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Associations Among Nurse and Certified Nursing Assistant Hours per Resident per Day and Adherence to Guidelines for Treating Nursing Home-Acquired Pneumonia

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Background. Nursing home (NH)-acquired pneumonia (NHAP) causes excessive mortality, hospitalization, and functional decline, partly because many NH residents do not receive appropriate care. Care structures like nurse/resident staffing ratios can impede or abet quality care. This study examines the relationship between nurse/resident staffing ratios, turnover, and adherence to evidence-based guidelines for treating NHAP.

Methods. A prospective, chart-review study was conducted among residents of 16 NHs in three states with ≥2 signs and symptoms of NHAP during the 2004–2005 influenza season. NH medical records were reviewed concurrently for functional status, comorbidity, NHAP severity, and guideline adherence. Ratio of licensed nurse and Certified Nursing Assistant (CNA) hours per resident per day (hrpd) and ratio of newly hired nursing staff/year to current nursing staff were provided by Directors of Nursing. Associations among guideline adherence, nurse and CNA hrpd, and turnover were assessed using multiple regression to adjust for case mix, facility characteristics, and clustering of residents in facilities.

Results. Mid (1.7–2.0) and high (>2.0) CNA hrpd were significantly associated with better pneumococcal and influenza vaccination rates. More than 1.2 licensed nurse hrpd was significantly associated with appropriate hospitalization (odds ratio [OR] 12.4; 95% confidence interval [CI], 3.5–43.8) and guideline-recommended antibiotics (OR 3.8; 95% CI, 1.7–8.7). A >70% turnover was inversely related to timely physician notification (OR 0.4; 95% CI, 0.2–0.7) and appropriate hospitalization (OR 0.09; 95% CI, 0.05–0.26).

Conclusions. NHAP treatment guideline adherence is associated with nurse and CNA hrpd and stability. An NH's ability to implement evidence-based care may depend on adequate staffing ratios and stability.

Key Words: Nursing homes—Pneumonia—Nurse staffing.

NURSING home (NH)-acquired pneumonia (NHAP) causes excessive morbidity, mortality, hospitalization, and loss of function, partly because many NH residents are not appropriately immunized and do not receive timely and appropriate care (1,2). Mortality rates from NHAP are as high as 44% (3); nearly one third of survivors suffer significant functional decline (4). At any given time, 1.1%–2.5% of the country's NH residents are ill with pneumonia (5,6).

There is now excellent evidence that NH processes of care for NHAP affect both mortality and hospitalization (7–10). A national, multidisciplinary, multispecialty panel has published evidence-based guidelines for evaluating and treating NHAP that address the full spectrum of care processes impacting pneumonia outcomes, including immunization, timing and thoroughness of nurse and physician evaluation of lower respiratory tract infections, antibiotic use, and criteria for appropriate hospitalization, which includes guidance based on both infection severity and the NH's capacity to provide acute care (11).

Unfortunately, NHs and practitioners vary widely in their care practices, and structures of care can impede or abet good care practices. For example, Konestzka and colleagues (12) recently found that hospitalization for NHAP varied by NH ownership status and resident payer source.

Among the most important structures of care are the ratio of nursing staff to residents and the rate of nurse turnover. However, evidence regarding the benefit of greater levels of nurse/resident staffing has been mixed, with some studies showing no impact on rehospitalization and mortality (13,14), other studies showing a positive impact on pressure ulcer rates, hydration, weight loss (15), use of benzodiazepines (16), in-bed time (17), and rehospitalization and mortality of short-stay (<60 days) residents (18). All of these outcomes result from complex care processes and patient characteristics, so that it is difficult to isolate the impact of nurse staffing and turnover. Thus, this report focuses instead on the impact of nurse staffing ratios and turnover on adherence to guideline-recommended care processes in 389 episodes of NHAP in 16 NHs that are part of one corporation located in three different states.

