A RETROSPECTIVE EVALUATION OF POTENTIALLY INAPPROPRIATE MEDICATION USE IN HOSPITALIZED ELDERLY PATIENTS

A research project by

Olivia Cartwright

Bachelor of Arts Field Major in Biology, Chemistry, and Physics, Wichita State University, 2003

and

Joshua Moulin

Master of Physical Therapy, University of Kansas, 2004

Bachelor of Science in Education, University of Kansas, 2002

Submitted to the Department of Physician Assistant

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Wichita State University

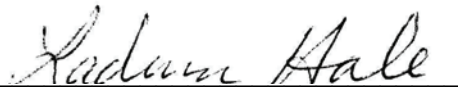
College of Health Professions

Department of Physician Assistant

We hereby recommend that the research project under our supervision by Olivia Cartwright entitled A Retrospective Evaluation of Potentially Inappropriate Medication Use in Hospitalized Elderly Patients be accepted as partial fulfillment for the degree of Master of Physician Assistant.

Approved:

Richard D. Muma, PhD, MPH, PA-C, Chair and Associate Professor
Department of Physician Assistant



LaDonna S. Hale, PharmD, Associate Professor and Research Advisor
Department of Physician Assistant

5/1/07
Date

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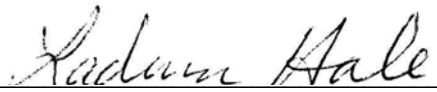

LaDonna S. Hale, PharmD, Associate Professor and Research Advisor
Department of Physician Assistant

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Date

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-Olivia Cartwright

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-Joshua Moulin

ABSTRACT

Background: An estimated 30% of hospitalizations in the elderly may be linked to drug related problems. The Beers criteria are a list of potentially inappropriate medications (PIMs) generally considered unsafe to prescribe in the elderly. These criteria are useful in assessing quality and safety of prescribing in the elderly population. ***Purpose:*** The purpose of this study is to evaluate PIM use, as defined by the Beers criteria, in elderly hospitalized patients. ***Setting:*** 760-bed tertiary care, teaching hospital. ***Methods:*** This cross-sectional study evaluated hospitalized patients ≥ 65 years old, consecutively admitted to general medical floors, starting 4/1/06 until 100 patients were enrolled. Each patient's home, discharge, and inpatient medication profiles were screened for PIMs. Actual usage and duration of therapy, source of prescription, potential justification for use, and pharmacy interventions regarding PIMs were also collected. ***Results:*** Based on home medication lists, 32% of patients were taking ≥ 1 PIM prior to admission; rising to 56% during hospitalization; and declining to 36% at discharge. Of the 93 active hospital PIM orders, 62% were new orders and 38% were continued home medications; 85% were categorized as "high" risk; 8.6% were potentially justified; and the pharmacist intervened on 3 of the PIM orders. ***Conclusion:*** The percentage of patients prescribed PIMs increased significantly during hospitalization, but returned to baseline at dismissal. Health care provider education regarding safe medication prescribing in elderly hospitalized patients, formulary changes, and alterations to preprinted orders may be needed.

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INTRODUCTION

As one ages, the likelihood for the use of multiple medications and the probability for adverse drug reactions (ADRs) increases. The elderly comprise approximately 1/5 of the population in the United States, yet account for 1/3 of all medications prescribed and used.[1] An estimated 30% of hospitalizations in persons ≥ 65 years old may be linked to drug toxicity or other drug related problems.[2] This disproportionate risk for ADRs is partly attributed to the physiological changes of aging resulting in variations in pharmacokinetics and pharmacodynamics in older patients as compared to younger adults such as slowed drug clearance, increasing the risk of accumulation and toxicity, a more permeable blood brain barrier, increasing the risk of central nervous system side effects, slowed orthostatic response, and others.[3] Multiple comorbid diseases may increase the likelihood for polypharmacy, subsequently increasing the risk of drug-drug interactions and obscuring the risk/benefit ratio.[4]

