Effect of changes in hospital nursing resources on improvements in patient safety and quality of care: A panel study

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Abstract

Background: Evidence demonstrates hospitals with better nursing resources have better outcomes but few studies have shown that outcomes change over time within hospitals as nursing resources change.

Objectives: To determine whether changes in nursing resources over time within hospitals are related to changes in quality of care and patient safety.

Research Design: Multilevel logistic response models, using data from a panel of 737 hospitals in which cross-sections of nurse informants surveyed in 2006 and 2016, were used to simultaneously estimate longitudinal and cross-sectional associations between nursing resources, quality of care, and patient safety.

Measures: Nursing resources included hospital-level measures of Work Environments, Nurse Staffing, and Nurse Education. Care quality was measured by Overall Rating of Care Quality, Confidence in Patients Managing Care after Discharge, Confidence in Management Resolving Patient Care Problems; patient safety was measured by Patient Safety Grade, Concern with Mistakes, and Freedom to Question Authority.

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Results: After taking into account cross-sectional differences between hospitals, differences among nurses within hospitals, and potential confounding variables, changes within hospitals in nursing resources were associated with significant changes in quality of care and patient safety. Improvements in work environment of one standard deviation decrease odds **of** unfavorable quality care and patient safety by factors ranging from 0.82 to 0.97.

Conclusions: Improvements within hospitals in work environments, nurse staffing, and educational of nurses coincide with improvements in quality of care and patient safety. Cross-sectional results closely approximate longitudinal panel results.

The 1999 Institute of Medicine (IOM) report "*To Err Is Human: Building a Safer Health System,*"[1] is a landmark for numerous reasons, including its emphasis on organizational aspects of patient safety and quality of care. The report signalled the need to shift the response to medical errors away from blame focused on individuals to redefining patient safety as a property of organizations. **Nursing is crucial to transforming the hospital work environment for all the reasons that nurses, and especially registered nurses (RNs), are crucial to hospital care. Nurses are the only professional caregivers at the patient's bedside around the clock; they are the primary sources of information to physicians regarding the condition of patients, and in particular changes in condition; and they are skilled practitioners in their own right.** Thus subsequent IOM recommendations for changing hospital work environments had a strong focus on nursing, noting the considerable research showing that there were fewer adverse patient outcomes in hospitals with (a) lower patient-to-nurse staffing ratios; (b) a highly educated, professional nurse workforce; and (c) work environments that enabled nurses to care for patients effectively.[2] Conceptually the first and second findings correspond to production function inputs of, respectively, labor and human capital. The third, work environments that foster professionalization, autonomy, and morale, are an emergent organizational property that has a great deal to do with whether other capital inputs are deployed efficiently. As the patient population presents with increasingly complicated risks, and hospital care becomes more complex, the question of whether nurses can use their professional skills and judgment in a manner that improves patient safety and increases quality of care becomes increasingly salient.

A large body of evidence accumulated over the past two decades has demonstrated, in the U.S. and internationally, that hospitals with better nursing resources have better patient and nurse outcomes.[3–6] However, these studies involve cross-sectional surveys of hospitals and the nurses in them, often linked to patient reports on care and/or objective patient outcomes measures. The associations uncovered, based on variation *between* hospitals, may or may not represent what occurs *within* hospitals as nursing resources change. There are few published papers that provide evidence that the cross-sectional associations observed at the hospital level may also be observable over time within hospitals as the work environment and attendant resources change. Mark *et al.* showed, for 422 hospitals observed between 1990 and 1995, that RN staffing increases led to significant risk-adjusted mortality reductions, over most of the range of existing nurse staffing levels.[7] For a sample of 137 Pennsylvania hospitals studied in both 1999 and 2006, improvements within hospitals in the work environment were associated with reduced nurse burnout, intention to leave the job,

and job dissatisfaction.[8] Increases in the hospital percentage of bachelor's degree RNs were associated with lower post-surgical mortality,[9] and among the hospitals that attained Magnet recognition during this interval, mortality reductions exceeded those observed in hospitals not making this transition associated with improvement in the work environment.[10]