Methods

Design

This prospective, chart-review study describes the processes of care and NHAP guideline compliance for lower respiratory tract infections.

Setting

Sixteen NHs that are members of one multifacility corporation were invited to participate in the study. Eight homes are located in the Denver, Colorado metropolitan area, and eight homes are located in Kansas and Missouri.

Participants

NH residents in study facilities who developed two or more of the following signs and symptoms of lower respiratory tract infection, at least one of which was respiratory (new or worsening cough; increased or newly purulent sputum; new or increased hypoxemia; dyspnea; tachypnea [respiratory rate $\geq$24]; chest pain; nurses' and physicians' notes of a decline in physical, cognitive, or functional status; fever [temperature $\geq$100.5°F]; or hypothermia [2°F $<$ baseline]), were eligible. Eligibility was based on lower respiratory tract infection, rather than pneumonia, because pneumonia requires the presence of an infiltrate on chest x-ray, and many episodes of NHAP are treated without a chest x-ray being obtained (19). Illness onset was defined as the first mention in the medical record of at least two of these signs and symptoms. Residents who refused to participate, who had been in the facility $\leq$4 days (because infections in newly admitted residents are unlikely to have been acquired in the NH), or whom the charge nurse believed to be within 48 hours of dying were excluded. If a resident had more than one infection episode, and subsequent episodes occurred $>$30 days from the beginning of the initial episode, data from all episodes were recorded. Health Insurance Portability and Accountability Act (HIPAA) authorization and informed consent were elicited from all participants or (if they were not competent to consent) from their proxy health care decision maker. Information about each facility, including nurse staff/resident ratios and turnover, was collected from the Director of Nursing at each facility. The Colorado Multiple Institutional Review Board approved the study (COMIRB #03-1243), and the corporation's two respective divisional offices provided Federal Wide Assurances for the Protection of Human Subjects.

Data Collection Protocol

A chart-review instrument, facility questionnaire, and systematic data collection protocol had been previously pilot tested, revised, and automated (20). Data on resident characteristics, NHAP onset and severity, comorbidity, laboratory and x-ray data, whether or not the resident was receiving subacute (Medicare Part A) care, and processes of care were gathered by trained nurse data collectors using the systematic chart-review instrument on laptop computers in Microsoft Access 2000 with built-in range and logic checks (21). Process-of-care data including acute illness onset, physician notification and call-back time, antibiotics (and time ordered and dispensed) were gathered from nurse and physician notes, orders, Medication Administration Records, and the Minimum Data Set (MDS) closest to illness onset. Where there was conflicting information, the data collectors were instructed to regard nurses' notes as most accurate for vital signs and residents' functional and cognitive status, and orders and Medication Administration Records as most accurate for orders. Six data collectors visited the facilities on a weekly basis during influenza season, October 2004 through April 2005, to enroll residents with respiratory infections referred by the charge nurse on each unit within 10 days of symptom onset. They collected raw data from the medical records, and did not make judgments about guideline adherence. Charts were reviewed again 60 days later to ascertain hospitalization and survival. Every 10th chart was copied and re-reviewed by the project manager and one other data collector to assure reliable data extraction. Only items with interrater reliability scores of 0.7 or better by Cohen's κ or percent agreement are reported here.

The Director of Nursing at each facility completed the facility questionnaire, which assessed the number of licensed nurses (Registered Nurses [RNs] and Licensed Practical Nurses [LPNs]) and the number of CNAs who worked during a 24-hour period; the average daily facility census; the number of licensed nurses and CNAs hired during the past year; and the current number of licensed nurses and CNAs on staff. The licensed nurse and CNA hours per resident per day (hrpd) were defined as the number of hours worked by licensed nurses or CNAs in the facility daily divided by the facility's average daily census. The turnover rate was defined as the number of newly hired licensed nurses and CNAs in the facility during the past year, divided by the number of licensed nurses and CNAs on staff at the time the questionnaire was completed.

