Mindful Workarounds in Bar Code Medication Administration

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Abstract. Bar-Coded Medication Administration systems (BCMA) are often used with workarounds. These workarounds are usually judged against standard operating procedures or the use of the technology as 'designers' intended'. However, some workarounds may be reasonable and justified to prevent safety errors. In this conceptual paper, we clarify BCMA safety mechanisms and provide a framework to identify workarounds with BCMA that nullify the error prevention mechanisms inherent in the technology design and process. We also highlight the importance of understanding the purpose behind a nurse's workaround in BCMA, focusing on the notion of mindful (thoughtful) workarounds that have the potential to improve patient safety.

Keywords. Medication safety, workarounds, barcoding, closed-loop systems

1. Introduction

Bar-Coded Medication Administration systems (BCMA) are implemented in hospitals to reduce preventable medication errors and improve medication safety [1, 2]. Research suggests that for BCMA to contribute to safety, BCMA must be used as designers' intended, without workarounds, as these may lead to medication administration errors [1, 3, 4]. Nurses are the main users of BCMA and also considered the last line of defense in preventing medication errors reaching the patient.

However, research in high-risk organizations has shown how safety is sometimes achieved by operators not using technology as designers intended [8]. In circumstances of danger unplanned for by designers, staff resourcefulness and deviations from protocols are mechanisms for resilience and contain potential harm. This contribution to safety should be considered when approaching the implementation of BCMA technology and assessing its impact. Some violations to BCMA procedures may be due to nurses' 'good judgement' [5] and enable safe care. It is therefore necessary to distinguish between workarounds of different quality – those that introduce risks to patient safety, those that do not introduce risks, and those that prevent or contain risks (also potentially created by the technology). An understanding of the mechanisms conducive to safety (or errors) may inform this distinction.

In this conceptual paper, we wish to distinguish between workarounds with BCMA that nullify the technology's safety mechanisms, and those that do not. We believe this would lead to a better understanding of the contribution of BCMA to medication safety.

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2. Methods

We sought to identify the mechanisms that may be conducive of safety in nurses' administration of medications to hospital patients with BCMA [6, 7].

We analyzed conceptually the typical BCMA functionalities to verify that the right medication (including right dose, route, and time) is being administered to the right patient, by scanning barcodes of both the patient and the medications against an electronic record. With such a system, the patient is associated to a machine readable barcode, typically by wearing a wristband; the medication's packaging (possibly in single dose) also bears a barcode that identifies the item. We analyzed and modelled the intended high-level workflow of such a BCMA (Figure 1) to identify the mechanisms of error prevention and underlying assumptions. We then hypothesized how workarounds in BCMA use could nullify (or not) each of the mechanisms we identified and how errors may then occur.
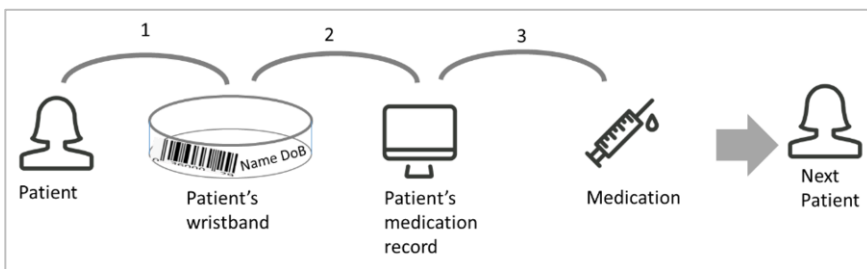
Figure 1. Bar-Coded Medication Administration (BCMA) high-level workflow for error prevention

3. Results

3.1. Mechanisms of error prevention

BCMA prevents medication errors by a three way match verification process involving four steps, performed at each administration, possibly in any order:

I.   Verification that the correct barcode is associated with the intended patient, e.g. by asking the patient to confirm their name and date of birth, and matching this information with patient details indicated on the wristband *(right patient)*.

II.   Verification that the correct medication record has been selected, by scanning the patient barcode with the electronic medication system *(right record)*. The system automatically opens the record, or alerts the nurse if a record cannot be found.

III.   Verification that the correct medication has been prepared for administration, as prescribed in the patient record, by scanning the medication barcode with the electronic medication system. The system alerts the nurse if the medication does not match what has been prescribed *(right medication – item, dose, time, route)*.

IV.   The three verifications steps are performed for each patient and their medications separately, not in batches over multiple patients. Nurses will prepare, verify and give medications to each patient one at a time. The risk

otherwise is that the medications may be mixed-up between patients *(right patient, right medication)*.

