

Nurse Staffing and Resident Outcomes: National and State-Level Analyses

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Abstract

Objectives: 1) To examine the relationship between nurse and nurse aide staffing levels and pressure sores in nursing homes. 2) To test the hypothesis that fewer staff hours would be associated with lower quality of care and therefore a higher number of sores. 3) To determine whether this relationship differs by state, given variation in quality of care, regulation, and monitoring.

Study Setting: All nursing homes in the United States during 2000 (14,280 nursing homes in total).

Data Sources: Data were drawn from the federal On-line Survey Certification System (OSCAR), a uniform database on all nursing facilities federally certified for Medicare and Medicaid that includes facility characteristics and staffing data reported by facilities themselves.

Study Design: The study is a cross-sectional analysis where the unit of analysis is the nursing home and where a separate regression equation is estimated for each state.

Key Findings: Fewer nursing aide hours were associated with more pressure ulcers in the United States as a whole, when controlling for specific patient and facility characteristics. At the state level, however, this relationship was significant in only four states. Fewer total nursing hours were not significantly associated with more pressure ulcers in the United States as a whole or in almost all states. Facilities that had a greater percentage of ambulatory residents had a smaller percentage of pressure ulcers per resident. Facilities that had a greater percentage of Medicare residents and those that were part of a chain had a greater percentage of pressure ulcers per resident, although the relationship between chain status and ulcers was not found within most individual states.

Conclusions: Nursing aide hours and total nursing hours were not significant predictors of pressure ulcers in most states. At the national level, however, nursing aide hours alone were a significant predictor of pressure ulcers. Other important predictors of pressure ulcers at the national and state levels were resident mobility and Medicare status.

Introduction

The U.S. population is aging. In less than ten years the “baby boom” generation will enter the elderly ages of 65 years and older. Within the elderly population, the fastest growing age group is of persons 85 years and older (Institute of Medicine, 2001). This trend in aging is having and will continue to have major effects on the demand for and supply of long-term care services.

Long-term care is a broad term covering a variety of health and health-related support services provided over a sustained period of time to people with chronic conditions and functional limitations (Institute of Medicine, 2001). Even though long-term care users are of all ages, the majority are 65 years and older, with needs ranging from minimal assistance with basic activities to almost total care. These needs are met in an array of care settings, such as nursing homes, residential care facilities, or people's homes.

Over the years, the quality of care in long-term care settings has become a major concern of policy-makers and the public. Particular attention has been focused on the nursing home sector with respect to quality, cost and accessibility of care as well as the adequacy of oversight and enforcement mechanisms. Debate also continues over the effectiveness and appropriate scope of state and national policies to regulate long-term care, reduce poor performance of providers, and improve the health and well being of those receiving care (Institute of Medicine, 2001).

Long-term care services are costly. Because of these costs, about two-thirds of nursing home residents rely on government assistance to pay for care. Medicaid, a federal-state entitlement program for low-income people, accounts for about 50 percent of nursing home expenditures and 40 percent of home health services. Under the Medicaid program, states set payment levels, establish eligibility criteria, and decide which services will be covered based on broad federal guidelines (CMS website). Historically and currently, differences across states in financing and regulations have a major impact on how easily services are accessed by those in need and how well they are

coordinated so as to effect the production of efficient and high quality care (Evashwick, 1996).

Quality of care provided by nursing homes can be examined through three different dimensions: structure, process, and outcome (Donabedian, 1966). *Structure* refers to the attributes of the facility in which care is provided. Nursing staff was the structural element that was examined in this study. *Process* refers to what is actually done in the delivery of care. Finally, *outcome* denotes the change in the health status of residents as a result of the care provided. (Donabedian, 1988) Quality indicators are often included under outcomes and, although these are not measures of health status, they may indicate when substandard care is being provided. Pressure ulcers are an example of a quality indicator and were used to represent outcomes in this study. Due to a lack of data on the process within nursing facilities, this study focused on the elements of structure (staffing) and outcomes (pressure ulcers).

Many studies have examined the relationship between staffing and nursing home quality. These studies consistently find a positive relationship between higher nurse staffing levels and resident outcomes (Linn et al., 1977; Nyman, 1988; Cohen & Spector, 1996; Bliesmer, 1988; Munroe, 1990; Aaronson et al., 1994; Spector & Takada, 1991; CMS, 2000; Harrington et al, 2000; Kovner et al., 2000; Schnelle et al., 2004; Zhang & Grabowski, 2004). Overall, studies have found that higher staff levels and lower turnover rates are related to improvements in resident functioning and reductions in the likelihood of death. Conversely, inadequate nurse staffing is associated with poor feeding of residents, malnutrition, dehydration, pressure sores, urinary tract infections, and hospitalization. (Harrington, 2001) Increasingly, studies are drawing attention to the

need to increase nurse staffing levels in nursing home facilities to improve the quality of care and the quality of life for residents.

Early studies examined the relationship between nursing hours and outcomes. Linn and colleagues (1977) demonstrated that more registered nursing hours were related to better outcomes among Veterans Administration nursing home patients. Nyman (1988) found that nursing hours per patient were positively related to three quality measures. Several later studies looked at resident functional improvement. Cohen and Spector (1996) and Bliesmer and colleagues (1998) found that higher staffing ratios have a significant positive impact on resident functioning. While Bliesmer (1988) found that licensed nursing hours in general were significantly related to improved functional ability and decreased probability of death in Minnesota nursing homes, Cohen and Spector (1996) found that higher LPN intensity improved resident functional outcomes and higher RN ratios reduced the likelihood for death. Similarly, in Spector and Takada's (1991) study of Rhode Island nursing homes, higher staff levels and lower RN turnover were related to functional improvement. Munroe's (1990) study examined deficiencies and found that for every 25 percent increase in the ratio of registered nurse to LPN hours, there was a decrease of 0.53 in the number of deficiencies in the facility.

Recent studies continue to advocate higher staffing standards based on their findings. Harrington (2000) found that fewer registered nurse hours and nursing assistant hours were associated with total deficiencies and quality of care deficiencies. Schnelle and colleagues (2004) found that the highest-staffed nursing homes reported significantly lower resident care loads and provided better care than all other homes. And Zhang and Grabowski (2004) found a positive relationship between registered nurse staffing and

quality for facilities that were particularly deficient prior to the Nursing Home Reform Act.

These latter studies came in the wake of a two-phase study conducted by the Centers for Medicare and Medicaid Services (CMS, 2000, 2001). The congressionally mandated study sought to assess the effects of nurse staffing on quality measures. Findings of the study suggest that shortages of all nursing staff contribute to high turnover rates and result in compromised quality of care. The CMS report on the study (Kovner, 2000) recommended that minimum staffing levels are needed to ensure quality of care. Of particular relevance to this current study is Chapter 10 of phase 1 of the CMS study in which the authors found a positive relationship between both skilled and unskilled nurse staffing and incident pressure ulcers in Ohio and New York (CMS, 2000).

Several of the aforementioned studies have also examined the relationship between staffing and pressure ulcers specifically, though with mixed results. Cohen and Spector (1996) found that pressure ulcers were not associated with staffing ratios when looking at prevalence rather than incidence. However, Harrington (2000) found that fewer RN hours and nursing assistant hours were associated with quality of care deficiencies, including prevention of pressure sores. And recently, Schnelle and colleagues (2004) found that higher-staffed nursing homes had a smaller percentage of residents with pressure ulcers.