In this paper, we investigate changes in nursing resources, quality of care, and patient safety in a panel of 737 hospitals in four large states first measured in 2006, and again in 2016. We provide evidence that changes in nursing resources are associated with changes in nurse reports of quality of care and patient safety. The longitudinal associations we find are similar to those observed cross-sectionally, hence to those previously reported in the literature. [6,11–13] These results are important corroboration that improving nursing resources, including the work environment, should lead to significant improvements in patient care within hospitals, a major premise in the IOM's recommendations to reduce patient harm.[1,2]

Methods

Design and data.

The work environment, nurse staffing, and nurse educational levels are time-varying properties of hospitals. Thus the relative level of autonomy afforded to nurses is a property of a hospital, as is the nurse staffing level and the average level of education among nurses in a hospital. Patient safety culture is also a hospital-level concept, as is quality of care (notwithstanding differences among patients in their experience within a hospital). Nurses are used as informants with respect to the unitary, organizational properties[14] of the hospitals within which they practice, so the primary *measurement* unit is the individual nurse.[15,16] Nurses within a hospital can and will differ with respect to their own education and their reports on the nurse work environment, levels of staffing, quality of care, and patient safety culture. Because our focus is on time-varying properties of hospitals, we synthesize these varying characteristics and reports as hospital-specific averages.

The data analyzed here are from two large-scale surveys of nurses in four large states—PA, NJ, FL and CA—first in 2006 and a decade later in 2016. Surveys were conducted by mailing questionnaires, return envelopes, and reminder postcards to homes of registered nurses randomly sampled from the different state licensure lists. Questionnaires were mailed to 273,000 nurses in 2006 and to 231,000 nurses in 2016. The large size of the two survey samples reflects two considerations: (1) most licensed RNs are not providing patient care in hospital settings, but the licensure lists constituting the sampling frame provide no information on place of employment; and (2) expected non-response among individual nurses.

The questionnaires asked nurses who reported currently working at a hospital to indicate that hospital from a list of all hospitals in their state. This allowed us to link survey respondents to specific hospitals, and to derive, from their aggregated responses, hospital-level measures of nursing resources and of quality of care and patient safety. We obtained information in both survey years from nurses in 737 hospitals, or more than 90% of the hospitals that existed in these states in both 2006 and 2016. The representation of *hospitals*—overall and especially in terms of patients served—is excellent. Representation of hospitals by nurses is

directly proportional to hospital size, so that the smallest hospitals had fewer nurse respondents. The precision of hospital-level measures is thus lower for smaller hospitals, which is taken into account in the multilevel analytic model we describe below. Thus our results are produced using the full sample of 737 hospitals, but they are primarily a function of 535 hospitals with at least ten respondents (RNs providing direct patient care) in each survey. There were 33,170 RNs ($\bar{X}$= 62 per hospital) in 2006 and 20,685 RNs ($\bar{X}$= 39 per hospital) in 2016. These hospitals account for roughly 95% of each state's general acute hospital discharges.

We did the large-scale sampling from a frame of all registered nurses in each state to avoid bias in the representation of hospitals. The classic two-stage sample first selects hospitals, then samples nurses from within hospitals. The problem with the classic sampling strategy is that participation of hospitals, including provision of a sampling frame for nurses, resides in the authority of hospital administrators. If hospital officials choose not to participate on the basis of the nursing features being studied—if, for example, administrators of hospitals with comparatively poor work environments are less likely to participate in a study centered on the quality of the nursing environment—then hospital-level non-response will translate into a biased sample of hospitals. We therefore opted to survey directly a large sample of nurses, and collect from them information on their workplace, thereby obtaining coverage of most hospitals in each state.

