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# Impact of a Multidisciplinary Intervention on Antibiotic Use for Nursing Home–Acquired Pneumonia

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## ABSTRACT

**Background:** Academic detailing in nursing homes (NHs) has been shown to improve drug use patterns and adherence to guidelines.

**Objective:** The purpose of this study was to evaluate the impact of a multidisciplinary intervention that included academic detailing on adherence to national nursing home–acquired pneumonia (NHAP) guidelines related to use of antibiotics.

**Methods:** This quasi-experimental study evaluated the effects of a 2-year multifaceted and multidisciplinary intervention targeting implementation of national evidence-based guidelines for NHAP. Interventions took place in 8 NHs in Colorado; 8 NHs in Kansas and Missouri served as controls. Interventions included (1) educational sessions for nurses to improve recognition and timely treatment of NHAP symptoms and (2) academic detailing to clinicians by pharmacists regarding diagnostic and prescribing practices. Differences in antibiotic use between groups were compared after 2 intervention years relative to baseline.

**Results:** A total of 549 episodes of NHAP were evaluated in the intervention group and 574 in the control group. Compared with baseline, 1 facility in the intervention group significantly improved in guideline adherence for optimal antibiotic use ($P = 0.007$), whereas no facilities in the control group improved. The mean adherence score for optimal antibiotic use in intervention NHs increased from 60% to 66%, whereas the control NHs increased from 32% to 39% ($P = 0.3$). Mean adherence to guidelines recommending antibiotic use within 4 hours of NHAP diagnosis increased from 57% to 75% in intervention NHs but decreased from 38% to 31% in control NHs ($P = 0.0003$ for difference). There was no difference between intervention and control NHs for guideline adherence regarding optimal duration of antibiotic use.

**Conclusions:** The ability of this multifaceted study to repeatedly remind nursing staff of the importance of timely antibiotic administration contrasts with its limited academic detailing interaction with clinicians. This difference within the intervention may explain the differential impact of the intervention on antibiotic guideline adherence. (*Am J Geriatr Pharmacother*. 2011;9:442–450) 

**Key words:** academic detailing, antibacterial agents, guideline adherence, nursing homes, physician practice patterns, pneumonia.

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## INTRODUCTION

Pneumonia is the most common, potentially serious acute illness that affects nursing home (NH) residents. Median reported incidence is 1 per 1000 patient-days, and mortality averages 25% annually.[1] High-quality care, including appropriate antibiotic use, hospitalization when indicated, and rapid identification of and response to respiratory symptoms, has been shown to be associated with improved survival of residents who acquired pneumonia in a national sample of NH residents. Many of the 58 NHs in that study were providing less than adequate care (eg, only 31% of residents received antibiotics within one 8-hour shift of symptom onset and 25% of NH-acquired pneumonia [NHAP] episodes were not treated with an appropriate antibiotic).[2] Loeb et al[3] reported that only 28% of antibiotics prescribed for NHAP in 22 Canadian facilities met guideline criteria. Similarly, Jones et al[4] and Nicolle et al,[5] reported inappropriate antimicrobial use in long-term care facilities to be 50% and 25% to 75%, respectively.

Regardless of whether residents with NHAP are hospitalized or treated in the NH, evidence-based guidelines recommend providing empirical antibiotic coverage for the bacteria that most commonly cause pneumonia in the NH setting: *Streptococcus pneumoniae*, *Haemophilus influenzae*, common gram-negative rods, and *Staphylococcus aureus*.[6,7] When guidelines for NHAP were originally promulgated, the recommended antibiotic regimens included 10 to 14 days of either (1) an anti-pneumococcal fluoroquinolone (eg, levofloxacin, moxifloxacin, or gatifloxacin) or (2) an extended-spectrum $\beta$-lactam (eg, amoxicillin/clavulanate, some second- and all third-generation cephalosporins) in combination with a macrolide (eg, azithromycin or clarithromycin).[6,8,9] The addition of a macrolide to a $\beta$-lactam–based regimen was designed to provide coverage for atypical organisms, which have also been recognized as potential causes of NHAP.[10,11] The guidelines also recommend that the antibiotic be provided within 4 hours of the physician's order and that residents being hospitalized or who have unstable vital signs receive antibiotics immediately.[6] The rationale for rapid antibiotic treatment is that a survival benefit among hospitalized Medicare patients with pneumonia was demonstrated for those who received antibiotics within 4 hours of arriving in the emergency department,[12] although this has never been studied in NH residents with NHAP who are not hospitalized.

Previous research in NHs, hospitals, and primary care settings has found that academic detailing (focused education of physicians and/or nursing staff about disease/drug therapy by other health care providers) can improve prescribing patterns of antibiotics and other drugs.[13–20] We hypothesized that multidisciplinary academic detailing regarding the above antibiotic recommendations would improve adherence to guideline recommendations for antibiotic choice, delivery, and duration of treatment in study NHs. This paper reports on the impact of the academic detailing facet of a multifaceted intervention whose objective was to test a multidisciplinary intervention implementing national evidence-based guidelines on care for NHAP.

