TITLE OF PROJECT: **PHARMACIST TECHNOLOGY FOR NURSING HOME RESIDENT SAFETY**

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STRUCTURED ABSTRACT:

Purpose: To evaluate the effectiveness of clinical software program, the Geriatric Risk Assessment Med Guide™ (GRAM™), in nursing facilities to improve medication safety

Scope: Efforts to reduce medication errors have focused on prescribing, dispensing, or medication administration; GRAM™ targets the monitoring stage of the medication use process. GRAM™ identifies medications that may cause, aggravate, or contribute to common geriatric problems; it correlates medication effects with signs, symptoms, syndromes, and indicators describing mood, behavior, cognition, psychosocial well-being, and functional status. GRAM™ is intended to assist in the clinical decision-making process to evaluate complex medication regimens of geriatric patients and identify and prevent potential medication-related problems.

Methods: We identified 26 nursing homes and randomized 13 to an intervention arm and 13 to usual care. The intervention arm received staff training, integration of GRAM™ in the pharmacy operations, and monitoring reports for falls and delirium.

Results: Integrating GRAM™ into the commercial pharmacy software and workflow was feasible. Nursing staff turnover posed a significant problem to the continuous delivery of the intervention. GRAM™ alerts assisted consultant pharmacists in making more targeted recommendations to discontinue or reduce dose on psychotropic medications. No resulting changes in hospitalizations due to falls and delirium were observed.

Key Words: nursing homes, medications, adverse drug effects, clinical informatics

PURPOSE

In nursing homes (NHs), the average resident uses six different medications, and 20% use at least 10 different medications (Bernabei et al, 1999). Given the medical complexity of nursing home residents, the use of multiple medications may be clinically appropriate and may indeed optimize functional status (Avorn and Gurwitz, 1995). However, changes in pharmacokinetics and pharmacodynamics, as well as multiple comorbid conditions, make older persons more vulnerable to adverse medication effects (Lamy 1991).

A recent study of residents in 18 Massachusetts nursing homes estimated 1.89 adverse drug effects (ADEs) per 100 resident-months, of which half were deemed preventable (Gurwitz et al, 2000). **Of all ADEs and potential ADEs, 1.39 per 100 resident months were deemed fatal, life threatening, or serious. Of preventable ADEs, 70% occurred at the monitoring stage of the medication use process.** Indeed, a report by the Office of the Inspector General (OIG), entitled Prescription Drug Use in Nursing Homes (1997), states that "…patients may be experiencing unnecessary adverse medication reactions as a result of inadequate monitoring of medications." This report states that "HCFA (Health Care Financing Administration) should require pharmacists' direct input to achieving optimal clinical outcomes for residents…." Medication-related problems continue in nursing facilities despite the fact that HCFA requires monthly retrospective drug regimen review of each resident by the consultant pharmacist, that the pharmacist report any "irregularities" to the attending physician and director of nursing, and that these reports "be acted on." Many clinical informatics systems focus on the reduction of medication errors at the point of prescribing (e.g., prevention of the wrong drug or dose); dispensing (e.g., medication barcoding, automated dispensing), or administration (e.g., scannable patient bracelets). Yet, few have proposed the use of information technology in the monitoring stage of the medication use process.

We tested the effectiveness of a unique clinical tool for pharmacists and other health professionals (Geriatric Risk Assessment MDS Med Guide™ [GRAM™]) in reducing serious preventable ADEs. We focused on the prevention of delirium and falls, as these are two of the most common preventable ADEs in nursing homes (Gurwitz et al, 2000). The GRAM™ software was intended to assist in the decision-making process of evaluating complex medication regimens of older patients. With the goal of preventing avoidable medication-related problems, GRAM™ facilitates incorporation of patient assessment data into the monitoring of medication therapy and inclusion of recommendations in the care plan.

To test this intervention, we conducted a large-scale randomized trial. We recruited 26 nursing homes located in Ohio serviced by the same long-term care pharmacy provider (Omnicare). Half of the homes were randomized to receive the innovative modality for delivery of the standard of care, and the other half received the existing method of delivery of standard of care. Evaluation of the project relied on existing data sources (i.e., federally mandated Minimum Data Set [MDS] cross-linked to CMS denominator file and inpatient claims). **The specific aims of the proposed project include both process evaluations and outcome evaluations.**

The aims of the study are:

1) To determine the extent to which the use of the GRAM™ clinical tool reduces the incidence of delirium and falls (with and without fracture);

2) To determine the extent to which the use of the GRAM™ clinical tool reduces the incidence of hospitalizations due to potential ADEs;

3) To determine the extent to which the use of the GRAM™ software reduces resident assessment protocol (RAP) triggers for delirium and falls; and

4) To quantify the impact of the GRAM™ software on the nursing home staff satisfaction.

SCOPE

Background: Over the past century, there has been a dramatic change in the distribution of age in the general population, with elderly persons comprising an increasing proportion, particularly those over the age of 80. Many countries have at least 10% of their populations aged 65 years and older; in the US, this percentage exceeds 12% (Census Bureau,1990; Butler 1997). Both increased longevity and the increase in the number of elderly persons have been estimated to increase expenditures for long-term care (LTC) at an accelerated rate (Spillman and Lubitz, 2000). In the US, approximately 21,000 LTC facilities provide care for over 1.6 million people (Rhoades, 1998). Elderly patients account for one third of the US healthcare costs, with the proportion of healthcare costs increasing with each decade (Harlan, 1989).

Accompanying this rise in elderly population is the increasing use of drug therapy in the management of chronic disease. Elderly persons consume 31% of all medications prescribed (Baum et al, 1987); the average number is between two to six prescribed medications (Stewart and Cooper, 1994). In US nursing homes, the average resident uses six different medications, and 20% use at least 10 different medications (Bernabei et al, 1999) Changing pharmacokinetics and pharmacodynamics (Lamy 1991) and inappropriate drug selection (Stuck et al, 1994; Wilcox et al, 1994; Beers et al, 1992) can lead to complications in drug therapy, often manifested as an ADE. Elderly patients are two to three times more likely to experience an ADE than are patients aged 20 to 30 years old; 1.5-44% of older hospitalized patients and over 30% of outpatients may also experience medication-related problems (Monette et al, 1995), resulting in associated economic costs of $136 billion (Johnson and Bootman, 1995). Moreover, a recent study had geriatric experts rank conditions for targeting of quality of care improvement initiatives in vulnerable older adults. The expert panel ranked pharmacologic management as the top condition in need of such targeting (Sloss et al, 2000).

Although over 1.6 million people reside in LTC and, over a lifetime, the risk of spending a long time there is substantial (Kemper et al, 1991), nursing homes have the reputation of providing the worst healthcare. The 1986 report from the Institute of Medicine highlighted substantial evidence of appalling care in nursing homes, including documentation of neglect and abuse leading to premature death, permanent injury, and unnecessary suffering (IOM, 1986). The Nursing Home Reform Act, embedded in the Omnibus Reconciliation Act of 1987 (OBRA, 1987), required an unprecedented implementation of comprehensive geriatric assessment in Medicare- and Medicaid-certified nursing homes (Hawes et al, 1997; Elon et al, 1992). Improvements in the residents' safety and quality of care provided (Hawes et al 1997; Fries et al, 1997, Phillips et al, 1997), as well as reduced hospitalizations, resulted (Mor et al, 1997). Yet, more can be done to *improve patient safety* in nursing homes.