A major concern for prescribers may be the difficulty differentiating between the medication's natural pharmaceutical effect versus the ADRs resulting from certain drug classes or agents, especially in the elderly.[5] For example, increased sensitivity to antihypertensive agents may lead to orthostatic hypotension; gastrointestinal antispasmodic agents may result in constipation. There is an unpredictable variation in the severity of ADRs that could occur, ranging from mild to severe, including the possibility of death. This poses a major concern for the elderly population, due to their increased sensitivity to drug effects at lower concentrations. One alarming outcome of ADRs in the elderly is the increased risk of falls. Falls are the sixth leading cause of death for the elderly population and comprise 2/3 of the deaths resulting from unintentional injuries.[6] Providers must be aware that early clinical pharmacokinetic and safety

trials are generally based on results from studies where the participants tend to be healthier with fewer comorbid conditions and in which the elderly are often under represented. Extrapolating dosing information and expected ADR profiles from studies in younger adults to the typical elderly patient may be inappropriate and partly responsible for preventable ADRs.[3]

In 1991, Beers and colleagues introduced a standard for medication prescribing, pertaining only to the frail elderly residing in nursing facilities.[7] Thirteen specialists, with an extensive pharmaceutical and geriatric background, were used in formulating thirty sets of criteria. Nineteen of the criteria described medications that should generally be avoided altogether in the elderly and eleven described dosing, frequency, and/or durations of therapy that were considered inappropriate.[7] Due to the overwhelming need for such criteria, it was being used in populations that it was not intended for, in particular, the non-institutionalized elderly patients.[8] As a result, the criteria were revised in 1997 to apply to all persons over the age of 65 years, not just the frail elderly. In 2003 the criteria were again revised to include new research, newly developed medications, and disease-medication interactions, as well as a severity rating given to 48 individual medications or classes of medications, either high or low.[2] As a result, the Beers criteria are seen as a useful tool in conducting studies and in assessing the quality of prescribing for the elderly population.[9]

LITERATURE REVIEW

A MEDLINE literature search of English-language articles involving human subjects published from 1997 to the present was conducted using the following search terms: geriatric, Beers criteria and inappropriate; and the following MeSH terms: aged, medication errors, drug utilization, standards, and polypharmacy, to identify studies similar to ours. There have been several studies examining potentially inappropriate medication (PIM) use in the elderly using the Beers criteria. See Table 1. These studies have been performed in a number of settings with varied results. Three of the studies involved the nursing home setting,[1, 10, 11] six in community dwelling elderly,[12-17] one in a hospital emergency department,[4] and one study conducted in the United States examining PIM use in patients admitted to a veterans hospital.[18] The rate of PIM use ranges from 12.6%,[4] to 50%,[10] with the highest being in nursing facilities and amongst the frail elderly. According to Lau et al, PIM usage was associated with a 30% increased risk of hospitalization and a 21% increased risk of death in the nursing home setting in the frail elderly who were prescribed at least one PIM.[10] Although the rate of PIM usage in the community dwelling elderly is generally lower than in the frail elderly, those on PIMs are also at increased risk for ADRs. Simon et al found that 28.8% of community dwelling HMO recipients received at least one PIM in 2000 and 2001.[14]

Utilizing the 1997 Beers criteria, a retrospective cross-sectional analysis of Kansas Medicaid beneficiaries aged $\geq$ 60 years compared the pattern of PIM prescribing amongst three mutually exclusive groups (n = 3185): nursing facility (NF) residents, recipients of home and community-based services through the Frail Elderly (FE) program, and persons with neither NF nor FE care (ambulatory). Thirty-eight percent, 48%, and 21% of the NF, FE, and ambulatory cohorts, respectively, were prescribed at least one PIM. The use of $\geq$ two PIMs occurred in 10%,

