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Effect of a Pharmacist-Led Multicomponent Intervention Focusing on the Medication Monitoring Phase to Prevent Potential Adverse Drug Events in Nursing Homes

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Abstract

OBJECTIVES—To determine the extent to which the use of a clinical informatics tool that implements prospective monitoring plans reduces the incidence of potential delirium, falls, hospitalizations potentially due to adverse drug events, and mortality.

DESIGN—Randomized cluster trial.

SETTING—Twenty-five nursing homes serviced by two long-term care pharmacies.

PARTICIPANTS—Residents living in nursing homes during 2003 (1,711 in 12 intervention; 1,491 in 13 usual care) and 2004 (1,769 in 12 intervention; 1,552 in 13 usual care).

INTERVENTION—The pharmacy automatically generated Geriatric Risk Assessment MedGuide (GRAM) reports and automated monitoring plans for falls and delirium within 24 hours of admission or as part of the normal time frame of federally mandated drug regimen review.

MEASUREMENTS—Incidence of potential delirium, falls, hospitalizations potentially due to adverse drug events, and mortality.

RESULTS—GRAM triggered monitoring plans for 491 residents. Newly admitted residents in the intervention homes experienced a lower rate of potential delirium onset than those in usual

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Conflict of Interest: Dr. Feinberg is employed by the ASCP Foundation, which developed the software used in the study. Dr. Daiello is an ASCP member (1987–present) and occasional consultant on educational and legislative matters and was a member of the ASCP board of directors 2000 to 2003. Dr. Lapane is a consultant to Ortho McNeil Jansen Scientific LLC to write two papers on the prevalence of pain in nursing home residents.

Author Contributions: Dr. Lapane wrote the original grant application, designed the study, worked with the team to develop the intervention, had complete scientific and financial responsibility for the grant, acquired and analyzed the data, prepared the draft of the manuscript, and incorporated all feedback from the authorship team. Dr. Hughes assisted with the original grant application, provided feedback on the intervention design, assisted in the development of the analytical plan, assisted in the interpretation of the data, and provided critical feedback on the manuscript. Dr. Daiello assisted with the interpretation of the data, suggested additional analyses, wrote parts of the Discussion section of the manuscript, and provided critical review of the manuscript. Ms. Cameron and Dr. Feinberg assisted in preparing the original grant, developing the intervention materials, implementing the intervention, engaging the pharmacy partners, overseeing the intervention, providing the training, developing the manuscript, interpreting the data, and providing critical feedback on the manuscript.

care homes (adjusted hazard ratio (HR) = 0.42, 95% confidence interval (CI) = 0.35–0.52), overall hospitalization (adjusted HR = 0.89, 95% CI = 0.72–1.09), and mortality (adjusted HR = 0.88, 95% CI = 0.66–1.16). In longer stay residents, the effects of the intervention were attenuated, and all estimates included unity.

CONCLUSION—Using health information technology in long-term care pharmacies to identify residents who might benefit from the implementation of prospective medication monitoring care plans when complex medication regimens carry potential risks for falls and delirium may reduce adverse effects associated with appropriate medication use.

Keywords

nursing homes; health information technology; delirium; pharmacy practice

In nursing homes, 40% of residents use at least nine different medications,[1] which may be clinically appropriate to optimize functional status.[2] Nevertheless, older persons are more vulnerable to adverse medication effects.[3] Adverse drug events (ADEs) are common in the nursing home setting[4,5] and may be preventable; 70% occur at the monitoring stage of the medication use process.[6]

The Office of the Inspector General (OIG) report entitled Prescription Drug Use in Nursing Homes[7] states that “patients may be experiencing unnecessary adverse medication reactions as a result of inadequate monitoring of medications.” In the federal nursing home interpretive guidelines, F-tags denote specific topic areas for assessment that state surveyors conduct during annual nursing home evaluations. F-Tag 428 requires that the consultant pharmacist conduct a medication regimen review of every nursing facility resident at least monthly; the pharmacist must identify any “irregularities and report them to the attending physician and director of nursing, and that these recommendations must be acted on.”[8] Monitoring is defined as a process that accomplishes three main goals: the ongoing collection and comparison of information with baseline status to assess treatment response; detection of the adverse consequences of treatments; and guiding decisions about modifying, continuing, or discontinuing any intervention.[9]