Context: Nursing homes provide an environment ripe for intervention, with the potential to provide supervised, around-the-clock clinical observation. Frail, older nursing home residents represent a vulnerable population, and their medication profiles and functional status are

increasingly representative of frail, older persons residing in assisted living (Larrat et al, 1995) and in the community. In NHs, physicians are responsible for medical management, including prescription of medications; however, their direct involvement and oversight is limited. It is often the nursing staff who influence prescribing decisions through telephone consultation with the physician (Avorn and Gurwitz, 1995). Consultant pharmacists provide medication monitoring and retrospective drug regimen review, but only on a monthly basis; therefore, important monitoring functions are necessarily left to the nursing facility staff. **The OIG report, Prescription Drug Use in Nursing Homes (1997), states that " . . . patients may be experiencing unnecessary adverse medication reactions as a result of inadequate monitoring of medications,"** and recommends that "HCFA should require pharmacists' direct input to achieving optimal clinical outcomes for residents." Medication-related problems that jeopardize patient safety are common in LTC (Hanlon, 2001). This occurs despite the fact that HCFA requires that the drug regimen of each resident be reviewed monthly by the pharmacist, that the pharmacist report any "irregularities" to the attending physician and director of nursing, that these reports be "acted on," and that each resident's drug regimen be "free of unnecessary drugs." The required retrospective drug regimen review may not be adequate to avoid preventable ADEs.

Settings/Participants: We recruited two Omnicare long-term care pharmacies: Beeber Pharmacy (Englewood, Ohio) and Home Care Pharmacy (Cincinnati, Ohio). Omnicare, Inc., is the nation's largest long-term care pharmacy provider, with pharmacies in 43 states serving 630,000 residents in skilled nursing facilities and assisted living communities. The workload of consultant pharmacists is approximately 1,000 residents per month. The consultant pharmacists then approached nursing homes serviced by their long-term care pharmacy for participation in this study. To be eligible for participation, the home had to be Medicare/Medicaid certified and adhering to the requirements of the MDS data collection, have at least 50 geriatric beds, and have a minimal proportion of short stays. Nursing homes were recruited into the study without knowledge of which condition they would be assigned. To avoid differential participation of nursing homes on the basis of random assignment, nursing homes had to consent to participating regardless of such assignment. Half of the nursing homes recruited within each long-term care pharmacy received the innovative modality for delivery of the standard of care, and half received the existing modality.

Incidence/ Prevalence: The costs of medication-related problems in US nursing facilities is estimated to be ~$8.2 billion (Bootman et al, 1997). With the increased disease severity in elderly persons and concomitant drug use (Kurfees and Dotson, 1987), the public health impact of the risk of accelerated decline, compounded by the economic burden through increased hospitalization, is enormous (Siu et al, 1993). A recent study of residents in 18 Massachusetts nursing homes estimated 1.89 ADEs per 100 resident-months, of which half were deemed preventable (Gurwitz et al, 2000). Until this landmark study, the extent to which ADEs were preventable in long-term care settings was unknown. **Of all ADEs, 1.39 per 100 resident months were deemed fatal, life threatening, or serious.** Of these, *all but* 0.23 per 100 resident months were preventable. Of residents experiencing preventable ADEs, 26% were on antipsychotics, 18% were on antidepressants, 18% were on sedatives/hypnotics, 13% were on anticoagulants, and 10% were on antiseizure medications. Among residents experiencing potential ADEs (which, by definition, are preventable), 80% were on anticoagulants. For many of these (>75%), the duration of symptoms lasted more than a day**. Among the preventable events, 70% occurred in the monitoring stages of the medication use process.** These data provide support for the proposed research project.*Gurwitz et al suggest that prevention strategies target the monitoring stages of the medication use process. Unlike many clinical informatics, the GRAM© software is a unique tool for health professionals to assist in the decision-making process of complex medication regimens of older patients and to facilitate*

the incorporation of monitoring recommendations into the care plan to detect potential ADEs that can be avoided, managed, or reversed.

METHODS

Study Design: We conducted a large-scale randomized study of 26 nursing facilities serviced by one of two long-term care pharmacies in Ohio that agreed to participate in a large randomized clinical trial. Nursing homes were randomized to receive the standard of care (n=13) or the intervention described below (n=13).

Data Sources/Collection: We derived data for the current study from the federally mandated Minimum Data Set (MDS) assessments. **MDS:** The MDS, which focuses on care assessment, has over 300 data elements. Trained clinical nursing and social work staff (Morris et al, 1992) responsible for the resident completed the MDS. Topics covered in the MDS include cognitive function, physical functioning, continence, psychosocial well-being, mood state, disease diagnoses, health conditions, communication/hearing problems, nutritional status, oral/dental status, skin condition, special treatments, and medication use. Although initial evaluation of the reliability of the MDS provided at least adequate reliability on most scales (Morris et al, 1992), investigators debated whether the MDS should be used for research (Teresi & Holmes, 1992). Studies to evaluate the reliability of the MDS followed. In one study, researchers reported that 89% of the MDS items achieved an intraclass correlation of 0.4 or higher, with 63% achieving an estimate of at least 0.6 (Hawes et al, 1995). Ninety-two percent of the background items were reliable, with an average reliability estimate of 0.71, and all MDS diagnoses were reliable, with an average reliability of 0.74, considered adequate for research purposes. Subsequent studies have evaluated the reliability of other MDS items (Hawes et al, 1995). The activities of daily living (ADL) classification is based on six levels of self-performance, including dressing, eating, toilet use, bathing, locomotion, transfer, and continence. Staff evaluated residents in each of these areas using a five-point scale as independent, needing supervision, needing limited assistance, needing extensive assistance, or totally dependent. The reliability of the ADL scores range from 0.87 to 0.92 (Hawes et al, 1995) and is highly correlated (0.89) with the Physical Signs and Symptoms Scale (Hawes et al, 1995; Lawton et al, 1969). The MDS Cognitive Performance Scale (CPS) is a categorical measure of cognition using these MDS items and several items that indirectly evaluate cognitive function (i.e., comatose state, total dependent eating) (Morris et al, 1994). Designed to assign residents into easily understood cognitive performance categories, the CPS score ranges from 0 (intact) to 6 (very severe impairment). The CPS has excellent reliability, with estimates in the range of 0.66 to 0.88, and high sensitivity (>90%) and specificity (>85%), using the MMSE as the gold standard (Hartmaier et al, 1994; Hartmaier et al, 1995). **Drug Inventory**: The pharmacy claims data were transmitted from Omnicare to Brown University for participating nursing homes throughout the study period. Pharmacy claims files contain information such as National Drug Code (NDC), days supply, dose, etc. NDCs are not suitable for research purposes. As pharmaceutical companies merge and new products are introduced, changes in NDCs occur. We linked NDCs to specific descriptive information to enable research using an historical reference archive for drug products that listed all NDCs ever attributed (MediSpan™ , First Data Bank) (MDDB Documentation Manual, 1995). MediSpan™ maps NDCs to the Generic Product Identifier, a 14-character field consisting of seven subsets, each providing more specific drug information. MediSpan™ includes over 88,000 generic drug products, products from regional manufacturers, and data on over 90,000 inactive drugs. **CMS Claims**: The HCFA Eligibility and Standard Analytic Files have been merged to the MDS data using the Health Insurance Claim

number of Medicare beneficiaries. The eligibility file contains gender, date of birth, survival status (verified date of death), and insurance type. The claims data include all health services consumption claims, such as hospitalizations, skilled nursing facility admissions, hospice, and home health agency bills. To date, we have achieved a match rate of over 90%.