16%, and 5% of patients in the NF, FE, and ambulatory cohorts, respectively. The most prevalent drug classes prescribed included analgesics, antihistamines, antidepressants, muscle relaxants, and oxybutynin. Other studies have reported benzodiazepines as one of the most commonly prescribed class of PIMs. The author attributes the low level of inappropriate benzodiazepine use in this population to formulary restrictions in Kansas Medicaid. Overall, Rigler et al concluded that only a small number of drugs comprised the total PIMs used. Of those drugs, short-term usage was most common.[13]

Caterino et al examined the national rate and trends of PIM prescribing to elderly patients in the emergency department (ED) and whether the administration of these drugs was justified based on diagnosis. The study gathered data from the National Hospital Ambulatory Medical Care Survey (n = 33,395) and utilized the 1997 updated Beers criteria to define PIMs. Results showed that medications were administered in 72% of elderly ED visits; 12.6% of all medication usage was considered inappropriate, as defined by the Beers criteria; and 20% of patients received more then one PIM. Six medications accounted for 70.8% of the total PIMs identified: promethazine (22.2%), meperidine (18.0%), propoxyphene (17.2%), hydroxyzine (10.3%), diphenhydramine (7.1%), and diazepam (6.0%). Unfortunately, Caterino et al could not justify or correlate the high rates of PIMs found, based on the patient's diagnosis.[4]

Goulding gathered data from office-based physician visits from the National Ambulatory Medical Care Survey using 13,003 ambulatory elderly patients from 1995-2000 in an outpatient physician office setting. She found that 7.8% of the time at least one PIM was prescribed, with pain relievers and central nervous system drugs being the most common.[17] According to a 2004 study by Curtis et al, in 765,423 subjects in an outpatient prescription claims database, 21.2% of

patients 65 years or older received 1 or more PIM. Greater than 45% of the inappropriate medications prescribed were psychotropic drugs.[16]

Table 1: Published Studies Evaluating PIM Usage According to the Beers Criteria

Lead Author / Year	Number subjects	Setting	Percent patients prescribed ≥ 1 PIM	Percent patients prescribed ≥ 2 PIMs
Caterino[4] 2004	33,395	Emergency department	12.6%	20.0% (of the 12.6%)
Fu[15] 2004	2,305	Community dwelling	13.3%	NA
Hajjar[18] 2005	1,088	Veterans hospital	44.0%	18.0%
Lau[10] 2005	3,372	Nursing facility	50.0%	NA
Mort[12] 2000	29,805	Community dwelling	27.2% psychotropics	18.30%
Rigler[13] 2005	3,185	All Medicaid patients	34.5%	NA
	1,164	Nursing facility	38.0%	10.0%
	858	Frail	48.0%	16.0%
	1,163	Community dwelling	21.0%	5.0%
Simon[14] 2005	157,517	HMO recipients	28.8%	NA
Sloane[1] 2002	2,078	Assisted living facility	16.0%	NA
Spore[11] 1997	2,054	Assisted living facility	25.0%	24.1%

PIM = potentially inappropriate medications; NA = not applicable; not measured; HMO = health maintenance organization

Clinical Significance

One study was found investigating the use of PIMs, as defined by the Beers criteria, in an in-patient Veterans' hospital setting in the United States. In this study (n = 1088), Hajjar et al found that 44% of hospitalized patients were prescribed at least one PIM and 18% were prescribed two or more PIMs.[18] In a previous investigation at our facility, a small study (n = 50) was conducted specifically investigating hypnotic medications in the elderly.[19] Baseline data revealed that 51% of orders for hypnotic medications were classified as inappropriate as defined by the Beers criteria, with 80% of these hypnotics being initiated in the hospital. Prescriber education in the form of in-services, posters, and changes to standing orders later reduced the incidence to 32%.