Although many of the aforementioned studies have examined at the relationship between nursing staff hours and resident outcomes in particular states or across regions of the United States, none have considered each state with a separate model. However, there are significant differences across states with respect to nursing home care. One

important variation between states is the staffing standards they have established as part of their state nursing facility licensing requirements. Many states set standards for Medicare and Medicaid certified facilities that reach beyond the federal requirements and certified facilities in those states are required to meet the higher state standards (Harrington, 2001). Individually, states are charged with monitoring nursing homes to ensure that each facility is meeting these guidelines. And when facilities are found deviating from standards, states are responsible for imposing remedies or sanctions. In addition to regulations, Medicaid payment policies and rates vary by state. Differences in Medicaid reimbursement levels can impact nurses' wages and subsequently, turnover (Evashwich, 1996). Finally, variation in the socio-economic status of state populations may influence nursing home quality outcomes.

Therefore, building on previous research, this study examined the relationship between nursing staff hours and resident outcomes where the unit of analysis was the nursing home and where a separate regression equation was estimated for each state. In particular, the resident outcome that was examined was pressure ulcers. The general hypothesis that was tested was that nursing staff hours per resident day in nursing homes would be negatively associated with the ratio of pressure ulcers to residents, when controlling statistically for resident characteristics and facility characteristics.

Quality of Resident Care

The federal survey process is designed to regulate the quality of care. State survey agencies inspect nursing facilities about once a year (between 9 and 15 months) under contract with the Centers for Medicare and Medicaid Services (CMS) (formerly the Health Care Financing Administration, HCFA). Surveyors evaluate facilities with respect

to quality of care. Data from the evaluations are entered in the federal On-Line Survey, Certification, and Reporting (OSCAR) system after the surveys are conducted. Federal regulations span 17 major categories and include 179 specific standards for nursing facility care (Harrington, 2000).

This study analyzed quality of care as relates to prevention of pressure sores/ulcers (or decubitus ulcers). Pressure ulcers are areas of the skin and the tissue beneath the skin that erode as a result of pressure or friction or lack of blood supply. Ulcers can range from persistent skin redness with no break in the skin to large open lesions exposing skin tissue and bone. (Brandeis, 1990) The sores can cause significant pain and are strongly associated with increased morbidity and mortality (Smith, 1995).

Pressure sores are a significant problem in nursing homes. 11 percent of nursing home residents develop new pressure ulcers during their first six months (Allman, 1997). Despite their commonness, pressure ulcers are one of the most preventable and treatable conditions associated with immobility in the elderly population (Kane, Ouslander, & Abrass, 1989). Pressure ulcer prevention depends on labor-intensive measures, such as frequently turning residents to relieve pressure. This type of care is typically carried out by nurse aides. (CMS, 2000) The procedures for prevention and treatment of pressure ulcers are well established; therefore, the high incidence may be an indicator of poor-quality care (CMS, 1999).

Determinants of Resident Outcomes

Following previous work, this study develops a model that predicts resident outcomes as dependent on the staffing hours, resident characteristics, and facility characteristics. The general form of this model is Resident Outcomes = $f(\text{Staffing Hours,}$

Resident Characteristics, and Facility Characteristics). Measures of the determinants of resident care quality are described below. It was expected that staffing hours, particularly nurse aide hours, are an important factor associated with resident outcomes, such as pressure ulcers, in nursing facilities. Variables related to resident characteristics and facility characteristics were included as they may interfere with the relationship between pressure ulcers and nurse staffing.

Staffing Hours

To ensure adequate nursing home care, federal standards have been established for different types of staffing in nursing facilities. In 1986, a report by the Institute of Medicine (1986) recommended a series of regulatory changes in the nursing home industry. Subsequently, the Omnibus Reconciliation Act of 1987 included nursing home reform legislation with increased minimum standards for nursing home staffing.

(Harrington et al., 2000) The legislation, titled the Nursing Home Reform Act (NHRA), required that Medicaid and Medicare certified nursing homes have licensed practical nurses (LPNs) on duty 24 hours a day; a registered nurse (RN) on duty at least 8 hours a day, 7 days a week; and an RN director of nursing in place. Facilities must also have sufficient nursing staff to provide nursing services to maintain the highest levels of physical, mental and psychosocial well being of residents (Omnibus Budget Reconciliation Act of 1987, 1987). In hours per resident day, for an average facility with 100 residents, the total licensed nursing requirements are about .30 hours per resident day (Harrington, 2001)

Beyond these basic requirements, the CMS regulations provide no guidelines for facilities on the appropriate levels of staff (CMS, 2000). Therefore, states are charged

with determining and monitoring adequate staffing levels. There is considerable variation in the minimum standards that states set. Some states set standards for licensed nurses (RNs and LVN/LPNs), some also have requirements specific to RNs and directors of nursing (DONs), and many states have requirements for total nursing staff or direct care staff. However, most states do not have specific requirements for nursing aide staffing. The majority of states have minimum requirements that are higher than the federal standards and states continue to increase minimum standards. Despite improvements, staffing standards are still below what experts have proposed (CMS, 2001).

The general hypothesis was that staffing hours would be inversely related to quality of care deficiencies, when resident characteristics and facility characteristics were controlled. Specifically, fewer nursing aide hours per resident day and fewer total nursing staff hours per resident day were hypothesized to be associated with a higher ratio of pressure ulcers per resident.

Resident characteristics

The majority of nursing home residents are the very old and frail. In 1997, the mean age for all residents was 81 years (Gabrel, 2000). However, there is still variation among nursing homes in terms of the health and needs of the resident population. This is commonly referred to as case mix variation. Resident characteristics or case mix may increase the likelihood of residents experiencing pressure ulcers, when staff hours and other factors are controlled for. It was expected that resident mobility would be associated with pressure ulcers because the sores are often caused or exacerbated by spending long periods of time in bed or in an immobility position. (Brandeis, 1990)

Specifically, this study anticipated a greater percentage of ambulatory residents would be negatively related to the number of pressure ulcers per resident. Conversely, it was expected that a greater percentage of bedfast residents would be positively associated with pressure ulcers. For these reasons, the percentage of ambulatory residents and the percentage of bedfast residents were included in the regression model as controls.

The other resident characteristics that were controlled for included the percentage of residents who are dependent on other for toilet use and the percentage of residents who are dependent on caregivers for eating. Studies have found that inadequate staffing contributes to poor feeding of residents as well as resident deterioration and resident hospitalization (Amella, 1999; Kayser-Jones et al., 1996, 1997) For this reason, eating dependence was expected to be positively related to pressure ulcers when other factors were controlled. Toilet dependence was also predicted to be positively related to pressure ulcers because pressure ulcers, in general, are associated with mobility (Kane, Ouslander, & Abrass, 1989).

Facility characteristics

The facility characteristics included in the model were size, occupancy, the percentage of residents using Medicare, the percentage of residents using Medicaid, and ownership.

1. Size. The total number of beds in the facility, representing the size of the facility, was expected to be related to the ratio of pressure ulcers to residents. Smaller facilities have been found to be less likely to have quality of care deficiencies (Harrington et al., 2000). Recently, Rantz and colleagues (2004)

found that small facilities of 60 beds were more likely to have good resident outcomes.

