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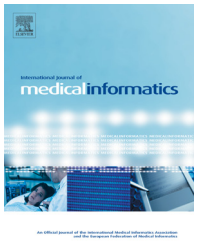

Implementing a bar-code assisted medication administration system: Effects on the dispensing process and user perceptions

N.R. Samaranayake[a,*], S.T.D. Cheung[b], K. Cheng[c], K. Lai[c], W.C.M. Chui[b], B.M.Y. Cheung[a]

[a] Department of Medicine, Faculty of Medicine, The University of Hong Kong, Hong Kong
[b] Department of Pharmacy, Queen Mary Hospital, Hong Kong
[c] Central Nursing Department, Queen Mary Hospital, Hong Kong

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ABSTRACT

Purpose: We assessed the effects of a bar-code assisted medication administration system used without the support of computerised prescribing (stand-alone BCMA), on the dispensing process and its users.

Methods: The stand-alone BCMA system was implemented in one ward of a teaching hospital. The number of dispensing steps, dispensing time and potential dispensing errors (PDEs) were directly observed one month before and eight months after the intervention. Attitudes of pharmacy and nursing staff were assessed using a questionnaire (Likert scale) and interviews.

Results: Among 1291 and 471 drug items observed before and after the introduction of the technology respectively, the number of dispensing steps increased from five to eight and time (standard deviation) to dispense one drug item by one staff personnel increased from 0.8 (0.09) to 1.5 (0.12) min. Among 2828 and 471 drug items observed before and after the intervention respectively, the number of PDEs increased significantly ($P < 0.001$). 'Procedural errors' and 'missing drug items' were the frequently observed PDEs in the after study. 'Perceived usefulness' and 'job relevance' of the technology decreased significantly ($P = 0.003$ and $P = 0.004$ respectively) among users who participated in the before ($N = 16$) and after ($N = 16$) questionnaires surveys. Among the interviewees, pharmacy staff felt that the system offered less benefit to the dispensing process (9/16). Nursing staff perceived the system as useful in improving the accuracy of drug administration (7/10).

Conclusion: Implementing a stand-alone BCMA system may slow down and complicate the dispensing process. Nursing staff believe the stand-alone BCMA system could improve the drug administration process but pharmacy staff believes the technology would be more helpful if supported by computerised prescribing. However, periodical assessments are needed to identify weaknesses in the process after implementation, and all users should be educated on the benefits of using this technology.

* *Corresponding author at*: Department of Medicine, Queen Mary Hospital, 102, Pokfulam Road, Hong Kong. Tel.: +852 22554347; fax: +852 28186474.
E-mail address: nithushisamaranayake@yahoo.com (N.R. Samaranayake).
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1. Introduction

Drug administration is the final step in the medication use process and errors that occur at this stage may directly harm the patient [1–3]. Therefore an additional defence, such as bar-code assisted medication administration (BCMA), is needed to intercept drug administration errors and to improve patient safety [4,5]. BCMA systems have been shown to reduce drug administration errors when used as a closed-loop system, where prescribing, dispensing and drug administration processes are electronically linked [4–6]. Computerised prescribing is a pre-requisite for a closed-loop BCMA system but many hospitals do not have this facility [7].

Hospitals that do not have computerised prescribing may use a system known as the stand-alone BCMA system [8]. This works by feeding the information on hand-written prescriptions to the computer, and generating and attaching bar-coded dispensing labels to each drug dispensed by the pharmacy. Therefore, implementing a stand-alone BCMA system requires considerable coordination between the pharmacy and the ward.

Staff are known to resist new technologies, and changes to work flow and their roles [9]. If users do not operate the technology correctly, technology-related errors may occur [10] and the envisioned benefits of the technology may not be achieved. Simple and easy-to-use systems that are perceived as useful may be more readily accepted [11,12], which means that the application of technological innovations are greatly reliant on user attitudes. The closed-loop BCMA system has been studied in detail and implementation issues and workarounds have been reported [13–15]. Koppel et al. found that most of these workarounds were due to unexpected problems that were encountered by nurses when using the technology [13]. While some have shown that implementing a closed-loop BCMA system did not increase the time nurses spent on medication administration activities [16], others reported that nurse's perception on time efficiency reduced with this intervention [17]. Therefore the system design and the practicality of its usage are vital aspects to test before and after implementing technological innovations. Stand-alone BCMA systems have not been studied as much as closed-loop systems [4,5,13]. Bargren et al. reported how a stand-alone BCMA system affected the drug administration process but its effects on the dispensing process and users have not been explored yet [8].

Our aim was to study a stand-alone BCMA system as it was introduced to a medical ward in a university hospital in terms of its effect on the dispensing process, pharmacy staff and nursing staff. More specifically, we aimed to study the timing and changes to the dispensing steps, identify socio-technical (human factor related) and technical issues introduced by the system to the dispensing process, assess changes in potential dispensing error (PDE) rates, and assess the attitudes of pharmacy and nursing staff after the introduction of the technology.

2. Methods

2.1. The study setting

A stand-alone BCMA system was initiated in one medical ward (12 beds; 8–9 nurses) in a tertiary-care hospital in Hong Kong. The hospital had a separate pharmacy that dispensed drugs to in-patients. Most of the drugs were dispensed on a batch refill method, where drugs for each patient were dispensed daily. Some drug items were dispensed to refill ward stocks. Prescribing information on hand-written pre-formatted prescriptions were transferred to computers, 2D bar-coded dispensing labels were printed (at one dedicated printer) and attached onto each drug item dispensed by the pharmacy. Drugs that were dispensed by an Automated Dispensing Machine (ADM) were directly dispensed, with a 2D bar-code printed on the packaging. At the bedside, the nurse matched the bar-codes on drug containers/packs with that of the patient's bar-coded wrist band and the prescription in the computer system, to confirm the accuracy of the drug administration process. We included new prescriptions as well as refill prescriptions in the study. A 'drug item' was defined as a chemical substance that is used in the treatment, cure, prevention, or diagnosis of disease or used to otherwise enhance physical or mental well-being of a patient. For example if 'Paracetamol 500 mg every 6 hourly' was prescribed, it was counted as one drug item. Both oral and parenteral drug items were included but were not analysed separately due to unavoidable practical issues. Although drug items that required simple re-constitutions were included, bulk sterile drug items that needed preparation in the pharmacy were not included in the study.

All pharmacy and nursing staff who were involved in the project had a brief training session prior to the implementation. Drugs to other wards (except the study ward) were dispensed manually (without the help of the technology). 16 pharmacy staff members were involved in the project during the study period and included pharmacists and dispensers.

An uncontrolled before and after study design was used. We used a mixed method approach that included direct observation, structured questionnaire and interviews to study the effects of the stand-alone BCMA system on pharmacy staff and the dispensing process. Nursing staff were interviewed to assess their views. Ethical approval was obtained from the Institutional Review Board of the study hospital.

2.2. Direct observation study

The number of dispensing steps, dispensing timing and potential dispensing errors (PDEs) in the pharmacy was observed, before and after implementing the stand-alone BCMA system. Technical and socio-technical issues encountered by pharmacy staff when using the technology were also observed.

The dispensing process was timed one month before and eight months after implementation. The time taken by one staff member to complete the dispensing process of one drug