An Electronic Medical Record (EMR)-Based Intervention to Reduce Polypharmacy and Falls in an Ambulatory Rural Elderly Population

Valerie Weber, MD[1]*, Alan White, PhD*[2]*, and Robb McIlvried, MD, MPH*[1]

[1]Department of General Internal Medicine and Geriatrics, Geisinger Health System, Danville, PA, USA; [2]Abt Associates, Durham, NC, USA.

BACKGROUND: Falls are the leading cause of injury-related deaths in the aging population. Electronic medical record (EMR) systems can identify at-risk patients and enable interventions to decrease risk factors for falls.

OBJECTIVE: The objectives of this study were to evaluate an EMR-based intervention to reduce overall medication use, psychoactive medication use, and occurrence of falls in an ambulatory elderly population at risk for falls.

DESIGN: Prospective, randomized by clinic site.

PATIENTS/PARTICIPANTS: Six-hundred twenty community-dwelling patients over 70 at risk for falls based on age and medication use.

INTERVENTIONS: A standardized medication review was conducted and recommendations made to the primary physician via the EMR.

MEASUREMENTS AND MAIN RESULTS: Patients were contacted to obtain self reports of falls at 3-month intervals over the 15-month period of study. Fall-related diagnoses and medication data were collected through the EMR. A combination of descriptive analyses and multivariate regression models were used to evaluate differences between the 2 groups, adjusting for baseline medication patterns and comorbidities. Although the intervention did not reduce the total number of medications, there was a significant negative relationship between the intervention and the total number of medications started during the intervention period ($p<.01$, regression estimate −0.199) and the total number of psychoactive medications ($p<.05$, regression estimate −0.204.) The impact on falls was mixed; with the intervention group 0.38 times as likely to have had 1 or more fall-related diagnosis ($p<.01$); when data on self-reported falls was included, a nonsignificant reduction in fall risk was seen.

CONCLUSIONS: The current study suggests that using an EMR to assess medication use in the elderly may reduce the use of psychoactive medications and falls in a community-dwelling elderly population.

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INTRODUCTION

Over the next 30 years, the United States will age dramatically, with rapid growth in the elderly population. The economic and social consequences of this trend will create an urgent need to develop innovative strategies to manage chronic illness and maximize quality of life in older persons. Many health care systems are implementing electronic medical records (EMRs); it is hoped that such systems could identify patients at risk for certain disease states and assist in providing routine processes of care for chronic diseases.

Falls are a common problem threatening the independence of older persons. Nearly 1/3 of community-dwelling adults over the age of 65 fall each year, with serious injuries resulting in almost a quarter of those fallers[1]. Falls lead to fractures, functional disability, and even death. Polypharmacy in the elderly is a common phenomenon, with estimates that more than 20% of elderly persons are taking medications with the potential for serious adverse effects, including an increased risk for falls[2]. The number of prescribed drugs has been found to be significant[3,4], with total medications of 4 or greater as an independent risk factor for falls in other studies[5,6]. Medications with sedating properties[7], and in particular, benzodiazepines[8], antidepressants, and phenothiazines[9], have been found to be correlated with an increased risk for falls. Despite this relationship, the literature regarding medication withdrawal for fall prevention is sparse, with only one such trial having previously been published[10]. Much of the literature regarding fall prevention in the elderly focuses on resource-intensive, hands-on programs, which would be difficult to implement in a geographically dispersed rural elderly population. Physicians in office practice struggle with how to fit fall risk factor evaluation into an office visit packed with competing needs; therefore, strategies that uncouple interventions from office visits are needed.

Over the past several years, reports of computerized systems being used to improve chronic disease care and/or prevention have appeared in the literature. Such trials showed enhanced compliance with cancer prevention guidelines[11,12] and increases in the use of cholesterol-lowering drugs for the secondary prevention of coronary disease[13]. Many of these studies used either computer-prompted "reminders" to physicians occurring during visits or guidelines available to physicians on the EMR. As reminders and prompts are more widely used, it is clear that their contextual relationship can impact physician usage. Prompts must be properly timed, be easy and quick to use, and provide helpful content. The response to "automated" prompts can quickly extinguish as physicians' attention to them declines; a phenomenon known as "alert fatigue"[14]. Conversely, there is strong evidence that physicians do respond well to professional "opinion leaders" in a specific content area and/or academic detailing[15]. The objectives of this study were to evaluate whether a unique EMR-based intervention combined with the use of opinion leaders could reduce medication use and the number of falls in an ambulatory elderly population at risk for falls.

