

# Enhance the Accuracy of Medication Histories for the Elderly by Using an Electronic Medication Checklist

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## Abstract

Medication errors may result in serious safety issues for patients. Medication error issues are more prevalent among elderly patients, who take more medications and have prescriptions that change frequently. The challenge of obtaining accurate medication histories for the elderly at the time of hospital admission creates the potential for medication errors starting at admission.

A study at a central Texas hospital was conducted to assess whether an electronic medication checklist can enhance the accuracy of medication histories for the elderly. The empirical outcome demonstrated that medication errors were significantly reduced by using an electronic medication checklist at the time of admission. The findings of this study suggest that implementing electronic health record systems with decision support for identifying inaccurate doses and frequencies of prescribed medicines will increase the accuracy of patients' medication histories.

**Keywords:** electronic medication checklist, medication history, adverse drug events (ADEs), admission interview, the elderly, medication errors, electronic health record

## Introduction

The occurrence of medication errors in healthcare facilities in the United States is a widely noted problem, and prevention of medication errors has become a critically important national priority.<sup>1</sup> In the medical field, an error is defined as “the failure of a planned action to be completed as intended (i.e., error of execution), or the use of a wrong plan to achieve an aim (i.e., error of planning).”<sup>2</sup> In previous studies, several types of medication errors were identified, including commission errors (addition of a drug not used before admission), omission errors (deletion of a drug used before admission), and incorrect drug dose and/or frequency.<sup>3</sup> Medication errors are associated with adverse drug events (ADEs) and with increased risk of patient morbidity and mortality.<sup>4-8</sup> However, obtaining accurate medication histories can often be a difficult task for health professionals.<sup>9-19</sup> The medication history in the hospital medical record is often incomplete, as 25 percent of the prescription drugs in use are not recorded and 61 percent of all patients have one or more drugs not registered.<sup>20</sup> The Institute of Medicine report *To Err Is Human: Building a Safer Health System* identified medication errors as the most common type of error in healthcare; medication errors occur commonly in hospitals and account for 1 out of 854 inpatient deaths.<sup>21</sup>

To avoid medication errors and ADEs, the Joint Commission mandated that all facilities accredited by it must “accurately and completely reconcile medications across the continuum of care.”<sup>22</sup> The medication reconciliation process involves compiling a complete and accurate list of a patient's home medications and comparing that list to a provider's admission orders.<sup>23</sup>

The US Department of Health and Human Services Administration on Aging reported there were 36.3 million people 65 years of age or older in the United States in 2005.<sup>24</sup> Prescription drugs were used more frequently by the elderly than by younger people, and the highest overall prevalence of medication use was among adults age 65 years and older: more than 40 percent of ambulatory patients over 65 years old use at least 5 medications per week, and 12 percent use at least 10 medications per week.<sup>25, 26</sup> With the increased number of medications being taken, the possibility of an error is increased. The elderly use the most medications, change medication prescriptions frequently, and have the highest potential risk from errors in prescribing.<sup>27-29</sup> Previous studies have estimated the prevalence of potentially inappropriate medication use by the elderly as ranging from 12 percent to 40 percent, and there was no decline in utilization of potentially inappropriate medications from 1995 to 2000.<sup>30</sup> Incorrect use of medications in the elderly can increase the risks of falling, confusion, depression, constipation, immobility, and hip fractures.<sup>31, 32</sup> Other potential problems are inappropriate drug interactions plus the condition that the prescription drug is not effective in treating.<sup>33</sup>

Researchers have identified multiple factors contributing to medication errors, including polypharmacy (defined as concurrent use of nine or more medications),<sup>34</sup> the loss of the community pharmacy filter,<sup>35</sup> language and cultural barriers,<sup>36</sup> old age,<sup>37, 38</sup> low health literacy,<sup>39, 40</sup> multiple changes in medication regimens,<sup>41</sup> and recall bias.<sup>42</sup> These multiple factors lead to difficulties for patients, especially the elderly, in identifying their medication regimens upon admission. Dobrzanski et al.<sup>43</sup> have identified that up to 27 percent of all hospital prescribing errors can be attributed to incomplete medication histories at the time of admission. Early identification and correction of admission medication errors may mitigate or prevent harm. In particular, the medication history is mainly based on the patient's self-reported medication history at the time of hospital admission. Inaccuracies in a medication history are not uncommon and are often caused by a patient's unreliable memory, hasty interviews, recording errors, or an interviewer's unfamiliarity with certain drugs.<sup>44, 45</sup> Therefore, it is imperative that admission medication histories of the elderly be evaluated for accuracy.<sup>46</sup>

The literature suggests a lack of a gold standard<sup>47, 48</sup> that constitutes a "good medication history." Most research does not include a formal definition of a good medication history. Gleason et al.<sup>49</sup> expressed that healthcare professionals need to educate patients concerning the importance of providing up-to-date medication lists and updating the information at every healthcare visit. A summary of safe-practice recommendations for reconciling medications at admission was published in the *Joint Commission Journal on Quality and Patient Safety* in January 2006. The recommendations included collecting a complete and accurate list of current medications for each patient upon admission. The goal is to develop the most complete medication list possible, although it was noted that this may not always be possible. The second recommendation is to confirm the medication list with the patient and then assign principal responsibility for collecting the list to someone with sufficient expertise, within a context of shared accountability.<sup>50</sup> In light of these broad and varied recommendations, it is clear that more specific interventions to obtain an accurate medication list are needed.

