BAR CODE MEDICATION ADMINISTRATION: A STRATEGIC TECHNOLOGY INTERVENTION FOR REDUCING HOSPITAL'S MEDICATION ERRORS

Elly Wardani
Faculty of Nursing, Syiah Kuala University
E-mail: ellywardani@yahoo.com

ABSTRACT

The purpose of this review is to investigate the bar code medication administration (BCMA) as a technological solution to reduce preventable medication administration errors. The evidence gathered will serve as a foundation for the hospital board's executive decision making about the adoption of a technology-based error reduction strategy. The future hope of the implementation of BCMA would be a system that interfaces with other IT (Information Technology) applications to enhance patient safety and quality of care at hospitals. The IT devices, cannot replace caregivers. Yet, the systems would improve and support caregivers' performance in meeting safety needs and delivering best practices.

Keywords: Bar code, medication errors, patient safety.

PENDAHULUAN

One of the primary concerns in patient safety is the medication process. It is frequently reported as a primary problem in the healthcare system and the cause of adverse events (Lafleur, 2004; Maviglia, Yoo, Franz, Featherstone, Churchill, et al., 2007). Each year in the United States, 1.5 million patients are harmed as a result of a hospital medication error (Institute of Medicine, 2006). This condition increases hospital lengths of stay and extra medical costs needed to treat errors. According to the National Coordinating Council for Medication Error Reporting and Prevention (2006), a medication error is defined as "…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, patient, or consumer."

The increasing alarm regarding medical mistakes influences the adoption of technology in healthcare to mitigate medication errors. Healthcare organizations are attempting to apply appropriate technology that could reduce errors and meet safety needs. The cost issues related to adverse events in healthcare organizations can be avoided by applying technology as a supporting tool to resolve issues and help the organization in healthcare-related decision making (Saba & McCormick, 2006).

BCMA as A Proposed Technological Solution

Medication errors may take place at any stage in the procedure. It could happen during prescribing, dispensing, administrating, or monitoring, and could be made by any clinical provider (Jones, 2009). A review of the literature indicated that barcoding enhanced the medication administration performance (Carroll, Owen, & Ward, 2006). The BCMA has defined as a "point-of-care system that requires positive patient identification and electronic verification of medications at the bedside before their administration" (Cescon & Etchells, 2008, p. 2200). The major benefit of BCMA is to increase medication process functionality.

During medication time, a single patient can receive up to 18 doses of medication per day. A nurse can administer as many as 50 medications per shift. This places the nurse at the front line in medication administration accountability (Mayo & Duncan, 2004). The BCMA system can help to clarify the medication administration five rights: right drug, right patient, right time, right dose, and right route. It also provides reminders and alerts of important clinical actions--either for pharmacists or nurses--before administering medications. BCMA assists healthcare organizations in complying with the National Patient Safety Goal requirements of obtaining two or more patient identifiers in medication administration (Saba & McCormick, 2006).

A BCMA system involves the pharmacy in dispensing barcoded and packaged medication doses. The nurse scans a bar code on the patient's wristband, which then generates medication lists. This system

will send approval or warning information about the drugs. After the nurse administers the medications, the system records the activity in the patient's electronic medication record for future billing purposes or analysis (Cescon & Etchells, 2008; Cummings, Bush, Smith, &Matuszewski, 2005).

By integrating existed technology such as CPOE (Computerized Physician Order Entry), pharmacy dispensing systems, and medication carts at the point-of-care, BCMA adds multiple layers of safety to the medication process. BCMA technology automatically confirms the appropriateness of medication orders, pharmaceutical dispensing systems, and point-of care administration within the context of individualized patient care data. Pop-up reminders and highlighted warnings alert the user to potential adverse medication reactions, known medical allergies, and vital sign parameters, among various other useful features.

Outcomes of BCMA Implementation

The application of bar code medication administration (BCMA) as a technological solution to reduce medication errors has been proposed in several studies. The expected purpose is not only to reduce preventable medication administration errors, but also to generate hospital savings as the desired outcome.

BCMA and Medication Administration Error

Implementation of BCMA technology resulted in significant reduction of medication errors in several hospitals (DeYoung, VanderKool, & Barletta, 2009; Foote & Coleman, 2008; Paoletti, Suess, Lesko, Feroli, Kennel, et al., 2007). A Brigham and Women's Hospital study found that BCMA technology prevented 517 medical errors in one year, and decreased the rate of potential adverse events by 63% (Maviglia, et al., 2007).

DeYoung, et al. (2009) conducted a study on medication errors in a 38-bed adult medical intensive care unit (ICU) in a 744-bed community teaching hospital. A total of 1465 medication administrations were directly observed. Seven hundred and seventy five pre-implementation and 690 post-implementation medication administrations were assessed. The investigators found that

the frequency of medication errors before and after BCMA implementation was 19.7% (153 of 775) and 8.7% (60 of 690). The medication administration errors (MAE) were reduced by 56% after the implementation of BCMA ($p<0.001$). This benefit was primarily related to a reduction in wrong time errors. It went from 18.8% during pre-implementation to 7.5% post-implementation ($p<0.001$).

Another study was performed by Paoletti, et al. (2007). Direct observation was used. Three inpatient nursing units participated. The control group was a 20-bed cardiac telemetry unit. First intervention group was also a 20-bed cardiac telemetry unit, and the second intervention group was a 36-bed medical surgical unit. By using a five-day manual medication administration record (MAR) in the pre-implementation phase, a total of 188 errors were reported in these units. In the post-implementation stage, the control group continued to use manual MAR, and both control groups used BCMA and eMAR systems. Post-implementation data demonstrated a 54% reduction in MAEs. Overall, the investigators found that the accuracy rate before BCMA was 86.5%. After BCMA implementation, the rate rose to 97%.