2. **Occupancy.** The occupancy was calculated by dividing the total number of residents by the total number of beds in the facility. Harrington and Swan (2003) found that high-occupancy rate facilities had lower total nurse staffing hours. Occupancy rates also influence the financial standing of the facility. When occupancy rates are high, access to care becomes more difficult, especially for residents on Medicaid (USGAO, 1990).
3. **Percentage of Medicaid and Medicare residents.** Medicaid rates are generally lower than Medicare rates. Several studies have found that high percentages of Medicaid residents result in lower staffing whereas high percentages of Medicare residents result in higher staffing (Nyman, 1988; Harrington et al., 2003). Medicaid reimbursement rates are lower than those of Medicare; consequently, facilities with a greater proportion of Medicaid residents may have fewer resources (Zinn et al., 1994). Indeed, Weissert and Scanlon (1985) found that after controlling for resident characteristics, a higher percentage of Medicaid-covered residents in a facility reduced the likelihood of discharge.
4. **Ownership.** The majority of the literature on relationship between nursing home ownership supports non-for-profit homes over for-profit facilities. Harrington and Swan (2003) found that for-profit homes lower total nurse staffing. Similarly, Zinn, Aaronson and Rosko (1994) found that non-for-profit homes had better staffing and better resident outcomes. Finally, Nyman (1988) and O'Neill and colleagues (2003) found that for-profit status was

negatively related to quality. However, there are studies that have discovered the opposite. Bliesmer and colleagues (1998) found that for-profit homes had better resident outcomes than did nonprofit institutions. The other ownership variable included in this study was whether or not the facility was part of a chain. Harrington and colleagues (2002) found a positive relationship between multi-facility organizations and deficiencies.

Hypothesis 1: Fewer nursing aide hours per resident day were hypothesized to be associated with a higher ratio of pressure ulcers per resident at both the (a) state and (b) national levels, when resident characteristics and facility characteristics were controlled.

Hypothesis 2: Fewer total nursing staff hours per resident day were also hypothesized to be associated with a higher ratio of pressure ulcers per resident at both the (a) state and (b) national levels, when resident characteristics and facility characteristics were controlled.

Methods

Data Sources

The secondary data for this study were gathered from the federal On-Line Survey, Certification, and Reporting (OSCAR) system for all certified nursing homes in the United States. OSCAR includes the results of site surveys conducted every 9 to 15 months by auditors under contract from Centers for Medicare and Medicaid Services (CMS). Data for this paper are from surveys conducted during 2000. The OSCAR data is the sole source for this paper because these data were available for all facilities in the United States.

Data Cleaning

All federally certified nursing facilities in the United States were included in this study, except for those in Washington D.C. and Alaska. Washington D.C., with only 12 nursing facilities, was considered too small a sample. Alaska was excluded due to technical errors in the OSCAR data. Also excluded were Guam, Puerto Rico, and the Virgin Islands. Duplicate provider records were eliminated by choosing the first provider record of 2000 for each provider number. Errors in reporting of total beds and residents were corrected by setting the maximum number of residents to the total number of beds in the facility. Only facilities that reported a positive number of total beds were included. Errors in reporting of resident characteristics were generally corrected by setting the minimum number of observations equal to zero.

Staffing Data

Facilities with fewer than 15 residents were eliminated because these smaller facilities tend to be specialty care facilities that have significantly higher staffing hours than other facilities (Harrington, et al., 2000). Outliers assumed to be erroneous were eliminated. Specifically, all facilities where nurse aide hours per resident day were greater than 10 hours or less than 15 minutes were eliminated. The same criteria were applied to total nursing hours per resident day to prevent a skewed distribution.

The staff measure was the number of nursing hours per resident day. The nursing categories were nurse aides, LPN/LVNs, and RNs. Each of these categories of nurses included all part-time, full-time, and contract staff. The number of nursing aide hours per resident day was calculated by adding up all part-time, full-time, and contract aide staff,

multiplying by 70 hours, and then dividing by the total number of residents and by the 14 days in the reporting period (the procedure used by CMS). The total nursing hours per resident day was calculated using the same procedure after computing the total nursing hours across all three nursing categories.

Resident Characteristics

Several variables were chosen for resident characteristics from the OSCAR dataset. Of the activities of daily living (ADLs), eating and toileting were selected. The percentage of residents dependent on others for eating and the percentage of residents dependent on others for toileting were computed. Two mobility variables were included: bedfast and ambulatory status. The percentage of residents who were bedfast and the percentage of residents who were ambulatory were computed. Finally, the percentage of residents with pressure ulcers was calculated for this study and included as the dependent variable.

Other Independent Variables

The total beds in the facility were taken from OSCAR to represent the size of the facility. The occupancy rate for the facility was calculated by dividing the total number of residents by the total number of beds. The percentage of residents using Medicare and the percentage using Medicaid were also calculated. Finally, dummy variables were included in the model to take into account facility ownership. One variable was added to represent a facility's status as a chain (yes = 1, otherwise = 0) and another was included to indicate whether the facility was a proprietary/for-profit (yes = 1, otherwise = 0).

Analytic Approach

Cross-sectional multivariate analyses were used to examine the relationship between nursing aide hours and pressure ulcers, by state. The relationship between total nursing hours and pressure ulcers was also examined by state. As indicated above, other independent variables taking into account resident and facility characteristics were included in the model. For each variable, the mean and standard deviation was calculated across all states. With the unit of analysis as the nursing home, a separate regression was estimated for each state using the statistical program SAS. Two regressions were estimated for each state. The models were the same except that the first one included nurse aide hours and the second included total nursing staff hours. The variables in the model were standardized by state before running each regression. In addition, two models were estimated for the United States as a whole. Again, the first included nursing aide hours as the independent variable and the second included total staff hours. The variables in the model were standardized across the U.S. before running the regression.

Results

National Level

The means and standard deviations of all the dependent and independent variables are shown in Table 1. As is indicated, the mean number of pressure ulcers per resident for facilities across all states was 0.07, and the standard deviation was 0.06. The mean nursing aide hours per resident day across all states was 2.12, and the standard deviation was 1.28. The mean total nursing staff hours per resident day across all states was 3.21,

and the standard deviation was 1.47. One variable from each category of resident characteristics, facility characteristics, and ownership characteristics was focused on in this study. The three variables chosen were the percentage of ambulatory residents, the percentage of residents using Medicare, and whether the facility was a chain. The means for these variables were 0.17, 0.10, and 0.56, respectively (with standard deviations: 0.14, 0.16, and 0.50).

Table 2 displays the regression results for the relationship between nursing aide staffing, pressure ulcers, and resident and facility characteristics for the United States as a whole (14,280 nursing homes). As indicated, most of the variables are highly significant. In particular, a significant negative relationship was found between nurse aide staffing hours per resident day and pressure ulcers for the entire United States. This result supports the hypothesis that higher staffing levels are associated with a lower percentage of pressure ulcers.

All resident characteristics produced expected and highly significant results ($p < .0001$). The percentage of bedfast residents, eating dependent residents, and toilet dependent residents were all positively associated with pressure ulcers. Conversely, the percentage of ambulatory residents was negatively associated with pressure ulcers. These results are in accordance with the existing literature. Four of the six facility characteristic variables produced significant results. The total number of beds, the percentage of Medicare residents, and whether the facility was a chain were all positively associated with pressure ulcers. The percentage of occupied beds was negatively associated with pressure ulcers. The percentage of Medicaid residents was negatively associated with pressure ulcers and for-profit facilities were positively associated with pressure ulcers,

however neither of these results were significant. This regression model, as indicated by the R-squared measure, explains about 19 percent of the variation.

