Hospital Nurse Staffing
Choice of Measure Matters

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Background: Researchers frequently use nurse staffing measures to examine hospital quality of care. Measure choices include nurse-reported perception of staffing adequacy, nurse-reported patient workloads, and empirically derived hours per patient day (HPPD).

Objective: To examine the correlations across these measures and identify factors associated with these staffing measures.

Design, Settings, and Subjects: A cross-sectional correlational study of 92 medical-surgical, rehabilitation, and intermediate in 11 acute care hospitals was carried out.

Methods: We surveyed registered nurses on their perceived staffing adequacy, last shift patient workload, and unit-level structures and processes of care delivery. Individual responses to these measures were aggregated to the nursing unit level, and unit-level HPPD, unit-level case mix index were obtained from each hospital's administrative data. After examining the correlation matrix across variables, those associated with the 3 staffing measures were then examined using linear regression.

Results: HPPD and the nurse-reported patient workload on last shift were correlated ($r = -0.276$, $P = 0.008$), and perceptions of the adequacy of staffing and nurse-reported patient workload on last shift were correlated ($r = -0.384$, $P = 0.000$). In multivariable analyses, inadequate numbers of assistive personnel was significantly associated with both perceived staffing adequacy and nurse-reported patient loads. Unit-level case mix index was significantly associated with both HPPD and nurse-reported patient loads. These data suggest that the 3 measures of nurse staffing are not highly correlated, and may capture different elements of the unit context to explain nurse staffing. Researchers should consider the correlates of these measures when selecting nurse staffing measures for future investigations.

Key Words: nurse staffing, perceptions of staffing adequacy, hours per patient day

Although hospital nurse staffing has been studied extensively,[1] the topic received renewed attention in the late 1990s, amidst concerns of unsafe staffing levels. Investigators confirmed a relationship between nurse staffing and mortality for hospitalized patients.[2,3] Staffing researchers have used a variety of measures: hours per patient day (HPPD),[3-6] registered nurse hours per patient day (RN HPPD),[3-8] nurse-to-bed ratios,[9,10] RN full-time equivalents,[11-14] perceived staffing adequacy,[2,15,16] and number of patients cared for on the last shift.[17]

Researchers have debated the ideal nurse staffing measure to use in quality of care studies. Measures derived from administrative data raise concerns for data completeness, reliability, and validity.[18] Investigators have also argued that nurse-reported measures are "superior to those derived from administrative databases, which generally include RN that do not involve inpatient acute care at the bedside."[2] Others have questioned the superiority of nurse-reported measures, given the inconsistent research findings across measures.[19]

We did not find empirical, multisite studies that correlated these measures or their relationships to hospital, unit, or nursing characteristics. Our purpose was to examine empirically the correlations among 3 measures of nurse staffing (nurse-reported patient workload on the last shift, nurse-perceived staffing adequacy, and hours of care per patient day) and to identify characteristics associated with these measures. In doing so, our results address pertinent issues regarding the measurement of nurse staffing for use in quality of care studies.

METHODS

Design and Sample

Participants' approval was obtained from our university and all participating hospitals. This cross-sectional correlational study used a purposive sample of 92 patient care units including medical-surgical (n = 68, 73.9%), intermediate (n = 17, 18.5%), and rehabilitation (n = 7, 7.6%) in 11 acute care hospitals. Hospital size ranged from 60 to 913 beds.

Unit inclusion criteria included an average length of stay ≥ 2 days and adult patient populations. Short stay, pediatric, women's health, perioperative, psychiatric, and intensive care units were excluded. This report focuses on survey data from RNs and administrative data obtained directly from inpatient units.

Procedures

Our survey methods have been published previously.[20] A packet with the survey, an informational letter, a candy bar, and a return envelope was distributed to each staff nurse. Questionnaires were completed anonymously and returned to locked boxes on each unit. Pizza parties were provided to units with at least a 50% response rate. All surveys were collected within a 4-week time frame. Consistent with earlier studies,[21] the overall return rate was 60%, with response rates ranging from 44% to 99% per unit. For staffing data hospitals were asked to provide the data in raw form (ie, numerator and denominator) to ensure consistency in computation across hospitals. Administrative staff in each hospital were given an Excel file with specific definitions and data requirements, and asked to input data into a template designed by the research team. Then, the research team computed all variables of interest. All the data were collected over a 4-week time frame.

Measures

Dependent Variables

Hours of care per patient day (HPPD): HPPD values were obtained using a standardized data collection tool described above. In accordance with the National Database of Nursing Quality Indicators definition, HPPD refers to the overall time expended by nurses and nursing assistants on the unit per patient day excluding vacation, sick time, orientation, education leave, or committee time.[22] HPPD values were calculated as the number of productive hours worked by all nursing staff (RNs, Licensed Practical Nurses, and nursing assistants) with direct patient care responsibilities divided by inpatient days.

The following 2 variables were collected by using the MISSCARE Survey.

Nurse-reported patient workload on last shift: We asked each nurse: On the current or last shift you worked, how many patients did you care for? We calculated the numbers of patients cared for from individual participants, then aggregated the individual nurse values to unit-level means.

Nurse-perceived staffing adequacy: The MISSCARE Survey[23] asked how frequently respondents perceived staffing to be adequate. Respondents rated the frequency of adequate staffing using a 5-point Likert scale: 100% of the time (1), 75% of the time (2), 50% of the time (3), 25% of the time (4), and 0% of the time (5). Individual responses were aggregated to the nursing unit level. After examining data distribution, we created a dichotomous measure to reflect whether staffing was adequate at least 75% of the time. Then the proportion of nurses on each unit who reported that staffing was adequate at least 75% of the time was calculated.