In addition, only if all three verification steps have been completed before (and not after) administration of the medication for each single patient (not in batches), the system may prevent administration errors. It is also necessary that the nurse does not disregard any alerts generated in these verification steps [8]. However, for safety to be achieved, this set of mechanisms also assumes that the right medications have been prescribed to the patient, in the correct patient record; otherwise the wrong (unintended) medication may be administered to the (unintended) patient.

3.2. Nullifying and not-nullifying workarounds

We propose that workarounds that nullify BCMA's error prevention mechanisms are those where only some, but not all, of the steps are completed. For example, when the nurse assumes that the barcode on the patient's wristband is correct and does not complete step I in the process; when the nurse does not use the patient wristband to open the record (step II), and instead selects the record on screen; when the nurse scans the medications after (instead of before) giving it to the patient; when the nurse scans multiple patients, and/or medications intended for different patients at the same time (processing the task in batches – IV). It is also possible that the steps are completed but without paying attention to alerts [8] or to 'what happened on the computer' [9] at the time of scanning barcodes.

Instead, not-nullifying workarounds are those where nurses adapt the use of BCMA to contextual aspects of the medication administration process, but still enable the nurse to complete all verification steps. For example, the patient wristband may not be physically on the patient, but the nurse still checks with the patient that the barcode on the wristband is correct (step I). These workarounds are not nullifying the error prevention mechanisms of the BCMA as intended by its design, and suggest that the nurse is 'mindful' (thoughtful) in their approach to the use of BCMA.

3.3. When the underlying assumptions do not hold true – the wrong order

A major risk introduced by the use of BCMA is the medication being given to an unintended patient when the order has been entered in the wrong patient record.

If doctors have prescribed a medication in the wrong record, BCMA may not prevent administration, or alert the nurse of the error. This was noted in a study [10], where a nurse explained: *'I know my patient and then an order will pop up, "Give Lopressor or give whatever to this patient" and I know that can't be for my patient. Sometimes physicians inadvertently make a wrong order on a patient'* (p85).

Instead, BCMA introduces the risk that nurses will rely on the technology and give to the patient what has been ordered without questioning it, as the technology 'says so' (non-mindful use of the BCMA). The main barrier to such errors is the nurse's quality of attention, as well as their knowledge of the patients, highlighting again the importance of 'mindful' approaches to the use of BCMA. In the context of reliability and safety, mindfulness indicates a critical stance [11, 12], such as nurses' asking questions of the technology and of the prescription.

Different combinations of nullifying and not-nullifying workarounds, and their relationship to 'mindful' use of the BCMA are summarized in Table 1.

Table 1. Examples of safety mechanisms of barcoded medication administration (BCMA), the nullifying/not nullifying effects of workarounds in combination across the different mechanisms and nurses' mindful (thoughtful) or non-mindful (over-reliance on technology) use of BCMA

Effect of combination of workarounds	Safety mechanisms				Description	Mindful use of BCMA
	I	II	III	IV		
Not-nullifying	Y	Y	Y	Y	Despite BCMA not used to the rule, nurses' actions still enabled to confirm right patient, right record and right medication	Mindful
Nullifying	Y	N	?	?	Despite BCMA use, and confirmation of the right patient, there has been no check on whether the record is right for this patient, thus a risk the medications are not right	Non-Mindful
Nullifying	N	?	?	?	Despite BCMA use, and a match on the record, there has been no check on whether the patient barcode is right, thus a risk that record and medications are not right	Non-Mindful
Nullifying	Y	Y	N	?	Despite BCMA use, and confirmation of the right patient, and check that the record is right for this patient, there has been no check on whether the medications are right	Non-Mindful
Nullifying	Y	Y	Y	N	Despite BCMA use, by processing medications across patients in batches there is a risk of medication mix-ups	Non-Mindful
No workarounds	Y	Y	Y	Y	Compliance with BCMA intended use may not detect orders written in the wrong record (unless mindful use)	Mindful/Non-mindful

Note: I = verifying patient with patient barcode; II = matching medication record with patient barcode; III = matching medication barcode with medication record; IV = verification one patient at a time, and with attention to alerts; Y/N = yes/no to performing each verification step; ? = either Y or N. The table does not include all possible alternatives; it does not intend to suggest a direct correspondence between (not-)nullifying workarounds and mindful attention; e.g. nullifying workarounds by nurses mindfully asking questions of the prescription are possible.