Beers et al.<sup>51</sup> stated that the methods used for sharing information about medications were inadequate and increased the risk for medication errors. They proposed that focusing on standardized processes to gather medication information and using appropriate tools may enable nurses to obtain complete and accurate medication lists from the elderly. Developing nursing interventions to be used at the time of admission that assist the elderly in managing their medications can help prevent medication errors and patient death. Electronic health record (EHR) systems have the potential to reduce errors and improve quality of care.<sup>52, 53</sup> As one of the applications in an EHR system, an electronic medication checklist is assumed to be able to reduce medication errors by using structured data input and an alert function. However, the alert function in an electronic medication checklist can also be a cause of medication errors because sometimes the alert function is turned off.<sup>54</sup> In that case, a feature that was meant to help can be a problem in the end because people assume that safety measures are in place.

The purpose of this study is to assess whether an electronic medication checklist can enhance medication histories of the elderly obtained at the time of hospital admission. In this study, the researchers proposed the following research question: Will an electronic medication checklist enhance the accuracy

of medication histories obtained at the time of hospital admission for elderly individuals, 65 years of age and older, who are taking five or more prescribed medications?

## **Methods**

This study was conducted at a central Texas hospital in fall 2011. The hospital is a 400-bed facility located in a suburban community. The hospital had been using a handwritten process to account for medication histories upon admission. The study was conducted partially because the hospital transitioned from one EHR system to a new EHR system within two months of the time of the study. The hospital wanted to assess the electronic medication checklist, which was a new application to be included in the new EHR system.

To conduct the research, convenience samples of eligible professional registered nurses were recruited first. Since the study was conducted without controlling for staffing levels, the researchers wanted to ensure that the participating nurses had sufficient and similar capabilities. Thus, participants' inclusion criteria included current employment of at least a 0.5 full-time equivalent (FTE), or 20 hours per week. Registered nurses working less than 0.5 FTE, float/PRN staff (any staff not regularly working on the specified unit), and any staff floated to the unit were excluded from the study. Eight registered nurses who satisfied the criteria were recruited. Nurse managers at the hospital were asked to explain the study to the nursing staff, and then a three-hour training on the use of the new electronic medication checklist was provided by the vendor to the participating nurses.

Next, research patients were recruited in the hospital on a voluntary basis. To eliminate patient-related factors that could influence medication errors, such as language,<sup>55</sup> the patients selected for the study included 64 inpatients, including both males and females, with at least one week of hospitalization in this hospital, who were 65 years of age or older, taking five or more medications, alert and oriented, and English speaking. The 64 patients' medication histories during the hospitalization were recorded in the hospital's new EHR system (under the pilot stage) as the assessment baseline. Within three days before discharge, mock admission interviews were conducted with the participating patients. The nurses interviewed the patients and documented the patient's accounting of the medications taken during this hospitalization, using both handwritten documentation and an electronic medication checklist. Each nurse interviewed eight patients and documented 16 medication histories, recording both a handwritten document and the electronic checklist for each patient. To eliminate the external validity risk of repeated tests, half of the patients were interviewed by using handwritten documentation first, then using an electronic medication checklist two days later; the other half were interviewed with an electronic medication checklist first, then using handwritten documentation two days later. The sample size of 32 patients per group was based on Cohen's<sup>56</sup> recommended size of 28. The experimental sample size was increased by 15 percent to allow for missing data; thus the final sample size was 32 patients for each group. Medication histories were collected from the 64 patients. This was a cross-sectional, repeated-measures study. The data collection process is shown in Figure 1.

After the interviews, medication reconciliations were conducted by comparing both the paper-based and electronically assisted documentation with the patients' medication records in the hospital's existing EHR system. Medication errors were identified if the medication had an incorrect dose or frequency. One point was assigned for each error. Also, any additional medications added to the medication list (commissions) or medications missing from the list (omissions) were assigned two points. Omissions and commissions were scored with two points due to an added or missing medication being significant enough to have a higher allocation of weight. In fact, some studies of medication errors only counted commissions and omissions.<sup>57, 58</sup> The total number of points assigned was the medication error score for each patient interview. The medication errors found in the study are reported by categories in Table 1.

## **Results**

In this study, both parametric and nonparametric tests were applied. The parametric test in Table 2 shows that in Group 1 (paper-based interview first, then electronic), the mean medication error scores are 1 when using paper-based documentation and 0.4063 when using the electronic medication checklist,

while in Group 2 (electronic checklist first, then paper-based interview), the mean medication error scores are 0 when using the electronic medication checklist and 0.1875 when using paper-based documentation. A comparison of the two means within the same groups,  $Z_{\text{Group 1}} = 2.6747$ ,  $p < .01$ , and  $Z_{\text{Group 2}} = -3.3205$ ,  $p < .001$ , illustrates that in both groups, the medication error scores obtained using the electronic medication checklist are significantly lower than those obtained using paper-based documentation.