BCMA and Institutional Savings

A major issue with technology is the substantial costs needed for the implementation process. Pertinent investment includes hardware/software purchases, infrastructure, and training (Cescon&Etchells, 2008). With the implementation of BCMA, it is expected that hospitals will gain the benefit of significant error reduction and generate hospital's extra savings.

Medication errors cost more than $3.5 billion per year in extra spending for hospitals (Foote & Coleman, 2008). A systematic review conducted by Chaudhry, Wang, Wu, Maglione, Mojica, et al. (2006) showed that having fewer medication errors is one of the major benefits of implementing health information technology. However, the investigators argued that very limited resources are available that discuss the empirical evidence on financial outcomes and cost efficiency.

According to Cescon and Etchells (2008), and Lafleur (2004), the Food and Drug Administration (FDA) estimated that the initial cost for implementing BCMA in a 191-

bed hospital was approximately $377,000. Annual operating and maintenance costs were $315,000. If implemented nationally, annual healthcare expenditures of $680 million would generate about $3.9 billion in benefits to public health. The hospital could gain an additional $450 million to $720 million in $3.2 billion annual net benefits.

The most current study of cost benefit analysis of the barcoding system is solely focused on the pharmacy dispensing process (Cescon & Etchells, 2008). Research by Maviglia, et al., (2007) was performed to assess costs, benefits, and return on investment at the hospital level after implementing a pharmacy bar code system. The study setting was Brigham and Women's Hospital (BWH), a 735-bed, tertiary, academic, nonprofit medical center. The hospital budgeted $3 million to initiate a bar code and electronic medication administration record system to reduce pharmacy and nursing related medication errors.

Costs and benefits were aggregated by fiscal quarter and analyzed with Microsoft Excel 2003™. The time value of money was adjusted by discounting future costs and benefits from the initial project launching day (10/1/2001). One-way and 2-way cost sensitivity analyses were performed. One-way analysis is performed to assess each *uncertain* component of a cost effectiveness evaluation, while a multi-way simple sensitivity analysis involves varying two or more inputs at the same time, and studying the effect on outcomes (Briggs, Sculpher, & Buxton, 1994). In this study, one-way analysis was utilized on all non-measured data inputs (e.g., discount and inflation rate), dispensing error rates that lead to adverse events, and cost savings from a preventable adverse event. Two-way analysis was used to estimate actual severe adverse events of observed dispensing errors rates.

The investigators found that the intervention decreased by 63% the rate of potential adverse events. There was a 0.07% dispensing error rate reduction after barcode implementation compared to 0.19% before the system initiation. It was estimated that 517 errors were prevented per year, which generated an annual savings of $2.2 million. The calculated cumulative benefit in 5 years was $5.73 million. The net benefit in 5 years was $3.49 million. The return on investment

estimation was in the first quarter of year 4 or in the first year after the system went live. However, in the severe adverse events analysis, return on investment occurred in the 10th year of operation.

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Direct observation is a frequent indicator used to measure the effect of BCMA on medication administration errors (MAE).This technique isutilized in pre and post-implementation process of BCMA. According to Paoletti and colleagues (2007), direct observation is "a consistent and reliable approach to data collection before and after the implementation of the changes to the medication-use process" (p. 537). The Direct observation approach allows hospitals to recognize any faulty processesand evaluate the changes with reliable data (Paoletti, et al., 2007). Furthermore, although cost-benefit analyses of barcoding are limited, the net benefit of implementing BCMA can be analyzed by comparing it to other technology-based error reducing strategies. For example, Maviglia and colleagues (2007) performed research that found that the costs and benefits of inpatient pharmacy bar coding were comparable to those of CPOE. However, while there have been clearly documented reports of significant reductions in MAE with the use of BCMA technology, empirical evidence remains contradictory and inconclusive. Most of the BCMA implementation research lack robustness in research design, sampling method, and data collection. Pretest-posttest design is categorized as a study that yields weak evidence. It is a basic experimental design and the result is not as strong as a randomized control trial study (Polit& Beck, 2008). The studies are mostly in a single site setting. Single site study may have limitations in generalizability. In addition, the Hawthorne effect may impact study results. It occurs because of direct observation in data collection. The effect is resulting from participant's awareness that they are under study (Polit& Beck, 2008).

In accordance to the technology system inefficiencies, a research by Koppel, Wetterneck, Telles, and Karsh (2008) found that there were 31 types of causes of workarounds of BCMA. Several shortcomings of BCMA including unreadable

medication barcodes, malfunctioning scanners, unreadable or missing patient identification band, failing batteries, uncertain wireless connection, and emergency.

Overall, although the BCMA is intended to advance the medication administration process, critical attention to ensure that the technology safety features work as it is supposed to is important. The BCMA shortcomings may occur at any time. Hence, efforts to address workarounds should include investigation of technology, task, organization, patient-related, and environmental circumstances. The hospital should also maintain ultimate control. Evaluators and implementation teams should work together with technology vendors to support hardware, software, user, policy, and patient safety needs (Koppel, et al., 2008).

KESIMPULAN

Technology is not an absolute solution for any safety issue. Regardless of how advanced a technology is to address safety needs, caregivers' diligence and critical thinking is the most important piece in preventing error. Overconfidence in technology support may harm patients. Therefore, information technology cannot substitute a clinician's good practice, skills, and competencies (Lafleur, 2004).

In summary, the costs issue frequently inhibits the implementation of technology. However, if compared with the extra costs and efforts needed to treat errors, investment on bar code medication administration is considered strategically sound for hospital. With rigorous planning, cost effectiveness analysis, appropriate system design, and benchmarking to other facilities that have implemented this project, the expected outcomes would be generated and ultimately improve patient safety.

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