There remained the concern, however, that we may not have obtained an unbiased sample of nurses. The response rate for the *nurses* sampled was 39% in 2006 and 26% in 2016. These nurse-specific response rates reflect endemic difficulties with mailed surveys in the 21st century[17] plus the length and complexity of a 12-page questionnaire where not all questions applied to all nurses. They do not reflect substantial non-response bias. We know this because we did intensive re-surveys of 1300 of the original non-respondents: 1300 from the first survey and 1400 from the second. By using exhaustive re-contact strategies, monetary incentives, and a slimmed-down version of the original questionnaire, we obtained responses from 91% of non-respondents circa 2006 and 87% in 2016. This produced, for a subset of items in the original questionnaire, an effective response rate relative to the original sampling frame of, respectively, 95% and 90% (see Harter *et al.*, eq. [5]),[18] hence "nearly unbiased"[19] estimates of population quantities. Nurse reports of hospital characteristics (e.g., work environments, nurse education, and workloads) and their own characteristics (job dissatisfaction and nurse burnout) differed little between respondents and non-respondents in the 2006 study,[20,21] a general result that obtains as well for the 2016 study. Also, no differences were found between respondents and non-respondents on reports of quality of care and patient safety.

Measures.

Our analyses focus on cross-sectional and longitudinal associations of three nursing resources with three quality of care indicators and three patient safety indicators. The nursing resources used as independent variables correspond to the core organizational factors or inputs examined in previous studies[3–6,11] that have been shown to have substantial predictive validity: the nurse work environment, nurse staffing, and nurse education. These

nursing resources were measured at the nurse-level and at the hospital level. This enabled us in analyses reported below to take account of effects of differences in nurse reports of different resources within hospitals while simultaneously estimating how changes within hospitals over time in the three resources are related to changes in quality of care and patient safety. Table 1 provides the survey questions and variable codings used to measure resources at the nurse level, and describes how the nurse level measures were aggregated to produce hospital level measures. Work environment was measured at the nurse level by asking nurses to rate their work environment on a four-point scale from poor to excellent. The staffing (or workload) for each nurse was measured by asking nurses how many patients were assigned to them on their last shift, and nurse education was measured by asking nurses to indicate the highest level of education they had completed in nursing. At the hospital level, work environment was measured by averaging nurses' reports of the work environment across all nurses within each hospital. Nurse staffing was measured using two items that were slightly different than the individual nurse level measure, which asked each nurse (on all units) how many patients were cared for on their unit on their last shift, and how many nurses were on that unit on that shift to provide their care. We averaged these across all nurses in each hospital, and divided the average number of patients reported by the nurses by the average number of nurses that were reported to have provided their care to produce an average hospital patient-to-nurse ratio. For nurse education, we created a hospital-level measure indicating the percentage of nurses with at least a bachelor's in nursing degree (BSN). The last two columns in Table 1 provide summary information related to these measures, and reveals how they changed from 2006 to 2016. At both the nurse and hospital levels, average work environment scores changed little, while staffing (i.e., individual nurse workloads and hospital patient-to-nurse ratios) declined substantially, and the percent of BSN nurses increased markedly.

Dependent variables included three quality of care indicators and three patient safety indicators. Quality of care indicators include a global quality of care rating, and measures of the amount of confidence that nurses expressed in patients being able to manage their care after discharge, and in management resolving patient care problems.[12] Patient safety indicators, based upon AHRQ research,[22] included an overall patient safety grade, and additional culture of patient safety metrics reflecting whether nurses perceived that mistakes were held against them, and whether staff feel free to question authority. Nurse-reported measures of hospital patient safety and quality of care have been shown to be associated with independent patient outcomes measures, including but not limited to mortality.[23,24] All dependent variables were measured at the nurse level and dichotomized, to facilitate the presentation of results and as a form of standardization, since the percentage of nurses using some response categories was often small. Survey questions and variable coding for these dependent variables are shown in Table 2, along with the percentages of nurses giving "unfavorable" responses, or responses that indicated poorer quality of care or lesser patient safety. Percentages varied greatly across different indicators, and while the differences in the percentages in 2006 and 2016 indicate that, overall, most changed favorably, two of them (confidence in patients managing their care after discharge, and staff feel their mistakes are held against them) showed unfavorable changes.

