Use of mobile devices and medication errors in acute care: a systematic review protocol

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Review question/objective: The objective of this review is to synthesize the best available evidence on the effects of healthcare providers using mobile devices at any stage of medication provision on medication errors in acute care settings. Provision of medication includes prescribing, dispensing or administrating medicine in the acute care setting.

Keywords Cellular phones; handheld computers; medication errors; tablets

Background

Medication errors are potentially life threatening but yet a common occurrence in the acute care setting. In Canada, medication errors are one of the most common adverse events in health care.1 According to the Canadian Institute for Health Information, about one in 10 patients had been given the wrong medication or the wrong dose over the past two years.2 According to the Institute of Medicine in the United States, 2% of admissions experience a preventable adverse drug event resulting in increased length of stay, 4.6 days on average, increased hospital cost of $4700 per admission, totaling $2.8 million for a 700-bed teaching hospital.3 This is similar to Australian data that suggest that 2-4% of all hospital admissions, and up to 30% of hospital admissions of those over 75 years of age, are directly related to medication errors of some kind.4 Up to three-quarters of these were found to be potentially preventable. A systematic review that included data from the United Kingdom and the United States of America indicated that prescription errors are a common occurrence, affecting 7% of medication orders, 2% of patient days and 50% of hospital admissions.5 Medication errors in hospitals are a leading cause of adverse drug reactions, resulting in disability or death in as many as 6.5% of inpatients.6-9 Medication errors also have an economic impact on patients and healthcare systems; two major reports have estimated the costs totaling up to billions of dollars.10,11

Factors that contribute to medication errors have been identified as the lack of appropriate technologies, poor labeling, prescription errors (e.g. inability to read handwriting), poor communication and workload of the healthcare professional.11 The majority of medication errors occur at the administration stage (53%), followed by errors made in the prescription stage (17%).12 With a lack of systems or technology in medication provision, practitioners either develop work-around solutions or significantly under-report the occurrence of adverse events11,13. Medication errors have a serious, detrimental effect on inpatients in the hospital setting, including physical injury, financial burden and death.15,16

To address medication errors, factors specifically related to verbal and written communication, drug interactions or incompatibilities, software programs have been created to allow for electronic orders of medication prescriptions. Studies have addressed the use of handheld computers for entering medication orders and alerts for dosages, drug interactions or allergies.17-21 In addition to using software programs to write or prescribe the medication orders,
programs have been created to assist with dosage calculations when dispensing the medications. Studies have been conducted that demonstrate the ability of these programs to reduce medication errors during the provision of medication, such as using handheld devices with specialized software to scan barcodes during medication administration.\textsuperscript{22-28} Using mobile devices at one point alone throughout the medication administration process has not been completely error free. Using computers for order entry is not error free and can even increase errors when initially converting from paper to computers.\textsuperscript{29} When wrong-time errors are excluded, using mobile devices during administration decreases medication error.\textsuperscript{30} In other studies, using mobile devices by physicians while prescribing medications decreased errors, while nurses who used mobile devices during medication administration did not report a significant reduction in medication errors.\textsuperscript{15,31} Given that medication errors have such detrimental and significant consequences on the safety of the hospitalized patient, and given that technology has increased its presence in the healthcare setting, determining the effectiveness of handheld computer use at various stages of medication provisions is necessary to contribute to the understanding of how medication errors are affected by mobile devices.

To ensure that no previous systematic reviews have been done on this topic, an initial search was done in the JBI Database of Systematic Reviews and Implementation Reports, the Cochrane Library, OVID Medline, Epistemonikos and CINAHL. Studies have been conducted that examined medication errors and handheld devices in the community or outpatient settings, as well as studies that focused specifically on healthcare providers as well as patients.\textsuperscript{32-34} There have been systematic reviews on interventions to reduce medication errors in intensive care units and in pediatric settings, which include handheld computer use but none addressed exclusively handheld computer use during medication provision.\textsuperscript{15-37} This systematic review aims to address that gap in the literature.

\textbf{Inclusion criteria}

\textit{Types of participants}

This quantitative review will consider studies that include any regulated healthcare provider (physicians, nurse practitioners, nurses and pharmacists) whose professional responsibilities and license include one or more of the following: medication prescription, medication dispensation or medication administration.

\textit{Types of intervention(s)/phenomena of interest}

This review will consider studies that evaluate the effectiveness of mobile devices at any stage of medication provision as compared to not using any technological device or the standard practice of utilizing desktop or laptop computers which lack portability, size and use different software applications. Mobile devices are devices that are portable and small in size (e.g. fit into a pocket or sleeve) such as personal digital assistants, smartphones, iPads or tablets that are used for medication provision (prescribing, dispensing or administration of medication). Software on the handheld computer can include any type of software, proprietary or commercial, that assists the provision of medication by the healthcare provider.

\textit{Outcomes}

For the purpose of this review, medication error will be limited to preventable adverse events, irrespective of resultant harm to the patient or client. Thereby this review will consider studies that include the following medication errors: wrong medication, wrong route or site, wrong dose, extra dose, unordered drug, wrong time related to any or all of the components of dispensing, administration or ordering.

\textit{Types of studies}

This quantitative review will include randomized controlled trials, non-randomized controlled trials, quasi-experimental, before and after studies, prospective and retrospective cohort studies, case-control studies and analytical cross-sectional studies.

\textit{Search strategy}

The search strategy will aim to find both published and unpublished studies. A three-step search strategy will be used for this review. An initial limited search of OVID Medline, CINAHL and EMBASE will be undertaken followed by analysis of the text words contained in the title and abstract, and of the index terms used to describe the articles. A second search using all identified keywords and index terms will
then be undertaken across all included databases and gray literature resources. Finally, the reference list of all selected reports and articles will be searched for additional studies. Studies published in English will be considered for inclusion in this review. The search will not include any limitations on publication dates as using mobile devices in health care is a relatively new phenomenon.