The regression results for the relationship between total nurse staffing, pressure ulcers, and resident and facility characteristics for the U.S. are displayed in Table 3. The variables that were significant in the previous model (Table 2) were also significant in this model and in the same direction. In this model, however, total nurse staffing was not a significant predictor of pressure ulcers. Unlike the relationship between nursing aide hours and pressure ulcers, there was almost no relationship between total nursing staff hours and pressure ulcers. Similar to the previous model, the total nurse staffing model explained roughly 19 percent of the variation in pressure ulcers per resident.

State Level

The state with the highest mean percentage of pressure ulcers per resident was West Virginia with 8.90, and the state with the lowest was North Dakota with 3.08. The state with the highest mean nurse aide hours per resident day was Missouri with 3.85, and the state with the lowest was Oklahoma with 1.52. Finally, the state with the highest mean total nursing staff hours per resident day was again Missouri with 4.65, and the state with the lowest was again Oklahoma with 2.35. (Appendix, Table A) Tables 4 and 5 summarize the key regression results by state for pressure ulcers.

Nurse Aide Staffing. As indicated in Table 4, a negative and significant association between nurse aide staffing hours per resident day and pressure ulcers per resident was found in four states. These states include: California, Georgia, Illinois, and

Wisconsin. Out of these, Georgia had the most negative result with a parameter estimate of -0.11. In twenty-four other states a negative, though not significant, association was found between nurse aide hours and pressure ulcers. This group included states from all regions of the U.S. Finally, the remaining twenty-one states produced results that were contrary to the hypothesized relationship. In these states, a positive or no association was found between nurse aide hours and pressure ulcers.

States were also divided into two groups: those with average pressure ulcers per resident greater than the average pressure ulcers for the US and those with average pressure ulcers per resident less than the average for the US. When the mean pressure ulcers and mean nurse aide hours were calculated for each group, we found that the group with greater pressure ulcers on average (0.079 compared with 0.053) had fewer nurse aide hours on average than the group of state with fewer pressure ulcers (2.04 compared with 2.22). (Appendix, Table B)

Other noteworthy variables included in the model were the percentage of ambulatory residents, the percentage of Medicare residents, and whether or not the facility was part of a chain. As indicated in Table 4, a negative relationship was found between ambulatory residents and pressure ulcers in the majority of states (43 out of 49). In twenty-three of these forty-three states, this relationship was significant. Of the remaining six states, where a positive (or no association) was found between ambulatory residents and pressure ulcers, no states produced a significant result. On the flip-side, in the majority of states a positive relationship was found between the percentage of bedfast residents and pressure ulcers.

The majority of states (45) also produced a positive relationship between the percentage of Medicare residents and pressure ulcers. In thirty-four of these forty-three states, this relationship was significant. In none of the remaining four states, in which the association between Medicare and pressure ulcers was positive (or zero), was the relationship significant. The association between a facility's status as a chain and pressure ulcers was not as uniform across states as ambulatory and Medicare status. For the majority of states (30), however, this relationship was positive or zero. In only five of these states was the association significant, though. Out of the remaining forty-nine states, where the relationship between chain status and pressure ulcers was negative, there were only two states with significant results.

Total staffing. As indicated in Table 5 and Table 7, a negative and significant association was found between total staffing hours per resident day and pressure ulcers in only two states, Georgia and North Dakota. Notably, in Georgia, this significant negative relationship was also found between nurse aide hours and pressure ulcers. For North Dakota, however, this relationship is unique to total staffing hours. For total staffing, Georgia had the most significant result. However, North Dakota had the most negative result with a parameter estimate of -0.42 between nursing staff hours and pressure ulcers. In an additional nineteen states a negative, though not significant, relationship was found between staffing and pressure sores. Similar to the nurse aide staffing model, this group includes states from all regions of the United States. The remaining twenty-eight states produced regression results that were contrary to the hypothesized result. In other words,

a positive relationship (or no relationship) was found between total nurse staffing and pressure ulcers in these states.

Analogous to the previous model of nurse aide staffing, in the majority of states (43 of 49) a negative relationship was found between the percentage of residents who are ambulatory and the ratio of pressure ulcers to residents. (Table 5) A significant negative relationship was found in over half of these states (22). Only one of the eight states where a positive relationship was found between percentage of ambulatory residents and pressure ulcers was significant. Once again, in nearly all states a positive relationship was found between the percentage of bedfast residents and pressure ulcers. (Appendix)

Also in accordance with the previous model, a positive relationship between the percentage of residents using Medicare and pressure ulcers was found in almost all states (46). None of the remaining three states where a negative relationship was found resulted in a significant relationship. Out of the forty-six states where a positive relationship was found between Medicare residents and pressure ulcers, thirty-one states produced significant results. Finally, a facility's status as part of a chain was not as uniform of a predictor of pressure ulcers when total staffing is included in the model. In the majority of states (31) the relationship between chain status and pressure ulcers is positive, yet in only six of these states is this positive relationship significant. In two other states, the relationship between chain status and pressure ulcers is negatively significant.

Discussion

This study has demonstrated a relationship between lower nurse aide staffing levels and greater likelihood of pressure ulcers for nursing home residents at the national-

level. Thus this study affirmed part (b) of Hypothesis 1. This relationship was not found, however, to hold at the state-level for the majority of states. Therefore, this study did not find strong support for part (a) of Hypothesis 1. In addition, no significant relationship was found between total nurse staffing levels and pressure ulcers at both the national and state levels, contrary to Hypothesis 2. Hence, for the most part, this study did not find strong support for the general hypothesis that there would be an inverse relationship between nurse staffing and pressure ulcers at both the state and national levels.

The resident outcome measure, pressure ulcers, was carefully chosen due to its clear association with quality of care in the domain of nursing staff, particularly nurse aides, supported by numerous studies on nursing home quality and staffing. The fact that prevention and treatment of pressure ulcers is typically the role of nurse aides may explain why there was an association between nurse aides and pressure ulcers and not between total nurse staffing and pressure ulcers at the national level.

This study found conflicting results for the relationship between nurse aide staffing and pressure ulcers between national and states analyses. One possible explanation for this outcome is that the inverse relationship between nurse aide staffing and pressure ulcers may not show up at the state-level in most instances because within many states there are not enough observations (nursing facilities) to create sufficient statistical power. Once all observations are combined at the national-level, however, the relationship can be seen. Indeed, in the majority of states a negative, although not usually significant, relationship was found between nurse aides and pressure ulcers.

Another possible explanation for the difference between national and state-level results is that some states may have generally high quality of care as represented by nurse

aide staffing and low pressure ulcers, while others have generally low quality of care as represented by low staffing and a high pressure ulcers. Therefore, when looking within state, the inverse relationship is generally lost, not only because of small sample size, but also because there is insufficient variation in staffing within states. A sensitivity analysis was conducted to test this explanation with no significant findings. There is some evidence for this explanation, however, with the result that states with above average pressure ulcers (compared with the US as a whole) had fewer average nurse aide hours than states with below average pressure ulcers (Appendix, Table B).

The national regression results for both staffing models (nurse aide staffing and total nurse staffing) support the validity of the models. This study found a strong association between resident mobility and pressure ulcers. In particular, we found a highly significant positive relationship between the percentage of bedfast residents and the percentage of residents with pressure ulcers. Further, this study found a highly significant negative relationship between the percentage of ambulatory residents and pressure ulcers. Additionally, the study found a strong negative association between resident dependence on staff for eating and toileting and pressure ulcers. These results, regarding the relationship between resident characteristics and pressure ulcers, make sense intuitively and are supported by the existing literature (Brandeis, 1990; Amella, 1999; Kayser-Jones et al., 1996, 1997; Kane, Ouslander, & Abrass, 1989).

