of the alerts in preventing errors was gauged to be "somewhat effective" by 20, "usually effective" by 19 and "almost always effective" by four. Less than half of the respondents recommended reducing the alert frequency.

Effect of the BCMA System on Nursing Workflow, Workarounds, Professionalism and Job Satisfaction

Most nurses believed that the BCMA system required more time to administer medications and maintain the medication administration record than had the previous paper-based procedure (Figure 2). Of those who had used both procedures in the study NICU, 25 of 32 believed that medication administration required "somewhat" or "much more" time than the former procedure. Moreover, a large percentage of the nurses believed that the use of the BCMA system distracted them from other patient care tasks; 23 of 45 indicated this occurred "occasionally" and eight selected "often." However, of the nurses who had worked long enough in the NICU to experience both procedures, 22 of 32 believed that the intervention increased nursing professionalism, and among all respondents, 23 of 45 believed that the BCMA system had a "good" effect on nursing staff job satisfaction, compared with six who thought it had a "bad" effect on job satisfaction. One of the comments offered by respondents was the statement, "Nurses don't hate change."

Figure 2. Nurses' opinions of the BCMA system on patient care, nursing professionalism and job satisfaction

Table 2. Nurses' responses to survey stress questions

Situation	Occasionally Stressful, *n* (%)	Frequently Stressful, *n* (%)	Extremely Stressful, *n* (%)
Breakdown of a computer	13 (30)	16 (36)	15 (34)
Fear of making a mistake when treating a patient	26 (59)	8 (18)	5 (11)
Uncertainty regarding operation and functioning of specialized equipment	25 (58)	12 (28)	4 (9)
Feeling inadequately trained for tasks to be performed	25 (57)	3 (7)	4 (9)
Having to make decisions under pressure	32 (73)	8 (18)	1 (2)
Not enough staff to cover unit	25 (57)	4 (9)	6 (14)
Too many non-nursing tasks	16 (36)	14 (32)	4 (9)
Not enough time to complete all nursing tasks	25 (57)	11 (25)	4 (9)
Being blamed for anything that goes wrong	21 (48)	4 (9)	8 (18)
Experiencing discrimination on the basis of sex	5 (12)	1 (2)	1 (2)

Almost one half (20 of 45) of the nurses were aware that workarounds occurred with the BCMA system, and narrative responses suggested that these were initially prompted by "faulty equipment." When asked to describe factors that limited the impact of the BCMA system effectiveness, responses included "technical problems," including bar codes that did not scan and reliability of the computer equipment, as well as medication administration scheduling control by the clinical pharmacists who entered those data into the system.

All respondents identified the breakdown of a computer as a stressful occurrence in the workplace and one generally more stressful than the fear of making a mistake when treating a patient.

Comparison of Potentially Stressful Situations

We summed the 10-item stress scale and examined internal consistency and factor structure. Cronbach's alpha revealed robust internal consistency (α = .88), and factor analysis indicated evidence of a single-factor structure with stress accounting for 80% of the item variance. Forty-two respondents completed the stress items (Table 2). Summed scores ranged from four to 27, with an overall score mean of 11.8 (*SD* 5.2) and median of 11.0. The mean stress score for those employed for more than three years (13.5) was significantly higher than that for those employed less than three years (10.1; p = .04).

All 44 respondents identified the breakdown of a computer as a stressful occurrence in the workplace and one generally more stressful than the fear of making a mistake when treating a patient, uncertainty regarding the operation and functioning of specialized equipment and other situations not associated with new technology.