METHODS

Study Population

The Geisinger Health System (GHS) is an integrated delivery system that serves a 40-county area of over 2.5 million persons in largely rural central and northeastern Pennsylvania. Since 2001, GHS has possessed a fully integrated ambulatory EMR. The EMR contains all information regarding patients' care, including medications, radiologic and laboratory studies, times and dates of appointments with all system providers, documentation of all phone calls between the office and patients, and documentation for each encounter.

The EPICcare database was queried in October, 2002, to identify GHS patients who met the following inclusion criteria: age 70 or older, 4 or more active prescription medications, and 1 or more psychoactive medications prescribed within the past year. All patients included in the study had Geisinger Health Plan (GHP) Medicare+Choice coverage. Eighteen (18) Geisinger clinic sites with more than 20 eligible patients were chosen for inclusion in the study. We then randomized clinic sites to receive either the intervention or usual care. Fifteen clinic sites received the electronic intervention, whereas 3 clinic sites served as controls. Randomization occurred according to clinic site, not physician, to avoid the potential confounding effect of communication about the intervention among physicians and/or cross-covering of patients within the practice. No forums where fall prevention was discussed or the guideline was publicized were conducted. A total of 413 patients were assigned to the EMR intervention, and a total of 207 patients were assigned as controls.

Description of Intervention

A GHS clinical pharmacist or MD fellowship-trained geriatrician with expertise in geriatric pharmacology reviewed each patient's medication record via the EMR, focusing on the use of medications that would increase the risk for falls. Psychoactive medications, the presence of polypharmacy, and the presence of medications at inappropriate doses were the focus of the review. After this review, the primary care physician was sent a message via the EMR. The message alerted the receiving physician that the patient was at risk for falls and made recommendations tailored to the individual patient, including specific medications and/or dosing. As part of the message, physicians were referred to an evidence-based guideline for fall prevention that the physician could access directly through the EMR. The guideline was closely based on the American Geriatrics Society/American Academy of Orthopedic Surgery fall prevention guidelines[16] and was reviewed by the GHS Practice Guidelines Committee. It was uploaded onto the EMR before the intervention period.

The messages were in no way linked to an in-office patient visit; i.e., they were received by the physician unlinked to a patient office visit. The messages were sent to the patient's primary physician as identified in the EMR. Messages were sent only once per patient during the study period.

Data Collection

To identify falls, we obtained data on all medical encounters (inpatient hospitalizations, emergency department encounters, and outpatient visits). This data included dates of service, provider type, place of service, provider name, primary and secondary diagnosis, procedure code, and payment amount. We counted both encounters in which a fall was identified as a diagnosis and those with 1 or more diagnoses for a potential fall-related diagnosis, including head injury, fracture, hip injury, sprain, abrasion, or concussion. To obtain direct information from patients regarding self-reported fall rates, patients were contacted by telephone by a study nurse at months 1, 3, 6, 9, 12, and 15, who collected data on self-reported falls. The nurse used a standardized definition of falls using a scripted template; no advice or other information was given. Thus, both self-reported fall rates and those requiring medical attention were captured.

The EPICcare database was also queried to generate data files on medication usage, which contained the following information: order date, starting date, medication ID and description, quantity, number of refills, and daily dosage amounts. Medication patterns were evaluated to create measures of the total number of medications that were active in a given time period (with time periods defined relative to the intervention start date), the total number of medications that were started during a given time period, the total number of psychoactive medications that were active in a given time period, and the total number of psychoactive medications that were started during a given time period.

Demographic data including age, sex, and the presence of other major medical diagnoses at baseline were obtained through the EMR as well for both intervention and control patients. Cost data were calculated using data collected from the Geisinger Health Plan insurance database.

The intervention date was defined as the date the electronic message was sent to the physician. The intervention dates were in January or February, 2003. For the comparison group, the baseline data were defined as January 30, 2003. At the completion of the data collection period, a survey was sent to participating physicians to assess their recollection of the message and the reaction to the message and/or fall guideline.

The study design was reviewed and approved by the Institutional Review boards of GHS and Abt Associates. A data use agreement was executed to secure protected health information.