Innovative health informatics tools targeting the monitoring stage of the medication use process are warranted. The American Society of Consultant Pharmacists (ASCP) Foundation developed the Geriatric Risk Assessment Med. Guide (GRAM),[10] which correlates medication effects with physical, functional, and cognitive decline to foster early recognition of potential ADEs. The GRAM software assists in the problem identification process when evaluating complex medication regimens of older patients and facilitates incorporation of medication monitoring information into the care plan. Although there are 15 GRAM-generated reports for resident assessment protocols (RAPs), this study focused on two of the most common preventable ADEs in nursing homes: falls and delirium.[6] Falls and delirium pose the largest threats to resident safety, and medications may provide an important point of intervention in these multi-factorial geriatric problems. As many as three out of four residents fall each year in nursing homes,[11] which contributes to further functional decline. Delirium is highly prevalent in the nursing home setting.[12] Medication use is associated with greater risk of falls and delirium; polypharmacy and psychoactive medications are contributing factors.[13,14] The overarching idea was to use health information technology to identify residents at risk for these outcomes and to implement monitoring plans for them. A randomized trial was conducted to determine the extent to which the use of the GRAM clinical tool would reduce the incidence of potential delirium, falls, hospitalizations potentially due to ADEs, and mortality.

METHODS

Design

The institutional review board of Brown University approved the protocol. Outcomes were measured in individual residents, but the nursing homes served as the unit of allocation, intervention, and analysis. Homes were randomized to receive a new method of delivery of the standard of care (GRAM) or usual care. Informed consent of residents was not required because the facility instituted a change in wholesale clinical and administrative practices. Nursing homes were stratified according to which of two long-term pharmacies provided their pharmacy services and randomized.

Study Pharmacies and Nursing Homes

Two Omnicare pharmacies (Beeber Pharmacy, Englewood, OH and Home Care Pharmacy, Cincinnati, OH) participated because they both used the same commercial pharmacy software (Rescot Systems Group, Trevose, PA) and together serviced enough nursing homes needed for the study. The consultant pharmacists employed by Omnicare conducted approximtely 1,000 resident chart reviews per month.

Using a comprehensive project recruitment package (designed by the study team), the consultant pharmacists approached nursing homes for participation. Nursing homes had to be Medicare and Medicaid certified, have 50 or more geriatric beds, agree to random assignment, have stable contracts with Omnicare, and have few shortstay residents. Of the 32 homes approached, 26 met the eligibility criteria (12 from Beeber, 14 from Home Care). An intervention home cancelled Omnicare services before implementation and thus became ineligible. All residents living in the homes in 2003 to 2004 participated.

Intervention

The overarching idea was to use health information technology to engage consultant pharmacists and nursing staff to identify residents at risk for delirium and falls, implement proactive monitoring plans as appropriate, and provide reports to assist consultant pharmacists in conducting the medication regimen review.

Geriatric Risk Assessment MedGuide

The GRAM software is an enhanced version of the Minimum Data Set (MDS)-MedGuide.[15] GRAM was designed to assist healthcare professionals with expertise in geriatric pharmacotherapy in problem identification when evaluating complex medication regimens of older adults to identify, resolve, and prevent medication-related problems; aid in the evaluation of medications as a cause or aggravating factor contributing to an older adult's physical, cognitive, or functional decline; and facilitate incorporation of medication monitoring information into the older adult's plan of care. An interdisciplinary panel of experts in geriatrics determined the face and content validity of GRAM. A consensus panel approach was piloted, tested, and implemented for the correlation of adverse medication effects with geriatric problems. Beginning in January 2004, the GRAM database for falls and delirium was integrated into the pharmacies' commercial pharmacy software system (Rescot LTCP System) for the intervention homes. Two types of GRAM reports were generated based on the residents' medications: GRAM RAP-Med report, which identified resident-specific medications that potentially cause, aggravate, or contribute to delirium and fall risk (separately), and Medication Monitoring Care Plans and Flow Records. The delirium medication monitoring care plan and flow record contained specific MDS items that are "indicators" of delirium and may be a consequence of ADEs. The falls medication monitoring care plan and flow record contained specific MDS items that may be caused by ADEs and contribute to the risk for falls. The goal of these care plans and flow records was

to facilitate early recognition of signs and symptoms indicative of potential medication-related problems. Nursing assistants observed and documented on the flow record; if symptoms were observed, they notified the nurse. Through observation, documentation, and action, the nursing assistant was an integral part of the intervention.