## PATIENTS AND METHODS

### Overview

This mixed-methods, quasi-experimental, unblinded study tested the impact of a multifaceted and multidisciplinary intervention implementing national evidence-based guidelines on care for NHAP. The multifaceted intervention included (1) institutional change to facilitate immunization and the availability of appropriate testing and treatment; (2) interactive educational sessions for NH nursing staff to improve vaccination rates and nursing assessment skills; (3) a study liaison nurse employed by the NH who agreed to act as the study's change agent; and (4) academic detailing to physicians to impact diagnostic and prescribing practices. We have previously reported the immunization findings, whereby no statistically significant relationship between the intervention and increased resident vaccination rates was identified; however, estimated direct patient care staff vaccination rates were improved during the baseline and increased more in the intervention NHs.[21]

### Setting

Sixteen nursing homes that are members of a multifacility corporation were invited to participate in this 3-year study. NHs were chosen by the corporation's clinical director for each corporate division based on their subjective perception of the home's capacity to participate in research. For example, 2 facilities, 1 in the Denver metropolitan area and 1 in Kansas and Missouri were excluded because of recent turmoil in facility management. A total of 8 facilities located in Kansas and Missouri served as control sites and 8 facilities located in the Denver metropolitan area served as intervention sites. Baseline data were collected from all facilities during the influenza season, October 2004 to April 2005, and intervention period data were collected from all sites during the influenza seasons of 2005/2006 and 2006/2007. Both the intervention and control facilities were paid $1000 per year to help cover the costs of lost work

time due to project activities. Details of subject recruitment and data collection have been reported elsewhere[21,22] and are summarized below.

## Patients

NH residents in study facilities who developed ≥2 signs and symptoms of a lower respiratory tract infection (LRTI) were eligible for the study. Illness onset was defined as the first mention in the medical record of ≥2 LRTI signs and symptoms, at least 1 of which being respiratory. Eligibility was based on findings of LRTI symptoms, rather than pneumonia, because pneumonia requires the presence of an infiltrate on chest radiograph (CXR), and many episodes of NHAP are treated without a CXR being obtained.[23] If a subject had ≥1 LRTI episode and subsequent episodes occurred >30 days from the preceding episode, data from all episodes were recorded. Residents who refused to participate in the study, who had resided in the facility <5 days, or whom the charge nurse believed to be within 48 hours of dying were excluded. Health Insurance Portability and Accountability Act (HIPAA) authorization and written informed consent were elicited from all subjects, or if they were not competent to consent, from their proxy health care decision maker. The Colorado Multiple Institutional Review Board approved the study (COMIRB #03-1243), and the corporation's 2 respective divisional offices provided Federalwide Assurance for the Protection of Human Subjects.

## Data Collection

Details of data collection have also been reported elsewhere.[21,22] Briefly, resident and NHAP characteristics, comorbidity, and process of care data were gathered weekly during the 3 study years by 7 nurse data collectors, who were trained and employed by the study, using a previously tested, systematic medical record review instrument on laptop computers in Microsoft Access 2000 (Microsoft, Redmond, WA) with built-in range and logic checks.[20] Process of care data including (1) physician notification and call-back time; (2) prescribed antibiotic, time ordered and dispensed, and duration of treatment; and (3) hospitalization orders were gathered from nurse and physician notes, orders, and the medication administration records. Every tenth medical record was copied and re-reviewed by the project manager and one other data collector to assure reliable data extraction. Only items with inter-rater reliability scores of 0.7 or better by Cohen's $\kappa$ or percent agreement are reported here, and reliability was acceptable for adherence to 24 of the 25 guidelines. The only guideline for which inter-rater reliability was <0.7 was whether the resident's desire for hospitalization was assessed at the time of the LRTI. In addition, although dichotomous adherence to the time-sensitive guidelines had an inter-rater reliability score >0.7, the number of hours did not.

The director of nursing (DON) at each facility completed the facility questionnaire wherein he or she estimated the number of licensed nurses (registered nurses [RNs] and licensed practical nurses [LPNs]) and certified nursing assistants (CNAs) who worked during a 24-hour period; average daily facility census; number of licensed nurses and CNAs hired during the past year; and current number of licensed nurses and CNAs on staff.

Data from both the chart abstraction and facility questionnaire were combined into 1 analytic file matched at the patient-case (episode) level for analysis using the SAS (SAS Institute Inc, Cary, North Carolina) and Stata (StataCorp LP, College Station, Texas) statistical software packages. A guideline adherence variable was written for each guideline, specifying the parameters for which an episode was considered to be in compliance. Like their component variables, the guideline adherence variables reported here all had inter-rater reliability by Cohen's $\kappa$ or percent agreement of ≥0.7.

## Multifaceted Intervention

The multifaceted intervention was implemented by a multidisciplinary team including a physician, pharmacists, and nurses. Following baseline data collection, members of the multidisciplinary research team (S.A.L., J.M.R., E.H., and K.S.O.) met with the medical directors and DONs or assistant DONs of the 8 intervention sites as a group to review our previous experience with implementing the guidelines,[24] discuss antibiotic treatment recommendations in detail, and present the baseline data from intervention sites. All intervention sites were represented at this meeting.