Survey: We also conducted a nursing home survey that was distributed and sought to evaluate perceptions of patient safety among nurses and nursing assistants participating in the trial. The participating nursing homes indicated their distribution method preference (mail directly to staff members' homes vs. distributed at work) and provided the necessary information to distribute the information according to their preference. Facilities provided lists of nurses (n=721) and nursing assistants (n=1,233). The survey process for both work and home distribution included four mailings spaced 2 weeks apart in the following sequence: an initial mailing of the survey packet, a reminder postcard, a re-mail of the survey packet to nonrespondents to the initial survey, and a final reminder postcard. The survey packets consisted of a cover letter explaining the survey and including the elements of informed consent as well as the procedures necessary to receive the incentive for survey completion, the survey with the unique identifier included on the survey (but not the respondent's name), and a postage-paid return envelope. Return envelopes were addressed to the research team at Brown Medical School. The respondents were asked not to complete the survey at work. Mailings began in August 2003 and continued throughout the fall of 2003, before the initiation of the intervention, and an abbreviated survey was sent 2 months after the intervention period. Incentive checks of $15 were mailed upon receipt of completed surveys. After the incentive checks were mailed, data were de-identified.

Interventions GRAM™ was developed to 1) aid in the evaluation of medications as a cause or aggravating factor contributing to negative patient outcomes (e.g., adverse drug events, functional decline); 2) facilitate the incorporation of medication information into the resident's care plan; 3) foster pharmacist involvement in the residents' assessment and care planning process; 4) promote the integration of MDS data with the therapeutic monitoring of medication therapy; 5) assist pharmacists in evaluating and monitoring complex medication regimens of nursing facility residents to identify, resolve, and prevent medication-related problems; and 6) facilitate the incorporation of resident assessment data into the pharmaceutical care plan**.** GRAM™ uses technology to facilitate informed, shared decision making, and monitoring for medication-related problems.

By federal mandate, the Minimum Data Set is used on all patients in all Medicare- and Medicaid-certified nursing homes to assist in problem identification via a process that includes a comprehensive geriatric assessment, decision making, care planning, implementation, and evaluation. The MDS includes items on cognitive function, physical functioning, continence, psychosocial well-being, mood state, disease diagnoses, health conditions, communication problems, nutritional status, oral/dental status, skin condition, special treatments, and medication use, with the goal of identifying residents who have or are at risk for developing specific problems. From this assessment, resident assessment protocols (RAPs), structured, problem-oriented frameworks used to form the basis for individualized care planning, may be "triggered." RAPs help staff evaluate causal or contributing factors (some reversible) for the problem areas. The GRAM™ software assists in the problem identification and clinical decision-making process when evaluating medication regimens of geriatric patients. The GRAM™ software facilitates the incorporation of patient assessment data in the monitoring of medication therapy. The GRAM™ software attempts to foster inclusion of medication monitoring into the patient's plan of care to proactively identify and prevent potential medication-related problems.

GRAM™ evaluates a geriatric patient's *potential* medication effects with signs, symptoms, syndromes, and indicators that describe mood, behavior, cognition, psychosocial well-being, and physical functioning, as captured in the MDS and corresponding RAPs. Details regarding the validation process of GRAM™ software are described elsewhere (Lapane et al 2005). Briefly, an interdisciplinary panel of experts in geriatrics participated in a consensus panel to determine the face and content validity of the software.

Members of the American Society of Consultant Pharmacists (ASCP) Foundation worked with the two long-term care pharmacies commercial pharmacy software system to integrate GRAM™ into the real-time existing processes of pharmaceutical care delivery. For new/readmits, GRAM™ generated several reports in real time (as integrated with the commercial pharmacy software) for use by the consultant pharmacist and the nursing facility staff. These reports included the GRAM™ RAP-Med Report as well as Medication Monitoring Care Plans and Flow Records for falls and delirium. The Medication Monitoring Care Plans and Flow Records were also generated for new patients receiving medications that may cause, aggravate, or contribute to falls and/or delirium. The Flow Records contain specific MDS items that may indicate adverse medication effects associated with falls and/or delirium. The goal of the Flow Record is to facilitate early recognition of signs and symptoms indicative of potential medication-related problems. Observation and charting were done by the nursing assistants; if symptoms were observed, the nursing assistants were directed to notify the nurse and chart the action. Through observation, documentation, and action, the nursing assistant was integral to the success of this intervention.

Monday through Friday, these reports were delivered daily to the MDS coordinators of the intervention facilities. Also, the consultant pharmacists received GRAM™-triggered RAP-Med Reports for all patients in the intervention arm who triggered the fall and/or delirium RAPs since the pharmacist's last visit to the facility. As part of the drug regimen review process, the consultant pharmacist evaluated the patient's medications for the potential to cause, aggravate, or contribute to falls and/or delirium; made appropriate recommendations for monitoring or changes in therapy; and reviewed these recommendations with the nursing staff. Medication Monitoring Care Plans and Flow Records were developed for falls and delirium.

The ASCP Foundation developed and delivered in-service programs for nursing staff of the 13 facilities receiving the intervention. The in-service programs provided detailed information regarding medications that cause, aggravate, or contribute to the risk for falls and delirium; reviewed specific signs and symptoms of adverse medication effects; and reinforced the importance of early observation for signs and symptoms of adverse medication effects. The training sessions introduced the processes of care and provided detailed instruction on how to use the specific reports, care plans, and flow records. Significant staff turnover has required repeat training sessions. The ASCP Foundation also provided training on GRAM™ for the consultant pharmacists involved in the project.

Measures We defined as "severe" any potential ADE that resulted in a hospitalization or indication of delirium on repeat MDS assessments. We considered these events potential, as it is not possible to determine origin based on hospital claims data or from the MDS. We used the first listed diagnosis to identify potentially ADE-related hospitalization. Based on previous research on the incidence of ADEs in nursing homes (Gurwitz et al, 2000), we considered as potential ADEs hospitalizations with these primary ICD-9 codes: gastrointestinal hemorrhage (ICD9 codes: 531.0, 531.2, 532.0, 532.2, 533.0, 533.2, 534.0, 534.2); nontraumatic intracranial hemorrhage (ICD-9: 432.0, 432.1, 432.9); allergic urticaria (ICD-9: 708.0); diabetic hypoglycemia/coma (ICD-9: 292.8, 250.3, 250.8, 251.0); acute liver failure (ICD-9: 570);

fractures (ICD-9: 800-829.9); falls with or without fracture (ICD-9: E880, E884.2, E884.3, E884.4, E884.5, E884.6, E885, E887, E888); and drug-induced delirium (ICD-9: 292.8). In addition to hospitalization claims, we used longitudinal MDS data to identify new-onset delirium. The MDS contains a specific section containing indicators of delirium (lethargy, altered perception or awareness, episodes of disorganized speech, periods of restlessness).