For new admissions, these reports were sent directly to the assessment nurse within 24 hours of admission so that the nurse could use the reports in the admission assessment to identify problems for which the resident's medication regimen put him or her at greatest risk and implement the monitoring plans. The consultant pharmacist was on-site at the facilities once every 30 days to conduct the federally mandated drug regiment review for every resident. Thus, consultant pharmacists used the GRAM reports during their regularly timed drug regimen review. The GRAM reports were generated to coincide with the timing of long-stay residents' quarterly or annual MDS evaluation or for residents who triggered the falls or delirium RAP. All GRAM reports for long-stay residents were timed in accordance with the consultant pharmacist's monthly visit to the home. Consultant pharmacists shared the reports with the nurse contact at the facility and used the reports as part of their monthly drug regimen review.

Training

The ASCP Foundation developed and delivered in-service programs for nursing staff and consultant pharmacists of the intervention facilities in fall 2003. For the nursing staff, the in-service programs lasted 1 to 1.5 hours. Instructors (JF, KC) provided detailed information regarding medications that cause, aggravate, or contribute to the risk of falls and delirium, reviewed specific symptoms and signs of adverse medication effects, and reinforced the importance of early observation for symptoms and signs of adverse medication effects. To provide a consistent educational experience, a detailed slide deck was developed with content review by a multidisciplinary team of geriatric pharmacists, geriatricians, and epidemiologists. Case examples were included to reinforce concepts. Detailed instruction was provided to facility staff on how to use the specific reports, care plans, and flow records. Training was repeated in facilities with staff turnover. Instructors trained the consultant pharmacists to provide a targeted drug regimen review for all patients who triggered the GRAM RAP-Med reports for falls and delirium. For residents with these reports, pharmacists were encouraged to include observation or assessment of the resident on each visit and an evaluation of the resident's medications, to make and document recommendations, and to review the medication monitoring care plans and flow records with the MDS nurse.

Operational Expression of the Outcomes

Survival and hospitalization experience were determined using cross-linkage of the MDS files to the Medicare eligibility files and the Medicare inpatient files. International Classification of Diseases, Ninth Revision (ICD-9) codes for the primary diagnosis were used to identify potentially ADE-related hospitalization. Based on previous work,[6] ICD-9 codes were included for gastrointestinal hemorrhage (531.0, 531.2, 532.0, 532.2, 533.0, 533.2, 534.0, 534.2), nontraumatic intracranial hemorrhage (432.0, 432.1, 432.9), allergic urticaria (708.0), diabetic hypoglycemia—coma (292.8, 250.3, 250.8, 251.0), acute liver failure (570), fracture (800–829.9), fall with or without fracture (E880, E884.2, E884.3, E884.4, E884.5, E884.6, E885, E887, E888), and drug-induced delirium (292.8). Onset of potential delirium and falls was evaluated using the MDS data.

The validated Nursing Home Confusion Assessment Method (NH-CAM) was used to determine onset of potential delirium.[13] Briefly, nine delirium-related MDS items map onto the CAM criteria.[16] Using longitudinal MDS data, falls were considered present if a fall in

the past 30 days was documented on the MDS in item J4a. Person-time was calculated as the number of days from date of first assessment to the first outcome occurrence, the last date in the nursing home, the death date, or December 31, 2004.

Analytical Approach

Data regarding consultant pharmacist recommendations for process evaluation came from the OSC2OR system, an Omnicare proprietary system. This system did not capture whether the recommendations were accepted. Thus, the OSC2OR data were complimented with analysis of medication use according to class before and after the intervention period. The distributions of demographic variables and case-mix variables were compared according to intervention status, and variables with more than an absolute 5% difference between intervention and comparison arms were noted as potential confounders. First, nursing home–and month-specific crude rates of hospitalizations and hospitalizations due to potential ADEs (per 100 resident months) were estimated and graphed. Poisson regression (using a binary distribution and log link) accounting for the cluster trial design was used to provide estimates adjusted for potential confounders. Before modeling, correlations among the confounders were checked for multicollinearity (and excluded). The Poisson distribution provided a good approximation of the binomial distribution for rare events. The MDS provided sociodemographic data; cognitive patterns; communication; mood and behavior; physical functioning; and an extensive array of signs, symptoms, syndromes, active clinical diagnoses, and treatments.[9] Variables whose inclusion resulted in more than a 10% change in the estimate of effect for the intervention term were retained in the model. Regression models were constructed in a stepped fashion (but not computer generated) to permit the ascertainment of the independent effect of the intervention while simultaneously controlling for the effects of the case mix of residents in the facility. This effect was estimated adjusting for the clustering effects due to the correlation of residents living within the same home with generalized estimating equations, and robust estimation was provided when appropriate.[17] Hazard ratios (HRs) quantifying the intervention effect and corresponding 95% confidence intervals (CIs) were derived from the final models.