## Academic Detailing

One of 3 pharmacists with expertise in geriatrics and infectious disease or the principal investigator, a geriatrician, met individually or in small groups with the medical director, physicians, and mid-level care providers (nurse practitioners and physician assistants) who attended to ≥4 residents at the intervention facilities. A member of this academic detailing team discussed the rationale for antibiotic, hospitalization, and diagnostic work-up guidelines during a scheduled 10- to 15-minute visit early in the first intervention year at times and

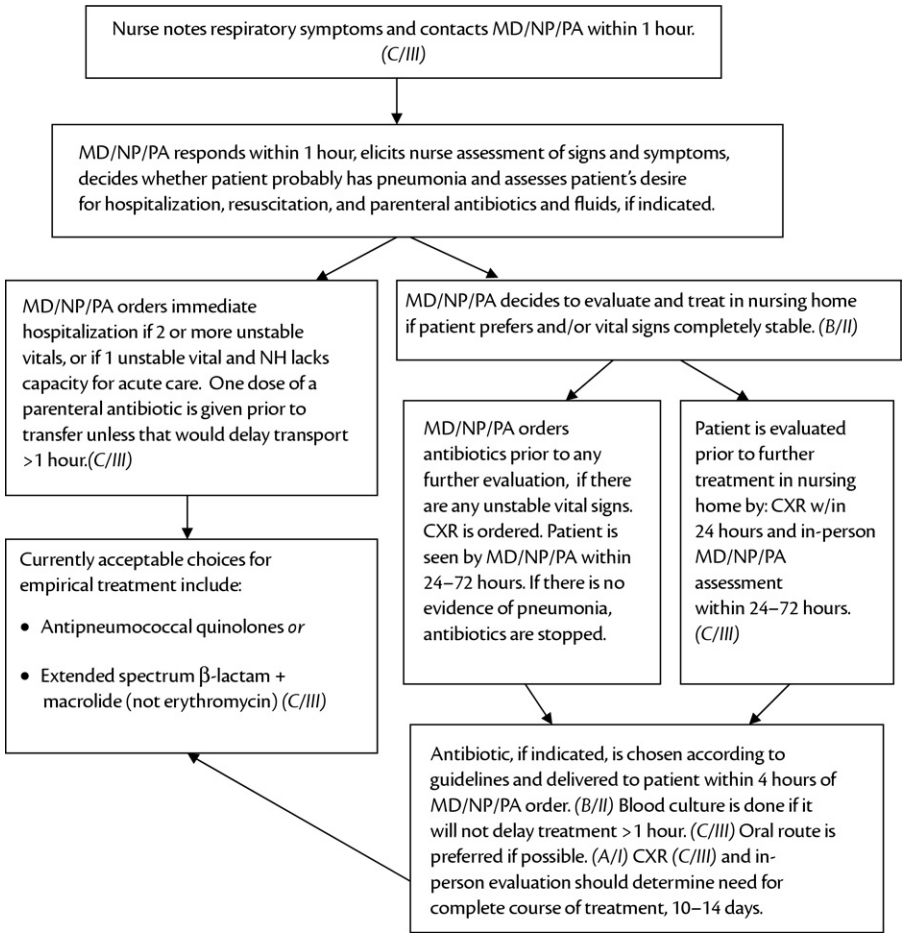


Figure 1. Care pathway for nursing home (NH)–acquired pneumonia. CXR = chest radiograph; MD/NP/PA = medical doctor/nurse practitioner/physician's assistant. Pathway recommendations were graded according to a standard system with 3 categories for recommendation strength (A, good evidence; B, moderate evidence; C, poor evidence) and 3 grades for quality of evidence (I, at least 1 properly randomized, controlled trial; II, at least 1 well-designed clinical trial without randomization from cohort or case-controlled analytic studies, multiple time series, or dramatic results in uncontrolled experiments; III, opinions of respected authorities based on clinical experience, descriptive studies, or reports of expert committees.

locations convenient to the physicians and mid-level providers. They also provided laminated pocket copies of the care pathway (**Figure 1**), preprinted orders (**Supplemental Appendix** appears in the online version at doi:10.1016/j.amjopharm.2011.09.009), and reprints of the guidelines. Follow-up telephone calls were made ~3 months after the initial visit to reinforce the care pathway. This process was repeated during the second intervention year. The research plan called for 2 in-person visits with the clinicians in each intervention year, but most of the clinicians were only willing to meet in person at the beginning of the intervention or at the beginning of each intervention year. Therefore, subsequent discussions with most clinicians were conducted via telephone. There were also some providers who would meet only with the principal investigator and were unwilling to meet with the study pharmacists.

### Institutional and Nursing Facets

Briefly, the intervention facilities were paid an additional $1000 each year during the 2 intervention years to incentivize guideline compliance and early detection of LRTI signs and symptoms. Each NH identified a liaison nurse who was the facility's change agent for the study. The liaison nurse was paid a small honorarium for attending 2 pneumonia collaborative meetings, participating in monthly conference calls, helping to develop and present quarterly staff development sessions on re-

Table. Comparison of intervention and control subjects and nursing homes during all study years.

