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Effects of Hospital Care Environment on Patient Mortality and Nurse Outcomes

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Abstract

Objective—The objective of this study was to analyze the net effects of nurse practice environments on nurse and patient outcomes after accounting for nurse staffing and education.

Background—Staffing and education have well-documented associations with patient outcomes, but evidence on the effect of care environments on outcomes has been more limited.

Methods—Data from 10,184 nurses and 232,342 surgical patients in 168 Pennsylvania hospitals were analyzed. Care environments were measured using the practice environment scales of the Nursing Work Index. Outcomes included nurse job satisfaction, burnout, intent to leave, and reports of quality of care, as well as mortality and failure to rescue in patients.

Results—Nurses reported more positive job experiences and fewer concerns with care quality, and patients had significantly lower risks of death and failure to rescue in hospitals with better care environments.

Conclusion—Care environment elements must be optimized alongside nurse staffing and education to achieve high quality of care.

A recent systematic review of research on the link between nurse staffing and patient outcomes in hospitals commissioned by the Agency of Healthcare Quality and Research concluded that a strong evidence base connects better nurse staffing to better outcomes.[1] Three large recent studies show that better-educated hospital nurse workforces are associated with lower patient mortality.[2-4] Research on magnet hospitals consistently demonstrates links between better care environments and superior nurse and patient outcomes.[5-7] General reviews of the literature support the case that better nurse care environments are associated with better patient outcomes,[8] but definitive evidence has been lacking.[9] Skepticism remains among some stakeholders about whether nurse practice environments actually have a significant net impact on patient outcomes after patient-to-nurse staffing ratios are taken into account. This debate is practical as well as academic because it concerns the options available to nurse leaders for improving nurse retention and patient outcomes.

The purpose of this article was to empirically examine whether better hospital nurse care environments are associated with lower patient mortality and better nurse outcomes independently of nurse staffing and the education of the registered nurse (RN) workforce in hospitals. We also provide the first empirical evidence that the practice environment scale of the Nursing Work Index (PES-NWI),[10,11] the measure selected as the National Quality

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Forum's standard for measuring hospital care environments, is associated with patient outcomes.

Methods

The project that generated the data analyzed here combined hospital characteristics, patient outcomes, and surveys of nurses involved in direct care in a population of 168 hospitals. The study was unique because it included consistently collected survey data regarding the quality of nurse practice environments in hospitals unavailable in any other data source. Furthermore, the inclusive sampling design did not allow hospitals to selectively opt out, which strengthens the generalizability of its results.[12] The study protocol was approved by the institutional review board of the University of Pennsylvania.

Samples

Hospitals

The hospitals studied included 168 (80%) of the 210 adult acute care hospitals in Pennsylvania in 1999. Our hospital sample was representative of all hospitals providing surgical care that employed a minimum of 40 nurses in this large state. We included all hospitals that (1) reported 100 or more surgical discharges of the specific types under study to the Pennsylvania Health Care Cost Containment Council, (2) had structural characteristics reported in the American Hospital Association Annual Survey or Pennsylvania Department of Health Hospital Questionnaire,[13,14] and (3) had sufficient nurse respondents to produce reliable estimates of survey-derived aggregate variables such as the care environment. An average of 60 nurse respondents from each hospital completed questionnaires; half of the sample hospitals had more than 50 nurse respondents, and more than 80% of the hospitals had more than 25 nurse respondents.