Because the intervention timing was different depending on whether the resident was a new admission or a long-stay resident, a stratified analysis was also conducted. It was hypothesized a priori that intervention effects may be stronger in new admissions because the intervention was implemented immediately; residents newly admitted from hospitals were often taking medications at doses placing them at high risk for ADEs, and the highest-risk period for ADEs was the first 30 days of admission. Using Cox proportional hazards regression models, a time-to-event analysis was conducted adjusting for the clustered nature of the data. To evaluate (and exclude) departures from the proportional hazards assumption, log-log survival functions were plotted, and the exposure variable was tested for an interaction with time. Using the Cox regression models, crude and adjusted HRs and 95% CIs were derived.

Sample Size

The sample size estimates were based on the least-frequent outcome: potential ADE-related hospitalizations. Based on information from the pharmacy partners, it was assumed that there would be an average of 100 residents for each facility and a minimum of 12 months of observation in each facility. Based on previous work,[6] it was assumed that the usual care homes would experience a potential ADE-related hospitalization rate of 1.39 per 100 resident-months, of which 0.23 per 100 resident-months would not be preventable. Assuming a within-facility correlation of 5%, a Type I error of 5%, and statistical power of 80%, it was determined that 12 homes per arm was necessary to detect a reduction of

potential ADE-related hospitalization to 0.7 per 100 resident-months because the intervention considered the use of clustered binomial data.[18]

RESULTS

Facility Characteristics

Table 1 shows the characteristics of the nursing homes participating in the study according to intervention status. Although the average total number of beds was similar in the intervention and usual care homes, the intervention group had more new admissions in 2002 than the usual care group. Thirty-eight percent of intervention homes were part of a chain (vs 54% in the usual care group) and 46% were for profit (vs 54% in the usual care group). The racial composition and psychiatric mix of patients in the intervention and usual care homes were comparable, as were the baseline risks of falls and delirium.

Resident Characteristics

The characteristics of the residents shown in Table 2 demonstrate that, on average, the patient mix appeared similar between the usual care and intervention homes and in 2003 and 2004. Table 2 shows that the distributions of age, sex, and cognitive and physical functioning of residents in the participating homes were similar and stable during the intervention period. Residents in intervention homes were more likely to be minorities than residents in the usual care homes. Although residents in the intervention homes were less likely than those in the usual care homes to have six or more diagnoses (37% vs 44% in 2004), the distributions of individual diseases were similar, with the exception of dementia. Thirty-five percent of residents in the intervention homes had a diagnosis of dementia, compared with 43% of residents in the usual care homes.

Process Evaluation

Overall, the residents in intervention and usual care homes had a similar number of interventions per resident (~ 6.8) made by consultant pharmacists. The use of GRAM resulted in an intervention in 491 residents during the intervention period, of which 50% were aged 85 and older, 33% were aged 75 to 84, and the remaining 18% were aged 65 to 74. Seventy-three percent were women. The numbers of specific interventions that consultant pharmacists made for residents who triggered the falls or delirium RAP were different from those for residents who did not trigger these RAPs. Intervention home residents with at least one GRAM flag had more recommendations (8.2) than the intervention residents without a GRAM flag (6.3). Consultant pharmacists were 4 times as likely to recommend a dose change in residents who triggered the falls or delirium RAP (5.7% vs 1.4%), 2.7 times as likely to recommend that a drug be discontinued (7.3% vs 2.7%), 0.4 times as likely to recommend a monitoring change (1.6% vs 3.8%). The consultant pharmacists were also less likely to change or add a drug (0.3% vs 1.5%), yet the distribution of the total number of medications that residents received was comparable in the intervention and usual care homes before and after implementation of the intervention. There was a 3% absolute reduction in opiate prevalence and prevalence of miscellaneous anticonvulsant medications and an approximately 4% reduction in tranquilizers in the invention homes but not the usual care homes.

