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Scanning medication administration systems

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Scanning medication administration systems

Policy question

Do scanning medication administration systems improve medication safety and improve efficiency?

Current evidence shows

Scanning medication administration systems are likely to reduce medication administration error (MAE) rates, however much of the supporting evidence is of weak quality relying on uncontrolled before-after studies. Most studies were conducted in hospitals that were simultaneously implementing an electronic medication administration record system. The evidence on whether scanning medication administration systems improve efficiency by reducing the time spent on medication administration is inconclusive. Furthermore, the use of scanning technology may be circumvented by healthcare workers if the technology does not support workflow adequately. Common problems include missing barcodes, scanning labels not on the patient wrist, slow computer response times and inadequate hardware to support scanning system use.

Background

Scanning medication administration systems aim to support safe medication administration by facilitating patient identification and verification of the medication to be administered. Typically, a nurse scans a code on a patient identification tag, as well as the medication to be administered. If a mismatch is detected, an alert will be activated to warn the nurse of a potential error. Scanning technology most commonly uses linear barcodes (barcoded medication administration [BCMA]), but can also be implemented using QR (quick response) codes, data matrix codes, radio frequency identification (RFID) and optical scanners.[1-3] In 2014, of 325 US hospitals participating in a pharmacy practice survey, almost all reported using barcode assisted medication administration (93.7%).[4] Scanning medication administration systems require electronic medication administration records,[5] which are often integrated with computerised physician order entry (CPOE) or electronic prescribing systems.[6] Scanning systems may or may not include automated dispensing or storage cabinets. In Australia, the Therapeutic Goods Administration introduced a new standard for the serialisation of medication and use of data matrix codes in order to comply with global standards for medication packaging.[1] The standards require all medication packaging to include a data matrix code, in addition to existing linear barcodes, to support new and existing scanning technology.

In 2013, the Australian Commission on Safety and Quality in Health Care commissioned a Medication Safety Evidence Briefing on barcode medication administration systems.[7] This briefing updates the 2013 evidence briefing with the most recent literature on scanning technology used in medication administration.

Methods

The databases PubMed, EMBASE and CINAHL were searched for articles evaluating the implementation of scanning technology for medication administration. The search terms were based on barcoding OR BCMA OR scanning OR MedEye OR RFID OR QR code combined with medication OR medicine OR drug, and yielded 1467 references in May 2021. Duplicates, review articles, commentaries and letters were excluded; however reference lists of relevant review and commentary articles were reviewed to identify further primary studies. Articles focusing on evaluating scanning technology (e.g. barcodes, QR codes, RFID) for medication administration were included. Articles where scanning technology was introduced and evaluated simultaneously with other technologies (e.g. computerised provider order entry, pharmacy information systems, automatic dispensing or storage cabinets, smart pumps) were excluded as it was not possible to determine the impact of the scanning technology alone on measured outcomes. However, study hospitals often introduced scanning technology in conjunction with electronic medication administration records system and these studies were included. Lastly, articles measuring the impact on MAEs using incident reporting systems were excluded due to known underreporting of errors.[8]

Results

Scanning technology and medication administration errors

There were 11 studies[9-19] evaluating the impact of scanning technology on MAEs and one also evaluated the impact on preventable adverse drug events (ADEs).[13] Ten evaluated BCMA scanning systems and one an optical scanner.[19] Three studies used controlled before-after designs [13,15,16] and eight uncontrolled before-after designs. The majority of studies were conducted in the USA (n=8); one was from Switzerland[12], one from the Netherlands[10] and one from the United Kingdom.[19]

Table 1 summarises the change in overall, non-timing and timing MAE rates reported by studies. Overall, nine of ten studies reported a decrease in MAE rates overall, non-timing MAEs, or timing MAEs. Of the seven studies reporting on wrong timing MAEs, two reported an increase in these errors, one no change and the remaining four a decrease. Two studies compared BCMA impacts on MAE rates in different wards and different hospitals demonstrating that effects can vary between sites (Table 1).

The three USA studies with controlled before-after designs are described in more detail.[13,15,16] The first, in 35 wards of an academic hospital used direct observation and observed a total 14,041 administrations.[16] The study reported a 41.4% reduction in MAEs after electronic medication administration with BCMA introduction (11.5% of administrations with an error on control wards vs. 6.8% on intervention wards, p<0.001). Additionally, there was a 50.8% relative reduction in potential ADEs with the use of electronic medication administration with BCMA (3.1% without vs. 1.6% with; p<0.001). Lastly, the study also reported a reduction in wrong timing errors by 27.33% (p<0.001).

The second controlled before-after study examined the impact of electronic medication administration record system with BCMA on MAEs on two wards against a control ward using direct observations of medication administration.[15] The electronic medication administration with BCMA reduced all MAEs and non-timing MAEs by 35.9% (p=0.035, n=320 administrations) and 54% (p=0.045, n=310 administrations), respectively on one of the intervention wards. However, there was no statistically significant change in MAE rates on the second intervention ward, and this inconsistency in effects was attributed to different medication administration practices on the two intervention wards.