Analysis.

Our primary interest is in the estimation of within-hospital associations between key features of hospital nursing and validated quality of care and patient safety measures. A two-wave panel of hospitals allows for the simultaneous estimation of longitudinal and cross-sectional association at the hospital level. Let y_{itj} be a report on a hospital (one of the three indicators of quality of care or one of the three indicators of patient safety) for the ith nurse in wave t ($t=0$ for the first wave, $t=1$ for the second wave) in hospital j. For the various binary response variables, $y_{itj} = 1$ for latent variable $y_{itj}^* > 0$ and $y_{itj} = 0$ otherwise. We estimate the following multilevel logistic response model for macro-level (hospital-level) panel data, adapted from Fairbrother:[25]

$$y_{itj}^* = \mu_S + \beta_1 x_{itj} + \beta_2 x_{1jM} + \beta_3 \bar{X}_j + \sum_k \gamma_k w_{kitj} + \sum_l \delta_\ell z_{\ell tj} + \xi t + u_j + u_{tj} + e_{itj} \quad 1$$

Nurse reports of organizational factor x for nurse i in hospital j in wave t —the same nurses are not in general observed in both waves—are indexed by x_{itj}, so that the mean evaluation for hospital j in wave t is $\bar{X}_{tj} = \sum_{i=1}^{n_{tj}} x_{itj}/n_{tj}$. Then the mean evaluation for hospital j across both waves is the arithmetic average of these wave-specific means, $\bar{X}_j = \left(\bar{X}_{0j} + \bar{X}_{1j}\right)/2$; and the within-hospital mean change is $x_{1jM} = \bar{X}_{1j} - \bar{X}_j = \bar{X}_{1j} - \left(\bar{X}_{0j} + \bar{X}_{1j}\right)/2 = \left(\bar{X}_{1j} - \bar{X}_{0j}\right)/2$. Then β_2 is interpreted as the effect of longitudinal (within-hospital) change in the effect of a nursing organizational variable on an outcome variable, and β_3 is an estimate of the same effect in the cross-section (between hospitals).

Because all wave-specific hospital means $\bar{X}_{tj}$ are based on individual nurse reports x_{itj}, and whatever factors cause some nurses to report differently on the global hospital characteristic $\bar{X}_{tj}$ may be present in their reports on an outcome analogue $\bar{Y}_{tj}^*$, we estimate β_1, corresponding to the within-hospital nurse-specific association in responses. These nurse-level associations are net of the effects γ_k for nurse-specific covariates w_{kitj}: age, sex, unit type or specialty (medical/surgical, ICU, or other) and, when the effects of work environments and staffing were estimated, nurse education. We also adjust (δ_ℓ) for hospital×wave covariates $z_{\ell tj}$: number of beds, teaching status, and technology, as reported by the American Hospital Association annual survey. Separate fixed-effects intercepts are estimated for each of the four states, μ_S, and there is a fixed effect ξ corresponding to wave, t. Random errors at the hospital (u_j) and hospital×wave (u_{tj}) are assumed to be normally distributed with mean 0 and, respectively, variances σ_{u3}^2 and σ_{u2}^2. Given the binary response and logistic link function, nurse-specific errors (e_{itj}) have a logistic distribution with mean 0 and variance $\pi^2/3$.

Results

Results from successive application of the basic analytic model appear as Table 3. The three panels correspond to the three organizational resources or inputs: work environment, nurse staffing, and nurse education. Each panel contains three major rows, with each row corresponding to one of the key β-coefficients for the relationship between a nursing resource and an indicator of either quality of care or patient safety. Thus for a given column, each panel portrays the three key coefficients for each of three nursing organizational resources, where each set of coefficients $\left\{\beta_2, \quad \beta_3, \beta_1\right\}$ corresponds to a single regression.