Data from both the chart abstraction protocol and facility questionnaire were combined into an analytic file matched at the patient–case (episode) level for analysis using the SAS (SAS Institute, Cary, NC) and Stata (Stata Incorporated, College Station, TX) 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. For example, Guideline 6 specifies, ''Nurse evaluation at symptom onset should include, at least, vital signs (temperature, pulse rate, respiratory rate and blood pressure)...''(11). The data collectors had recorded the date and time of illness onset and vital signs noted within 24 hours as raw variables. The Guideline 6 adherence variable specified that none of temperature, pulse, respiratory rate, and blood pressure were missing from the data file for the given episode. Like the raw variables, the guideline adherence variables all had interrater reliability by Cohen's κ or percent agreement of 0.7 or better.

Analysis

For each guideline, we calculated the percentage of episodes for which care adhered to the guideline. We then compared the demographics, functional status, comorbidities, care processes, and care structures for the episodes

Table 1. Demography, Disease Severity, Baseline Functional Status, Comorbidity, Facility Characteristics: 389 NHAP Episodes in Participants Enrolled October 2004–April 2005

Characteristic	Mean or %	*SD*	Min	Max
Demographics				
Average age, y	83.9	10.9	27.9	101.4
% Female	70			
% African American	11			
% Hispanic/Latina	3			
% Receiving subacute care	16.3			
% Residing in rural facility	15.8			
Average NHAP severity score	0.8	0.8	0	4
Comorbidity				
% with COPD	23			
% with CHF	27			
Functional status				
Average Barthel score	31.8	24	0	90
Average CPS	2.4	1.5	0	6
% Independent in eating	44			
Resuscitation status—DNR	70			
Average facility bed size	130	33.5	82	220

Note: NHAP = nursing home-acquired pneumonia; *SD* = standard deviation; COPD = chronic obstructive pulmonary disease; CHF = congestive heart failure; CPS = cognitive performance score; DNR = do not resuscitate.

compliant with a particular guideline to the episodes not compliant with that guideline, using the Fisher Exact test for dichotomous and the Mann–Whitney *U* test for continuous independent variables. Facility characteristics, including urban versus rural location, facility size, staffing ratios, and turnover rates, were disaggregated to the episode level. Presence of key comorbid diagnoses (chronic obstructive pulmonary disease, heart failure, stroke, diabetes, depression) were derived from those listed in the NH record of diagnoses. Baseline functional status was derived from MDS items recorded in the NH medical record and built into a modified Barthel Index (22). This 100-point index is a weighted scale based on ability to bathe, dress, transfer, maintain continence, eat, groom, walk, and ascend stairs. Points are assigned for each activity in five-point increments, with a maximum value for the different activities of daily living (ADLs) depending on importance in terms of ability to function independently. The Barthel Index was modified for this analysis to eliminate ability to climb stairs, because this is not assessed in the MDS, so that maximum independence is defined as a score of 90. A score of $\leq$20 indicates complete dependence in ADLs; a score of $\geq$65 indicates ability to live independently in the community. Baseline cognitive status was defined by the admission Cognitive Performance Scale (CPS) score (23–25). The scale uses MDS items, is independently validated, and divides cognitive function into seven grades from independent (CPS level 0) to comatose (CPS level 6). An NHAP Severity Index (26), a five-point scale summing respiratory rate >25 (2 points), pulse >125 bpm (1 point), presence of dementia (1 point), and presence of delirium (1 point), was calculated for each episode.