The hospital's pharmacy department currently does not have a formalized program to identify PIM prescribing, as defined by the Beers criteria. Literature demonstrates the need for

interception of and prevention of PIM prescribing. One way of regulating medications in a hospital setting is to perform periodic retrospective cross-sectional studies, to provide current usage patterns, helping hospitals to maintain a higher standard of geriatric pharmaceutical management. Previous studies done at this facility have proven beneficial to overall compliance and patient care.

Study Purpose

The purpose of this study is to evaluate potentially problematic medication usage, as defined by the Beers Criteria, in hospitalized patients ≥ 65 years of age. This study may help identify a need for further education regarding Beers criteria and safe prescribing in the elderly population.

METHODOLOGY

Research Design, Setting, Patient Population

This study was a retrospective cross-sectional chart review conducted at a 760-bed tertiary care, teaching hospital. Patients were selected via a computer-generated list of all patients ≥ 65 years old, consecutively admitted to a general medical floor beginning April 1, 2006 until 100 patients were enrolled. Patients with a length of stay < 3 days were excluded. All of the data for this study were collected from the hospital's integrated computerized patient medication, laboratory, diagnostic and dictated medical records. See Appendix for the data collection tool.

Data Measurements

Age, gender, attending physician, length of stay, admission date, discharge date, and unit housed were extracted electronically. The number of admitting home medications was obtained by screening the dictated history and physical, dictated consults, and/or the nursing medication admission history. If the home medication list was not available in one of these sections, hospital medications ordered on day one of admission were used to determine a likely home medication count. The count of discharge medications was obtained from the dictated discharge summary. If the discharge home medication list was unavailable, hospital medications ordered on the last day of admission were evaluated similarly. The count of home and discharge medications included oral prescription medications, over-the-counter (OTC) medications, inhalers, and ophthalmics. Insulin was counted as one medication only, even if the patient was on multiple types of insulin. Double ingredient medications were counted separately; multiple

vitamins were counted as a single medication. Each patient medication profile, including home medications, discharge medications, and medications ordered during hospitalization, was screened for PIMs appearing on the Beers criteria. For each identified PIM, the following was determined: actual usage and duration of therapy, whether it was a continuation of a home medication or a new medication, the prescriber, whether the patient was discharged on it, its indication for use, whether its use was potentially justified, and finally if the pharmacy department made any recommendations for or against its use. An example of a PIM being considered potentially justified would be digoxin dosed at 0.25 mg per day for the management of heart failure in a patient with digoxin levels within the recommended parameter. The Beers criteria suggest that the dose of digoxin for the treatment of heart failure should not exceed 0.125mg/day because this dose is usually sufficient for persons over the age of 65. However, this medication would be considered "justified" for this particular patient because the serum levels achieved with the higher dose were appropriate. Another example might be a patient prescribed meperidine who was allergic to many other opioids.

Patient Confidentiality and IRB Approval

Each patient was assigned a sequential identification number for study purposes. The data collection forms and data analysis spreadsheets contained this study identification number only and did not contain any patient names or protected identifiable health information. To access patient data from the computerized medical records, the patient name was necessary. A master list of patients linking the names with the identification numbers was kept for this purpose in a locked cabinet in the pharmacy department. The computerized data analysis spreadsheets were password protected.

This project was approved by both the Wichita State University and Wesley Medical Center Institutional Review Boards (IRB). Since this was a non-interventional, retrospective cross-sectional study evaluating data that were originally collected solely for non-research purposes (diagnosis and treatment), the IRB determined that prior informed patient consent was not necessary.

Data Analysis

Data were recorded and analyzed using Microsoft Excel. Descriptive data were reported using means $\pm$ standard deviation or percentages as appropriate. Frequency data were compared using the Chi square test.

RESULTS

A total of 100 patients were enrolled and evaluated. Patient characteristics are presented in Table 2. Mean age was 77.7 ± 7.18 years with 56% females. One patient died prior to discharge. A majority of patients were admitted from home, 82%, while 18% were admitted from a nursing home, assisted living facility or another hospital, indicating some level of frailty. The mean length of hospital stay was 6.9 ± 4.94 days (range 3 to 37). The mean number of medications per patient increased from 9.2 ± 5.48 to 10.5 ± 5.03, indicating a mean increase of 1.3 ± 2.88 medications per patient, range -8 to +9).