Note that terms are also estimated for all other parameters in [equation 1], but are not presented here, since they are functionally control variables. Coefficients in Table 3 have been exponentiated, and are interpretable as odds-ratios. In particular, they are the effects of better work environments, poorer staffing (or more patients per nurse), and higher percentages of BSN nurses on the odds **of** nurses providing unfavorable rather than favorable evaluations of the six indicators of quality of care or patient safety. Estimated confidence intervals are reported for each odds-ratio, along with their conventional level of statistical significance.

The odds-ratios of greatest interest are in the first row of each panel. They show the longitudinal associations between the three resources and the six outcomes, or the changes in outcomes over time within hospitals that are associated with changes in resources. They reveal that even after taking into account cross-sectional differences between hospitals, differences among nurses within hospitals, and a number of measurable potential confounding variables, changes over time within hospitals in the three key organizational resources are in general associated with significant change in hospital quality of care and patient safety. Improvements in the work environment of one standard deviation decrease odds **of** unfavorable quality care and patient safety by factors ranging from 0.82 to 0.97 (*i.e.*, reduction in odds **of** unfavorability by between 3% and 18%, a statistically significant decline for five of six indicators [highlighted in Table 3]). Increases of one patient per nurse, or in the average number of patients per nurse, are associated with increases in the odds **of** nurses giving unfavorable responses to the quality care and patient safety indicators, by factors of 1.04 or 1.05, and here too for five of the six measures the changes are statistically significant. Every ten-point difference in the percentage of BSN nurses reduces the odds **of** nurses giving unfavorable responses to the quality care and patient safety indicators, by significant factors ranging from 0.93 to 0.97. While the patient safety indicators appear to be less affected by changes in nurse education, the odds **of** grading patient safety as average or lower (C, D, or F) are diminished by a factor of 0.96 with every ten-point increase in the percent of BSN nurses (p = .06).

While some effects may appear to be small, these coefficients are multiplicative, and indicate the differences in the change over time in the odds of nurses giving unfavorable responses between hospitals that differed in their change over time in the nursing resource measures by a single unit. While many hospitals showed little change in the three resources, substantial numbers of hospitals showed increases (n = 100, or 14%) and decreases (n = 57, or 8%) in work environment scores of more than 1.5 units (or standard deviations), and

substantial numbers showed decreases (n = 144, or 20%) and increases (n = 54, or 8%) in patient-to-nurse ratios of more than 1.5 units (or patients per nurse). The differences between hospitals in which work environments changed favorably by 1.5 units and unfavorably by 1.5 units would involve differences ranging between $.82^3 = 0.55$ and $0.97^3 = 0.91$, or differences in the odds **of** unfavorable responses by between 9% and 45%. Differences between hospitals in which staffing changed favorably by 1.5 patients per nurse and unfavorably by 1.5 patients per nurse would involve differences ranging between $1.04^3 = 1.12$ and $1.05^3 = 1.16$, or differences in the odds **of** unfavorable responses by between 12% and 16%. While few hospitals decreased in terms of percent of BSN nurses, many hospitals witnessed 25-point increases in percent of BSN, or increases of 2.5 units (n = 175, or 24%). The difference between them, and hospitals that didn't change at all, range from $0.97^{2.5} = 0.93$ to $0.93^{2.5} = 0.83$, or differences in the odds of unfavorable responses by between 7% and 17%.

Discussion

In this paper, survey data from RNs across a wide range of hospitals have been extended to examine how changes in nursing organizational factors—work environment, educational composition of the hospital RN workforce, and patient-to nurse ratios—are associated with changes in nurse assessments of hospital quality of care and patient safety. The results show a strong pattern for improvement in resources to be associated with improvements in quality of care and patient safety.