Separate logistic regression models were used to predict compliance with each guideline as a function of staffing ratios and staff turnover, adjusting for demographics, disease severity, baseline functional and cognitive status, comorbidities, resident/family desire for aggressive cardiopulmonary resuscitation (cor status), facility size, percentage of residents in subacute care, urban location, and clustering by facility. Logistic models followed the general form:

$$GA_i = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + \varepsilon$$

where guideline adherence for patients indexed by ''i'' were measures of pneumococcal vaccination, timely notification of physicians, vital sign assessment, and so on. The vectors X include patient demographic characteristics (X_1), baseline functional and cognitive status (X_2), comorbidities (X_3), cor status (X_4), and facility characteristics such as size and location (X_5). The key covariates were included in their respective categories of variables (i.e., staffing ratios and staff turnover were included as part of X_5). Epsilon (ε) represents error in the regression model. The b symbols represent coefficients that were subsequently converted to odds ratios for interpretation of findings relative to hypotheses.

Stepwise regression procedures were used in model development. Only variables significant at the 0.15 level or better were retained in the final regression models, which also adjusted standard errors for clustering of residents in facilities. Model fit was assessed using a C-statistic, which assesses whether the model predicts correct classification of outcomes among patients. When a model provides no information, c = 0.5. For our regression models, the C-statistic exceeded 0.6, suggesting moderately good model fit.

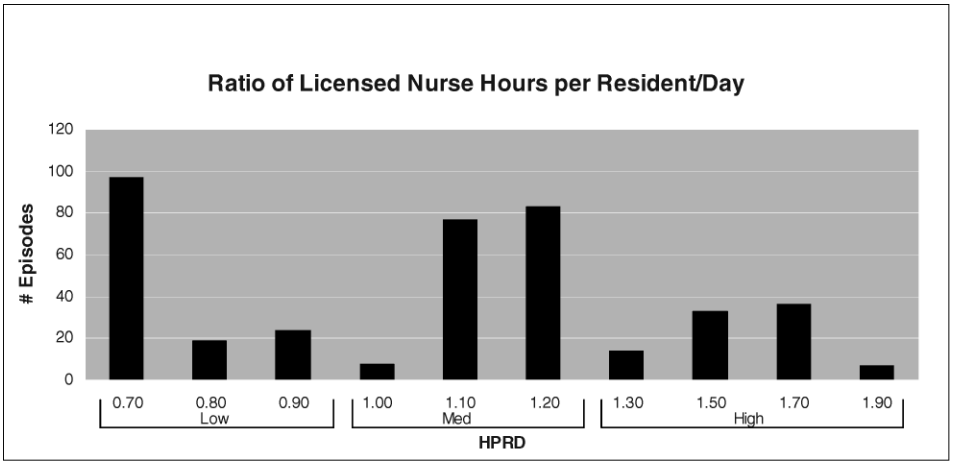
Table 2. Average Guideline Adherence

Guideline	% Adherent
Pneumococcal vaccine	36
Resident influenza vaccine	57
Staff influenza vaccine	21
$\leq$1 hour from disease onset to physician/RNP/PA notification	64
Complete set of vital signs at disease onset	66
$\leq$1 h from physician call to response	80
Appropriate hospitalization	53
Chest x-ray obtained for residents not hospitalized	74
In person physician/RNP/PA evaluation $\leq$72 h for residents not hospitalized	42
$\leq$4 hours from antibiotic ordered to given	47
Antibiotic timing appropriate to illness severity	34
Oral antibiotic if resident able to swallow	95
Treatment duration 10–14 d	25
Optimal choice of antibiotic	44

Note: RNP = registered nurse practitioner; PA = physician assistant.

Results

As shown in Table 1, participants were mostly elderly women with multiple comorbidities and functional and cognitive limitations who had relatively mild lower respiratory tract infections. The 16 facilities had an average size of 130 beds, access to laboratory testing and portable x-ray, and the ability to provide parenteral hydration. Fourteen facilities were located in cities; two were rural. Eleven had two or more RNs working every shift. Average adherence for each guideline appears in Table 2, and ranges from a low of 21% for staff influenza vaccination to a high