Statistical Analysis

We used descriptive statistics and simple *t* tests to do comparisons of medication use over the period of the study. We then used multivariate models to further evaluate the impact of the intervention, employing a "difference-in-differences" model. Each multivariate model included the baseline (i.e., preintervention) value of the dependent variable as a covariate. The use of the difference-in-differences model allowed us to adjust for differences in medication use patterns for treatment and control group members that were present before the intervention. Other independent variables in the model were identified by examining utilization records for the 12 months preceding the intervention for medical conditions that have been identified in the literature as risk factors for falls and that had a high enough prevalence rate to be included as independent variables in our models. These included indicators for whether the patient had 1 or more medical encounters for these conditions: dementia, dizziness, hypotension, and hypothyroidism. To take advantage of the longitudinal nature of the data, we used generalized estimated equations (GEE) to estimate medication-related impacts. GEE models account for the correlation between observations for a given individual over time. We measured medication use patterns at 1-month intervals and used the GEE model to adjust for the correlated data that arise from repeated measures. We estimated these models using PROC GENMOD in SAS software, Cary, NC, USA. For falls-related outcome measures, we used logistic regression models to analyze whether the individual had 1 or more falls (based on medical records and/or the patient surveys) during the study period. These models included baseline fall measures derived from the EMR. Independent variables in the models included an indicator of whether the patient was in the intervention group and other types of independent variables believed to be related to either falls or medication usage, including baseline presence of medical conditions, psychoactive medication use, and a history of falls. We included a binary indicator for whether the patient was taking 2 or more psychoactive medications, as well as a binary measure of whether the patient had 1 or more fall-related medication encounters in the year before the intervention. Simple descriptive statistics were used to summarize the results of the physician follow-up survey.

Table 1. Baseline Patient Characteristics

Parameter	Intervention Group *n*=413	Comparison Group *n*=207
Age	76.9	76.8
% Female	79%	80%
Dementia	1.6%	2.0%
Dizziness	10.1%	9.2%
Lower extremity weakness	0.5%*	2.0%*
Depression	0.3%	0.0%
Baseline falls	4.16%	2.96%
Total medications	7.65	7.46
# of meds started	1.48	1.46
# of psychoactive meds	1.74	1.82

**p*=.10. No significant differences seen between other values.*

RESULTS

Study Population

Table 1 illustrates the baseline characteristics of the intervention and comparison groups. Although the intervention group had a higher percentage of patients with a history of falls in the preintervention period than the comparison group, this difference was not statistically significant. The 2 groups were similar in terms medication patterns at baseline, as well as medical comorbidities.

Impact on Medication Use

At baseline, the average number of total medications was 7.65 for the intervention group and 7.46 for the comparison group; 40% of the intervention group had 8 or more medications, compared with 44% of the comparison group. At the end of the period of study, the total number of medications was 7.88 for the intervention group and 7.62 in the comparison group. No statistically significant trends were seen in the total number of medications over the 12-month period of study when comparing medication numbers during each month of the study.

The average number of psychoactive medications was 1.74 for the intervention group and 1.82 for the comparison group at the beginning of the study. At baseline, 65% of the intervention group and 71% of the comparison group had at least 1 psychoactive medication. By month 3, the average number of psychoactive medications was lower for the intervention group; this persisted to the end of the 15-month study period but did not reach statistical significance (p=.10). Looking separately at patients with 2 or more or 4 or more psychoactive medications at baseline, sharp decreases were seen in the number of psychoactive medications beginning in month 3; for patients with 4 or more psychoactive medications at baseline, these differences reached statistical significance beginning in month 3 (p=.05) and persisted into month 7 (p=.01). This group also saw a decrease in the number of new psychoactive medications started beginning in month 2 (p=.05).

Multiple Regression Results

A significant negative relationship between the intervention and the total number of medications started during the time period of the study was seen (p<.01). A similar association was seen between the intervention and the number of psychoactive medications (p<.05). Trends toward an association were seen in the number of active medications and the number of psychoactive medications started (p<.10). In groups with 2 or more psychoactive medications at baseline, a significant negative relationship was seen in the number of psychoactive medications and the number of psychoactive medications started (p<.01). Table 2 summarizes the multivariate regression results of the EMR intervention.