Outcome Measures

Table 3 shows that residents in the intervention homes experienced fewer falls, less potential delirium, and death, but more hospitalizations than in the comparison homes. In new admissions, there appeared to be a trend toward lower mortality (adjusted HR = 0.88, 95% CI = 0.66–1.16) and a lower overall hospitalization rate (adjusted HR = 0.89, 95% CI =

0.72–1.09) and a clear reduction in the rate of potential delirium (adjusted HR = 0.42, 95% CI = 0.35–0.52) in the intervention homes than the comparison homes. The power analyses were not specific to new admissions. Table 4 shows a summary of the analyses of monthly rates for the outcomes based on Medicare claims. Although an average percentage increase was observed in mortality in the usual care homes (17.4 per 1,000 person-months in 2003 and 19.6 in 2004), a reduction was observed in the intervention homes (19.4 in 2003 and 17.7 in 2004). Hospitalization rates appeared stable in the pre- and postintervention period in intervention and usual care homes. Although potential ADE-related hospitalizations occurred infrequently, greater reductions in hospitalization rates were realized in intervention homes than comparison homes. The intervention homes experienced an average 32% decline in hospitalizations due to potential ADEs (2.8 in 2003 vs 1.9 in 2004), whereas the usual care homes experienced a 14.3% decline.

DISCUSSION

The use of health information technology for improving care quality has been touted widely in various healthcare settings but less so in nursing homes.[19,20] 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 bar coding, automated dispensing), or administration (e.g., scannable patient bracelets). Systems that use information technology to improve the monitoring stage of the medication use process are sparse. The feasibility of integrating software into the real-time operations of a long-term care pharmacy to provide medication monitoring plans specific to residents' medication regimen and to provide reports indicating medications that may cause, aggravate, or contribute to delirium and fall risk was demonstrated. In addition, nursing homes were able to successfully integrate the medication monitoring care plans and flow records into their workflow. Although the homes using the GRAM software experienced lower rates of falls, potential delirium, and mortality than those of the nursing homes receiving usual care, hospitalization rates were higher in the intervention homes. It was hypothesized that, owing to the nature of the implementation of the intervention, the effect would be stronger in new admissions, and this was observed. Although the study was not adequately statistically powered to evaluate differences between the new admissions, trends toward reductions in mortality and hospitalization rates and a clear intervention effect on reducing the rate of potential delirium onset were observed.

The use of health information technology in prescribing support for physicians in the form of alert systems and computerized order entry systems is likely to improve practitioner performance,[21] but their effects on patient outcomes remain less well studied.[22] In the long-term care sector, few studies have specifically evaluated health information technology.[23–25] Despite the implementation of computerized provider order entry with clinical decision support, the software did not prevent ADEs in long-term care.[24] The findings of the current study are more encouraging than those of other pharmacist-based intervention studies in nursing homes conducted in various parts of the world. Although many studies were able to show an effect on drug use[26–29] no corresponding changes in hospitalizations were observed, and some,[23] but not all,[24] showed an effect on falls. Thus, although process measures appear promising in pharmacist interventions in nursing homes, changing patient outcomes has proven elusive.

That the use of the GRAM software has the potential to prevent or resolve delirium in residents newly admitted to nursing homes is important. Delirium is associated with severe adverse consequences, including higher mortality and longer hospital stays.[30] There is evidence that delirium is not always of brief duration; the results of a recent post-acute care study indicated that nearly one-third of the residents initially diagnosed with delirium still

met criteria for delirium at 6 months. Those with persistent delirium were 2.9 (95% CI = 1.9–4.4) times more likely to die during the 1 year of follow-up than those whose delirium resolved.[31]

The most effective interventions for prevention and treatment of delirium in this setting may be those that incorporate multimodal and multidisciplinary strategies. This intervention was effective in accomplishing a robust reduction in the risk of potential delirium in newly admitted and long-stay residents. Recent innovations primarily using education and nursing interventions to reduce the adverse consequences of delirium have not been effective in typical postacute care facilities.[32] Thus, treatment of delirium is based on the treatment of precipitating factors, and prevention plays the most important role. The GRAM software provided a mechanism for prospective monitoring of residents during the period in which residents are at highest risk for ADEs—the first 30 days of nursing home stay.