Nurses

A 50% random sample of RNs residing in and registered to practice in Pennsylvania received questionnaires at their homes in the spring of 1999. Responses from nurses about the hospitals where they work are aggregated to the hospital level and linked with patient mortality data. Surveys were completed by more than 40,000 nurses (52% of the nurses receiving the survey), including some who are working in places other than hospitals and some who are not working at all. The 52% response rate to the survey compares favorably to other voluntary, anonymous surveys of health professionals,[15] and the sampling fraction of 50% created a large database, very unusual in survey research where samples of 1,500 are routinely used to generate national estimates. Our sample of hospital nurses used in this study had similar demographics with that of the sample of Pennsylvania hospital nurses in the National Sample Survey of Registered Nurses with respect to age, working status, and education.[16,17]

Patients

Outcomes for 232,342 patients aged 20 to 85 years, who underwent general surgical, orthopedic, or vascular procedures from April 1, 1998, to November 30, 1999, in the 168 hospitals, with discharge abstract data from the Pennsylvania Health Care Cost Containment Council were analyzed. The targeted diagnosis-related groups are described elsewhere.[16] The study was limited to patients with common surgical procedures because most hospitals perform these procedures, and risk adjustment for surgical outcomes is better developed than that for medical conditions.

Measures

Hospital Structural Characteristics

The 1999 American Hospital Association Annual Survey and the 1999 Pennsylvania Department of Health Hospital Survey provided data on hospital characteristics used as control variables. Three size categories (≤100, 101-250, and ≥251 beds) were used. Hospitals without postgraduate medical residents or fellows (nonteaching) were distinguished from those with 1:4 or smaller trainee-to-bed ratios and ratios higher than 1:4 (minor and major teaching facilities, respectively). High (vs low)-technology hospitals were those that had facilities for either open-heart surgery, major organ transplants, or both.

Hospital-Level Measures Derived From Nurse Surveys

Staffing and Education—Nurse staffing was measured as the mean number of patients assigned to staff nurses who reported caring for at least one, but less than 20, patients on their last shift. The educational composition of each hospital's nurse workforce was measured by the percentage of staff nurses holding bachelor's degrees or higher nursing credentials.

Patient Care Environments—The measure of the patient care environment was based on the PES-NWI.[11] Three of 5 PES-NWI subscales that did not overlap empirically with direct staffing and nurse education measures were analyzed: nursing foundations for quality of care (dealing primarily with issues of staff development and quality management); nurse manager ability, leadership, and support; and collegial nurse/physician relations. All 3 of these subscales have favorable psychometric properties. Subscale scores were calculated for each hospital, taking the mean values of all items comprising the subscale for all nurses in each hospital, and statewide hospital-level medians were then computed for each subscale. Table 1 lists characteristics of the 3 subscales and the distribution of their hospital-level scores in the current data set. Hospitals above the median on all 3 subscales, on 1 or 2 subscales, and on none of the subscales were classified as having “better,” “mixed,” and “poor” care environments, respectively

Nurse Job Outcomes and Nurse-Rated Quality of Care

Six nurse survey measures which were analyzed included job satisfaction, burnout, and intent to leave their jobs within the next year and 3 questions related to nurses' perceptions on quality of care. Burnout was measured using the 9-item emotional exhaustion subscale of the Maslach Burnout Inventory, a widely used standardized tool.[18] Cronbach α for this subscale in the current data set was .92. Scores of 27 or above were considered indicative of high burnout, consistent with published norms for health professionals in the Maslach Burnout Inventory manual.

Surgical Patient Outcomes and Characteristics

Patient deaths within 30 days of hospital admission and deaths within 30 days of admission among patients with complications, also called failure to rescue, were analyzed.[19] International Classification of Diseases, Ninth Revision, Clinical Modification codes in the secondary diagnosis and procedure fields of discharge abstracts were scanned for evidence of 39 clinical events suggestive of complications rather than comorbidities. The board certification status of the operating surgeons of record was determined using linkages to the American Board of Medical Specialties directory for use as a control variable in the outcomes analyses.

Differences across hospitals in patients' baseline (underlying) risks of mortality were taken into account by controlling for 133 variables that were predictive of mortality and failure to rescue in the present data set, including age, sex, and whether the patient was transferred from

another hospital or admitted emergently; 48 dummy variables that indicated the surgery type; 28 dummy variables that indicated the absence or presence of chronic preexisting conditions as classified by the International Classification of Diseases, Ninth Revision, Clinical Modification codes; and interaction terms. The *C* statistics for the mortality risk adjustment model was .89, and that for the failure-to-rescue model was .81.