The search will use both index terms and keyword searching as appropriate to each individual database. Search terms (and their variants) will focus on two concepts:

- Technology: cellular phones, handheld computers, mobile devices, tablets, wireless technology, mobile health, text messaging, personal digital assistants, mobile applications and Apple/Android/Blackberry.
- Medication errors: medication/prescription errors, inappropriate prescribing, drug dosage calculations, medication safety, adverse drug events, transcription errors, near misses and accidental overdoses.

The following databases will be searched for published studies:

- OVID Medline
- EMBASE
- Cochrane Central Register of Controlled Trials
- International Pharmaceutical Abstracts
- CINAHL
- Scopus
- Web of Science
- PubMed.

The following resources will be searched for unpublished work:

- Google Scholar
- TRIP
- ProQuest Dissertations and Theses
- Canadian Agency for Drugs and Technologies in Health
- OpenGrey

Assessment of methodological quality

Quantitative papers selected for retrieval will be assessed by two independent reviewers for methodological validity prior to inclusion in the review using standardized critical appraisal instruments from the Joanna Briggs Institute Meta Analysis of Statistics Assessment and Review Instrument (JBI-MAStARI) (Appendix I). Any disagreements that arise between the reviewers will be resolved through discussion or with a third reviewer.

Data extraction

Quantitative data will be extracted from papers included in the review using the standardized data extraction tool from JBI-MAStARI (Appendix II). The data extracted will include specific details about the interventions, populations, study methods and outcomes of significance to the review question and specific objectives.

Data synthesis

Quantitative papers will, where possible, be pooled in statistical meta-analysis using JBI-MAStARI. All results will be subject to double data entry. Effect sizes expressed as odds ratio (for categorical data) and weighted mean differences (for continuous data) and their 95% confidence intervals will be calculated for analysis. Heterogeneity will be assessed statistically using the standard Chi-square and also explored using subgroup analyses based on the different quantitative study designs included in this review. Where statistical pooling is not possible, the findings will be presented in narrative form including tables and figures to aid in data presentation where appropriate.

Acknowledgements

This study is funded in part by the College of Nursing, Faculty of Health Sciences, University of Manitoba Systematic Review Award.

References


Appendix I: MAStARI appraisal instruments

JBI Critical Appraisal Checklist for Randomised Control / Pseudo-randomised Trial

Reviewer ................................ Date ................................

Author ...................................... Year .............. Record Number ........

1. Was the assignment to treatment groups truly random? Yes ☐ No ☐ Unclear ☐ Not Applicable ☐
2. Were participants blinded to treatment allocation? ☐ ☐ ☐ ☐
3. Was allocation to treatment groups concealed from the allocator? ☐ ☐ ☐ ☐
4. Were the outcomes of people who withdrew described and included in the analysis? ☐ ☐ ☐ ☐
5. Were those assessing outcomes blind to the treatment allocation? ☐ ☐ ☐ ☐
6. Were the control and treatment groups comparable at entry? ☐ ☐ ☐ ☐
7. Were groups treated identically other than for the named interventions? ☐ ☐ ☐ ☐
8. Were outcomes measured in the same way for all groups? ☐ ☐ ☐ ☐
9. Were outcomes measured in a reliable way? ☐ ☐ ☐ ☐
10. Was appropriate statistical analysis used? ☐ ☐ ☐ ☐

Overall appraisal: Include ☐ Exclude ☐ Seek further info. ☐

Comments (Including reason for exclusion)

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## JBI Critical Appraisal Checklist for Descriptive / Case Series

**Reviewer __________________________ Date __________________________**

**Author __________________________ Year __________ Record Number __________**

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<th>Question</th>
<th>Yes</th>
<th>No</th>
<th>Unclear</th>
<th>Not Applicable</th>
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<tbody>
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<td>1. Was study based on a random or pseudo-random sample?</td>
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<td>2. Were the criteria for inclusion in the sample clearly defined?</td>
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<td>3. Were confounding factors identified and strategies to deal with them stated?</td>
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<td>4. Were outcomes assessed using objective criteria?</td>
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<td>5. If comparisons are being made, was there sufficient descriptions of the groups?</td>
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<td>6. Was follow up carried out over a sufficient time period?</td>
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<td>7. Were the outcomes of people who withdrew described and included in the analysis?</td>
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<td>8. Were outcomes measured in a reliable way?</td>
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**Overall appraisal:**
- Include □
- Exclude □
- Seek further info □

**Comments (Including reason for exclusion)**

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### JBI Critical Appraisal Checklist for Comparable Cohort/Case Control

**Reviewer**  
Date

**Author**  
Year  
Record Number

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<td>1. Is sample representative of patients in the population as a whole?</td>
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<td>2. Are the patients at a similar point in the course of their condition/illness?</td>
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<td>3. Has bias been minimised in relation to selection of cases and of controls?</td>
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<td>4. Are confounding factors identified and strategies to deal with them stated?</td>
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**Overall appraisal:**  
Include  
Exclude  
Seek further info.

**Comments (Including reason for exclusion)**

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Appendix II: MASTARI data extraction instrument

JBI Data Extraction Form for Experimental / Observational Studies

Reviewer  Date
Author  Year
Journal  Record Number

Study Method
RCT  Quasi-RCT  Longitudinal
Retrospective  Observational  Other

Participants
Setting
Population

Sample size
Group A  Group B

Interventions
Intervention A

Intervention B

Authors Conclusions:

Reviewers Conclusions:
### Study results

**Dichotomous data**

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**Continuous data**

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