This study, like others,[24] showed no effect on falls. The causes of falls in nursing homes are multifactorial and include individual risk factors and environmental factors. Review and adjustment of drug therapy has not been proven to reduce the risk of falling.[33] Even multidisciplinary approaches that target the various risk factors for falling have not been effective in reducing falls in nursing homes.[34] Unfortunately, the approach in the current study to reduce falls focused completely on medications. These findings support the notion that, in the wider context of falls prevention, a multicomponent intervention may need to be considered. Given that 80% of residents trigger the fall RAP, such interventions are warranted.

The extent to which contamination may have diluted the effect of the intervention must be considered. First, by integrating the GRAM software into the commercial software of the long-term care pharmacies, it was possible to prevent contamination by triggering the software only in the homes randomized to the intervention arm. Second, the GRAM software generated the medication monitoring care plans only for the intervention homes. Third, nursing staff worked in intervention or comparison homes, limiting the potential for contamination, although it is possible that consultant pharmacists and physicians exposed to GRAM reports for residents in the intervention homes learned from these reports and changed clinical practice for residents in the comparison homes. Yet the hospitalizations and adverse outcomes were essentially consistent throughout the study period in the usual care homes. If contamination occurred, it would have diluted the measurable intervention effects. There was also concern that the use of administrative data sources rather than rigorous chart reviews, as used in previous studies,[6] would introduce misclassification of the hospitalizations for potential ADEs. In addition, studies of the agreement of falls collected from the MDS with falls collected from medical charts indicates that falls within 30 days collected on the MDS are likely to be underestimated.[35] This misclassification, introduced by not using primary data collection for outcome ascertainment and lack of validated tools, was likely to be nondifferential, thus diluting the intervention effect.

These findings must be considered with several caveats in mind. First, the use of RAPS in nursing homes has been highly criticized[36] although others commend the value of at least some of the RAPs.[37,38] The approach of the current study to implementing the GRAM reports in practice addresses some of the concerns because the study focused on only two high-priority areas and provided highly specific information. In October 2010, the MDS 3.0 replaced the MDS 2.0, and RAPs have been discontinued. Regardless of this change, this approach could still be implemented.

CONCLUSION

Nursing home residents experience medication-related problems at an alarming rate. Novel methods to enhance the federally mandated drug regimen review are needed. Clinical informatics tools may be useful to identify residents at highest risk for medication-related problems and to incorporate medication-monitoring recommendations into care plans to foster early recognition of potential ADEs. Although this study demonstrated that such an approach is feasible, how such extended services would be paid for has yet to be determined because information technology adoption in nursing homes has been slow.[39]

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Table 1

Characteristics of Intervention and Usual Care Nursing Homes at Baseline

Characteristic	Intervention Group (n = 12)	Usual Care Group (n = 13)
Number of beds, mean (SE) (range)	129 (17.3) (66–293)	120 (14.9) (50–234)
Number of new admissions in 2002	74 (9.3) (32–135)	52 (7.8) (14–111)
Home in urban county, 1995, %	92	85
Facility is part of a chain	38	54
For profit	46	54
Facility has Alzheimer's disease unit, %	38	24
Percentage of black residents, mean (SE) (range)	19 (9) (0–98)	11 (4) (0–50)
Percentage with psychiatric diagnosis, mean (SE) (range)	31 (5.6) (8.7–69.3)	37 (4.3) (0–59.0)
Number of falls in past 30 days, mean (SE) (range)	40 (3) (26–66)	19 (3) (15–55)
Percentage with delirium, mean (SE) (range)	4.0 (1) (0–10)	3.0 (4) (0–50)
Size of homes (number of beds), %		
0–62	15	15
63–129	77	77
> 129	8	8
Number of FTE certified nursing assistants, mean (SE) (range)	38.3 (16.4) (14.9–66.7)	40.5 (12.3) (19.9–61.5)
Number of FTE registered nurses, mean (SE) (range)	21.5 (12.2) (9.5–56.1)	21.9 (9.4) (6.0–39.4)
Presence of physician extenders, %	23	38

SE = standard error; FTE = full-time equivalent.