The third study assessed the change in preventable ADEs after implementation of the electronic medication administration with BCMA in a neonatal intensive care unit (NICU) using a structured record audit with a trigger tool.[13] The study reported a reduction in preventable ADEs from 0.86/1000 doses to 0.43/1000 doses (p=0.008), and no change for control beds without the technology. This reduction was primarily due to a reduction in omitted doses with the BCMA. The study also noted that there was an increase in the number MAEs/1000 doses. However, importantly the authors noted that this was likely due to an improved ability to detect wrong timing errors with electronic medication administration with BCMA (there was a 117% increase in wrong timing error detection in the post-intervention period).

Efficiency of medication administration

The association of scanning technology, specifically BCMA, on time spent on medication administration was examined in five before-after studies, with four from the USA[20,22-24] and one[21] from Switzerland. All studies were time and motion studies where observers shadowed nurses during medication administration and timed activities. The studies reported inconsistent effects on time taken to administer medication and differences in methods prohibit firm conclusions.

One study in mixed medical-surgical wards reported a decrease in the average time taken to prepare a single-medication dose (from 24.3s to 15.1s p=0.002);[21] while another study in an ICU reported an increase in the mean duration of total medication administration time from 313s to 378s.[20] However, the latter study reported that this was due to more time spent in medication preparation (27.3s pre- vs. 159.5s post- p<0.05), and that the cohort of patients after BCMA implementation may have differed leading to a more complex medication preparation procedure.[20] One study examined the time taken to administer a medication with BCMA to after RFID implementation and found a significant decrease from 98s to 35s.[24] The RFID was implemented using smart carts (with a computer and scanner) that were used at bedside and contained medications. The remaining two studies examined the proportion of nursing time that was spent on medication administration tasks in medical, surgical wards and ICUs, and reported no significant change after implementation.[22,23]

Workarounds and adherence to scanning procedures

Adherence to scanning procedures has the potential to affect the safety benefits of the technology. Studies examining adherence to scanning reported rates ranging from 55% to 95% or higher.[15,25-30] A large study

Table 1. Results of studies evaluating the impact of BCMA on medication administration error (MAE) rates

	Reported effect on MAE rate outcomes		
Study	**Total MAEs**	**Non-timing MAEs**	**Wrong timing MAEs**
Controlled before-after studies			
Morriss, 2009	↑	NR	↑
Paoletti, 2007	NR	NR	↓
Poon, 2010	NR	↓	↓
Before-after studies			
Bonkowski, 2013*	NR	↓	NR
DeYoung, 2009*	↓	NR	↓
Helmons, 2009 (med-surg units)	●	↓	↑
Helmons, 2009 (ICUs)	●	●	●
Hassink, 2013	↓	↓	NR
Kung, 2021*	●	NR	↓
Owens, 2020	NR	↓	NR
Seibert, 2014 (hospital 1)	↓	↓	NR
Seibert, 2014 (hospital 2)	●	↓	NR
Tolley, 2021	●	●	●

↓ indicates a statistically significant decrease; ↑ indicates an increase; ● indicates no change. NR is not reported.
*These studies evaluated the impact of BCMA alone without a concurrent eMAR implementation.

of over 23,000 administration in a Dutch hospital reported the most frequent reasons for not adhering to scanning medication administration system procedures included: difficulties in scanning barcodes on medication labels, lack of awareness of barcodes on medication labels, slow computer response times, lack of time and administration of the medication before a prescription was available.[29]

Workarounds may be used when the implemented technology does not adequately support workflows. A study from the Netherlands observed 5793 instances of medication administrations across four hospitals and found that 63% of these instances had one or more BCMA workarounds, with substantial differences in this rate between hospitals.[31] Furthermore, the use of workarounds was associated with a 3-fold higher odds of MAEs (odds ratio: 3.06, 95% CI: 2.49-3.78). Workarounds reported in studies include: scanning barcodes not on patients' wrists, carrying several patients' pre-scanned medication on trolleys or carts, and scanning before actual administration.[31-33] Studies

Medication scanner (photograph: Viewfinder, Adobe Stock)

emphasised that ensuring the hardware supports scanning technology use (e.g. computers on wheels that fit in patient rooms; wireless scanners) and understanding why workarounds are used assisted in finding solutions that minimise workarounds.

Conclusions

While scanning medication systems can include a range of technologies, research has primarily evaluated BCMA systems reflecting the wider adoption of BCMA technology.[2,4] There is growing evidence that BCMA may reduce MAEs; however, this primarily comes from uncontrolled studies and evidence from studies with more rigorous designs, such as randomised controlled trials, are not available. Furthermore, most studies are conducted in one hospital, limiting generalisability to other settings. This is reinforced by the few studies that reported variation in BCMA effects on MAEs in different wards and different hospitals; as well as differences in the use of workarounds. Given the complexities of implementing scanning medication administration systems, careful consideration of how they support medication administration workflow is needed prior to, and after implementation, to minimise workarounds and improve adherence to scanning procedures.[34]

Lessons learned from implementation

- Implementation of scanning medication administration systems requires careful consideration of infrastructure (e.g. wireless network), device selection, and software interface with pharmacy systems (including whether repackaging of medication and new labelling to accommodate machine-readable codes is required).[24,31-33]
- Using data generated by scanning medication administration systems (e.g. alert override data) allows identification of potentially unsafe medication practices that may need to be addressed, as well as concerns regarding the accuracy of machine-readable codes.[28-30]
- Staff engagement, consultation and feedback was a key component in successful scanning medication administration system implementation, and to understand and address the use of workarounds.[24,30]

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