TABLE 2: Patient Characteristics

Characteristic	Result	
Percentage females	56%	
Mean age (years)	77.7 ± 7.18	range 65 to 100
Mean length hospital stay (days)	6.9 ± 4.94	range 3 to 37
Mean number home meds/pt	9.2 ± 5.48	range 0 to 29
Mean number discharge med/pt	10.5 ± 5.03	range 2 to 31
Mean increase in number	1.3 ± 2.88	range -8 to +9
Percent patients admitted from:		
Home	82%	
Nursing home	10%	
Assisted living facility	4%	
Another hospital	4%	
Percent patients discharged to:		
Home	67%	
Rehabilitation / Skilled nursing	14%	
Nursing home	9%	
Assisted living facility	5%	
Another hospital	4%	
Died during hospitalization	1%	
Percent patients discharged to:		
Similar level of care	79%	
Higher level of care	18%	
Lower level of care	2%	

Means reported as mean ± standard deviation.

Based on home medication lists, 32% of patients were taking at least one PIM prior to admission. This percentage increased to 56% during hospitalization and declined to 36% at discharge, indicating that not all of the home medications were continued during hospitalization and likewise, not all PIMs ordered during hospitalization were continued upon discharge. ***See*** Table 3**.** Prescribers self-discontinued 9 PIMs upon admission; however, 2 of these medications were restarted when the patient was later discharged from the hospital.

TABLE 3: Frequency of PIM Prescribing

Percentage of Patients Prescribed:	Home Medication List	Hospital Medication List	Discharge Medication List
≥ 1 PIM	32%	56%	36%
≥ 2 PIM	11%	25%	10%
≥ 3 PIM	1%	7%	0%

Number shown indicates percentage of patients.

A total of 93 PIMs were identified as active orders during hospitalization. Of these, 38% were continuations of home medications and 62% were newly ordered medications (45% being individually written orders and 17% being initiated as part of pre-printed, standing orders. Eighty-five percent of the PIM orders were categorized as "high" risk according to the Beers criteria and 15% categorized as "low" risk. Pharmacists intervened on three of the 93 PIM orders; all three recommendations were accepted by the prescriber. Of the 93 PIMs identified, eight (8.6%) were deemed potentially justified. The mean number of PIMs per patient, including all 100 patients, was 0.9 ± 1.13, range 0 to 5. The mean number of PIMs per patient, including only those patients with at least one PIM was 1.6 ± 1.03, range 1 to 5.

The PIMs prescribed are listed in Table 4. The most commonly prescribed PIMs were promethazine, amiodarone, and diphenhydramine. The PIM drug classes prescribed are listed in Table 5. The most commonly prescribed PIM by drug class were antihistamines, and cardiovascular drugs.

TABLE 4: PIM Medications Prescribed

Medication	Number of Active Orders
Promethazine	13
Amiodarone	11
Diphenhydramine	11
Clonidine	6
Cyclobenzaprine	6
Propoxyphene	5
Ketorolac	4
Nitrofurantoin	4
Temazepam	4
Meperidine	3
Oxybutynin	3
Amitriptyline	2
Belladonna Alkaloids	2
Desiccated Thyroid	2
Diazepam	2
Digoxin	2
Fluoxetine	2
Hydroxyzine	2
Metaxalone	2
Chlorazepate	1
Dicyclomine	1
Doxazosin	1
Doxepin	1
Ferrous Sulfate	1
Hyoscyamine	1
Lorazepam	1
Grand Total	93