The other variables in the model are facility characteristics. In both staffing models, a positive relationship was found between the total number of beds in a facility and the percentage of residents with pressure ulcers. Although this relationship was significant, it did not have as strong an association with pressure ulcers as many of the

other resident and facility characteristics. This result is, however, in accordance with previous studies that have found that smaller facilities are more likely to have good resident outcomes and less likely to have quality of care deficiencies (Rantz et al., 2004; Harrington et al., 2000). Larger facilities' resources may be overextended and hence result in compromised quality of care.

Two ownership variables were included in the model. Chain membership was found to be positively and significantly associated with pressure ulcers. This finding is concurrent with studies that have found a positive relationship between chain ownership and deficiencies (Harrington, 2002). The policies and practices of multi-facility organizations may be less flexible, more institutionalized and less personable than those of individually-owned facilities. Additionally, most chains are investor-owned, and investor-owned facilities may be more concerned with cost and therefore may not be as focused on quality of care. These are possible explanations for the positive association between chain membership and pressure ulcers.

The other ownership variable that was included was whether the facility was for-profit. Unlike several previous studies (Harrington et al., 2003; Nyman, 1988; O'Neill et al., 1998; Bliesmer et al., 1998), this study did not find a significant relationship between for-profit status and quality of care, as measured by pressure ulcers. Within this body of literature, however, there are inconsistent results. Although the majority of the studies find a negative relationship between for-profit status and quality, Bliesmer and colleagues (1998) found better resident outcomes among for-profit homes. Therefore, this variable requires further study.

The three other variables included in this study produced results that require further exploration. First, this study found an inverse relationship between the percentage of occupied beds in a facility and pressure ulcers. Typically, it is believed that higher occupancy rates create barriers to the access of care (USGAO, 1990). Higher occupancy could, however, be indicative of successful facilities that are able to attract and maintain high numbers of residents with good quality of care. Lower occupancy, on the other hand, could be associated with facilities that have unfavorable reputations for poor quality of care.

Finally, the last two variables in the model are policy-related: percentage of residents using Medicaid and percentage of residents using Medicare. This study did not find a significant relationship between Medicaid percentage and pressure ulcers. Previous studies have found that a higher percentage of Medicaid residents results in lower staffing (Nyman, 1988; Harrington, 2003); since Medicaid reimbursement rates are lower than those of Medicare and typically private payment, facilities with a greater proportion of Medicaid residents may have fewer resources. Our study looked at staffing directly and we find that, when staffing is controlled for, the Medicaid percentage does not independently influence the quality of patient care, as measured by pressure ulcers.

In contrast, this study found a highly significant positive association between the percentage of Medicare residents and pressure ulcers. One possible explanation for this finding is that most of the nursing home residents who are using Medicare are doing so because they have recently been treated in a hospital. The Medicare nursing home benefit is for relatively short-stay, typically post-hospital, recovery of health, rather than long-term care. (Evashwich, 1996) Often, pressure ulcer incidence is increased with a

hospital stay. Consequently, more Medicare residents may be associated with more residents who have incurred pressure ulcers while in the hospital.

The relationships between resident and facility characteristics and pressure ulcers seen at the national level also held for many states. Explanations for the state-level findings are potentially similar to the probable causes of the national results described above. In the majority of states, a negative, though not always significant, relationship was found between the percentage of ambulatory residents and pressure ulcers. Further, almost all states displayed a significant positive association between the percentage of bedfast residents and quality of care, as measured by pressure ulcers. The percentage of Medicare residents was also strongly positively associated with pressure ulcers in most states. The relationship between chain status and pressure ulcers, however, was not as strong at the state level as it was at the national level. Although the majority of states did produce a positive association between chain status and pressure ulcers, the relationship was rarely significant. As a whole, the resident and facility measures are more strongly associated with pressure ulcers at the national level than at the state level for the majority of states.

Our general finding of stronger relationships between patient outcomes and facility and patient characteristics is perhaps most pronounced for our focal measure, nurse aide staffing. Hence, an important conclusion is that there are larger differences across states with respect to quality and nurse aide staffing than within states. This conclusion suggests certain policy and management implications, as discussed below.

Policy Implications

First, the impact of nurse aide staffing on pressure ulcers should be recognized. Pressure ulcer prevention serves as an important indicator of quality of care and is highly visible to all stakeholders, including residents, their families, and regulators. (CMS, 2000) Typically, the procedures associated with ulcer prevention fall in the task requirements of nurse aides. The findings of this study suggest that the amount of time nurse aides are able to spend caring for residents influences the likelihood that residents contracting pressure ulcers. Therefore, more attention should be focused on the role of nurse aides.

The fact that there is variation among states with respect to the relationship between nurse aide staffing and pressure ulcers, which we have argued is consistent with a finding of variation across states in both staffing and patient outcomes, suggests that some states are doing a better job at regulating nursing home quality. While additional research is necessary to understand the specific nature of the regulatory approaches across states, our results suggest that CMS or another federal agency should work on achieving more uniformity in state survey procedures.

Currently, there are no federal standards for the appropriate level of nurse aides or hours. In addition, most states do not have specific nurse aide requirements. (CMS, 2000) Creating standards for nurse aide hours may prove futile, however, if facilities lack the resources to comply. Increasing funding for nursing home care would enable facilities to hire more nurse aides and to increase current nurse aide wages. Higher wages, in turn, will lead to decreased turnover (Harrington & Swan, 2003) and fewer hours spent training nurse aides and, consequently, more hours spent caring for residents.

Management/Organizational Implications

This study highlights the importance of nurse aide staffing for the care of pressure ulcers and calls for ways to improve quality of care. The results of this study support the general conclusion that higher nurse aid staffing reduces resident pressure ulcers. However, variation in the strength of the relation across states and the weak relationship in many states imply that there is much more that explains resident outcomes than the number of nurse aide resources and the other variables in the model. In particular, various aspects of nursing home management likely can facilitate improvements in quality of resident care. While the procedures for the prevention and treatment of pressure ulcers are well-established, managers should look for ways to facilitate the relationship between nurse aides and residents so that aides are able to provide the best possible care.

One approach is to focus on improving coordination and communication between all levels of personnel, but particularly in this case, among nurse aides and between nurse aides and their supervisors. Improving coordination and communication can be difficult; however, nursing homes should take advantage of the fact that they are able to manage their own in house training and adapt their methods of care to meet the needs of the facility and its resident population. (Harrington, 2000) Often, increased coordination and communication comes from fostering a positive and supportive working environment that has sets guidelines, but allows for flexibility. One can imagine that in such an environment, nurse aides help one another and cooperate to maximize the amount of time they are able to spend caring for residents.