Impact on Falls

As expected, there was drop off in patients who were able to respond to the telephone survey over the period of the study,

Table 2. Impact on Number of Medications and Number of Psychotropic Medications—Multivariate Regression Results

Parameter	Estimate	Standard Error	Wald Chi-square	Pr > ChiSq
Number of active medications	−0.496*	0.291	−1.71	0.0875
Number of medications started	−0.199†	0.075	−2.67	0.0076
Number of psychotropic medications	−0.204‡	0.100	−2.03	0.0425
Number of psychotropic medications: 2 or more psychotropic medications at baseline	−0.443‡	0.194	−2.28	0.0226
Number of psychotropic medications: 4 or more psychotropic medications at baseline	−0.795‡	0.353	−2.25	0.0243
Number of psychotropic medications started	−0.052*	0.030	−1.74	0.0811
Number of psychotropic medications started: 2 or more psychotropic medications at baseline	−0.106*	0.060	−1.78	0.0758
Number of psychotropic medications started: 4 or more psychotropic medications at baseline	−0.353†	0.128	−2.75	0.0060

Note that all models adjusted for the baseline value of the dependent variable, an indicator of whether the individual had any falls in the baseline period, and indicators of whether the following medical conditions were present at baseline: dementia, dizziness, hypotension, hypothyroidism. Source: EpicCare
*$p<.10$
†Statistically significant at 1% level
‡Statistically significant at 5% level

because of death [14 (6.7%) in comparison group versus 17 (4.1%) in intervention group], inability to contact [12 (5.8%) in comparison group versus 29 (7.0%) in intervention group], nursing home placement [9 (4.3%) in comparison group versus 17 (4.1%) in intervention group], relocation [3 (1.4%) in comparison group versus 4 (0.96%) in intervention group], or refusal to participate [11 (5.3%) in comparison group versus 9 (2.2%) in intervention group]. By the last patient survey at 15 months, 158 patients (76%) in the comparison group and 337 (81.6%) in the intervention group were able to respond. The dropout rate was fairly constant over the period of the study.

The percent of patients reporting 1 or more falls in the comparison group was 10.4% at month 3 and 14.2, 19.39, 15.72, and 15.44% at months 6, 9, 12, and 15, respectively. For the intervention group, 8.74% reported at least 1 fall at month 3, with 14.86, 12.54, 14.95, and 14.13% reporting at least 1 fall at months 6, 9, 12, and 15.

Multiple Regression Analysis

The intervention was associated with a significant difference in the incidence of fall-related medical encounters. Other factors held constant, those in the intervention group were only 0.38 times as likely to have 1 or more fall-related diagnoses during the 1-year study period as comparison group members. This difference was statistically significant ($p<.01$). Based on fall

Table 3. Falls Regression Analysis

Parameter	Estimate	Standard Error	Wald Chi-square	Odds Ratio
EpicCare data only	−0.9686*	0.4375	4.9021	0.38
EpicCare data and self reported falls from patient survey	−0.1497	0.22	0.4629	0.86

*$p<.01$

reports including the patient survey, however, whereas the intervention group had a lower rate of falls than the comparison group, the difference was not statistically significant (Table 3).

Impact on Costs

The baseline medical costs for the intervention and comparison groups were similar at $443.69 per quarter in the intervention group versus $418.66 for the comparison group. No significant trends in medical costs were seen over the period of study in outpatient, inpatient, emergency department, or total costs.

Physician Response

Nineteen (53%) of the 36 surveyed physicians responded. Of these physicians, 94.7% agreed that they had read all or some of the messages, 47.4% stated that they had reviewed the fall guideline as a result of the message, and 42.1% replied that they had changed some aspect of medical management because of the electronic messages. A majority of physicians responded that they had increased awareness of falls and the effects of polypharmacy in their elderly patients and stated that they had made some medication changes in response to the messages (Table 4).