TABLE 5: PIM Drug Categories Prescribed

PIM Drug Class	Number of Active Orders
Antihistamines	26
Cardiovascular	20
Opioid	8
SMR	8
Benzodiazepine	7
Antibiotic	4
GI Antispasmodic	4
NSAIDs	4
Anticholinergic	3
TCA	3
Antidepressant	2
Thyroid	2
Barbiturate	1
Ferrous Sulfate	1
Grand Total	93

DISCUSSION

Study Limitations

Several study limitations must be considered when reviewing these results. Frequent discrepancies between the home medication lists as dictated in the history and physical, consults, and nursing history were noted. These types of discrepancies in home medication lists occur for a variety of reasons and are not unique to this setting, as previously documented by other researchers[20-22] Any inaccuracies in the home or discharge medication list could have inadvertently altered the count of home and discharge medications and the ability to identify all PIMs. To overcome this limitation, researchers utilized all these home medication lists to create, what was likely a more complete home medication list. Generally, there was only one resource for the discharge medication list, a dictated discharge summary. When dictated lists were not available, the day of admission or day of discharge hospital orders had to be used. Although every attempt was made to compile accurate lists using clinical reasoning, these cases present the highest likelihood for errors.

Assessing each PIM to determine whether or not it was potentially "justified" also required clinical reasoning. PIMs ordered on an "as needed" basis generally listed an indication for use, allowing for appropriate justification to be evaluated. However, indications for scheduled PIMs required review of each patient's past medical history. Along with indication for use, justification included laboratory information, past medical history, medication allergies, and any documentation of other issues that may have justified a particular PIMs use such as failed therapy or compliance issues. Prescribers were not contacted individually to discuss rationale for therapy selection. To overcome this limitation and to increase standardization, all

PIMs were evaluated by at least two of the researchers, one of those two being a clinical pharmacist. Because prescribers were not contacted to specifically discuss individual patient orders or PIM prescribing patterns, it is unknown if prescribing PIMs occurs due to a lack of familiarity with the Beers criteria or simply a disagreement with aspects of the criteria. Because the criteria are based on expert opinion rather than levels of evidence, this suggests that the criteria may be open to a wider variety of interpretation than typical evidence based consensus guidelines.

The cross-sectional study design may have introduced a time-dependent change in prescribing patterns. It is possible that the time or season of year could have had some bearing on medication prescribing. For example, during the allergy season it may be more common to prescribe antihistamines. Antihistamines with anticholinergic side effects are considered potentially inappropriate according to the Beers criteria. Because this is a teaching facility, variation in numbers and experience of medical residents may influence prescribing patterns. It is unknown what influence time of year may have on PIM prescribing patterns if any.

Clinical Implications

The medications included in the Beers criteria are considered potentially inappropriate because safer alternatives are available. In this study the percentage of patients receiving PIMs increased during hospitalization. Twenty-eight percent of patients who were admitted to the hospital without any PIMs were started on at least 1 PIM during hospitalization. The percent declined prior to discharge but was higher than that observed upon admission. Fifty-eight of the 93 PIMs identified during hospitalization were newly ordered in the hospital and 85% (79/93) were categorized as having a "high" severity rating. Most studies utilizing the Beers criteria to

evaluate prescribing in the elderly use lists of prescribed medications that do not incorporate the patient's past medical history, drug indication, or potential justification for use. Because several of the Beers criteria depend upon this information to classify the medication as appropriate or potentially inappropriate, this was important information to include. Only 8.6% (8/93) were considering "potentially justified." Even taking into account individualized potential justification for use, there was a higher than expected rate of PIM usage occurring during hospitalization. This possibly puts hospitalized elderly at increased risk of ADRs.