| Parameter | Intervention Homes (n = 549) | Control Homes (n = 574) | P |
|---|---|---|---|
| Mean age, y | 83.4 | 83.5 | 0.77 |
| Mean NHAP severity score, range: 0–5 | 0.77 | 0.72 | 0.21 |
| Ability to eat independently, % | 33.8 | 46.9 | 0.0001 |
| Mean Barthel score, range: 0–90 | 27.7 | 35.8 | <0.0001 |
| Do not resuscitate status, % | 75.3 | 60.6 | <0.0001 |
| Received CXR, % | 87 | 71 | <0.0001 |
| CXR showed possible pneumonia, % | 41 | 40 | 0.47 |
| Hospitalized for treatment, % | 16 | 26 | <0.0001 |
| Mean no. of beds | 134.3 | 128.0 | 0.80 |
| Annual nursing staff turnover, % | 36.81 | 108.68 | <0.0001 |
| Nurse/resident hours per resident day | 3.17 | 2.60 | <0.0001 |

CXR = chest radiograph; NHAP = nursing home–acquired pneumonia.

spiratory illness, helping troubleshoot the intervention implementation, and encouraging other nurses to use (and remind the physicians to use) the guidelines. The liaison nurse was not responsible for medical record reviews or other data collection.

Just prior to each intervention data collection period (October–April, years 2 and 3), the research team's nurse educator investigator (K.S.O.) and study liaison nurse co-taught a staff development conference for licensed nurses (RNs and LPNs) and nurse aides at a regular mandatory staff meeting, convenient to both day and evening staff in each facility. The NHAP guidelines and recognition of respiratory illness in residents were discussed, and preprinted NHAP orders (**Appendix**) were introduced and distributed. The study liaison nurse repeated this staff development conference quarterly, at times convenient to all staff. Nursing staff were asked to remind physicians and mid-level providers to use the care pathway to guide treatment when they called to report residents with LRTI symptoms, and to remind physicians of the availability of preprinted NHAP orders, which included appropriate antibiotic orders.

### Statistical Analysis

The outcomes of interest for this study were based on treatment guidelines that were current at the time the study was performed.[6,8,9] Specific outcomes included the percent of episodes for which an antibiotic was ordered where the resident (1) received the antibiotic within 4 hours of the clinician's order; (2) received either an anti-pneumococcal fluoroquinolone or an extended-spectrum $\beta$-lactam plus a macrolide (clarithromycin or azithromycin); and (3) received an antibiotic for 10 to 14 days. The study was designed to have an 80% power to detect a 15-percentage-point difference in adherence to a single guideline with an $\alpha$ of 0.05.

A detailed description of the demographic covariates, functional and cognitive status assessments, and comorbidity covariates for residents who acquired LRTI has been previously reported.[21,22]

Outcomes, demographics, functional and cognitive status, and comorbidity were compared between the intervention and the control homes at baseline and between baseline and the intervention years using the $\chi^2$ or Fisher exact test for dichotomous and $t$ test or Mann-Whitney U test for continuous independent variables. Although mortality was not a main outcome of the study, the 3-year combined mortality rate for the control and intervention facilities was compared using a $\chi^2$ test.

## RESULTS

The **Table** describes the baseline characteristics of the study participants and their facilities. The subjects in the control facilities were significantly more independent and had fewer "do not resuscitate" (DNR) orders than subjects at the intervention facilities. There was no correlation between presence of a DNR order and compliance with the antibiotic guidelines ($[\rho] = 0.02$). Additionally, the control facilities had significantly lower staffing ratios and higher nursing turnover than the intervention facilities. Fewer CXRs were performed in control facilities compared with intervention facilities, but the percent with an infiltrate on CXR (~40%) was not significantly different.

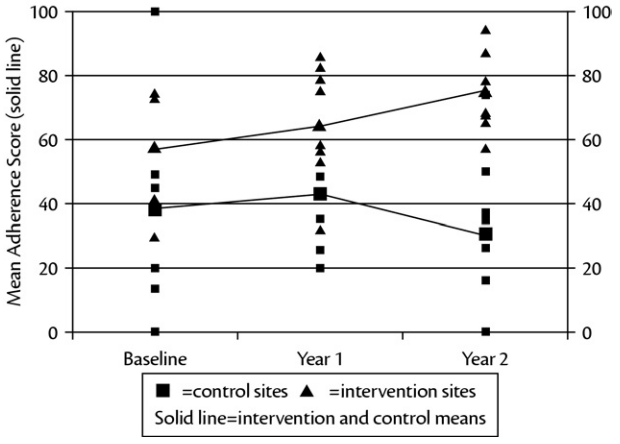


Figure 2. Mean percentage adherence to providing antibiotics within 4 hours of the order.

The mean change in adherence to the guideline recommending delivery of an antibiotic within 4 hours of the clinician's order is shown in **Figure 2**. Mean adherence was better during the baseline year in the intervention facilities than the control facilities, but it increased in the intervention facilities from 57% at baseline to 75% at year 2, whereas the mean adherence decreased in the control facilities from 38% at baseline to 31% at year 2. The difference in change between study groups was statistically significant ($P = 0.0003$).

Mean adherence to the use of an anti-pneumococcal fluoroquinolone or combination treatment with an extended-spectrum $\beta$-lactam plus a macrolide in patients who were prescribed antibiotic therapy is shown in **Figure 3**. The most commonly prescribed antibiotics in both study groups were levofloxacin and azithromycin as monotherapy regimens. Mean adherence to guideline-recommended antibiotics was almost twice as high at baseline in the intervention facilities compared with the control facilities. Use of guideline-recommended antibiotics increased in both groups from baseline to year 2: 60% to 66% in the intervention facilities and 32% to 39% in the control facilities. However, the difference in change between the intervention facilities and control facilities was not significantly different ($P = 0.3$). Among individual facilities, only 1 facility in the intervention group significantly increased guideline adherence for using optimal antibiotics compared with baseline ($P = 0.007$), whereas no facilities in the control group significantly improved over the baseline adherence rate.