Results

Using the median cutoffs for hospital-level scores shown in Table 1, of the 168 hospitals, 43 (26%) were in the poor environment category, 83 (49%) were in the mixed category, and 42 were in the better category. In terms of structure, 19% were large (more than 500 beds), 36% were teaching hospitals, and 28% were high-technology hospitals offering open-heart surgery, major organ transplants, or both. The average hospital-level staffing was 5.7 patients per nurse, although staffing was lower in hospitals with poor care environments (6.0) than in hospitals with mixed and better environments (5.8 and 5.3, respectively—poor and mixed environments were significantly different from best, $P = .02$ and $P = .03$, respectively, by Scheffé post hoc tests). The mean proportion of nurses with bachelor of science in nursing (BSN) degrees was 31% overall and was lower in the hospitals with poor and mixed care environments (29% and 30%, respectively) than in hospitals with better environments (35%); however, these were only marginally significantly different ($P < .10$). Overall, 2% of the surgical patients died within 30 days of admission, as did 8% of those who developed complications (ie, 8% of the patients at risk experienced failure to rescue).

Table 2 shows the distribution of nurse characteristics and nurse reports overall and across the 3 categories of hospitals by type of practice environment. Overall, 6% of the 10,184 nurses in our sample were men, the average age was 40 years, and the average number of years working as a nurse was approximately 14 years. Approximately 1 of 3 nurses (31%) worked on medical/surgical units, and 18% worked on intensive care units. Forty percent of the nurses had bachelor's degrees or higher, 35% held diplomas, and 25 had associate degrees as their highest credentials in nursing. Breaking down the nurses by type of hospitals, higher percentages of the nurses in hospitals with poor care environments reported high burnout levels and dissatisfaction with their jobs. The percentage of nurses who reported that the quality of care was poor or fair (rather than good or excellent) was twice as high in hospitals with poor care environments as in hospitals with better ones. A similar pattern was observed with respect to the likelihood of nurses lacking confidence that patient care problems would be resolved by management and that their patients were able to manage their own care at discharge. Higher proportions of those in the hospitals with poor and mixed environments were unwilling to recommend their hospital to a family member.

Table 3 shows the results of the modeling of the effects of better versus mixed or mixed versus poor care environments on nurse outcomes and nurse reports of quality of care, controlling for nurse characteristics and the clustering of patients within hospitals. The effects of care environments were first analyzed separately and then jointly. The care environment and nurse staffing had significant effects on burnout and job dissatisfaction, although only the care environment had a significant effect on intentions to leave. The coefficients in the right panel of Table 3 imply that in fully adjusted models (where care environments and staffing are entered together), the odds of nurses being burned out, being dissatisfied with their jobs, and intending to leave were lower by 24% (ie, (1-0.76) × 100), 25%, and 13% in hospitals in the mixed category relative to the poor category and in the better category relative to the mixed one. The results of the logistic regression models used here allow us to determine the effect of moving from better to poor staffing by squaring the odds ratios. Therefore, nurses working in the hospitals with better care environments have odds on experiencing these deleterious outcomes, which were 24% (ie, $(1-0.87^2) \times 100$) to 42% lower than the odds for nurses working in the

hospitals with the poor environments. In addition, even after controlling for the effects of care environments, the odds of nurses reporting high burnout or dissatisfaction increased by roughly one-fifth and one-tenth, respectively, with each increase of 1 patient per nurse in mean workloads in their hospitals. Nurses in hospitals with better care environments were also much less likely to provide negative assessments of the care in their hospitals. The odds on nurses reporting concerns with patient care quality were between 42% and 69% lower in hospitals with better care environments than in hospitals with poor ones.