While improvements in both continuity of care and productivity can flow from a focus on coordination and communication, there are other ways that management can effect such improvements. We mention several more here that arise from the general management literature and suggest additional research on nursing homes, as discussed below. One is the establishment of clear measures of organizational effectiveness which all members of the organization accept. This approach is sometimes referred to as using a balanced scorecard. Inclusion of specific resident outcomes, such as the rate of pressure ulcers, in a balanced scorecard can focus management decisions, such as aide staffing levels, and management processes, such as the identification of methods to increase aide productivity. (Kaplan & Norton, 1996)

A second approach is to manage performance through motivation. There are several ways managers can help motivate employees. First, management should help employees see the importance of their tasks to the organization and the resident population. In addition, employees need to be given sufficient autonomy in order to feel a sense of responsibility and ownership towards their jobs. Finally, it is important that managers provide employees with adequate and timely feedback about their performance. Along with these steps, managers can also increase motivation through the use of incentives, such as rewards. Aside from monetary rewards that may not always be available, rewards can include public recognition or honors for work well done. Essentially, managers have the ability to influence motivation, and consequently, performance. (Nahavandi & Malekzadeh, 1999)

Our final suggestion alluded to above, is to develop an organizational culture of patient care excellence. Although difficult to build, an organizational culture of shared

norms, values, and practices can be a very potent means of achieving organizational goals. We suspect such a culture is in place in many organizations but not in others. Variation along this dimension probably weakens the observed relationship between staffing and outcomes; i.e., organizations with a culture of resident care excellence may not need as rich a staff complement to produce good outcomes as those without such a culture. We need to know more about how organizational culture applies within the context of the nursing home.

A defining characteristic of the nursing home is that it is an organization where we entrust the care of frail individuals to workers near the bottom of national pay scales. Nurse aides are among the lowest paid workers we have. While this research has shown that more nurse aides improve resident outcomes, we suspect that the approach management takes to nurse aides is an even more important determinant of resident care outcomes.

Limitations and Future Research

Despite the comprehensiveness of the OSCAR data, there are no variables that represent differences in education levels, capability, or experience of the staff (Harrington, 2000) when these factors may be just as important, if not more important, than staffing hours. Additionally, as discussed above, the relationships between individual nursing staff members and other aspects of the culture of the facility may be important factors influencing the quality of care. Future research might explore ways of analyzing and quantifying these variables.

Another issue is whether pressure ulcers are an adequate representation of quality as presented in this study. Unfortunately, this study was unable to examine the incidence of pressure ulcers within facilities over a certain time period. Also, due to the way the data is collected, we cannot be sure that pressure ulcer prevalence as indicated by the OSCAR data is representative of the nursing home's care or a result of prior hospital care. Therefore, this study may overestimate the number of pressure ulcers that are contracted by residents while in the care of nursing facilities. Future studies should continue to examine the relationship between staffing and quality, focusing on the organization of care within nursing facilities, in an attempt to provide society with tools for better caring.

The rather speculative nature of the management implications drawn above suggest that the nursing home presents several opportunities for future organizational research. We need to know more about how best to organize the work of the nursing home staff in general, to promote both efficiencies and improvements in care outcomes. The role of organizational culture and the effectiveness of well-developed and deployed organizational goals systems, in the context of a low-paid workforce, can be explored with the nursing home as the research focus.

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Table 1. Means and Standard Deviations for Dependent and Independent Variables for 2000

Characteristic and Variable	Mean	Standard Deviation
Pressure ulcers (per resident)	0.07	0.06
Nurse aide staff (hours per resident day)	2.12	1.28
Total nursing staff (hours per resident day)	3.21	1.47
Resident Characteristics		
percent of bedfast residents	0.05	0.07
percent of ambulatory residents	0.17	0.14
percent eating dependent	0.19	0.11
percent toilet dependent	0.35	0.16
Facility Characteristics		
total beds	111.03	72.14
percent of occupied beds	0.83	0.16
percent Medicaid	0.65	0.24
percent Medicare	0.10	0.17
chain (yes = 1)	0.56	0.50
for-profit (yes = 1)	0.02	0.12

Table 2. Regression results for the relationship between nurses aide staffing, pressure ulcers, and resident and facility characteristics for the United States as a whole.

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	11	2685.22	244.11	300.41	<.0001
Error	14269	11595	0.81		
Corrected Total	14280	14280			
Root MSE	0.90144	R-Square	0.19		
Dependent Mean	3.92E-15	Adj R-Sq	0.19		
Coeff Var	2.30E+16				

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > t
Intercept	1	9.46E-16	0.008	0	1
Nurse aide staffing	1	-0.024	0.008	-3.09	0.002
Resident Characteristics					
bedfast residents	1	0.162	0.008	19.71	<.0001
ambulatory residents	1	-0.095	0.008	-11.52	<.0001
eating dependent	1	0.073	0.011	6.74	<.0001
toilet dependent	1	0.061	0.011	5.7	<.0001
Facility Characteristics					
total beds	1	0.023	0.008	2.95	0.003
occupied beds	1	-0.079	0.008	-10.1	<.0001
% Medicaid	1	-0.005	0.01	-0.55	0.5842
% Medicare	1	0.291	0.01	29.93	<.0001
chain	1	0.03	0.008	3.86	0.0001
for-profit	1	0.005	0.008	0.66	0.508

Table 3. Regression results for the relationship between total nurse staffing, pressure ulcers, resident and facility characteristics for the United States as a whole.

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	11	2677.66	243.42	299.37	<.0001
Error	14269	11602	0.813		
Corrected Total	14280	14280			
Root MSE	0.902	R-Square	0.19		
Dependent Mean	3.92E-15	Adj R-Sq	0.19		
Coeff Var	2.30E+16				

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > t
Intercept	1	1.16E-15	0.008	0	1
Total nurse staffing	1	0.004	0.008	0.51	0.608
Resident Characteristics					
bedfast residents	1	0.163	0.008	19.75	<.0001
ambulatory residents	1	-0.093	0.008	-11.32	<.0001
eating dependent	1	0.071	0.011	6.49	<.0001
toilet dependent	1	0.061	0.011	5.64	<.0001
Facility Characteristics					
total beds	1	0.023	0.008	3.01	0.003
occupied beds	1	-0.08	0.008	-9.54	<.0001
% Medicaid	1	-0.003	0.01	-0.3	0.767
% Medicare	1	0.289	0.01	29.04	<.0001
chain	1	0.031	0.008	4.09	<.0001
for-profit	1	0.005	0.008	0.61	0.545

Table 4. Summary of the key regression results by state for pressure ulcers (nurse aide staffing)