4. Discussion and conclusion

Workarounds are a difference between work as done and work as prescribed or imagined, explainable by a variety of sociotechnical factors (e.g. [13, 14]). In use of clinical systems, 'dangerous workarounds exist that should be reduced to improve safety' [7]. In using BCMA to reduce medication errors, the question is which workarounds are dangerous and should be reduced, and which ones contribute to safety. To answer this question, we propose that workarounds may be 'nullifying' and 'not nullifying' BCMA safety mechanisms, and nurses' attention with BCMA may be of mindful or mindless quality. Given that BCMA systems have been implemented across health care systems worldwide; having a more detailed and nuanced analysis of the types of workarounds used by nurses, including where they may actually be justified to enhance patient safety is crucial for our future understanding of technology development and usability.

We believe that understanding BCMA technology's safety mechanisms, may inform interventions to improve the safety of BCMA use. The set of mechanisms we have

identified can provide a framework for evaluating the adoption/use of BCMA. The framework may also be part of nurses' training in the use of BCMA. It is essential that nurses understand how and why this technology may improve safety, including its limitations, as understanding *why* may encourage mindful attention in using BCMA, and prevent them engaging in nullifying workarounds. Future research may empirically investigate what are the most common types of workarounds for each mechanism, which ones are nullifying/not-nullifying, what are the contexts that may influence these workarounds, and propose interventions focused on nullifying workarounds.

To conclude, we stress that in using BCMA, what is important is not necessarily compliance with designers' intentions (i.e. absence of workarounds), but the 'quality of workarounds' and the quality of attention nurses pay to the activity and the technology. There is a real risk of nurses' 'reduced critical thinking and [reduced] situational awareness' with BCMA [15]. The potential of nurses' over-reliance on technology is one of the most difficult challenges to address in pursuing medication safety.

References

[1]   Strudwick G, Reisdorfer E, Warnock C, Kalia K, Sulkers H, Clark C, and Booth R, Factors Associated With Barcode Medication Administration Technology That Contribute to Patient Safety: An Integrative Review, J Nurs Care Qual 33 (2018), 79-85.
[2]   Hutton K, Ding Q, and Wellman G, The Effects of Bar-coding Technology on Medication Errors: A Systematic Literature Review, J Patient Saf 17 (2021), e192-e206.
[3]   van der Veen W, van den Bemt PM, Wouters H, Bates DW, Twisk JW, de Gier JJ, Taxis K, Group BS, Duyvendak M, and Luttikhuis KO, Association between workarounds and medication administration errors in bar-code-assisted medication administration in hospitals, Journal of the American Medical Informatics Association 25 (2017), 385-392.
[4]   Koppel R, Wetterneck T, Telles JL, and Karsh BT, Workarounds to barcode medication administration systems: their occurrences, causes, and threats to patient safety, Journal of the American Medical Informatics Association 15 (2008), 408-423.
[5]   Koppel R, Bar-coded medication administration brings trade-offs even with humane automation and lean approaches, Joint Commission Journal on Quality & Patient Safety 40 (2014), 339-340.
[6]   Holden RJ, Rivera-Rodriguez AJ, Faye H, Scanlon MC, and Karsh B-T, Automation and adaptation: nurses' problem-solving behavior following the implementation of bar-coded medication administration technology, Cognition, Technology & Work 15 (2013), 283-296.
[7]   Patterson ES, Workarounds to intended use of health information technology: a narrative review of the human factors engineering literature, Human Factors 60 (2018), 281-292.
[8]   Sloss EA and Jones TL, Alert Types and Frequencies During Bar Code–Assisted Medication Administration: A Systematic Review, J Nurs Care Qual 35 (2020), 265-269.
[9]   Hong JY, Ivory CH, VanHouten CB, Simpson CL, and Novak LL, Disappearing expertise in clinical automation: Barcode medication administration and nurse autonomy, Journal of the American Medical Informatics Association 28 (2021), 232-238.
[10]   Eisenhauer LA, Hurley AC, and Dolan N, Nurses' reported thinking during medication administration, J Nurs Scholarsh 39 (2007), 82-87.
[11]   Langer EJ, Mindfulness, Da Capo Press, 2014.
[12]   Weick KE, Sutcliffe KM, and Obstfeld D, Organizing for High Reliability: Processes of Collective Mindfulness, Research in Organizational Behavior (1999), 81-123.
[13]   Azad B and King N, Enacting computer workaround practices within a medication dispensing system, European Journal of Information Systems 17 (2008), 264-278.
[14]   Blijleven V, Koelemeijer K, Wetzels M, and Jaspers M, Workarounds emerging from electronic health record system usage: consequences for patient safety, effectiveness of care, and efficiency of care, JMIR human factors 4 (2017), e7978.
[15]   Williams R, Aldakhil R, Blandford A, and Jani Y, Interdisciplinary systematic review: does alignment between system and design shape adoption and use of barcode medication administration technology?, BMJ Open 11 (2021), e044419.