

Evidence Briefings on Interventions to Improve Medication Safety

Bar code medication administration systems



Policy question: Do bar code medication administration (BCMA) systems reduce administration errors and improve efficiency?

Current evidence shows: BCMA systems have the potential to reduce administration errors but are sometimes used incorrectly due to technology limitations and poor design (e.g. faulty barcodes). Evidence for reduced error rates comes from studies using voluntary incident report data. Controlled observational studies report inconsistent findings. Limited work has assessed cost of BCMA, although time-and-motion studies reveal reduced time administering medications and potentially more time spent in patient care following BCMA implementation.

Background

Bar code medication administration (BCMA) systems (also referred to as bar code enabled point of care (BPOC) technology), are now adopted by the majority (65.5%) of American hospitals to allow patient identity verification and electronic checking of orders¹. The nurse scans a bar code on their identification tag, the patient's wrist-band, and the medication to be administered. This information is compared with details

in the electronic medication administration record (eMAR) and if a mismatch is detected, the nurse is alerted, typically via a visual or auditory warning on the computer screen. BCMA is believed to enable the verification of the 5 rights of medication management (and so prevent wrong-patient, wrong-dose, wrong-time, wrong-drug and wrong-route errors)². The system also ensures accurate and complete documentation of the medication administration process³. BCMA implementation requires all medication packaging to contain bar codes that can be read by BCMA scanners and all ordered medications to be listed in an eMAR. In Australia, this may require pharmacists to affix appropriate barcodes to medications and manually enter doctor orders into an eMAR, significantly increasing pharmacy workload and creating new opportunities for error.

Methods

We searched PubMed, EMBASE and CINAHL using the terms Barcod* or Bar cod* and Admin*. The search yielded 818 articles. We excluded duplicates, review articles, commentaries and letters. Articles focusing on the adoption of bar coding for processes other than medication administration (e.g. pharmacy dispensing, point-of-care testing, blood transfusions) were excluded. Articles where bar coding was introduced and evaluated simultaneously with other technologies (e.g. computerised provider order entry, decision support, pharmacy information systems, automatic dispensing, smart pumps) were excluded as

it was not possible to determine the impact of BCMA on measured outcomes. Finally, articles describing implementation of BCMA (e.g. guidelines for successful implementation) were excluded. The remaining 43 articles were included in this review.

Results

Safety

Observation of administration errors/review of medication charts

Several before- and after-observational studies determined the impact of BCMA on medication administration errors but results are inconsistent. In a study conducted in two medical-surgical wards and two intensive care units (ICUs), no change in administration errors rates was observed following BCMA implementation, but this was most likely due to the

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large increase in timing errors that occurred⁴. This finding is consistent with another study that reported more medication errors post-implementation in a neonatal ICU due to a large increase (117%) in timing errors⁵. However,

it was inconsistent with a study in a medical ICU that found a 56% reduction in medication errors overall, primarily driven by a large decrease in wrong timing errors⁶. Further evidence of results being inconsistent comes from a before and after prospective observational study, where BCMA was associated with a 54% reduction in medication administration errors in one intervention ward, but no change in the other intervention ward⁷.

Other observational studies have shown clear reductions in error rates: 41% reduction in non-timing administration errors and 27% reduction in timing errors following BCMA in an academic medical centre⁸; 50% reduction in administration errors following BCMA in a surgical ward in a community hospital⁹.

Whether administration errors are reduced post-BCMA appears to be related to the inclusion/exclusion of timing errors in calculating the error rate, and how this error type is defined.

Incident reports

Several studies have involved review of incident reports before and after implementation of BCMA to determine any change in the number of medication errors reported¹⁰⁻¹². All report significant reductions in the number of administration errors reported by staff.

...alerts rarely warn of true medication errors...

In a study that used incident data as a baseline measure of medication error rate and BCMA log data (i.e. alerts generated) as post implementation error rate, an 18% increase in medication errors was observed, but this was most likely due to the change in data source used¹³.