Adherence to the guideline recommending antibiotic treatment for 10 to 14 days was low overall and decreased in both the intervention facilities (27% to 13%) and the control facilities (24% to 19%) from baseline to year 2 (data not shown). Subjects who received antibiotics were treated for a mean of 6.2 days in the intervention homes and 6.1 days in the control homes ($P = 0.445$).

Pooled data from all facilities were analyzed to evaluate the impact of a positive CXR result on antibiotic prescribing. Eight hundred sixty-seven CXRs were completed and 63% showed probable or possible pneumonia. After adjusting for study year, site, rural location, patient age, illness severity, functional status, and discharge to emergency department or hospital, patients with CXR evidence of pneumonia were 5 times more likely (odds ratio [OR] = 5.1; 95% CI, 3.1–8.4) to have an antibiotic initiated, and they were more likely to receive an anti-pneumococcal quinolone or extended-spectrum $\beta$-lactam.[25] CXR evidence of pneumonia was associated with a significantly longer antibiotic treatment: 6.5 (3.3) days versus 5.5 (3.2) days ($P < 0.01$).[25]

The overall mortality rate in the study was low. When the mortality rate was combined for the 3 study years, there was no difference in mortality between the control facilities (9.93%) compared with intervention facilities (7.29%) ($P = 0.115$).

## DISCUSSION

In the present study, a multifaceted intervention, including (1) nursing staff education emphasizing rapid recognition and treatment of LRTI, (2) a within-facility change agent, (3) financial incentives, and (4) academic detailing, succeeded in significantly increasing the number of NHAP episodes receiving timely antibiotics com-

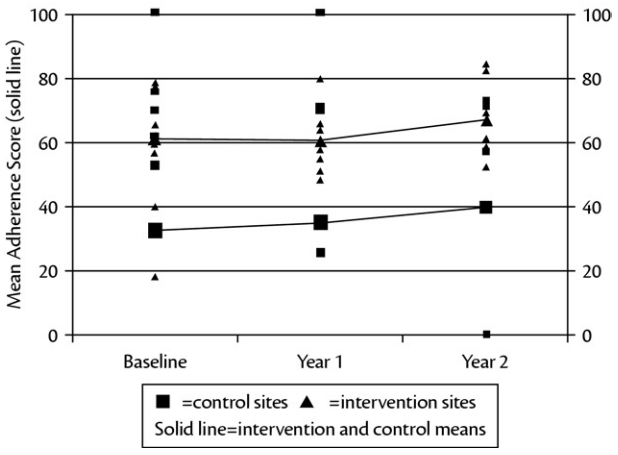


Figure 3. Mean percentage adherence to "optimal antibiotic use."

pared with episodes in control facilities. This improvement in timely administration occurred despite significant baseline differences between intervention and control homes and their NHAP processes of care. Although a prior study by Naughton et al[13] did demonstrate local guideline concordance changes in the use of parenteral antibiotics for NHAP, to our knowledge, the present study is the first to examine specifically the impact of an effort to improve timely antibiotic delivery. The intervention's impact was likely successful because it was recurring, championed by the study liaison nurses, and clearly within their scope of nursing practice to effect this change. As stated earlier, the clinical significance of providing antibiotics within 4 hours of diagnosis of pneumonia in an NH setting is unknown, and this study was not powered to detect differences in mortality. This topic requires further research.

In contrast, antibiotic choice and length of therapy proved harder to affect. It is not possible to identify exactly why these outcomes were not affected. However, there are several possible reasons why clinicians were not persuaded to alter their prescribing. First, interactions between the clinicians and the study pharmacists were limited to, at the most, one 10- to 15-minute, in-person visit per intervention year and 1 phone call per year. Although possibly effective for some clinicians, this limited contact was likely insufficient to elicit any changes in prescribing habits. Moreover, some clinicians were unwilling to meet with the study pharmacists, and many limited their contact time to even less than the study had planned. For the academic detailing to be optimally successful, it likely would have required more engagement by the clinicians.[26] In previous studies in which academic detailing significantly altered prescribing practices, the relative intensity of the interventions was substantially greater than that achieved in the present study.[18,19] One intervention that was aimed at reducing use of antipsychotic drugs in NHs included a 45- to 60-minute visit of the physician investigator with NH physicians, a series of 6 in-services for other NH staff, and follow-up visits with physicians and other staff at 4 weeks and 8 weeks after the program began.[18] A second study, also aimed at reducing use of psychoactive drugs, used an intervention consisting of 6 topical summaries of the literature distributed to NH physicians in 3 mailings. These mailings were followed by meetings of the physician investigator with each NH physician to discuss the program and 3 scheduled educational meetings between each physician and a clinical pharmacist.[19] By comparison, the present study used an intervention that was able to achieve relatively minimal contact with NH providers at widely spaced intervals. The lower intensity of this intervention was likely not sufficient to affect significant changes in the prescribing practices of experienced clinicians. Similar findings were reported by Naughton et al,[13] who found that academic detailing significantly increased use of parenteral antibiotics but did not significantly affect actual antibiotic selection, hospitalization rates, or mortality.