Finally, Table 4 shows that care environments, nurse staffing, and nurse education were associated with 30-day mortality and failure to rescue, both individually and jointly, in models controlling for patient and hospital characteristics (in the case of the effect of the care environment on failure to rescue, the association was marginally significant, $P = .06$). In the final model, taking all patient and nursing factors into consideration, the likelihood of patients dying within 30 days of admission was 14% lower in hospitals with better care environments than in hospitals with poor care environments (ie, $(1\text{-}0.93^2) \times 100$). The odds on patients dying in hospitals with better care environments were lower by 14% than in hospitals with poor ones. The odds on patients dying in hospitals with an average workload of 8 patients per nurse is 1.26 times greater than in hospitals with mean workloads of 4 patients per nurse. The odds ratio of 0.96 associated with nurse education indicates that each 10% increase in the proportion of nurses with BSN was associated with a 4% decrease in risk of death. By extension, the odds of patients dying in hospitals in which 60% of the nurses held BSN versus hospitals in which 20% (or 40% fewer) of the nurses were BSN prepared would be lower by 15% (ie, $(1\text{-}0.96^4) \times 100$).

Direct standardization methods were used to express the effects of the care environment, nurses' education, and nurse staffing together in terms of extrapolated death and failure-to-rescue rates under various hypothetical conditions. The “average” hospital had a mixed care environment, a 6:1 ratio of patients to nurses, and a nursing staff that consisted of 30% BSN-prepared nurses. Overall, the 30-day mortality rate for general surgical patients was 19.5 per 1,000 admissions, and 84.4 per 1,000 surgical patients with complications died within 30 days of admission. Our models imply that if all hospitals had better care environments, a 4:1 patient-to-nurse ratio, and 60% BSN-prepared staff nurses, the overall mortality rate would have been 15.6 per 1,000 admissions, and the failure-to-rescue rate would be 68.2 per 1,000. Under the worst case scenario (a poor care environment, 8:1 patient-to-nurse ratio, and 20% BSN-prepared staff nurses), the mortality rate would have been 25.1 per 1,000 admissions, and the failure-to-rescue rate would be 105.9 per 1,000. All else being equal, hospitals that ranked poorly on all 3 factors had mortality rates and failure-to-rescue rates that were 61% and 55% higher, respectively, than hospitals that ranked high on all 3.

Discussion

Surgical mortality rates were more than 60% higher in poorly staffed hospitals with the poorest patient care environments than in hospitals with the better care environments in the sample, the best nurse staffing levels, and the most highly educated nurses. Using death rates under the existing distribution of patients across hospitals with different care environments and nurse education and staffing levels, assuming an ideal situation where all 3 of these factors were above their current averages for all hospitals, and extrapolating our direct standardization results to patients across the United States, it seems reasonable to assume that the actual number of patient deaths that could be averted annually by improved care environments, nurse staffing, and nurse education is somewhere in the range of 40,000 per year.

Our estimates of numbers of lives that might be saved through improved care environments are meant to be rough estimates and should be interpreted cautiously. This study shares a

limitation with many health services research projects based on cross-sectional data. Longitudinal data, as well as the inclusion of other variables related to competing explanations for the findings, would help to establish causal links between better care environments and more favorable patient and nurse outcomes. The data were drawn from a comprehensive study of hospitals in a large state and replication in additional states or nationally would be informative. Although the data are from 1999, there are no more recent data of comparable scope. Moreover, the nature of the relationships between the study variables transcends any recent or short-term trends in healthcare; otherwise, the problems we studied would have been solved by now, which is unfortunately not the case.[20]

The analyses reported here suggest that nurse leaders have at least 3 major options for improving nurse retention and patient outcomes: improving RN staffing, moving to a more educated nurse workforce, and improving the care environment. The best present example of care environments that support professional nurse practice are magnet hospitals.[21,7] Emerging research demonstrates that hospitals that implement the blue print for American Nurses Credentialing Center Magnet designation achieve significant improvements in their practice environments.[22] In this study, we are able to demonstrate that hospitals with even some of the features of magnet hospitals (investments in staff development, quality management, frontline manager supervisory ability, and good relations with physicians) are associated with better nurse and patient outcomes. Our findings show that each of the 3 options for improving outcomes—improving nurse staffing, education, and the care environment—contributes independently to better patient outcomes, and maximizing all 3 would seem to hold the greatest promise for achieving the best outcomes.