Table 2

Characteristics of Nursing Home Residents in Intervention and Usual Care Nursing Homes

	Baseline (2003) (%)		Intervention Period (2004) (%)	
Characteristic	**Intervention (n = 1,711)**	**Usual Care (n = 1,492)**	**Intervention (n = 1,769)**	**Usual Care (n = 1,769)**
Female	72.3	68.2	73.9	73.9
Age				
65–74	16.3	15.8	15.5	15.1
75–84	35.9	35.3	38.8	38.8
85	39.7	36.4	39.0	39.0
Minority race or ethnicity *	17.7	11.3	18.8	18.8
Physical functioning				
Moderate impairment	59.7	58.3	64.3	64.3
Severe impairment	29.2	26.0	25.4	25.4
Cognitive function				
Moderate impairment	47.8	47.1	49.1	49.1
Severe impairment	22.3	26.2	19.6	19.6
Number of medications				
6–9	32.9	33.3	30.3	30.3
≥10	53.9	53.7	56.3	56.3
Number of diagnoses				
4–5	30.4	31.3	32.5	32.5
≥6 *	37.3	45.4	37.1	37.1
Specific diagnoses				
Dementia *	35.4	43.4	33.4	33.4
Alzheimer’s disease	12.7	14.6	13.0	13.0
Cancer	8.3	12.1	8.1	8.1
Diabetes mellitus	27.5	31.0	28.4	28.4
Cerebrovascular accident	22.2	22.4	20.1	20.1
Heart failure	26.5	28.5	26.6	26.6
Coronary artery disease	18.6	16.2	15.9	15.9
Arrhythmia	15.8	15.8	16.6	16.6
Hypertension	64.9	61.8	66.9	66.9
Other cardiovascular disease	23.6	28.0	25.0	25.0

* Absolute differences of greater than 5% were observed at baseline only.

Table 3

Effect of Geriatric Risk Assessment MedGuide on Resident Outcomes

Outcome	Intervention Homes			Usual Care Homes			Crude Hazard Ratio	Adjusted Hazard Ratio (95% Confidence Interval)
	Events, n	Resident-Months	Incidence Rate per 1,000 Resident-Months	Events, n	Resident-Months	Incidence Rate per 1,000 Resident-Months		
In home 2003/04								
Death	211	10,139	20.8	215	9,300	23.1	0.90	0.89 (0.73–1.08)
Any hospitalization	317	8,184	38.7	265	7,741	34.2	1.13	1.11 (0.94–1.31)
Potential ADE-related hospitalization	25	10,005	2.5	23	9,163	2.5	1.00	1.12 (0.63–1.98)
Falls	797	2,793	285.4	747	2,371	315.0	0.93	0.94 (0.85–1.04)
Potential delirium indicator	338	7,789	43.4	333	6,977	47.7	0.91	0.93 (0.80–1.09)
New admits 2004								
Death	114	5,472	20.8	98	3,940	24.9	0.85	0.88 (0.66–1.16)
Any hospitalization	217	4,455	48.7	180	3,144	57.3	0.87	0.89 (0.72–1.09)
Potential ADE-related hospitalization	14	5,387	2.6	7	3,905	1.8	1.44	1.47 (0.58–3.71)
Falls	722	1,263	571.7	529	1,012	522.9	1.05	1.03 (0.92–1.15)
Potential delirium indicator	169	4,647	36.4	264	2,664	99.1	0.41	0.42 (0.35–0.52)

ADE = adverse drug event.

Table 4

Facility Level Change in Primary Outcomes* in the Preintervention and Intervention Periods, Intervention Versus Usual Care

		Mean (Standard Error of the Mean)		
Outcome Measure	**Study Group**	**Preintervention (2003)**	**Intervention Period (2004)**	**Change, %**
Mortality	Intervention	19.4 (1.2)	17.7 (1.3)	−8.8
	Usual care	17.4 (1.2)	19.6 (1.3)	12.6
Any hospitalization	Intervention	38.0 (3.3)	39.4 (3.9)	3.7
	Usual care	40.2 (3.2)	40.6 (3.9)	1.0
Potential adverse drug event hospitalization	Intervention	2.8 (0.39)	1.9 (0.52)	−32.1
	Usual care	2.1 (0.43)	1.8 (0.48)	−14.3

*Minimum Data Set data are collected quarterly, so the analysis of monthly rates according to nursing homes was not conducted on the fall and delirium outcomes.