	Nurse Aide Staffing		Ambulatory		Medicare		Chain		R^2	N
		SE		SE		SE		SE		
AL	-0.07	0.06	-0.05	0.06	0.25**	0.1	0.07	0.06	0.48	183
AR	0.02	0.07	-0.13*	0.07	0.04	0.12	-0.07	0.07	0.11	234
AZ	-0.10	0.11	-0.09	0.09	0.42***	0.13	-0.03	0.09	0.16	123
CA	-0.09***	0.03	-0.23***	0.03	0.16***	0.03	0.01	0.03	0.23	1038
CO	-0.02	0.07	-0.17**	0.07	0.10	0.09	0.15**	0.07	0.25	191
CT	0.02	0.07	-0.26***	0.07	0.13	0.08	0.03	0.06	0.15	240
DE	-0.09	0.21	-0.27	0.18	0.29	0.21	0.15	0.2	0.40	35
FL	0.09**	0.04	-0.14***	0.04	0.38***	0.05	0.0	0.04	0.21	639
GA	-0.11*	0.06	-0.11*	0.06	0.01	0.08	-0.04	0.06	0.10	316
HI	0.06	0.21	-0.11	0.26	0.02	0.24	-0.09	0.22	0.36	31
IA	0.09*	0.05	-0.09*	0.05	0.21***	0.06	0.07	0.05	0.19	377
ID	-0.07	0.10	-0.16	0.10	0.54***	0.13	0.02	0.11	0.54	65
IL	-0.09**	0.04	-0.14***	0.04	0.35***	0.05	0.04	0.03	0.27	766
IN	-0.04	0.05	-0.17***	0.04	0.37***	0.06	-0.07	0.04	0.16	497
KS	-0.02	0.05	-0.15***	0.05	0.27***	0.06	-0.05	0.05	0.21	354
KY	-0.02	0.06	-0.10	0.06	0.30***	0.09	0.02	0.06	0.19	244
LA	0.02	0.05	-0.15**	0.06	0.43***	0.1	-0.04	0.05	0.32	294
MA	0.13***	0.05	-0.10**	0.05	0.15**	0.07	0.10**	0.05	0.19	456
MD	0	0.07	0.01	0.07	0.28***	0.08	0.22***	0.07	0.14	219
ME	0.04	0.10	-0.06	0.11	0.36**	0.15	0.2*	0.1	0.16	107
MI	-0.05	0.04	0.01	0.04	0.41***	0.06	0.04	0.04	0.33	418
MN	0.16***	0.06	-0.07	0.06	0.15***	0.06	0.04	0.05	0.18	387
MO	-0.03	0.04	-0.08*	0.04	0.22***	0.06	0.06	0.04	0.19	484
MS	0.11	0.08	0.07	0.08	0.26**	0.11	0	0.07	0.28	162
MT	0.08	0.13	0.23	0.12	0.26*	0.15	-0.02	0.15	0.23	80
NC	0.02	0.05	-0.07	0.05	0.33***	0.06	-0.02	0.05	0.18	371
ND	-0.24	0.15	-0.09	0.12	0.05	0.17	-0.3**	0.12	0.19	79
NE	-0.08	0.07	0.02	0.06	0.53***	0.07	-0.02	0.06	0.42	184
NH	-0.06	0.14	-0.08	0.10	0.57***	0.16	-1	0.15	0.51	68
NJ	0.04	0.05	-0.13**	0.06	0.46***	0.07	0.03	0.05	0.21	301
NM	-0.02	0.13	-0.16	0.14	-0.19	0.14	0.07	0.13	0.31	63
NV	-0.08	0.18	-0.44**	0.18	-0.12	0.23	-0.21	0.17	0.36	39
NY	0.07	0.04	-0.21***	0.05	0.22***	0.05	0.03	0.04	0.13	557
OH	0.05	0.03	-0.10***	0.04	0.24***	0.05	-0.02	0.03	0.14	812
OK	0.0	0.06	-0.05	0.06	0.28***	0.08	0.11*	0.06	0.10	272
OR	-0.02	0.08	-0.16*	0.09	0.16*	0.1	-0.06	0.09	0.13	142
PA	-0.03	0.04	-0.08**	0.04	0.29***	0.05	0.06	0.04	0.16	678
RI	-0.08	0.10	-0.11	0.12	0.25	0.16	-0.12	0.11	0.34	84
SC	-0.09	0.09	-0.01	0.08	0.36***	0.12	-0.03	0.08	0.18	150
SD	0.13	0.10	-0.2*	0.10	0.11	0.11	0.07	0.1	0.21	106
TN	-0.01	0.05	-0.04	0.06	0.61***	0.09	0.01	0.05	0.32	293
TX	-0.04	0.03	-0.06**	0.03	0.28***	0.05	0.04	0.03	0.20	943
UT	0.29***	0.11	-0.03	0.11	-0.02	0.18	0.23**	0.1	0.49	78
VA	0.02	0.06	-0.02	0.06	0.45***	0.06	0.01	0.06	0.27	246
VT	-0.08	0.17	0.02	0.18	0.34	0.23	-0.56***	0.18	0.32	41
WA	-0.02	0.06	-0.03	0.06	-0.0	0.08	0.03	0.06	0.12	249
WI	-0.10*	0.05	-0.11**	0.05	0.19***	0.06	0.07	0.05	0.13	382

WV	-0.12	0.08	-0.16*	0.08	0.74***	0.19	-0.04	0.08	0.45	121
WY	0.00	0.18	-0.44**	0.20	-0.19	0.22	0.24	0.24	0.37	33

* p<.1

SE = standard error

** p<.05

*** p<.01

Table 5. Summary of the key regression results by state for pressure ulcers (total nurse staffing)

	Total Staffing	SE	Ambulatory	SE	Medicare	SE	Chain	SE	R^2	N
AL	-0.04	0.06	-0.05	0.06	0.26***	0.1	0.08	0.06	0.48	183
AR	0.08	0.08	-0.13*	0.07	0.0	0.13	-0.06	0.07	0.11	234
AZ	-0.03	0.13	-0.09	0.09	0.39***	0.14	-0.02	0.09	0.16	123
CA	-0.05	0.03	-0.23***	0.03	0.17***	0.04	0.02	0.03	0.23	1038
CO	-0.01	0.09	-0.17**	0.07	0.11	0.10	0.16**	0.07	0.25	191
CT	0.03	0.07	-0.26***	0.07	0.13	0.08	0.03	0.06	0.15	240
DE	-0.22	0.21	-0.30	0.18	0.27	0.21	0.11	0.20	0.43	35
FL	0.12***	0.04	-0.14***	0.04	0.34***	0.05	0.0	0.04	0.21	639
GA	-0.19***	0.07	-0.11**	0.06	0.06	0.08	-0.05	0.06	0.11	316
HI	0.10	0.26	-0.14	0.29	0.02	0.24	-0.13	0.25	0.36	31
IA	0.11*	0.06	-0.09*	0.05	0.18***	0.07	0.07	0.05	0.19	377
ID	-0.01	0.10	-0.17*	0.1	0.53***	0.13	0.04	0.11	0.53	65
IL	-0.06	0.04	-0.14***	0.04	0.35***	0.05	0.04	0.03	0.26	766
IN	-0.03	0.06	-0.17***	0.04	0.38***	0.07	-0.07	0.04	0.16	497
KS	-0.07	0.06	-0.15***	0.05	0.30***	0.07	-0.06	0.05	0.21	354
KY	0.02	0.08	-0.10	0.06	0.30***	0.09	0.03	0.06	0.19	244
LA	0.12*	0.07	-0.14**	0.06	0.39***	0.10	-0.03	0.05	0.33	294
MA	0.24***	0.06	-0.08*	0.05	0.08	0.07	0.11**	0.05	0.21	456
MD	0.04	0.08	0.01	0.07	0.26***	0.09	0.22***	0.07	0.14	219
ME	0.08	0.10	-0.06	0.11	0.33**	0.15	0.20**	0.10	0.16	107
MI	0.02	0.05	0.00	0.04	0.40***	0.06	0.06	0.04	0.33	418
MN	0.19***	0.60	-0.07	0.05	0.12**	0.06	0.05	0.05	0.19	387
MO	-0.01	0.04	-0.08*	0.04	0.22***	0.06	0.06	0.04	0.19	484
MS	0.26***	0.09	0.06	0.08	0.14	0.12	0.04	0.07	0.30	162
MT	0.14	0.15	0.24**	0.12	0.23	0.15	0.0	0.15	0.23	80
NC	0.05	0.06	-0.07	0.05	0.33***	0.06	-0.02	0.05	0.18	371
ND	-0.42**	0.20	-0.13	0.12	0.37*	0.20	-0.35***	0.13	0.21	79
NE	-0.03	0.08	0.02	0.06	0.53***	0.07	-0.01	0.06	0.42	184
NH	-0.05	0.12	-0.08	0.10	0.57***	0.16	-0.10	0.15	0.51	68
NJ	0.08	0.06	-0.13**	0.06	0.45***	0.07	0.03	0.05	0.21	301
NM	0.14	0.14	-0.12	0.14	-0.18	0.14	0.08	0.12	0.32	63
NV	-0.19	0.21	-0.45**	0.17	0.05	0.23	-0.22	0.17	0.38	39
NY	0.12***	0.04	-0.21***	0.04	0.22***	0.05	0.02	0.04	0.14	557
OH	0.10**	0.04	-0.09***	0.03	0.22***	0.05	-0.02	0.03	0.14	812
OK	0.04	0.07	-0.05	0.06	0.27***	0.08	0.11	0.06	0.10	272
OR	0.01	0.09	-0.15*	0.09	0.16	0.1	-0.06	0.09	0.13	142
PA	0.03	0.04	-0.08**	0.04	0.29***	0.05	0.07*	0.04	0.16	678
RI	0.0	0.11	-0.10	0.12	0.25	0.16	-0.11	0.11	0.34	84
SC	-0.09	0.12	-0.01	0.08	0.41***	0.12	-0.03	0.08	0.17	150
SD	0.14	0.10	-0.20*	0.1	0.09	0.11	0.08	0.10	0.21	106
TN	0.02	0.06	-0.04	0.06	0.60***	0.1	0.02	0.05	0.32	293