Use of BCMA logs

Studies have used data extracted from BCMA logs to determine the number of errors potentially prevented by BCMA (i.e. alerts generated) and those actually prevented by BCMA (i.e. cases where an alert prevented an inappropriate administration)¹³⁻¹⁴ but several reviews of the alerts generated and overridden by nurses in BCMA have demonstrated that alerts rarely warn of true medication errors¹⁵⁻¹⁸. For example, data extracted from six hospitals using BCMA revealed that although 42% of attempted administrations triggered an alert, 78% were overridden by users and of these, only 10% signaled a discrepancy between what was being administered and what was written in the order¹⁸. In a study assessing the severity of the medication errors detected by BCMA, it was discovered that only 1% of alerts warned of errors with potentially severe consequences¹⁹.

Simulation

In a study where nurses used a manual process and then BCMA to administer medications to patients in a simulated scenario, fewer nurses administered medications to the incorrect patient when using BCMA (39% vs 8%) than when using the manual process²⁰.

Workflow

Many studies have adopted ethnographic approaches and interviews to understand the impact of BCMA on nurses'

work²¹⁻²⁶. These techniques have also resulted in the identification of a number of unanticipated side-effects of BCMA use (e.g. decreased ability to deviate from routine sequences)²⁷, a number of factors influencing use of BCMA (e.g. time shortages)²⁸, and the identification and description of a range of nurse



workarounds to BCMA use (e.g. scanning surrogate barcodes not on patients' wrists)²⁹⁻³². Workarounds are a frequent occurrence and so represent a significant problem for hospitals with BCMA as they potentially compromise patient safety³³. Workarounds are due to a number of technology related, task related, patient related, and environmental factors. Ensuring all medications are barcoded and that bar codes scan reliably and consistently appears to be critical for preventing workarounds.

Use of a 'think out loud' technique revealed that most nurses' thinking did not change after BCMA was introduced³⁴.

Time and motion

A number of studies have used 'time and motion' to assess impact of BCMA on workflow. In all cases, trained observers with stopwatches shadowed nurses during administration rounds. In some studies, time spent on medication administration did not change following implementation of BCMA³⁵⁻³⁶, but in several other studies, time spent on medication administration decreased post BCMA³⁷⁻³⁹. There is also evidence to suggest that use of BCMA is associated with an increase in the time spent in direct patient care (e.g. 182.3s post BCMA vs. 47.4s pre BCMA³⁸; 29.9% of all tasks post vs 26.1% of tasks pre BCMA³⁶).

A study utilising work sampling to assess time spent on various tasks in a medication centre in Taiwan also reported that nurses spent less time on medication related activities following BCMA implementation⁴⁰.

Attitudes and perceptions

Many studies involved the administration of surveys to nurses pre and post BCMA implementation to gauge views and perceptions of the new technology⁴¹⁻⁴⁶. In all cases, nurses believed that fewer errors were likely to occur with BCMA in place, but also felt that the system was more time consuming than the traditional paper approach, and so potentially reduced time spent with patients, contrary to what has been reported in 'time and motion' studies.

Cost

In only one study was cost of implementing and operating a BCMA system estimated⁴⁷. Cost data were collected from interviews with key informants and the financial records of four community hospitals. Based on the authors' estimate of number of potential adverse drug events prevented by BCMA (based on BCMA log data),¹⁸ the cost of

BCMA was estimated to be US\$2000 per harmful medication error avoided, less than the estimated cost of care associated with such errors (US\$3100-\$7400).

Conclusions

BCMA systems are potentially effective in reducing administration errors when designed well and used correctly, but the evidence for improved patient outcomes with these systems is less clear. Much research has utilised incident reports (which under-estimate error rates) and BCMA log data (which provide more comprehensive data but often overestimate error rate) to demonstrate effectiveness. Different data sources used to measure errors pre- and post-BCMA influence study results. Controlled observational studies that have been conducted report inconsistent findings. Technology limitations (e.g. system 'time outs', faulty bar codes) frequently prevent scanning of barcodes and result in nurse workarounds. Informing nurses of the impact of BCMA systems on time spent administering medications and time spent with patients may result in more frequent use and improved satisfaction with this technology. Alerts in BCMA systems warning of potential errors appear to be over-sensitive and require revision to minimise alert fatigue.

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