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Table 1

Properties of the Hospital-Level Practice Environment Scale of the Nursing Work Index Subscales Used to Classify Hospitals as Better, Mixed, or Poor Care Environments (N = 168)

	No. of items	Cronbach α	Range	Mean (SD)	Median
Nursing foundations for quality of care[a]	7	.74	1.2-2.8	2.2 (0.3)	2.2
Nurse manager ability, leadership, and support[b]	4	.82	1.3-3.0	2.4 (0.2)	2.4
Collegial nurse/physician relations	3	.80	2.2-3.2	2.8 (0.2)	2.8

Scale scores range from 1 to 4, with higher scores representing more positive work environments.

[a] Differs from the foundations scale in Lake[11] because (1) items related to the use of nursing diagnoses were not included in the current study questionnaire, and (2) others related to the use of a nursing (vs medical) model for care and a preceptorship model were overly highly correlated with staffing and education and were dropped.

[b] Differs from the nurse manager ability subscale because the item "Supervisors use mistakes as learning opportunities, not criticism" was not included in the study questionnaire.

Table 2

Nurse Characteristics, Outcomes, Reports of Adverse Events, and Assessments of Patient Care Quality in the Study Hospitals, by Care Environment Categories

	Care Environment Category			
	All	**Poor**	**Mixed**	**Better**
Total nurses	10,184	2,237 (22.0)	4,752 (46.7)	3,195 (31.4)
Male	596 (5.9)	140 (6.3)	289 (6.2)	167 (5.3)
Years as registered nurse, mean (SD)	13.8 (9.8)	14.5 (10.0)	14.0 (9.6)	13.0 (9.8)
Unit: Medical surgery	2,549 (25.0)	557 (24.9)	1,177 (24.8)	815 (25.5)
Unit: intensive care unit	1,863 (18.3)	382 (17.1)	868 (18.3)	613 (19.2)
Unit: operating room	1,031 (10.1)	230 (10.3)	503 (10.6)	298 (9.3)
Unit: Other	4,741 (46.6)	1,068 (47.7)	2,204 (46.4)	1,469 (46.0)
Nurse Outcomes				
High burnout	4,364 (43.2)	1,127 (50.8)	2,087 (44.3)	1,150 (36.3)
Job dissatisfaction	4,175 (41.6)	1,053 (47.9)	2,067 (44.1)	1,055 (33.5)
Intent to leave	2,312 (23.0)	521 (23.5)	1,134 (24.2)	657 (20.8)
Nurse's Assessments of Quality				
Report quality of nursing care on their unit as poor or fair	1,308 (13.1)	425 (19.3)	626 (13.4)	257 (8.2)
Not confident that management will resolve patient care problems	1,290 (13.0)	366 (16.7)	625 (13.6)	299 (9.7)
Not confident that patients can manage their care when discharged	2,986 (29.8)	905 (41.0)	1,429 (30.6)	652 (20.8)
Would not recommend hospital to family member	2,147 (21.8)	696 (32.3)	1,057 (23.0)	394 (12.7)

Values are in n (%) except when otherwise indicated.