Second, the antibiotic guidelines being recommended had only B/II evidence to support their implementation.[6] B/II is moderate-quality evidence with at least 1 well-designed clinical trial without randomization or cohort studies. Clinicians simply may not have been convinced by the evidence.

Third, although all 3 study pharmacists had expertise in pneumonia treatment and geriatrics, it is possible that they were ineffective in delivering the academic detailing. However, the detailing delivered by the principal investigator, a geriatrician, was not notably more effective. Previous research has shown that even physician leaders are not always successful at improving antibiotic use through academic detailing.[27,28] It is widely known that changing practice habits is challenging. Halm et al[29] found that physicians with less experience treating pneumonia were more likely to report that guidelines are helpful in decision making than physicians with more experience. Many of the clinicians in the intervention homes in this study were seasoned clinicians who likely chose their antibiotic treatment based on years of clinical experience with NHAP patients. Moreover, it is unknown if the educational intervention was ineffective due to the educational preferences of the clinicians in the intervention homes. One study that compared academic detailing to computerized decision support found that antibiotic prescribing was improved much more in the computerized decision support group than the academic detailing group.[30]

Adherence to the guideline recommending 10 to 14 days of antibiotic treatment diminished in both study groups during the intervention period. This result likely reflects a change in national clinical practice to limit antibiotic use to the shortest amount of time necessary to treat the NHAP and avoid adverse events. Changes to clinical practice occurred halfway through the intervention period of the study, making it impractical to change the care pathway and preprinted orders. For example, in 2005, the American Thoracic Society and the Infectious Disease Society of America recommended a 7- to 8-day treatment course in patients with health care–associated pneumonia not due to *Pseudomonas*.[7] In addition, a new dosing schedule for levofloxacin (750 mg/d for 5 days)

was approved by the US Food and Drug Administration. This shorter dosing schedule, though only approved for community-acquired pneumonia, may have impacted the duration of use for levofloxacin in both study groups. Because levofloxacin was the most prescribed antibiotic in both study groups (46%–64% of antibiotic courses in the intervention group and 26%–33% in the control group), it is likely that shorter prescription times may have impacted the overall adherence to the guideline regarding duration of antibiotic treatment. Interestingly, CXRs were seemingly used in the study to help initiate, and possibly discontinue, antibiotic therapy. Overall, the duration of antibiotic use was ~6 days after diagnosis, but this was shortened in the group without a positive CXR.

### Strengths and Limitations

The study's strengths include its multistate, multifacility focus, prospective data collection, and comprehensive approach to improving care for NHAP. The study has a number of important limitations. First, there were significant differences between intervention and control homes in baseline guideline compliance, subject characteristics, and facility characteristics, including nursing resident staffing ratios, and nursing staff turnover. This was a consequence of the quasi-experimental study design. Whereas a randomized trial would have been stronger, the logistics and cost of such a national study would have been prohibitive, and a locally randomized trial would have been confounded by the tendency of physicians and nurse practitioners to practice simultaneously at many different NHs. In spite of this limitation, significantly greater improvement in timely antibiotic delivery was effected in the intervention NHs.

Second, no data were collected regarding the training, expertise, and number of clinicians treating patients in the intervention or control homes, and clinicians were not interviewed after the study to understand why the academic detailing did not alter their practice.

Third, some of the illness episodes occurred in the same NH resident, although episodes were ≥30 days apart. The distribution of recurrent episodes did not differ among homes or between intervention and control sites (data not shown), possibly limiting the clinical significance of recurrent episodes.

Generalizability of the study is limited by use of homes from a single multifacility corporation.

## CONCLUSIONS

The ability of this multifaceted study to repeatedly remind nursing staff of the importance of timely antibiotic administration contrasts with its limited academic detailing interaction with clinicians. This difference within the intervention may explain the differential impact of the intervention on antibiotic guideline compliance.

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All authors contributed to the study design, methods, and the interpretation of findings. Drs. Linnebur, Hutt, and Fish contributed to writing and editing the manuscript. All authors approved the final version of the manuscript.

## SUPPLEMENTAL MATERIAL

A supplemental appendix accompanying this article can be found in the online version at doi:10.1016/j.amjopharm.2011.09.009.

## REFERENCES

1. Muder RR. Pneumonia in residents of long-term care facilities: epidemiology, etiology, management, and prevention. *Am J Med.* 1998;105:319–330.
2. Hutt E, Frederickson EB, Ecord M, Kramer AM. Processes of care predict survival following nursing home-acquired pneumonia. *J Clin Outcomes Manage.* 2002;9:249–256.
3. Loeb M, Simor AE, Landry L, McGeer A. Adherence to antibiotic guidelines for pneumonia in chronic-care facilities in Ontario. *Clin Invest Med.* 2001;24:304–310.
4. Jones SR, Parker DF, Liebow ES, et al. Appropriateness of antibiotic therapy in long-term care facilities. *Am J Med.* 1987;83:499–502.
5. Nicolle LE, Bentley DW, Garibaldi R, et al. Antimicrobial use in long-term care facilities. *Infect Control Hosp Epidemiol.* 2000;21:537–545.
6. Hutt E, Kramer AM. Evidence-based guidelines for management of nursing home-acquired pneumonia. *J Fam Pract.* 2002;51:709–716.
7. American Thoracic Society, Infectious Disease Society of America. Guidelines for the management of adults with hospital-acquired, ventilator-associated, and healthcare-associated pneumonia. *Am J Respir Crit Care Med.* 2005;171:388–416.
8. Bartlett JG, Dowell SF, Mandell LA, et al. Practice guidelines on the management of community-acquired pneumonia in adults. *Clin Infect Dis.* 2000;31:347–382.