Limitations include the possible omission of potentially confounding variables to account for other unmeasured secular changes. Further, while the hospital-level response rate is high, the nurse response rate was somewhat low. As noted above however, our intensive resurvey and analyses involving non-respondents did not suggest any substantial bias in the original survey respondents. Also, our quality of care and patient safety measures are derived from nurses' reports, rather than from an external source, but we do know that such reports track directly measured patient outcomes.[23,24] Longitudinal data on in-patient mortality and readmission will be used to in future analyses to examine the association between the organization of nursing and patient outcomes established previously with cross-sectional analyses.[3–6,26,27] This study also employs single-item indicators that have been collapsed to render them easier to interpret, but there may be some loss of information that results from the collapsing of categories. These indicators also have a subjective component, and some nurse respondents do tend to report critically on all aspects of hospital work, while others take a more rose-colored view. This is evident in Table 3 for estimates of $\exp\beta_1$, the individual-level, cross-sectional, within-hospital association between the report of a nurse on an aspect of nursing resources and his or her report on quality of care or patient safety. Nurse staffing and nurse education are comparatively objective, in the sense that differences in nurses' personal characteristics should be less relevant to their evaluation of these resources than with their evaluation of the work environment. Not surprisingly, the nurse-level associations with all outcome indicators are very strong for the latter, less so for the former. But this inter-subjective variability in viewing the world is captured separately within this model, and is not the focus of this study, which is on hospital-level variation.

As for this hospital-level variation, the longitudinal associations $(\exp\beta_2)$ shown in Table 3 are reasonably close in most cases to the cross-sectional associations $(\exp\beta_3)$. Data such as these, featuring a panel of hospitals, are rare, so it is reassuring to see that when we are able to observe change in nursing resources, the change in several aspects of assessed patient care is positive, in the same fashion that this correlation has appeared in studies where differences can only be compared across hospitals. This suggests the possibility that cross-sectional results that have guided the field may reasonably approximate what happens within hospitals as nursing resources change.

Conclusions

Change can occur for many reasons.

Over the past decade, numerous policy and practice changes have affected US hospitals. The Affordable Care Act increased care access for millions of previously uninsured patients and has begun shifting towards pay-for-performance versus fee-for-service. There have been changes specific to hospital nursing as well. Jurisdictions including California in the U.S., Wales, Ireland, and Victoria and Queensland in Australia have mandated minimum hospital nurse staffing ratios.[28–30] Thirteen U.S. states require hospitals to form committees to guide staffing decisions and/or to publicly report nurse staffing. The IOM's *Future of Nursing* recommendation for the U.S. to move to at least 80% BSNs by 2020 has spurred significant increases in employment of BSN nurses.[31] The voluntary accreditation of hospitals for nursing excellence through the Magnet Recognition program shows promise for improving hospital work environments.[10] The challenge for the future in improving patient safety and quality of care is to find the most efficient mechanisms for inducing the type of organizational change in nursing that is observed in the data analyzed here.

Acknowledgements:

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Table 1.

Survey Questions and Codes Used to Measure the Independent Variables (Nursing Resources) in the Analyses, at the Nurse-Level and Hospital-Level, with Distributions in 2006 and 2016.

Nursing Resource Measures	Survey Question	Variable Coding at the Nurse Level	Mean (and SD) or Percent 2006	Mean (and SD) or Percent 2016
Nurse Level				
Nurse Work Environment	How would you rate the work environment of your job?	1 = Poor; 2 = Fair; 3 = Good; 4 = Excellent	$\bar{X}$ = 2.7 σ = (.0.8)	$\bar{X}$ = 2.8 σ = (0.8)
Nurse Staffing	How many patients were assigned to you on your last shift?	1 = 1 Patient; 2 = 2 Patients; etc.	$\bar{X}$ = (5.2) σ = (5.4)	$\bar{X}$ = (4.5) σ = (5.4)
Nurse Education	What is your highest level of education completed in nursing?	1 = BSN or Higher; 0 = Diploma or AD	44.2%	60.1%