Table 3

Adjusted Odds Ratios (Or) Indicating the Effect of Better Versus Mixed (or of Mixed vs Poor) Care Environment and Nurse Staffing on Nurse Outcomes

Outcome and effect	Estimated Separately		Estimated Jointly	
	OR	(95% CI)	OR	(95% CI)
Job Outcomes				
Burnout				
Care environment	0.74	(0.68-0.80)[a]	0.76	(0.70-0.82)[a]
Nurse staffing	1.21	(1.11-1.31)[a]	1.17	(1.09-1.25)[a]
Job dissatisfaction				
Care environment	0.74	(0.67-0.80)[a]	0.75	(0.68-0.81)[a]
Nurse staffing	1.15	(1.06-1.24)[a]	1.11	(1.04-1.18)[a]
Intent to leave within 1 y				
Care environment	0.87	(0.78-0.96)[a]	0.87	(0.79-0.96)[a]
Nurse staffing	1.05	(0.96-1.14)[b]	1.03	(0.95-1.12)[b]
Nurse Reports of Quality of Care				
Quality of nursing care is poor or fair				
Care environment	0.60	(0.53-0.68)[a]	0.62	(0.55-0.69)[a]
Nurse staffing	1.33	(1.23-2.01)[a]	1.27	(1.16-1.40)[a]
Not confident that management will resolve patient care problems				
Care environment	0.62	(0.56-0.68)[a]	0.63	(0.57-0.68)[a]
Nurse staffing	1.16	(1.05-1.29)[c]	1.11	(1.01-1.21)[d]
Not confident that patients can manage their care when discharged				
Care environment	0.74	(0.66-0.84)[a]	0.76	(0.68-0.86)[a]
Nurse staffing	1.22	(1.09-1.36)[a]	1.18	(1.06-1.31)[a]
Would not recommend hospital to family member				
Care environment	0.55	(0.44-0.68)[a]	0.56	(0.45-0.70)[a]
Nurse staffing	1.26	(1.04-1.52)[d]	1.19	(0.99-1.43)[b]

Abbreviation: CI, confidence interval.

Odds ratios are from robust logistic regression models adjusted for nurse (sex, experience, education, and nursing specialty) and hospital (size, teaching status, and technology) characteristics and the clustering of nurses within hospitals. Odds ratios for staffing express changes in risk of poor outcomes for every 1 patient per nurse increase in mean nurse workload in the hospital.

[a] $P < .01$.

[b] $P < .10$.

[c] $P < .001$.

[d] $P < .05$.

Table 4

Adjusted Odds Ratios (Or) Indicating the Effect of Better Versus Mixed (or of Mixed vs Poor) Care Environment, Nurse Staffing, and Nurse Education on Mortality and Failure to Rescue

	Estimated Separately		Estimated Jointly	
Outcome and effect	**OR**	**(95% CI)**	**OR**	**(95% CI)**
Mortality				
Care environment	0.91	(0.85-0.97)[a]	0.93	(0.87-0.99)[b]
Nurse staffing	1.08	(1.03-1.13)[a]	1.06	(1.01-1.11)[a]
Nurse education	0.94	(0.90-0.97)[a]	0.96	(0.92-0.99)[b]
Failure to rescue				
Care environment	0.91	(0.85-0.98)[a]	0.94	(0.88-1.00)[c]
Nurse staffing	1.08	(1.03-1.13)[a]	1.06	(1.01-1.11)[b]
Nurse education	0.93	(0.89-0.97)[a]	0.95	(0.91-1.00)[b]

Abbreviation: CI, confidence interval.

Odds ratios are from robust logistic regression models adjusted for patient clinical characteristics and hospital characteristics (size, teaching status, and technology) and the clustering of patients within hospitals. Odds ratios for staffing express changes in risk of poor outcomes associated with 1 patient per nurse increase in mean nurse workload in a hospital. Odds ratios for education express changes in risk of poor outcomes associated with a 10% increase in the proportion of staff nurses with bachelor of science in nursing degrees in a hospital.

[a] $P < .01$.

[b] $P < .05$.

[c] $P < .10$.