9. American Thoracic Society. Guidelines for the management of adults with community-acquired pneumonia. *Am J Respir Crit Care Med*. 2001;163:1730–1754.
10. Mills K, Nelson AC, Winslow BT, Springer KL. Treatment of nursing home-acquired pneumonia. *Am Fam Physician*. 2009;79:976–982.
11. El Solh AA. Nursing home-acquired pneumonia. *Sem Respir Crit Care Med*. 2009;30:16–25.
12. Meehan TP, Fine MJ, Krumholz HM, et al. Quality of care, process, and outcomes in elderly patients with pneumonia. *JAMA*. 1997;278:2080–2084.
13. Naughton BJ, Mylotte JM, Ramadan F, et al. Antibiotic use, hospital admissions, and mortality before and after implementing guidelines for nursing home-acquired pneumonia. *J Am Geriatr Soc*. 2001;49:1020–1024.
14. Ilett KF, Johnson S, Greenhill G, et al. Modification of general practitioner prescribing of antibiotics by use of a therapeutics adviser (academic detailer). *Br J Clin Pharmacol*. 2000;49:168–173.
15. Awad AI, Eltayeb IB, Baraka OZ. Changing antibiotics prescribing practices in health centers of Khartoum State, Sudan. *Eur J Clin Pharmacol*. 2006;62:135–142.
16. Seager JM, Howell-Jones RS, Dunstan FD, et al. A randomised controlled trial of clinical outreach education to rationalize antibiotic prescribing for acute dental pain in the primary care setting. *Br Dent J*. 2006;201:217–222.
17. Kisuule F, Wright S, Barreto J, Zenilman J. Improving antibiotic utilization among hospitalists: a pilot academic detailing project with a public health approach. *J Hosp Med*. 2008;3:64–70.
18. Ray WA, Taylor JA, Meador KG, et al. Reducing antipsychotic drug use in nursing homes. A controlled trial of provider education. *Arch Intern Med*. 1993;153:713–721.
19. Avorn J, Soumerai SB, Everitt DE, et al. A randomized trial of a program to reduce the use of psychoactive drugs in nursing homes. *N Engl J Med*. 1992;327:168–173.
20. Stein CM, Griffin MR, Taylor JA, et al. Education program for nursing home physicians and staff to reduce use of non-steroidal anti-inflammatory drugs among nursing home residents. *Med Care*. 2001;39:436–445.
21. Hutt E, Radcliff TA, Oman KS, et al. Impact of NHAP guideline implementation intervention on staff and resident vaccination rates. *J Am Med Dir Assoc*. 2010;11:365–370.
22. Hutt E, Radcliff TA, Liebrecht D, et al. Associations among nurse and certified nursing assistant hours per resident per day and adherence to guidelines for treating nursing home-acquired pneumonia. *J Gerontol*. 2008;63:1105–1111.
23. Mehr DR, Binder EF, Kruse RL, et al. Clinical findings associated with radiographic pneumonia in nursing home residents. *J Fam Pract*. 2001;50:931–937.
24. Hutt E, Reznickova N, Morgenstern N, et al. Improving care for nursing home-acquired pneumonia in a managed care environment. *Am J Manag Care*. 2004;10:681–686.
25. Cella ND, Radcliff T, Oman K, et al. Impact of chest X-ray findings on antibiotic ordering behavior in nursing home acquired pneumonia. *J Am Geriatr Soc*. 2009;57:S191–S192.
26. Colon-Emeric CS, Lyles KW, House P, et al. Randomized trial to improve fracture prevention in nursing home residents. *Am J Med*. 2007;120:886–892.
27. Doyne EO, Alfaro MP, Siegel RM, et al. A randomized controlled trial to change antibiotic prescribing patterns in a community. *Arch Pediatr Adolesc Med*. 2004;158:577–583.
28. Mol PG, Wieringa JE, Nannanpanday PV, et al. Improving compliance with hospital antibiotic guidelines: a time-series intervention analysis. *J Antimicrob Chemother*. 2005;55:550–557.
29. Halm EA, Atlas SJ, Borowsky LH. Understanding physician adherence with a pneumonia practice guideline: effects of patient, system, and physician factors. *Arch Intern Med*. 2000;160:98–104.
30. Buising KL, Thursky KA, Black JF, et al. Improving antibiotic prescribing for adults with community acquired pneumonia: does a computerized decision support system achieve more than academic detailing alone?—a time series analysis. *BMC Med Inform Decis Mak*. 2008;8:35.


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Supplemental Appendix: Preprinted orders provided as part of academic detailing.