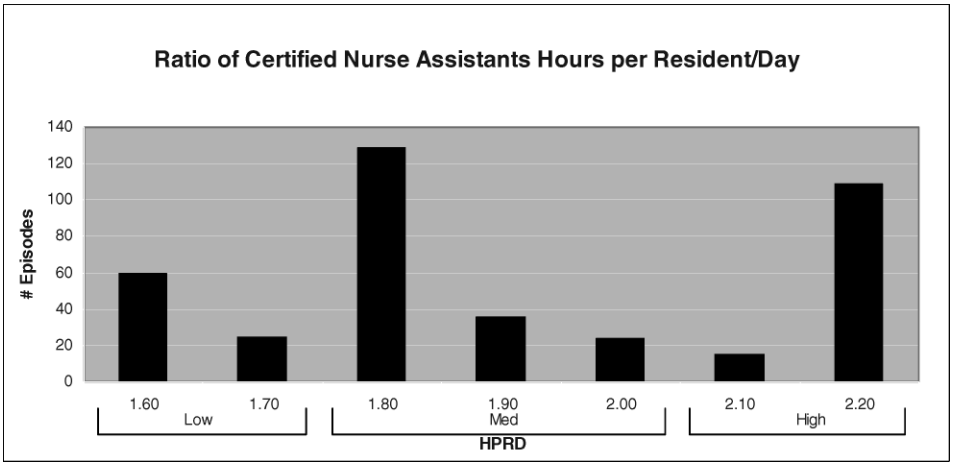


Figure 1. Distribution of nurse/resident staffing ratios. HPRD = Certified Nursing Assistant (CNA) hours per resident per day.

of 95% for use of an oral antibiotic if the resident was able to swallow.

Distribution of staffing ratios and turnover are shown in Figures 1 and 2. Licensed nurse staffing ranged from a low of 0.7 hrpd to a high of 1.9 hrpd, with a mean of 1.1, and standard deviation (*SD*) of 0.3. CNA staffing ranged from a low of 1.6 hrpd to a high of 2.2 hrpd, with a mean of 1.9 (*SD* 0.2). Turnover ranged from 20% to 100%, with a mean

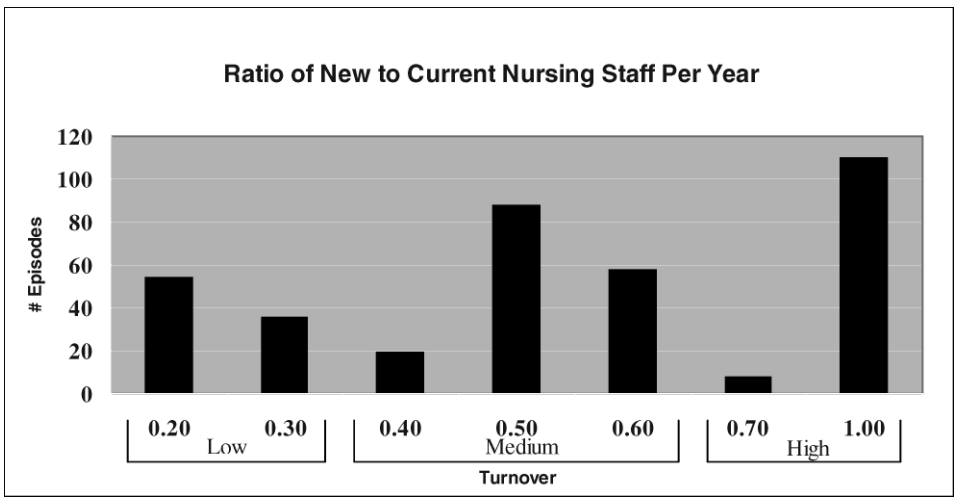


Figure 2. Distribution of annual nursing staff turnover rates.