We also focused on resident assessment protocol (RAP) triggers for delirium and falls. We anticipated that such identified problems would be resolved prior to the periodic MDS assessments. It followed that, if the intervention was effective, we would see a corresponding reduction in the triggering of specific RAPs based on the MDS data. The RAP triggers for delirium and falls are based on meeting a set of criteria, using information routinely captured on the MDS. For delirium, these criteria are based conceptually on risk factors for delirium in order to trigger a more in-depth assessment and take steps to alleviate the problem. There are four criteria; meeting any one of them triggers a RAP. These criteria are 1) any indicator of disordered thinking (MDS 2.0: B5a, B5b, B5c, B5d, B5e; any checked); 2) cognitive/communication/behavior decline (MDS 2.0: B6=2 or C6=2 or H7=2); 3) mood decline (MDS 2.0 item: H6=2); and 4) at least one of the following: motor agitation (MDS item: H1c) or withdrawal (MDS 2.0 item: H1d = checked), or hallucinations/delusions (MDS 2.0 item: K1g), or alcohol withdrawal-induced, drug-induced, acute, or subacute delirium (MDS 2.0 item J2 coded as ICD-9 291.0, 292.81, 293.0, or 293.1).

The RAP trigger for falls is based on three criteria. Meeting any one of these criteria triggers the RAP for falls. The first two are conceptually based on the premise that a recent fall may indicate an environment prone to future falls; the third criterion specifies three classes of risk factors for falls, at least two of which must be present to trigger a fall prevention RAP: 1) fell in past 30 days (K2a), 2) fell in past 31-180 days (K2b), and 3) no indication of fall (K2a and K2b = not checked) and two or more of the following: use of any psychoactive drugs (MDS 2.0 items: O4a, O4b or O4c=1-7 days), impaired sense of balance (MDS 2.0 items E4a, E4j=any checked), or bedfast or hemi/quadriplegia or poor leg control (MDS 2.0 items: E4b, E4d, E4e, E4h=any checked).

For the staff questionnaire, the sections were sociodemographic items (gender, ethnicity, educational achievement, years worked in the nursing home, and years worked in present position), items relating to job satisfaction (six items with a five-point scale ranging from ‘never’ to ‘most or all of the time’), a modified version of the Health Profession Stress Inventory (HPSI, containing 28 items with a five-point scale ranging from ‘never’ to ‘often or frequently’), a modified version of a communication effectiveness instrument, and questions regarding staff perceptions of resident safety (34 items with a five-point scale ranging from ‘never’ to ‘all of the time’).

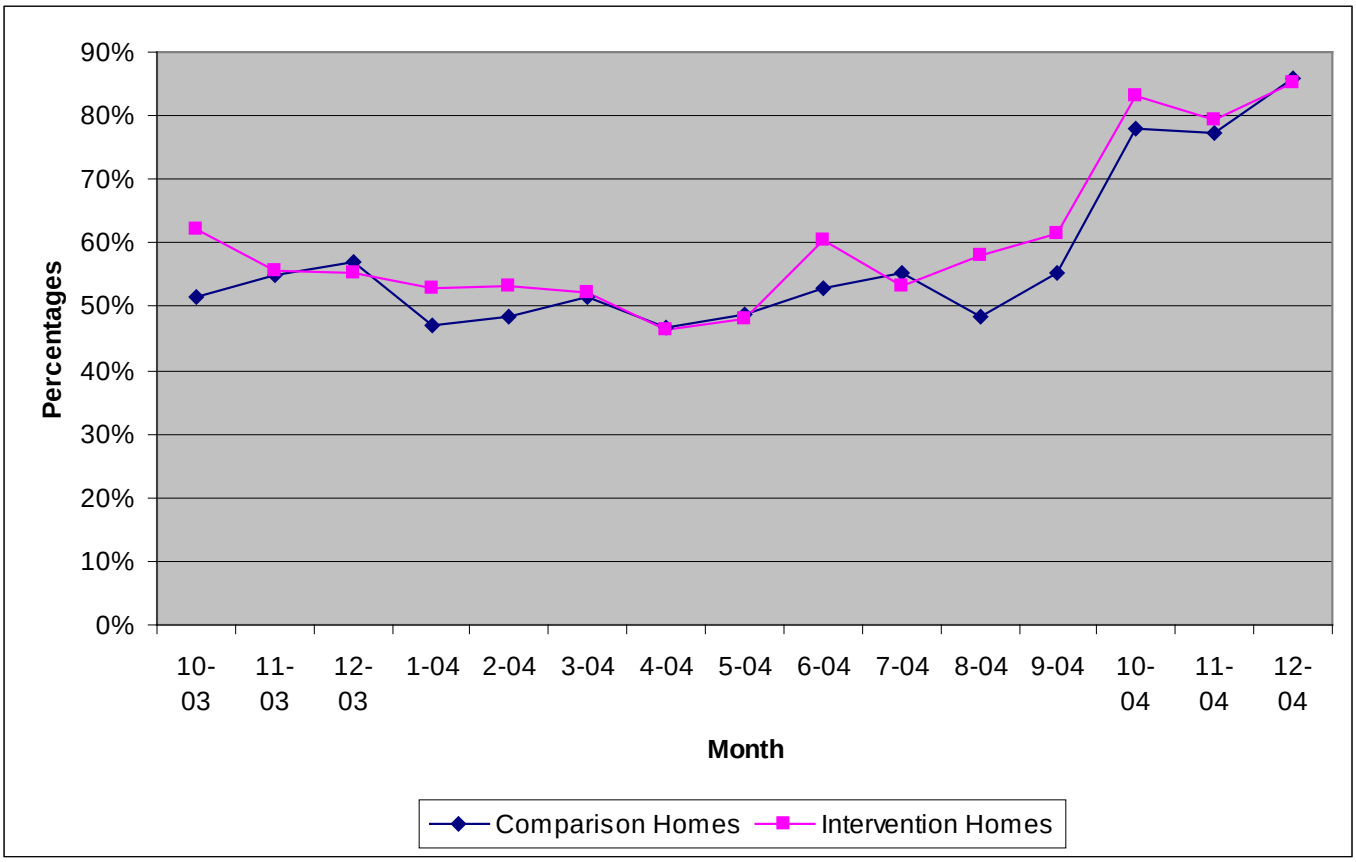
Limitations This study was hampered by several issues. First, with the introduction of HIPPA, we were unable to conduct detailed chart reviews to clearly ascertain adverse drug events within the limitations of our original budget. As such, we relied on CMS claims data and MDS data to define out primary outcomes. In doing so, we recognize that we may have introduced significant misclassification that was nondifferential with respect to the intervention status of the home. This is likely to have underestimated any potential effect we may have observed. Also, the nursing homes included in our study were not immune to the turnover issues plaguing the nursing home industry. Although the ASCP Foundation team repeated the intervention in-services, it is unclear how systematically the intervention was delivered by a dynamic nursing home staff.