Promethazine and diphenhydramine were two of the most commonly prescribed PIMs at 14% (13/93) and 12% (11/93) respectively. More than half of the orders for these two drugs originated from pre-printed orders: nine for promethazine and six for diphenhydramine. All of the nine promethazine orders were as needed for nausea/vomiting; one dosed at 25mg, five dosed at 12.5 – 25mg, and three dosed at 12.5mg. According to the Beers criteria, all promethazine use is considered inappropriate regardless of dose. However, lower dosages would be preferred to higher dosages in the elderly. According to the Beers criteria, diphenhydramine is considered appropriate for itching if the smallest possible dose is used. Therefore, any diphenhydramine orders for 12.5mg or a range of 12.5 – 25mg were not counted as a PIM, but were considered appropriate. All 6 of the diphenhydramine orders written from pre-printed orders were for 25 – 50mg or for 50mg as needed for itching. Amiodarone was also frequently prescribed. Amiodarone is considered potentially inappropriate in the elderly because it is associated with a high rate of ADRs even when prescribed at the recommended dosages. Bradycardia was more common in the elderly than in younger persons. Experts recommend that the usual amiodarone dose be reduced by 50% in the elderly and that it only be used when a clear indication exists.[23]

Because PIM usage puts patients at risk of ADRs, reduction strategies should be implemented whenever possible. One PIM reduction strategy identified in this study would be to target hospital pre-printed orders. In response to a previous study at our institution regarding hypnotics in the elderly, all pre-printed orders containing hypnotics were changed to include a mandatory lower dosage option for persons ≥ 65 years old. This was fairly simple to accomplish and was effective. A similar strategy could be used on all the diphenhydramine pre-printed orders, listing the lower dosage option for the elderly. Another PIM reduction strategy is to restrict use of or remove certain drugs from the formulary to help prevent prescribing of those PIMs. Meperidine is no longer considered a first line analgesic due to its higher rate of central nervous side effects than the other opioids and it has been suggested that meperidine be removed from hospital formularies.[24, 25] Propoxyphene has minimal efficacy, similar to that of plain acetaminophen, yet has all the usual opioid side effects plus a high rate of other cardiovascular and central nervous system toxicities, especially in the elderly.[26] This may justify removing propoxyphene products from hospital formularies or at least restricting their use in the elderly population. Had these formularies and pre-printed order changes been implemented, PIM usage would have been reduced from 56% to 50% in this study, $p = 0.23$. See Table 6. This is helpful, but not a statistically significant reduction. Therefore, other reduction strategies must also occur such as prescriber education regarding the Beers criteria and pharmacist education regarding identification of PIM orders and interception / interventions to alter prescribing patterns.

TABLE 6: Hypothesized PIM Usage if Changes to Pre-Printed Orders and Formulary Had Been Implemented

Percent patients with orders for indicated number of PIMs	Actual Hospital Medication List	Hypothesized Hospital Medication List	p Value*
≥ 1 PIM	56%	50%	not significant
≥ 2 PIM	25%	22%	not significant
≥ 3 PIM	7%	5%	not significant

**Frequency data were compared using the Chi square test.*

Current clinical pharmacy services at our facility include: clinical pharmacy specialists assigned to round with the internal medicine, hospitalist, and surgery/trauma teams, and a pharmacist-run drug information center, antibiotic monitoring program, and anticoagulation service. Staff pharmacists perform a variety of daily clinical services including intravenous to oral conversion, renal function monitoring and intervention, deep vein thrombosis prophylaxis, adverse drug reaction reporting, and drug-related laboratory monitoring. However, we do not have a program specifically targeted towards the elderly or compliance with the Beers criteria. This likely accounted for the low rate of pharmacy interventions in this study, only 3.2%.

Areas of Future Research

Use of PIMs, as defined by the Beers criteria, has been associated with higher rates of morbidity and mortality. This study did not specifically evaluate the incidence of ADRs. Future research should evaluate the impact that this transient increase in PIM usage has on ADR rates during hospitalization. Little research has been conducted evaluating the use of PIMs in the hospital setting or the impact hospitalization has on PIM usage; more research should be done in this area. Future research should also focus on effective PIM reduction strategies in the hospital setting including alterations to pre-printed orders, formulary changes, and educational

interventions. Because hospitals receive a majority of their patients from the surrounding outpatient communities, these educational PIM reduction strategies would likely be most effective if also expanded to those settings when possible. Because hospitalized patients, as found in this study, generally return back to those communities, any PIM reductions during hospitalizations may also reduce the PIM usage after discharge.