ORIGINAL COPY

**PHYSICIAN/PRESCRIBER**
**PLEASE SIGN AND RETURN**

☐ Send NO MEDS ☐ Send * MEDS ONLY
☐ Send ALL MEDS ☐ _____ Doses taken from Emergency/Backup Stock

| Facility Name | Address | Signature of Nurse Receiving Order | Date/Time |
|---|---|---|---|
| | | | |

| Family Name | First Name | Admission Number | Room Number | Attending Physician |
|---|---|---|---|---|
| | | | | |

| Date Ordered | Time Ordered | Date DC'd | MEDICATION/Order | Dose & Form | Route | Schedule | INDICATION – DX |
|---|---|---|---|---|---|---|---|
| | | | 1. Patient has two or more symptoms and signs of possible pneumonia | | | | Pneumonia |
| | | | 2. Document vital signs and O2 Sat every shift until antibiotics complete/symptoms resolve | | | | |
| | | | 3. Call MD for O2 Sat ≤ 88% or ≥ 2 l increase in O2 to keep Sat >90%; SBP <90, RR>30, P>130 | | | | |
| | | | 4. Ask whether resident/proxy desires hospitalization and aggressive care. Report to MD | | | | |
| | | | 5. **IF** MD **orders hospitalization/ER**, give **Rocephin 1G IM**, unless severely allergic to PCN | | | | |

**Encourage hospitalization if pt has 2 or more: O2sat ≤ 88% or needs 3lpmO2>baseline, SBP<90, RR>30, newly unarousable or agitated**

| Physician/Prescriber Signature | Title | Date |
|---|---|---|
| | | |

**NURSE: Please Initial The Documentation Record As Performed** ☐ **Read back and verified** ☐ **Family notified of change in condition**

| Pharmacy | On Physician's Order Sheet | Med Sheet | TX Sheet | Nurse's Notes | Patient Care Plan | ADL/Flow | Signed | Date | Time |
|---|---|---|---|---|---|---|---|---|---|
| ☐ Courier<br>☐ Faxed (Fax Original)<br>☐ Phone | | | | | | | | | |

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|---|---|---|---|
| | | | |

| Family Name | First Name | Admission Number | Room Number | Attending Physician |
|---|---|---|---|---|
| | | | | |

| Date Ordered | Time Ordered | Date DC'd | MEDICATION/Order | Dose & Form | Route | Schedule | INDICATION – DX |
|---|---|---|---|---|---|---|---|
| | | | **IF** patient NOT sent to hospital or ER, **order CXR to r/o infiltrate** | | | | Pneumonia |
| | | | **IF** MD orders antibiotics, **see antibiotic choices below and** | | | | |
| | | | ☐ get 1 set of blood cultures (unless it will delay giving antibiotics) | | | | |
| | | | ☐ **IF** on Coumadin, PT/INR MWF while on antibiotics | | | | |
| | | | | | | | |

**Immediate antibiotics encouraged if pt has: P>130 T>101.5, O2sat ≤ 88%, needs 3 lpm O2> baseline, SBP<90, RR>30, newly unarousable or agitated**

| Physician/Prescriber Signature | Title | Date |
|---|---|---|
| | | |

**NURSE: Please Initial The Documentation Record As Performed** ☐ **Read back and verified** ☐ **Family notified of change in condition**

| Pharmacy | On Physician's Order Sheet | Med Sheet | TX Sheet | Nurse's Notes | Patient Care Plan | ADL/Flow | Signed | Date | Time |
|---|---|---|---|---|---|---|---|---|---|
| ☐ Courier<br>☐ Faxed (Fax Original)<br>☐ Phone | | | | | | | | | |

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|---|---|---|---|
| | | | |

| Family Name | First Name | Admission Number | Room Number | Attending Physician |
|---|---|---|---|---|
| | | | | |

| Date Ordered | Time Ordered | Date DC'd | MEDICATION/Order | Dose & Form | Route | Schedule | INDICATION – DX |
|---|---|---|---|---|---|---|---|
| | | | **IF** MD orders antibiotics, **choose ONE treatment option**, **give first dose STAT** *(oral is preferred)*: **Check Allergies** | | | | Pneumonia |
| | | | ☐ **Treatment 1:** Levaquin 500mg PO daily x 10 days | | | | |
| | | | ☐ **Treatment 2:** (if SCr >1.3): Levaquin 500mg day 1, then 250mg PO daily, days 2-10 | | | | |
| | | | ☐ **Treatment 3:** Augmentin 875mg PO BID x 10 days **PLUS** Zithromax 500mg PO day 1, 250mg PO daily 2-5 days | | | | |
| | | | ☐ **Treatment 4:** Rocephin 1G IM daily until able to take PO, then call MD for PO antibiotic order | | | | |

| Physician/Prescriber Signature | Title | Date |
|---|---|---|
| | | |

**NURSE: Please Initial The Documentation Record As Performed** ☐ **Read back and verified** ☐ **Family notified of change in condition**

| Pharmacy | On Physician's Order Sheet | Med Sheet | TX Sheet | Nurse's Notes | Patient Care Plan | ADL/Flow | Signed | Date | Time |
|---|---|---|---|---|---|---|---|---|---|
| ☐ Courier<br>☐ Faxed (Fax Original)<br>☐ Phone | | | | | | | | | |