TX	-0.01	0.04	-0.06**	0.03	0.27***	0.05	0.04	0.03	0.19	943
UT	0.36**	0.17	-0.05	0.11	-0.15	0.19	0.24**	0.10	0.46	78
VA	-0.01	0.07	-0.02	0.06	0.45***	0.06	0.01	0.06	0.27	246
VT	-0.08	0.19	0.02	0.18	0.35	0.23	-0.56***	0.18	0.32	41
WA	-0.01	0.07	-0.03	0.06	-0.0	0.03	0.03	0.06	0.11	249
WI	-0.05	0.05	-0.11	0.05	0.19***	0.06	0.08	0.05	0.13	382
WV	0.02	0.09	-0.18**	0.08	0.75***	0.20	-0.02	0.08	0.44	121
WY	0.0	0.18	-0.44**	0.20	-0.19	0.21	0.24	0.24	0.37	33

Table 6. Regression results for the relationship between nurse aide hours and pressure ulcers, grouped by significance

Negative and significant	Negative and not significant	Positive
California	Alabama	Arizona
Georgia	Arizona	Connecticut
Illinois	Colorado	Florida
Wisconsin	Delaware	Hawaii
	Idaho	Iowa
	Indiana	Louisiana
	Kansas	Massachusetts
	Kentucky	Maryland
	Michigan	Maine
	Missouri	Minnesota
	North Dakota	Mississippi
	Nebraska	Montana
	New Hampshire	North Carolina
	Nevada	New Jersey
	Oregon	New York
	Pennsylvania	Ohio
	Rhode Island	Oklahoma
	South Carolina	South Dakota
	Tennessee	Utah
	Texas	Virginia
	Vermont	Wyoming
	Washington	
	West Virginia	

Table 7. Regression results for the relationship between total nursing hours and pressure ulcers, grouped by significance.

Negative and significant	Negative and not significant	Positive
Georgia	Alabama	Arkansas
North Dakota	Arizona	Connecticut
	Colorado	Florida
	Delaware	Hawaii
	Idaho	Iowa
	Illinois	Kentucky
	Indiana	Louisiana
	Kansas	Maine
	Missouri	Massachusetts
	Nebraska	Michigan
	New Hampshire	Minnesota
	Nevada	Mississippi
	South Carolina	Montana

Texas
Virginia
Vermont
Washington
Wisconsin

New Jersey
New Mexico
New York
North Carolina
Ohio
Oklahoma
Oregon
Pennsylvania
Rhode Island
South Dakota
Tennessee
Utah
West Virginia
Wyoming

Appendix

Table A: Average pressure ulcers per resident and nurse aide hours per resident day, by state

	Pressure Ulcers	Nurse Aide Hours
USA	0.07	2.12
AL	0.067	2.34
AR	0.076	1.88
AZ	0.077	2.11
CA	0.088	2.69
CO	0.059	1.84
CT	0.049	2.18
DE	0.081	2.36
FL	0.081	2.08
GA	0.074	1.99
HI	0.059	2.45
IA	0.04	1.73
ID	0.049	2.48
IL	0.07	1.93
IN	0.072	1.56
KS	0.049	1.7
KY	0.073	2.07
LA	0.089	1.81
MA	0.06	2.13
MD	0.082	2.19
ME	0.061	2.57
MI	0.066	2.25
MN	0.04	1.89
MO	0.064	3.85
MS	0.077	2.05
MT	0.037	2.29
NC	0.087	2.32
ND	0.031	2.29
NE	0.042	2.05
NH	0.043	2.33
NJ	0.084	1.97
NM	0.07	2.12
NV	0.071	1.77
NY	0.069	2.02
OH	0.063	2.08
OK	0.086	1.52
OR	0.072	2.06
PA	0.08	2.05
RI	0.06	2.38
SC	0.079	2.17
SD	0.047	1.95
TN	0.075	1.88
TX	0.08	1.87
UT	0.063	1.94
VA	0.081	2.12
VT	0.058	2.09
WA	0.074	2.41
WI	0.05	2.14
WV	0.089	2.06
WY	0.053	2.26

Table B: Comparison of average pressure ulcers and average nurse aide hours between states with average pressure ulcers greater than the US average and states with average pressure ulcers less than the US average.

Below Average Pressure Ulcers			Above Average Pressure Ulcers		
	Pressure Ulcers	Nurse Aide Hours		Pressure Ulcers	Nurse Aide Hours
AL	0.067	2.34	AR	0.076	1.88
CO	0.059	1.84	AZ	0.077	2.11
CT	0.049	2.18	CA	0.088	2.69
HI	0.059	2.45	DE	0.081	2.36
IA	0.04	1.73	FL	0.081	2.08
ID	0.049	2.48	GA	0.074	1.99
KS	0.049	1.7	IN	0.072	1.56
MA	0.06	2.13	KY	0.073	2.07
ME	0.061	2.57	LA	0.089	1.81
MN	0.04	1.89	MD	0.082	2.19
MO	0.064	3.85	MS	0.077	2.05
MT	0.037	2.29	NC	0.087	2.32
ND	0.031	2.29	NJ	0.084	1.97
NE	0.042	2.05	NV	0.071	1.77
NH	0.043	2.33	OK	0.086	1.52
NY	0.069	2.02	OR	0.072	2.06
OH	0.063	2.08	PA	0.08	2.05
RI	0.06	2.38	SC	0.079	2.17
SD	0.047	1.95	TN	0.075	1.88
UT	0.063	1.94	TX	0.08	1.87
VT	0.058	2.09	VA	0.081	2.12
WI	0.05	2.14	WA	0.074	2.41
WY	0.053	2.26	WV	0.089	2.06
Average	0.053	2.217	Average	0.079	2.043
SD	0.010	0.426	SD	0.006	0.262

SD PU

0.056
0.057
0.045
0.054
0.073
0.049
0.03
0.051
0.055
0.043
0.051
0.049
0.048
0.06
0.049
0.047
0.047
0.067
0.043
0.07
0.046
0.046
0.033
0.059
0.057
0.034
0.058
0.028
0.055
0.035
0.049
0.039
0.043
0.041
0.044
0.087
0.047
0.055
0.053
0.05
0.033
0.058
0.066
0.044
0.053
0.035
0.066
0.036

0.066

0.026