Table 3. Relationship Between CNA Staffing and Compliance With Vaccination Guidelines for Treating Nursing Home-Acquired Pneumonia

Guideline	Pneumovax		Influenza	
Number of episodes	379		333	
Model C-statistic	.79		.69	
	OR	95% CI	OR	95% CI
Staffing variables				
Aide ratio mid (1.7–2.0 hrpd)	19.1	(3.7–98.6)	3.6	1.0–13.0
Aide ratio high (>2.0 hrpd)	53.5	(11.4–250.6)	2.6	1.0–6.8
Covariates				
African American	0.8	(0.3–1.7)	0.6	(0.2–1.4)
Hispanic	6.4	(2.1–19.1)	1.8	0.3–10.4
Barthel score	1.0	(.97–.99)	1.0	(0.98–1.0)
Resides on SA unit	0.37	(0.16–0.86)	0.28	(0.18–0.44)
Facility size	1.01	(1.00–1.02)	1.0	(0.99–1.02)
Urban location	0.58	(0.06–5.97)	0.5	(0.16–1.58)

Note: CNA = Certified Nursing Assistant; OR = odds ratio; CI = confidence interval; hrpd = hours per resident per day; SA = subacute.

of 60% (*SD* 28%) per year. As is evident from the graphs, the staffing levels fell into three natural groupings. Therefore, for subsequent analyses, low licensed nurse staffing was denoted as <0.9, mid from 0.9 to <1.2, and high >1.2 hrpd. For CNAs, low staffing was denoted as <1.7, mid from 1.7 to <2.0, and high >2.0 hrpd. Thirty percent or lower staff turnover was considered to be low. From 30% to <70% was considered middle, and >70% was considered high staff turnover. We created dummy variables for low, middle, and high staffing categories and turnover groups for inclusion in the regression models to predict guideline compliance (see Tables 3–6).

Our regression results showed that compliance with the guidelines for influenza and pneumococcal vaccination were associated with higher CNA staffing levels. The strength of the association was high and significant for both vaccinations, but more variable for pneumovax than for influenza. Vaccination compliance was also inversely associated with residence on the subacute unit. Those residents were probably in the NH for a shorter period of time, and staff is likely to assume that they were previously vaccinated.

The assessment guidelines, grouped together in Table 4, represent a wide array of care processes. Those processes that are primarily the nursing staff's responsibility, such as assessing vital signs and calling the physician promptly, were inversely related to higher turnover, whereas physician response times were not. Even processes under the purview of physicians, such as ordering a chest x-ray, or making an in-person assessment, appear to be associated with staff turnover.

Appropriate hospitalization (Table 5) was directly associated with higher licensed nurse staffing ratios and inversely associated with staff turnover.

Of the antibiotic use guidelines shown in Table 6, both delivery of the medication within 4 hours of the physician order and appropriate antibiotic choice were associated with licensed nurse staffing, whereas treatment duration and whether the antibiotic was ordered and delivered rapidly for residents with more severe illness were not.

Discussion

This study adds to the literature on NH staffing by demonstrating that nurse and CNA staffing and turnover within a single, multistate, multifacility corporation affect adherence to guidelines for treating NHAP. In fact, staffing and turnover impact the full spectrum of care processes, including vaccination, communication with attending physicians, hospitalization, and antibiotic use, all of which contribute to quality of care for NHAP.

This study is unique in demonstrating that nurse staffing and turnover impact the care of a particular and important acute illness in NHs. Other staffing studies have focused on

Table 4. Relationship Between Staff Turnover and Assessment Guidelines for Treating Nursing Home-Acquired Pneumonia