RESULTS

Principal Findings:

There were initially 5,319 individuals in 13 usual-care homes and 13 intervention homes. An intervention home canceled services from the long-term care provider and thus was ineligible for the study. We excluded people younger than 65 (733 individuals) and people with a missing discharge date, a discharge date before October 2003, or inconsistent admit and discharge dates (179 individuals). The final sample includes 4,157 individuals. The intervention period was calendar year 2004. There were 2,316 individuals who had a total of 15,835 interventions. The figure below shows that there were no significant differences in the proportion of residents receiving interventions in intervention versus usual-care homes. At least one GRAM™ assessment was received by 382 people for a total of 467 interventions: 21, delirium assessment protocol; 113, falls RAP; and 333, general assessment. The percent of residents within a home receiving the GRAM™ interventions varied, with a low of 3.7% and a high of 15.9%.

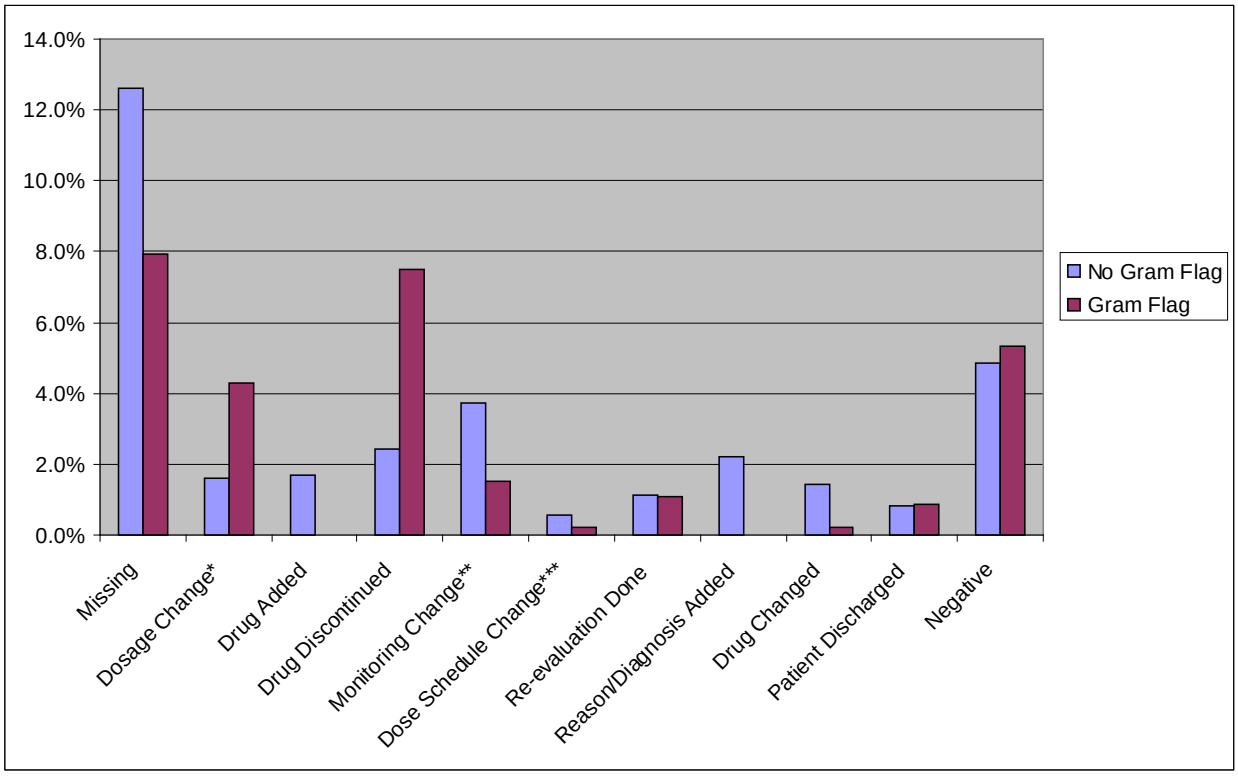
Figure. Percentage of People with Interventions by Intervention and Comparison Study Group



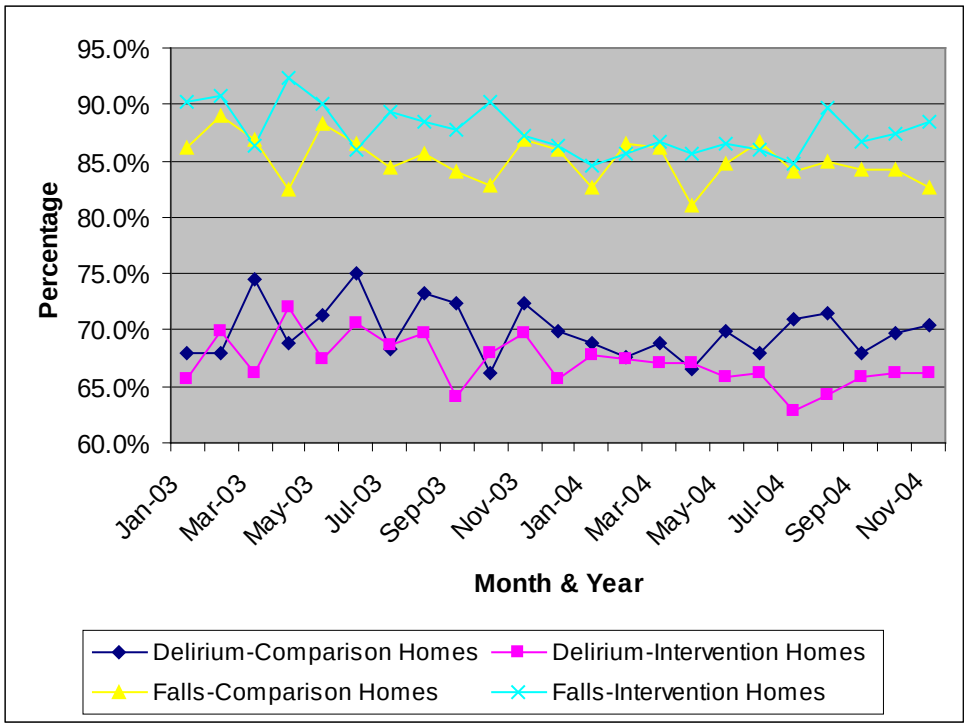
The specific interventions that consultant pharmacists performed in response to the GRAM™ flag were different than interventions performed on residents without the flag. Consultant pharmacists were four times as likely to recommend a dose change in response to the GRAM™ flag (5.7% vs. 1.4%), 2.7 times as likely to recommend a drug be discontinued (7.3%

vs. 2.7%), 0.4 times as likely to recommend a monitoring change (1.6 vs. 3.8%), and less likely to change or add a drug.

Figure. Type of Interventions for Intervention Facilities by GRAM Flag



The figure below shows the proportion of residents within a given month who triggered the falls and delirium resident assessment protocols, stratified by intervention home status. With respect to the delirium resident assessment protocols, prior to the intervention year in 2004, the proportions of residents in intervention homes and usual-care homes were on average similar. By June 2004, the proportion of residents in the intervention homes triggering the delirium resident assessment protocol was less than the proportion of residents triggering the delirium resident assessment protocol in the usual-care homes. With respect to the falls resident assessment protocol, throughout the entire course of the study (pre-intervention in 2003, continuing through the intervention year 2004), the proportion of residents triggering the fall resident assessment protocol was lower in the usual-care homes relative to the intervention homes.