Table 4. Physician Survey Results

Item		Percent Response (%)
Read message	All	78.9
	Some	15.8
	None	0
	Do not know	15.3
Reviewed fall guidelines	Yes	47.4
	No	52.6
Changed medical management because of fall guidelines	Yes	26.3
	No	73.7
Types of management changes		
More attention to asking about falls		62.5
Increased awareness of falls		50
More attention to polypharmacy in the elderly		100
Changed some medication dosages		62.5
Discontinued medications		25
Reviewed high-risk medications		80
Performed “get up and go test”		20
Referred to physical therapy		20
Performed a mini-mental status exam		20
Referred for geriatric assessment		20

DISCUSSION

As discussed previously, falls and their sequellae account for significant morbidity and mortality in the elderly population. In most cases, multiple risk factors for falls exist, such as age[17], a history of past falls[18,19], and medical diagnoses such as cardiac conditions[20]. Factors relating to gait and balance are also important[19,21], as are visual limitations[22] and cognitive impairment[23]. In most patients who fall, multiple risk factors coexist, many of which are nonmodifiable. Faced with a large number of variables, clinicians often feel helpless to impact fall risk. In 2006, The Joint Commission made fall screening a National Patient Safety Goal[24]; yet, in a busy practice, it may be difficult to identify strategies to impact this problem.

Most intervention programs defined in the literature are multifaceted and require significant resources. Interventions combining education, environmental adaptations, balance/ resistance training, and hip protectors successfully reduced falls in 1 study[25]; in another, a combination of exercise, visual, and counseling interventions showed some success in reducing falls[26]. Gillespie, Gillespie, and Robertson[27] reviewed 10 years of randomized trials of interventions designed to reduce falls in elderly patients. Effective single intervention programs included muscle strength and balance enhancements, home hazard assessments, and psychoactive medication withdrawal. Multifactorial interventions using programs including benzodiazepine reductions and other medication changes and balance and flexibility exercises have also been effective[28].

To our knowledge, there is no previous literature analyzing the effect of an EMR-based intervention on polypharmacy reduction or fall risk modification in the elderly; however, recent work has examined the use of informatics to enhance care delivery to the elderly. Browne et al. trialed an inpatient adult falls program using the EMR to increase the accuracy of fall risk assessments[29]. In addition, Nebecker et al. recently described multiple ways in which informatics can be used to assist in the management of geriatric patients, including enhanced interdisciplinary communication and decision support[30].

Because the current study involved only a single intervention, it is perhaps not surprising that mixed effects were seen. Although there was no change in the overall number of medications, a negative association between new medication starts and the number of psychoactive medications and the intervention was seen in multivariate analysis. Stronger relationships were seen in those patients with heavier use of psychoactive medications at baseline. Although sample size limited our ability in some cases to show strong relationships, we believe that this relatively simple EMR-enabled strategy was able to impact the use of psychoactive medications in our population, and in addition, an association with a reduced risk for fall-related diagnoses was seen.

The ability to accurately count falls limits our results. It should be noted that, when the measure of falls included both self reports and fall-related encounters, the negative association between the intervention and falls was not seen. “Fall” is seldom presented as the visit diagnosis, so surrogate diagnoses such as contusion, fracture, and others had to be used. This may under- or overestimate falls. In addition, patients' reports of falls are likely to underestimate fall occurrences because of memory issues and/or a reticence to report falls.

Such an intervention is appealing, as it can be done over a geographically dispersed practice network, apart from the office visit. Why would such an intervention work? Perhaps the effectiveness of the intervention was enhanced by the fact that it was not “automated” but rather came from a colleague, i.e., a geriatrician or a doctor of pharmacy. Surveyed physicians agreed that their care was impacted by the messages. We are unsure whether the effects of the intervention would extinguish over time or in fact would carry over to other patients of these physicians. In addition, we do not know if there were any “unintended consequences” of our intervention. Could there be an increase in symptoms or psychiatric issues in our population as a result of decreases in these medications? The present study was not designed to assess such effects. One wonders if automated prompts could replace an actual review by pharmacists or geriatricians. We suspect that automated prompts do not garner the same attention as an electronic communication from a colleague; however, further study would be needed to assess such strategies.

Our ability to show cost-effectiveness is limited given our limited access to nursing home cost data. If the intervention were successful at decreasing the number of falls, it could lead to lower medical costs. The present work must be taken in the context of the overall literature on fall reduction, where most successful strategies are multipronged. However, the combination of EMR-enabled strategies and team management of chronic disease is likely to become a prominent feature of health care in the coming decade.

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Conflict of Interest: *None disclosed.*

Corresponding Author: *Valerie Weber, MD; Department of General Internal Medicine and Geriatrics, Geisinger Health System, 100 N Academy Avenue, Danville, PA 17822-1401, USA (e-mail: vdweber@geisinger.edu).*

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