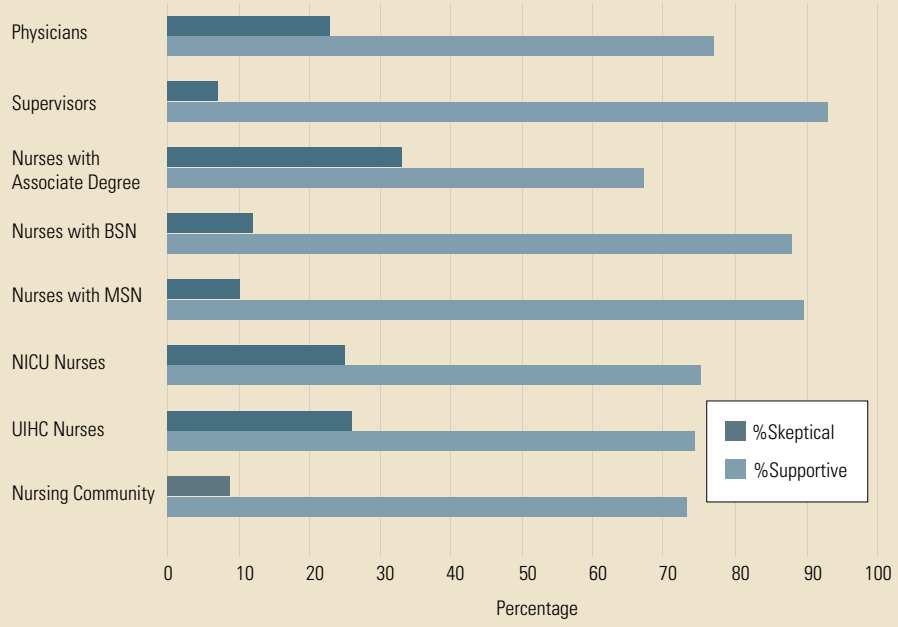
Diffusion of Innovation and Acceptance of Technology

We found strong institutional support for technological innovation in the NICU. Subjects were asked to rate the supportiveness of colleagues and supervisors (Figure 3). We scored each level of support (e.g., extremely supportive = 2, somewhat supportive = 1 and somewhat skeptical = 0) and then summed the scores from all eight items. The 39 respondents' scores ranged from zero to 16 with a mean of 8.5 (*SD* 3.6) and a median of 8.0, reflecting a generally strong level of support for new technology overall.

Discussion

Administration of medications is a complex process that involves critical thinking as well as technical action (Eisenhauer et al. 2007). A BCMA system implementation constitutes a significant change in the process. This study supports the idea that the extensive pre-implementation preparations conducted in the NICU were successful in that the BCMA resulted in a

Figure 3. Nurses' perceptions of support for new technology by others



BSN = bachelor degree of science in nursing; MSN = master's degree of science in nursing; NICU = neonatal intensive care unit; UIHC = University of Iowa Hospitals and Clinics.

significant reduction in ADEs and the system gained enthusiastic acceptance by a large percentage of the nursing staff. Most nurses who now work in the NICU indicated that they recognize that the system improves patient safety, although it is not completely effective in eliminating medication errors. Most nurses believe that the system improves their professionalism, and about one half said that it contributes to their job satisfaction. Stress scores indicate that they did not feel a high level of occupational stress using the system, although computer breakdown is an important stressor.

However, there are concerns associated with BCMA system implementation reflected in the survey results. The time spent in medication administration is perceived to have increased. Moreover, use of the system distracted more than two thirds of the nurses from other patient care tasks at least occasionally. We asked this question because we had observed an increase in peripheral intravenous line infiltrations and central line complications during the BCMA effectiveness study. The increase was not statistically significant, but it was clinically concerning. The best explanation we could postulate for the increase in such non-targeted, preventable ADEs after the BCMA system was implemented was that nurses were sufficiently distracted by their frequent interaction with the computer, especially to respond to alerts, that intravenous line complications occurred. The survey responses support this interpretation. Moreover, distractions are known to contribute to medication errors, and efforts to reduce distractions during the medication administration process have been shown to be effective in reducing medication errors (Pape et al. 2005).

An undesirable response to the change of medication administration process imposed by the BCMA system is a "workaround," or bypassing a feature of the system that is designed to improve safety. Workarounds are lapses in the fidelity to the intervention. Almost one half of the survey respondents were aware that workarounds occurred. Koppel et al. (2008) studied workarounds to BCMA systems in five hospitals, identifying 15 types and 31 causal categories. They found that nurses overrode alerts for 4.2% of patients and 10.3% of medications charted in executing the workarounds.

The main strength of this study is that it provides the opinions of nurses about a BCMA system implementation and information about their fidelity to the intervention that augment the previously reported end points of clinical process and patient outcomes. The main weaknesses of the survey are the moderate voluntary response rate from the potential participants and the limitation of a single-site study on generalization of the results to other BCMA systems and clinical settings.

Most nurses believe that the system improves their professionalism, and about one half said that it contributes to their job satisfaction.

Conclusions

The nurses in the NICU were adaptive to the new technology when they believed it increases patient safety, nursing professionalism and job satisfaction and when they were supported by their peers and supervisors. However, the new technology requires more time, may distract from other care tasks and is not perfectly effective. HQ

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