Slight changes in following medications in the CNS drug class were observed: opiate agonists, miscellaneous anticonvulsants, tranquilizers, and benzodiazepines. The rate for opiate agonists was 23% for each study group in August 2004; by December 2004, it was 31% for the usual-care homes and 27% for the intervention homes. The study groups had a rate of 10% for miscellaneous anticonvulsants in July 2004;by December 2004, the rate changed to 15% for the usual-care homes and 12% for the intervention homes. The rate for usual-care homes was slightly higher (17% vs. 16%) in June 2004 for tranquilizers; by November 2004, there was a significant variation (26% vs. 16%). The rate for benzodiazepines was approximately the same (7.5% vs. 7.7%) for each study group in April 2004; by October 2004, it was 16% for the usual-care homes and 12% for the intervention homes.

The characteristics of the residents shown in the tables below demonstrate that, on average, the patient mix appeared similar between usual-care and intervention homes in 2003 and 2004.

Table. Baseline Characteristics[1] of nursing home residents in intervention and usual-care nursing homes participating

	Baseline 2003		*Intevention period 2004*	
	Usual Care	*Intervention*	*Usual Care*	*Intervention*
Characteristics	*(n=1,492)*	*(n=1,711)*	*(n=1,552)*	*(n=1,769)*
	Percentage	*Percentage*	*Percentage*	*Percentage*
Female	68.2	72.3	67.5	73.9
Age (years)				
<65	12.5	8.1	12.9	7.1
65-74	15.8	16.3	15.5	15.1
75-84	35.3	35.9	36.0	38.8
85+	36.4	39.7	35.6	39.0
Minority race/ethnicity	11.3	17.7	9.6	18.8
Physical Functioning				
Moderate impairment	58.3	59.7	59.5	64.3
Severe impairment	26.0	29.2	24.3	25.4
Cognitive function				
Moderate impairment	47.1	47.8	49.7	49.1
Severe impairment	26.2	22.3	22.7	19.6
Number of diagnoses				
4-5 diagnoses	31.3	30.4	31.5	32.5
≥6 diagnoses	45.4	37.3	44.1	37.1
Specific diagnoses				
Dementia	43.4	35.4	42.7	33.4
Alzheimer's disease	14.6	12.7	13.5	13.0
Cancer	12.1	8.3	11.0	8.1
Diabetes mellitus	31.0	27.5	31.1	28.4
Cerebrovascular accident	22.4	22.2	20.1	20.1
Heart failure	28.5	26.5	26.6	26.6
Coronary artery disease	16.2	18.6	15.9	15.9
Arrhythmia	15.8	15.8	14.4	16.6
Hypertension	61.8	64.9	65.1	66.9
Other cardiovascular disease	28.0	23.6	25.5	25.0

[1] Derived from resident level MDS data.

The table below shows the estimates of the impact of the intervention on mortality, hospitalization, and hospitalization due to a potential adverse drug effect. Usual-care homes experienced a 12.6% increase in mortality rate between the pre and post study periods, whereas the intervention homes experienced an 8.8% decrease. It is unclear if this can be attributed to the slight differences in mortality at baseline. With respect to any hospitalization, the intervention homes experienced a 3.7% increase relative to the usual-care homes (1.0% increase). Both usual-care and intervention homes experienced a decline in potential adverse drug event related hospitalizations, but, when evaluating the primary diagnosis as the reason for hospitalization, the usual-care homes experienced a 14.3% decline, whereas the intervention homes experienced a 32.1% decline. None of these differences represented a statistically significant effect.

Table. Facility-level change in primary outcomes by pre-intervention and intervention period and intervention vs. usual care

Outcome Measure	*Study Group*	*Study (2003) Mean (Standard Error of the Mean)*	*Intervention Period (2004) Mean (Standard Error of the Mean)*	*Percentage Change*
Mortality	Usual Care	*17.4 (1.2)*	*19.6 (1.3)*	*12.6*
	Intervention	*19.4 (1.2)*	*17.7 (1.3)*	*-8.8*
Any Hospitalization	Usual Care	*40.2 (3.2)*	*40.6 (3.9)*	*1.0*
	Intervention	*38.0 (3.3)*	*39.4 (3.9)*	*3.7*
Adverse Drug Event Related Hospitalization based on all Diagnoses	Usual Care	*3.7 (.53)*	*3.4 (.45)*	*-8.1*
	Intervention	*4.4 (.56)*	*4.0 (.88)*	*-9.1*
Adverse Drug Event Related Hospitalization based on Primary Diagnosis	Usual Care	*2.1 (.43)*	*1.8 (.48)*	*-14.3*
	Intervention	*2.8 (.39)*	*1.9 (.52)*	*-32.1*

There was no differential change in the job satisfaction reported by nurses and aides by intervention arm. Although there was no differential change by treatment arm among nurses with respect to reported effectiveness of the nursing homes in providing needed services, the change was significant in aides (p=0.0023). For both nurses and aides, no significant differential changes in reports of patient safety domains were attributable to the intervention. Differential changes by treatment arm in stress levels reported by nurses and aides were observed. Among nurses, no differences by treatment arm in perceptions of communication among nurses and aides were observed. Among aides, significant differences by treatment arm were apparent for perceptions of communication between aides and nurses and among aides.

Outcomes:

We found that this tool would not be used effectively unless completely integrated in the real-time operations of the long-term care pharmacy or unless the drug information could be easily

imported into the software without re-entering detailed, complicated drug regimens. Yet, the ASCP Foundation worked to bring all the partners together to make the integration occur seamlessly. The extent to which this finding is generalizable to other commercial software vendors or other decision support tool innovations is unknown.

We appear to have overestimated the proportion of residents who would likely to be flagged by the software product, thus triggering the intervention. In our study, between 3.7% and 15.9% of residents within the intervention homes were triggered to receive the intervention. We anticipated a much higher percentage based on previous use of the software. The rigorous validation protocol and enhancements to the algorithms underlying the software may have made the triggering much more selective. It may also be that the mix of patients in the nursing homes participating in the study was less likely to be taking drug regimens that place them at high risk for falls and delirium.

Discussion:

Our findings may reflect in part that delirium, rather than a fall, is more likely caused by a drug. Gurwitz et al (2000) estimated that one third of preventable adverse drug events were neuropsychiatric (including delirium, hallucinations, and oversedation) and 20% were falls. The pathogenesis of delirium is multifactorial, with factors that increase vulnerability and precipitating events interacting in a complex way (Francis, 1998). Factors increasing vulnerability include advanced age, dementia, stroke, Parkinson's disease, and sensory impairment. In people at increased risk, even trivial events can result in the manifestation of delirium. However, the most common precipitating factors are drugs (especially psychoactive drugs) and iatrogenic complications, including infections, dehydration, immobility (including use of physical restraints), malnutrition, and use of bladder catheters (Inouye et al, 1996).