The above tests rely on an assumption of normal distribution. However, the data sets in this study are not normally distributed according to the tests of normality (Tables 3 and 4), since the Kolmogorov-Smirnov tests are significant ( $p = .000$ ). Therefore, the researchers applied nonparametric tests to retest the data sets. Because the results in this study came from repeated measures, the Wilcoxon signed-rank tests, which are used in comparing two related conditions,<sup>59</sup> were adopted. The analysis was run with SPSS v. 18. The outcomes of the Wilcoxon signed-rank tests are reported in Tables 5 and 6. In these two tables, note that in both groups, the median of differences between using an electronic checklist and using a paper chart are significantly different,  $Z_{\text{Group 1}} = 2.449$ ,  $p < .05$  and  $Z_{\text{Group 2}} = -3.945$ ,  $p = .000$ .

In this study, both the parametric and nonparametric tests demonstrate that the electronic medication checklist results in a lower medication error rate than when the medication history is documented by handwritten transcription at the time of admission. These findings are similar to previous studies,<sup>60-62</sup> which identified that using a standardized reconciliation process decreased medication errors. Reasons for the discrepancies include the fact that EHR systems have all medications names listed, so the possibility of error due to free typing in the medication field is eliminated. And when the alert functions are appropriately used in the EHR system, the medication alert function also reduces dose and frequency errors.

This research demonstrates that with a diligent approach to the way in which nurses obtain medication histories, improvement in outcomes may be delivered through the reduction of medication errors. An electronic medication checklist can decrease medication transcription errors when it is used by professional nurses at the time of hospital admission. The results of this study and other studies discussed above suggest that implementation of EHR systems with decision support for identifying inaccurate medication doses and frequencies is expected to increase the accuracy of patients' medication histories.

## Limitations

First, the most obvious limitation to this study is the lack of a gold standard to identify what constitutes a good medication history. Second, nurses participating in the study were primarily on the first shift because this timing made it easier for the researchers to compile the documentation after the mock interviews. The nurses on the first shift may have greater mastery of the new electronic medication checklist than the nurses on other shifts because the vendor representatives are available during that time. In future research, the nurses on other shifts should be included. Third, this study was conducted over a limited time span. When the hospital was approached about this study, the hospital was planning to implement a new EHR system within six weeks. Therefore, the window of opportunity for this study was small. Variables such as staffing levels and patient perception were not studied or controlled. Finally, the sample for this study was from one central Texas hospital, which limits the generalization of results.

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## Notes

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**Table 1**

Data Summary

		Number of Errors by Categories				
		No Error	Frequency Error	Dose Error	Commission Error	Omission Error
Group 1, $n = 32$ (paper, then electronic)	Paper-based documentation	9	12	6	2	5
	Electronic checklist	20	6	5	0	1
Group 2, $n = 32$ (electronic, then paper)	Electronic checklist	32	0	0	0	0
	Paper-based documentation	26	4	2	0	0

**Table 2**

## Parametric Test Outcomes and Comparison

		Error Scores			Comparison		
		Sum	Mean	SD	Z	p-value	r
Group 1, $n = 32$ (paper, then electronic)	Paper-based documentation	32	1	0.8424	2.6747	0.0075	0.43
	Electronic checklist	13	0.4063	0.5599			
Group 2, $n = 32$ (electronic, then paper)	Electronic checklist	0	0	0	-3.3205	0.0009	-0.51
	Paper-based documentation	6	0.1875	0.3966			

**Table 3**

Tests of Normality in Group 1

	Kolmogorov-Smirnov <sup>a</sup>			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Electronic	.391	32	.000	.672	32	.000
Paper	.281	32	.000	.836	32	.000

<sup>a</sup> Lilliefors significance correction

**Table 4**

## Tests of Normality in Group 2

	Kolmogorov-Smirnov <sup>a</sup>			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Paper	.494	32	.000	.478	32	.000

*Note:* Electronic result is constant and was omitted from the test.

<sup>a</sup> Lilliefors significance correction

**Table 5**

Nonparametric Test Statistics

	Differences between Using a Paper Chart and Using an Electronic Checklist in Group 1	Differences between Using an Electronic Checklist and Using a Paper Chart in Group 2
Standardized test statistics ( <i>Z</i> )	2.449	-3.945
Asymp. sig. (two-tailed)	.014	.000
Effect size ( <i>r</i> )	0.31	-0.49

**Table 6**

## Nonparametric Hypothesis Test Summary

	<b>Null Hypothesis</b>	<b>Test</b>	<b>Sig.</b>	<b>Decision</b>
1	The median of differences between using an electronic checklist and using a paper chart equals 0 in Group 1.	Related samples Wilcoxon signed-rank test	.000	Reject the null hypothesis
2	The median of differences between using an electronic checklist and using a paper chart equals 0 in Group 2.	Related samples Wilcoxon signed-rank test	.014	Reject the null hypothesis

**Figure 1**

Data Collection Process