Hospital Level	Description of Hospital-Level Measures		Hospital-Level Mean (and SD) in 2006	Hospital-Level Mean (and SD) in 2016
Nurse Work Environment	Nurse-level work environment scores were averaged across all nurses in each hospital, and standardized, so that coefficients can be interpreted as reflecting the cross-sectional differences across hospitals, or longitudinal changes within hospitals, produced by a shift in the work environment of one standard deviation.		$\bar{X}$ = 2.7 σ = (0.3)	$\bar{X}$ = 2.8 σ = (0.3)
Nurse Staffing	Two questions were used, which asked nurses 1) how many patients were cared for on their unit on their last shift, and 2) how many nurses were on that unit on that shift to provide their care. We averaged these across all nurses in each hospital, and divided the average number of patients reported by the nurses by the average number of nurses that were reported to have provided their care. The resulting coefficients can be interpreted as reflecting the cross-sectional differences across hospitals, or longitudinal changes within hospitals, produced by an average increase of one patient per nurse.		$\bar{X}$ = 5.3 σ = (1.4)	$\bar{X}$ = 4.7 σ = (1.5)
Nurse Education	Nurse education was measured at the hospital level by calculating the proportion of nurse with BSN degrees or higher, and multiplying the proportions by 100 so the coefficients can be interpreted as reflecting the cross-sectional differences across hospitals, or longitudinal changes within hospitals, produced by a 10-point increase in the percentage of BSN nurses.		$\bar{X}$ = 41.3% σ = (12.5%)	$\bar{X}$ = 56.3% σ = (15.4%)

Table 2.

Survey Questions and Codes Used to Measure the Dependent Variables (Quality of Care and Patient Safety Indicators) in the Analyses, at the Nurse-Level, with Percentages of Nurses Responding Unfavorably in 2006 and 2016.

Quality of Care Indicators	Survey Question	Variable Coding (at the Nurse Level)	Percent 2006	Percent 2016
Overall Rating of Care Quality	In general, how would you describe the quality of nursing care delivered to patients in your work setting?	1 = Poor or Fair; 0 = Good or Excellent	15.5%	12.2%
Confidence in Patients Managing Care after Discharge	How confident are you that that your patients and caregivers can manage their care after discharge?	1 = Not at all or Somewhat Confident; 0 = Confident/Very Confident	45.1%	48.7%
Confidence in Management Resolving Patient Care Problems	How confident are you that that management will act to resolve problems in patient care that nurses identify?	1 = Not at all or Somewhat Confident; 0 = Confident/Very Confident	55.8%	50.6%
Patient Safety Indicators				
Overall Grade on Patient Safety	Please give your current practice setting an overall grade on patient safety.	1 = F [Failing], D [Poor] or C [Acceptable]; 0 = B [Good] or A [Excellent]	31.0%	27.7%
Concern with Mistakes	Please indicate whether you agree or disagree that staff feel like their mistakes are held against them.	1 = Agree or Strongly Agree 0 = Disagree, Strongly Disagree or Neither	55.1%	59.6%
Freedom to Question Authority	Please indicate whether you agree or disagree that staff feel free to question the decisions or actions of those in authority.	1 = Agree or Strongly Agree 0 = Disagree, Strongly Disagree or Neither	42.9%	40%

Table 3.

Longitudinal and Cross-Sectional Odds-Ratios (OR) and 95% Confidence Intervals (CI) for the Regressions of Three Quality of Care Indicators and Three Patient Safety Indicators on Each of Three Nursing Resources