Even modest reductions in the occurrence of delirium can have a big impact on quality of life owing to the severity of the outcomes. In a meta-analysis of studies in the hospitalized population, delirium was associated with a 1-month mortality of about 15% and with a 6-mortality of over 20%, which is about twice the mortality rate of patients of similar age but without delirium (Cole et al, 1993). Delirium is also associated with longer hospital stays (12 vs. 7 days), increased mortality (8% vs. 1%), increased admission to LTC (16% vs. 3%), and prolonged cognitive impairment. Delirium is resolved in only 4% at discharge, 21% by 3 months, and 18% by 6 months, with the remainder extending beyond 6 months (Levkoff et al, 1992). Although some of these outcomes may be confounded by the presence of dementia or by severity of illness, it has been shown that delirium is an independent risk factor for poor outcomes among patients with hip fracture (Marcantonio et al, 2000). Treatment of delirium is based on the treatment of the precipitating factor, and *prevention plays the most important role.*

The etiologic fracture of falls owing to medications is likely small compared with other potential underlying causes of falls (e.g., environment, balance, etc.). In long-term care facilities, the incidence of falls is 1,600 per 1,000 patients per year (Rubenstein et al, 1998), with over 50% of residents falling each year. Regardless of the low percent of fracture and serious soft-tissue injuries in people over 85 years, the rate of fall-related mortality is excessive (131.2 per 100,000) (Ory et al, 1993). It is likely that a more comprehensive, multifactorial intervention using a multidisciplinary approach of which GRAM™ is a component would yield more favorable results than what we observed with the current intervention.

Despite the use of claims data to evaluate the outcomes, these data sources may have been subject to misclassification. If the misclassification was nondifferential, it would have diluted any real intervention effect. Heightened awareness of adverse drug events may have occurred in the intervention homes. If so, it would have also attenuated any observable impact of the intervention.

Conclusion:

Integrating clinical informatics relating to medication use must be done at the pharmacy level and not at the consultant pharmacist level. To do so requires commitment to change; re-engineering the workflow of the pharmacy; and continued training among nursing staff, consultant pharmacists, and the MDS coordinator. If done, the tool can assist in making targeted recommendations and assist in altering the prevalence of medications used in this setting. Trends in decreases in hospitalizations due to serious adverse events were observed but did not reach statistical significance. This may be due in part to several factors, including that the dose was not strong enough, the threshold to receive the intervention was too high, and the misclassification in the outcomes was too great.

Significance: GRAM™ was developed as a clinical decision-making tool for geriatric patients on medication therapy to treat chronic disease and conditions. It has applicability in all settings where elderly persons reside, including home care, assisted living, and in the community. Widespread implementation of the clinical decision-making tool is likely to occur in nursing facilities. Just four long-term care pharmacy providers service nearly 70% of the nursing facility beds in the US. As such, the potential for immediate widespread implementation of GRAM™ exists. Anyone can use the GRAM™ software. However, only health professionals with expertise in geriatric pharmacotherapy can use it as a clinical decision-making tool. Futhermore, the cost of the GRAM™ software is relatively inexpensive. The ASCP Foundation is a 501(c)(3) nonprofit charitable organization. As such, the yearly licensing fee for GRAM™ is only $400. However, this does not include the additional costs of pharmacists' professional services. In the US context, the significance of the widespread implementation of the decision support tools will only increase as the standards for processing of electronic information regarding prescriptions infiltrates the long-term care industry. The true value with respect to gains in patient safety will be realized as we expand the use of such tools to use information to specifically target areas for improvement of monitoring and other aspects of care delivery in long-term care settings.

Implications: Nursing facilities participating in Medicare/Medicaid are regulated by CMS. The results of this study provide evidence for policy consideration in the following areas:

Rationale for inclusion of Section U (medication inventory) in the Minimum Data Set (MDS): The Resident Assessment Instrument forms the foundation for the planning and delivery of care for frail, elderly nursing facility residents. The MDS is the assessment tool, containing more than 300 data elements, including demographic variables, clinical items (diagnoses, signs, symptoms, syndromes, treatments), and indicators describing mood, behavior, cognition, psychosocial well-being, and involvement in activities. The MDS identifies residents who have problems or who are at risk for developing problems in those areas in which care planning is important to improve or maintain physical, functional, and psychosocial status. The one glaring omission from the federally mandated MDS is the drug regimen. Medications must be considered in the assessment process for important information concerning medications to be routinely included in the care plan. Medication monitoring information must be in the care plan for early detection of preventable adverse drug effects and reduced threat to patient safety. Our

study reinforces the need for inclusion of a comprehensive data source regarding medications in nursing homes.

Prospective drug regimen review: Current regulations require that the drug regimen of every nursing facility residents be reviewed at least monthly by the consultant pharmacist; that the pharmacist identify any "irregularities and report them to the attending physician and director of nursing; and that these recommendations must be "acted on." Retrospective drug regimen review has resulted in improvement in care since it was first mandated; however, it has obvious limitations, because it can occur up to 30 days after a medication is dispensed. Prospective review can identify actual and potential medication-related problems before the medication is dispensed and can have a greater impact on preventing avoidable adverse medication effects. The Institute of Medicine report entitled "To Err is Human: Building a Safer Health Care System" reinforces the need for optimizing medication use in a population that is associated with polypharmacy and comorbidities. Also, a recent Institute of Medicine report (IOM, 2001) states that "Congress should continue to authorize and appropriate funds for… monitoring and tracking processes for use in evaluating the progress of the health system in pursuit of the above-cited aims of safety, effectiveness, patient-centeredness, timeliness, efficiency, and equity." This study has shown a proof of concept with respect to using clinical informatics tools to begin the process of prospective monitoring of residents with respect to their medication regimen. We have proven that long-term care pharmacies can be integral in working toward this ideal.

Payment for pharmacist's professional services: Exploiting the potential of pharmacists and professional pharmacy services would appear to justify such an intervention. We estimate avoiding just one hospitalization and rehabilitation for a preventable hip fracture would provide the cost justification for payment for pharmacist's professional services, such as the intervention tested in this study. However, the issue remains as to who absorbs the costs for such services (under existing model: long-term pharmacy providers) and who are the likely recipients of the cost benefits (e.g., the government through reduced expenditures owing to hospitalizations). Indeed, at the end of the intervention period, Omnicare elected to turn off the intervention, because they did not want to pay for it and because such programs were not a part of the required delivery of their services.

LIST OF PUBLICATIONS AND PRODUCTS

Cameron KA, Feinberg JL. Study Testing GRAM™'s Effectiveness on Patient Safety Begins. Spotlight, newsletter of the ASCP Foundation. January 2004.

Feinberg JL, Cameron KA, Lapane KL, Allsworth JE. The use of GRAM™ software to improve patient safety in nursing facilities. Consult Pharm 2004;19:398-413.

Feinberg J, Pepper G. Improving patient safety in long-term care facilities: an overview of AHRQ funded projects. Annals of Long-term Care: Clinical Care and Aging 2004;12(8):34-38.

Lapane KL, Cameron K, Feinberg J. Technology for improving medication monitoring in nursing homes. In: Henriksen K, Battles JB, Marks ES, Lewin DI, editors. *Advances in patient safety: From research to implementation, Vol. 4, Programs, Tools, and Products.* AHRQ Publication Number 05-0021-3. Rockville, MD: Agency for Healthcare Research and Quality; Feb. 2005. p. 410-413. Government Health IT: http://www.governmenthealthit.com/article90512-08-29-05-Web

Feinberg JL. The prevention of adverse drug events. ECPN 2005;June:26-32.

Feinberg JL. Improving patient safety through early recognition of adverse medication effects. Annals of Long-Term Care: Clinical Care and Aging. Submitted Sept 2005.