Guideline	Complete Vital Signs		MD Notified < 1 h		MD Responded < 1 h		Chest X-Ray		In Person MD Evaluation	
Number of episodes	333		365		319		318		272	
Model C-statistic	.71		.63		.65		.67		.74	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Staffing variables										
Turnover ratio mid (30%–70%)	0.3	(0.1–0.7)	1.2	(0.7–2.3)	1.5	(0.8–1.4)	0.5	(0.28–0.90)	0.9	(0.3–2.9)
Turnover ratio high (>70%)	1.2	(0.5–2.5)	0.4	(0.2–0.7)	0.8	(0.5–1.1)	0.4	(0.20–0.68)	0.2	(0.1–0.3)
Covariates										
African American	0.7	(0.4–1.4)			3.1	(0.6–15.9)			0.6	(0.3–1.4)
Hispanic					2.4	(0.4–16.4)				
CPS					1.1	(0.9–1.4)			0.9	(0.8–1.1)
COPD									1.8	(1.0–3.2)
Residing on SA unit	1.2	(0.4–3.9)	1.2	(0.7–2.3)	1.0	(0.4–2.2)	1.9	(0.9–3.8)		
Facility size	1.0	(0.99–1.01)	1.0	(1.00–1.01)	1.0	(0.99–1.00)	1.0	(0.99–1.00)	1.0	(0.99–1.02)
Urban location	0.6	(0.2–1.8)	1.1	(0.7–1.6)	0.69	(0.12–3.9)	2.2	(0.2–23.3)	1.7	(0.5–6.3)
Comfort care order							0.3	(0.1–0.7)	0.3	(0.1–0.9)
DNR order					2.2	(1.0–4.9)				
Hospitalized									1.1	(0.6–1.9)

Note: MD = physician; OR = odds ratio; CI = confidence interval; CPS = cognitive performance score; COPD = chronic obstructive pulmonary disease; SA = subacute; DNR = do not resuscitate.

Table 5. Relationship Between Staffing, Turnover, and Hospitalization Guidelines for Treating Nursing Home-Acquired Pneumonia

Guideline	Hospitalization		Hospitalization	
Number of episodes	148		148	
Model C-statistic	.75		.71	
	OR	95% CI	OR	95% CI
Staffing variables				
Licensed ratio mid (0.9–1.2 hrpd)	3.2	(0.69–14.6)		
Licensed ratio high (>1.2 hrpd)	12.4	(3.5–43.8)		
Turnover ratio mid (30%–70%)			0.3	(0.1–0.6)
Turnover ratio high (>70%)			0.09	(0.05–0.16)
Covariates				
Resident on SA unit	0.4	(0.2–0.9)	0.3	(0.16–0.75)
Facility size	1.0	(0.98–1.01)	1.0	(0.99–1.00)
Urban location	2.1	(0.8–5.8)	1.1	(0.2–6.0)

Note: OR = odds ratio; CI = confidence interval; hrpd = hours per resident per day; SA = subacute.

a variety of outcomes and care processes, including both those that are clearly within the purview of nursing, such as pressure ulcers or weight loss, as well as those that are more likely to be impacted by both physician and nurse behavior, such as hospitalization, prescription of psychoactive medication, or mortality. It is not surprising that the strongest links between staffing, turnover, and quality of care have been found with such outcomes as pressure ulcers, functional status, and weight loss (15,17), which are more completely within nurse and CNA scope of practice. The current study bears out this relationship in our finding of an association between licensed nurse staffing and timely physician notification of a change in patient status, but no association between physician response time and nurse staffing. Similarly, we found an association between licensed nurse staffing and delivery of antibiotic within 4 hours of the order, but not with overall antibiotic timing, because the order for immediate medications is primarily the physician's responsibility.

More complicated is the relationship between nurse staffing, turnover, and hospitalization. Here the evidence is mixed, and depends on how refined a view of hospitalization is considered. Freiman and Murtaugh (13) and Intrator and colleagues (14), who looked broadly at all hospitalizations using secondary data, found no relationship. In contrast, those who have examined short-stay residents (18) or particular admitting diagnoses where nursing care and observation logically would play a significant role (such as for heart failure, electrolyte imbalance, or infection) both demonstrated an association with staffing and turnover (27,28).