Conclusion

The percentage of patients prescribed PIMs increased significantly during hospitalization, but returned to near baseline at dismissal. Health care provider education regarding safe medication prescribing in elderly hospitalized patients, formulary changes, and alterations to preprinted orders may be needed.

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APPENDIX: Data Collection Tool

Wesley Medical Center **Beers Criteria: Drug Usage Evaluation 2006**

Pt DUE Number:	Unit:	Length of Stay (days):	Gender: M F
Admit From: Unknown Home Nursing Home Assisted Living Other (specify):			Age(yr):
Discharge To: Unknown Home Nursing Home Assisted Living Deceased Other (specify):			

Medications Prior to Admission(list): □ H&P □ cons □ day1 □ assmnt form	DC'd on Med?	**Medications Prior to Admission(list):** □ H&P □ cons □ day1	DC'd on Med?
	□ yes □ no □ unkn		□ yes □ no □ unkn
	□ yes □ no □ unkn		□ yes □ no □ unkn
	□ yes □ no □ unkn		□ yes □ no □ unkn
	□ yes □ no □ unkn		□ yes □ no □ unkn
	□ yes □ no □ unkn		□ yes □ no □ unkn
	□ yes □ no □ unkn		□ yes □ no □ unkn

Discharge Meds Not Listed Above:____

____

Beers Medication Orders (Home Meds, Discharge Meds, or Other Ordered During Hospital Stay:

□ Home Med □ New Med □ Pre-printed Ord#_____	Medication	Dose/Route/Frequency	Indication:
Prescriber:	Justified? □ No □ Yes (describe)	Pharm Rec Made?: □ No □ Yes (outcome)	
Administered? □ No □ Yes (# doses)		Duration Therapy (days)	

□ Home Med □ New Med □ Pre-printed Ord#_____	Medication	Dose/Route/Frequency	Indication:
Prescriber:	Justified? □ No □ Yes (describe)	Pharm Rec Made?: □ No □ Yes (outcome)	
Administered? □ No □ Yes (# doses)		Duration Therapy (days)	

□ Home Med □ New Med □ Pre-printed Ord#_____	Medication	Dose/Route/Frequency	Indication:
Prescriber:	Justified? □ No □ Yes (describe)	Pharm Rec Made?: □ No □ Yes (outcome)	
Administered?	□ No □ Yes (# doses)	Duration Therapy (days)	

Vita

Name: Olivia M. Cartwright

Date of Birth: 03-04-81

Place of Birth: Wichita, KS

Education:

2005 – 2007	Master – Physician Assistant (M.P.A.) Wichita State University, Wichita, KS
1999 – 2003	Bachelor of Arts – Field Study Major in Biology, Chemistry, and Physics Wichita State University, Wichita, KS

Professional Experience:

2004 – 2005	Satellite Clinic Coordinator Hunter Health Clinic Wichita, KS
2003 – 2004	Phlebotomist American Red Cross Wichita, KS
2002	Phlebotomist Via Christi – St, Francis Wichita, KS

Vita

Name: Joshua C. Moulin

Date of Birth: 05-11-79

Place of Birth: Kansas City, KS

Education:

2005 – 2007	Master – Physician Assistant (M.P.A.) Wichita State University, Wichita, KS
2002 – 2004	Master – Physical Therapy (M.P.T.) University of Kansas Medical Center, Lawrence, KS
1999 – 2002	Bachelor of Science in Education University of Kansas, Lawrence, KS

Professional Experience:

2006 – present	Registered Physical Therapist Westview Mannor Wichita, KS
2004 – present	Registered Physical Therapist Life Care Center of America Wichita, KS
2003 – 2005	Registered Physical Therapist Supplemental Health Care Wichita, KS