Simonson W, Feinberg JL. Medication-related problems in the elderly: defining the issues and identifying solutions. Drugs Aging 2005;22(7):559-69.

Hughes CM, Lapane KL. Nurses' and nursing assistants' perceptions of patient safety culture in nursing homes. Int J Qual Health Care. 2006 Aug;18(4):281-6.

Hughes CM, Wright RM, Lapane KL. Use of medication technicians in US nursing homes: part of the problem or part of the solution? J Am Med Dir Assoc 2006;7(5): 294-304.

Hughes CM, Lapane KL. Administrative initiatives for reducing inappropriate prescribing of psychotropic drugs in nursing homes: how successful have they been? Drugs Aging 2005;22(4):339-51.

Hanlon JT, Scmader KE, Hughes C, Lapane KL, Swine C, Spinewine A. Approaches for optimisation of drug prescribing in elderly people. In submission, Lancet)

Lapane KL, Quilliam BA, Hughes CM. Impact of distribution method on response rates to a patient safety questionnaire in nursing homes (in revision, BMC Methodologic Research)

REFERENCES

Alliance for Aging Research. When Medicine Hurts Instead of helps: Preventing medication problems in older persons. Washington, DC: 1998

Avorn JA,Gurwitz JH. Drug use in the nursing home. *Ann Intern Med* 1995;123:195-204.

Baum C, Kennedy DL, Knapp DE, et al. Drug utilization in the US: 1986. Rockville MD: Department of Health and Human Services, Food and Drug Administration, 1987.

Bernabei R, Gambassi G, Lapane KL, Sgadari A, Landi F, Gatsonis C, Lipsitz L, Mor V. Characteristics of the SAGE Data Base. A new resource for research on outcomes in long term care. *J Gerontol A Biol Sci Med Sci.* 1999 Jan;54(1):M25-33.

Bootman JL, Harrison DL, Cox E. The health care cost of drug-related morbidity and mortality in nursing facilities. *Arch Intern Med* 1997; 157: 2089-2096.

Gurwitz JH, Field TS, Avorn J, et al. Incidence and preventability of adverse drug events in nursing homes. *Am J Med*. 2000;109(2):87-94.

Hartmaier SL, Sloane PD, Guess HA, Koch GG, Mitchell CM, Phillips CD. Validation of the Minimum Data Set cognitive performance scale: Agreement with the Mini-Mental State Examination. *J Gerontol* 1995; 50A:M128-M133.

Hawes C, Morris JM, Phillips CD, Mor V, Fries B, Nonemaker S. Reliability estimates for the Minimum Data Set for nursing home resident assessment and care screening (MDS). *The Gerontologist* 1995; 35(2):172-178.

Institute of Medicine. Improving the quality of care in nursing homes. Washington, DC: National Academy Press, 1986.

Institute of Medicine. Crossing the quality chasm: A new health system for the 21st century. Wasington DC. National Academy Press, 2001.

Inouye SK, Charpentier PA. Precipitating factors for delirium in hospitalized elderly persons. Predictive model and interrelationship with baseline vulnerability. *JAMA* 1996;275(11):852-7.

Johnson JA, Bootman JL. Drug-related morbidity and mortality: a cost-of-illness model. *Arch Intern Med* 1995; 155:1949-56.

Kemper P, Murtaugh CM. Lifetime use of nursing home care. *N Engl J Med* 1991; 324(9): 595-600.

Kuehl AK Chrischilles EA Sorofman BA. System for exchanging information among pharmacists in different practice environments. *Consult Pharm* 1998:13;564-574.

Lamy PP. Physiological changes due to age. *Drugs Aging* 1991; 5: 385-404.

Lapane KL, Cameron K, Feinberg J. Technology for improving medication monitoring in nursing homes. In: Henriksen K, Battles JB, Marks ES, Lewin DI, editors. Advances in patient safety: From research to implementation, Vol. 4, Programs, Tools, and Products. AHRQ Publication Number 05-0021-3. Rockville, MD: Agency for Healthcare Research and Quality; Feb. 2005. p. 410-413. Government Health IT: http://www.governmenthealthit.com/article90512-08-29-05-Web

Levkoff SE, Evans DA, Liptzin B, Cleary PD, Lipsitz LA, Wetle TT, Reilly CH, Pilgrim DM, Schor J, Rowe J. Delirium: The occurrence and persistence of symptoms among elderly hospitalized patients*. Arch Intern Med.* 1992 Feb;152(2):334-40.

Lobas NH, Lepinski PW, Abramowitz PW. Effects of pharmaceutical care on medication cost and quality of patient care in an ambulatory care clinic. *AJHP* 1992; 49-1681-88.

Master Drug Data Base (MDDB) Documentation Manual, Indianapolis, IN: MediSpan Inc., 1995.

Marcantonio ER, Flacker JM, Michaels M, Resnick NM. Delirium is independently associated with poor functional recovery after hip fracture. *J Am Geriatr Soc* 2000;48(6):618-24.

Mor V, Intrator O, Fries BE, Phillips C, Teno J, Hiris J, Hawes C, Morris J. Changes in hospitalization associated with introducing the Resident Assessment Instrument. *J Am Geriatr Soc* 1997; 45(8):1002-10.

Monane M, Avorn J. Medications and falls. Causation, correlation, and prevention. *Clin Geriatr Med* 1996;12(4):847-58.

Morris JN, Fries BE, Mehr DR, et al. MDS cognitive performance scale. *J Gerontol* 1994; 49:M174-M182.

Morris JN, Hawes C, Murphy K, et al. Multistate Nursing Home Case Mix and Quality Demonstration Training Manual. Natick, MA: Eliott Press, 1992.

Pharmacy Practice Activity Classification Consortium. Pharmacy practice activity classification. *J Am Pharm Assoc* 1998; 38(2):139-48.

Phillips CD, Morris JN, Hawes C, Fries BE, Mor V, Nennstiel M, Iannacchione V. Association of the Resident Assessment Instrument (RAI) with changes in function, cognition, and psychosocial status. *J Am Geriatr Soc* 1997; 45(8): 986-93.

Raschke RA, Gollihare B, Wunderlich TA, Guidry JR, Leibowitz AI, Peirce JC, Lemelson L, Heisler MA, Susong C. A computer alert system to prevent injury from adverse drug events. *JAMA* 1998; 280: 1317-1320.

Ray WA, Taylor JA, Meador KG, Lichtenstein MJ, Griffin MR, Fought R, Adams ML, Blazer DG. Reducing antipsychotic drug use in nursing homes: A controlled trial of provider education. *Arch Intern Med* 1993;153: 713-721.

Schneider EL, Guralnik JM. The aging of America. Impact on health care costs. *JAMA* 1990; 263(17):2335-40.

Sloss EM, Solomon DH, Shekelle PG, Young RT, Saliba D, MacLean CH, Rubenstein LZ, Schnelle JF, Kamberg CJ, Wenger NS. Selecting target conditions for quality of care improvement in vulnerable older adults. *J Am Geriatr Soc* 2000;48:363-9.

Stuck A, Beers MH, Steiner A, Aronow HU, Rubenstein LZ, Beck JC. Inappropriate medication use in community-residing older persons. *Arch Intern Med* 1994;154: 2195-2200.