Only one other study (12) examined the relationship between hospitalization rates for pneumonia in particular and nurse staffing. Konetzka and colleagues (12) found a relationship between staffing and hospitalization only in hospital-based NHs. The facilities in the present study were all freestanding, and we examined ''appropriate hospitalization'' rather than total hospitalization. It is important to note that the three guidelines that comprise ''appropriate hospitalization'' were based both on infection severity as well as the NH's capacity to provide acute care, including frequent vital sign assessment, laboratory access, and parenteral hydration. Using this more refined measure, we demonstrated a clear relationship between appropriate hospitalization and licensed nurse staffing and turnover.

Compliance with guidelines driven primarily by physicians and midlevel providers had variable relationships with staffing that are difficult to explain on an individual guideline basis. For example, why is there a relationship between licensed nurse staffing and choice of guideline-recommended antibiotics, but not between staffing and duration of antibiotic treatment? Why does staff turnover impact the ordering of a chest x-ray or a physician's decision to evaluate a resident within 72 hours of illness onset? Unmeasured confounders likely account for some of these associations. In addition, it is possible that significant associations were found by chance, because numerous regression models were prepared in analyzing the data. However, the repetitive pattern of relationships among staffing, turnover, and those care processes that fall particularly within the nursing purview, are strongly suggestive of a real relationship.

This study was limited to facilities within a single NH corporation. However, as can be seen in Table 1, facility size and the demographic, functional, and comorbid illness characteristics of participants are typical of facilities and NH residents nationally (4,8,12). The age range for participants was particularly wide, but the guidelines were meant to apply to all NH residents regardless of age, because NH residence implies a level of frailty and an institutional

Table 6. Relationship Between Licensed Nurse Staffing and Antibiotic Guidelines for Treating Nursing Home-Acquired Pneumonia

Guideline	Antibiotic Within 4 Hours of Order		Antibiotic Choice		Timing Appropriate to Severity		10–14 Day Course	
Number of episodes	307		315		298		292	
Model C-statistic	.65		.66		.63		.61	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Staffing variables								
Licensed ratio mid (0.9–1.2 hrpd)	1.5	(0.5–4.5)	2.9	(0.9–10.1)	1.6	(0.6–3.7)	0.7	(0.4–1.3)
Licensed ratio high (>1.2 hrpd)	2.7	(1.1–6.9)	3.8	(1.7–8.7)	2.0	(0.9–4.5)	0.9	(0.5–1.3)
Covariates								
African American							3.4	(2.2–5.1)
CHF			1.6	(0.8–3.3)				
Resident on SA unit	1.4	(0.8–2.4)	1.7	(0.9–3.1)	1.0	(0.6–1.5)	1.2	(0.6–2.4)
Facility size	1.0	(0.98–1.00)	1.0	(0.98–1.00)	1.0	(0.99–1.0)	0.4	(0.02–5.3)
Urban location	0.9	(0.3–3.1)	0.9	(0.2–5.1)	0.7	(0.2–1.9)	1.4	(0.4–4.7)

Note: OR = odds ratio; CI = confidence interval; hrpd = hours per resident per day; CHF = congestive heart failure; SA = subacute.

bacterial flora requiring particular care processes (11). A second limitation is that we relied on reports of the facilities' Directors of Nurses, rather than on direct observation of staffing and turnover. However, the staffing ratios fall between the first and third quartiles of staffing found in much larger secondary data analyses (28), so they are likely to be both valid and representative of most NHs in the United States.

Summary

As both the NH population and the costs of hospitalization continue to increase, the importance of being able to care for acute illness in the long term care setting will continue to grow. We have demonstrated that adequate licensed nurse and CNA staff ratios and stable staffing patterns contribute significantly to an NH's ability to provide good care for pneumonia. Because this study was the prelude to a multifaceted, controlled, implementation trial to improve NHAP guideline adherence, we will soon be able to report whether there is an association between staffing ratios, turnover, and the ability to improve care and outcomes for what is arguably the most important infection in long-term care.

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