Nursing Resources		Quality of Care Indicators			Patient Safety Indicators		
		Rate Quality Poor or Fair	Not Confident Patients Can Manage Care After Discharge	Not Confident Management Will Resolve Patient Care Problems	Rate Patient Safety as C,D, or F	Worry That Mistakes Are Held Against Them	Do Not Feel Free to Question Authority
Nurse Work Environment							
Longitudinal Association - Hospital Level ($\exp\beta_2$)	OR	0.82***	0.97	0.84***	0.85***	0.94**	0.96*
	CI	[0.76,0.87]	[0.93,1.02]	[0.80,0.88]	[0.81,0.90]	[0.90,0.99]	[0.92,1.00]
Cross-Sectional Association - Hospital Level ($\exp\beta_3$)	OR	0.72***	0.84***	0.81***	0.78***	0.91***	0.98
	CI	[0.69,0.76]	[0.81,0.88]	[0.78,0.84]	[0.75,0.81]	[0.88,0.94]	[0.95,1.01]
Cross-Sectional Association - Individual Level ($\exp\beta_1$)	OR	0.23***	0.46***	0.24***	0.23***	0.50***	0.46***
	CI	[0.22,0.24]	[0.45,0.47]	[0.23,0.25]	[0.22,0.24]	[0.49,0.52]	[0.45,0.47]
Nurse Staffing							
Longitudinal Association - Hospital Level ($\exp\beta_2$)	OR	1.04	1.04*	1.05**	1.04*	1.05**	1.04**
	CI	[1.00,1.09]	[1.00,1.07]	[1.02,1.08]	[1.01,1.08]	[1.01,1.08]	[1.01,1.07]
Cross-Sectional Association - Hospital Level ($\exp\beta_3$)	OR	1.07**	1.06**	1.03	1.05*	1.02	1.06***
	CI	[1.02,1.12]	[1.02,1.10]	[0.99,1.07]	[1.01,1.09]	[0.99,1.06]	[1.03,1.09]
Cross-Sectional Association - Individual Level ($\exp\beta_1$)	OR	1.04***	1.03***	1.02***	1.04***	1.02***	1.02***
	CI	[1.03,1.04]	[1.03,1.04]	[1.02,1.03]	[1.03,1.04]	[1.01,1.02]	[1.01,1.02]
Nurse Education							
Longitudinal Association - Hospital Level ($\exp\beta_2$)	OR	0.93**	0.97*	0.96*	0.96	1.03	1.00
	CI	[0.88,0.98]	[0.93,1.00]	[0.92,0.99]	[0.92,1.00]	[1.00,1.06]	[0.97,1.03]
Cross-Sectional Association - Hospital Level ($\exp\beta_3$)	OR	0.92***	0.92***	0.91***	0.94**	0.97**	0.91***
	CI	[0.88,0.97]	[0.89,0.95]	[0.88,0.94]	[0.90,0.97]	[0.94,0.99]	[0.88,0.93]
Cross-Sectional Association - Individual Level ($\exp\beta_1$)	OR	0.95	0.99	0.90***	0.93**	0.95*	0.92***
	CI	[0.89,1.01]	[0.94,1.03]	[0.86,0.94]	[0.89,0.98]	[0.91,0.99]	[0.88,0.95]

Source: The survey data are from the 2006 Multi-State Nursing Care and Patient Safety Study and the 2016 RN4CAST-U.S. Panel Study of Effects of Changes in Nursing on Patient Outcomes, conducted by the Center for Health Outcomes at the University of Pennsylvania. 35,228 hospital nurses from 737 hospitals completed the surveys in 2006, and 21,696 nurses from these hospitals completed the surveys in 2016.

Notes: For each of the six dependent variables--three Quality of Care Indicators and three Patient Safety Indicators--there is a separate regression corresponding to each of the three Nursing Resource variables. As per the text equation, the association of these Nursing Resource variables with each indicator is decomposed at the hospital level into a longitudinal (β_2) and a cross-sectional effect (β_3), and the individual- (nurse-level) association between evaluation of resources and indicators (β_1) is also shown. All regressions control for measurement occasion (first or second survey), state, and selected nurse (age, age-squared, sex, unit type of specialty [medical/surgical, ICU, or other], and education [in the models for Work Environment and Staffing]) and hospital (number of beds, teaching status, and technology) characteristics. Single, double, and triple asterisks indicate associations that are significant at the .05, .01, and .001 levels, respectively. Longitudinal associations that are significant at the .05 level or higher are also shaded.