Independent Variables

Case mix index (CMI): CMI is the average diagnosis-related group weight for all Medicare patients on a given patient care unit. In contrast to hospital-level CMI, available through administrative data, we asked each hospital's finance department to calculate a unit-level CMI, using a standardized data collection tool. Although CMI does not measure patient acuity directly, it represents the relative differences in resources expended for patient care.

Labor resources subscale: The labor resources subscale includes 4 items from the MISSCARE Survey—urgent patient situations, inadequate number of assistive personnel, unbalanced patient assignments, and heavy admission and discharge activity.[23] We aggregated individual values to unit-level measures by computing unit-level mean scores. Variable scores ranged from 1 to 4 (with higher scores reflecting more resources).

Unit-level demographic variables: We collected age, sex, last completed degree, and years of nursing experience from all participants. Sex (male/female) and education (bachelor's degree or higher) were treated as dichotomous variables. Age and years experience were measured in the questionnaire as ordinal scales. Individual participant responses were aggregated to the unit level, and dichotomized for analysis based on the median distribution (age above/below 35 y and years of experience above/below 5 years).

Analysis

The data was entered into SPSS 17.0 for unit-level analyses and for calculation of Pearson correlation coefficients to examine associations among nursing unit characteristics and the staffing measures. Significant variables in bivariate relationships and nursing education (which showed a significant association with perceptions of staffing adequacy) were retained in multivariable linear regression models for estimating the staffing measures, which were continuous variables. Preliminary analyses were performed to ensure no violations of the assumptions of normality, linearity, and homoscedasticity. We first built a model to examine nurse-perceived staffing adequacy, incorporating HPPD, CMI, and nursing education in a stepwise manner. Next, we added items from the MISSCARE Survey that were significant in the bivariate analyses. The final models for HPPD, nurse-reported patient workload, and nurse-perceived staffing adequacy used identical variables to facilitate model comparisons. To control for hospital clustering, dummy variables for each hospital were included in regression analyses. We assessed multicollinearity by tolerance values and the variance inflation factor.[24]

RESULTS

Table 1 shows participating nurses' characteristics and nursing units' characteristics. More than half of the participants were older than 35 years (59.0%), and most were female (94.0%). Nearly half of the participants had BSN or higher degrees in nursing (47.2%) and 53.5% had 5 years or more of work experience.

Correlation Among Staffing Variables and Unit Characteristics

Table 2 shows the Pearson correlation coefficients among study variables. Both HPPD ($r=0.314$, $P=0.006$) and nurse-reported patient workload ($r=0.348$, $P=0.002$) were

TABLE 1. Descriptions of Participating Nurses and Nursing Units (N = 92 nursing units)

Nurses Characteristics	Unit Level Mean (±SD)
Age ≥ 35 y	0.59 (±0.20)
Female	0.94 (±0.06)
Job experience ≥ 5 y	0.54 (±0.19)
Unit Characteristics	**Unit Level Mean (±SD)**
Case mix index	1.61 (±0.46)
Nurse perceived staffing adequacy ≥ 75% of the time	0.67 (±0.21)
Hours of care per patient day	8.99 (±2.31)
Nurse reported patient workload on the last shift	4.75 (±0.93)

significantly correlated with unit-level CMI. Two items from the staffing resources subscale of the MISSCARE Survey were significantly associated with perceived staffing adequacy—unexpected rise in patient volume and/or acuity ($r = -0.29$, $P = 0.005$) and inadequate number of assistive personnel ($r = -0.43$, $P = 0.000$). Units with more reports of inadequate numbers of assistive personnel had lower HPPD ($r = -0.22$, $P = 0.037$). Units with greater proportions of nurses with BSN or higher degrees reported higher staffing adequacy ($r = 0.21$, $P = 0.040$) (not reported in Table).

Perceived Staffing Adequacy, HPPD, and Nurse-reported Patient Workloads

Table 3 shows the results of multivariable linear regression models. To examine the contribution of each set of variables across the 3 staffing measures, we estimated 6 models. First, the relationship between nurse-perceived staffing adequacy and HPPD was examined (model 1). Next, a model to estimate staffing adequacy with HPPD and unit-level CMI was constructed (model 2). We then added proportion of nurses with at least a BSN degree (model 3). We then included significant items from the labor resources scale of the MISSCARE Survey were added next (model 4). We then replicated model 4 for HPPD (model 5) and nurse-reported patient workload on the last shift (model 6). All 6 models included dummy variables for hospitals. We did not detect multicollinearity, as the tolerance values ranged between 0.25 and 0.76, and the variance inflation factor values ranged from 1.32 to 4.00.

Multivariable analyses revealed that units who reported inadequate numbers of assistive personnel had lower perceived staffing adequacy ($\beta = -0.50$, $P < 0.01$). Model 4,

which includes HPPD, unit-level CMI, nursing education, and the missed care items, explained 33.8% of the variance in nurse-perceived staffing adequacy. CMI was significantly associated with HPPD ($\beta = 0.33$, $P < 0.001$); model 5 explained 57.4% of the variance in HPPD. Finally, both unit-level CMI ($\beta = -0.29$, $P < 0.01$) and inadequate number of assistive personnel ($\beta = 0.30$, $P = 0.04$) were significantly associated with nurse-reported patient workload on the last shift. Model 6 explained 46.8% of the variance in nurse-reported patient load.

DISCUSSION

Three commonly used measures of nurse staffing are moderately correlated with each other, and these measures are associated with different characteristics of hospitals and nurses. The administratively derived measure, HPPD, is not significantly associated with perceived staffing adequacy. However, nurse reports of inadequate assistive personnel are significantly associated with perceived staffing adequacy. CMI, a proxy measure for the acuity of patients, is associated with both HPPD and nurse-reported patient workloads. These 2 staffing measures are quantity-based measures of nurse staffing. This relationship is not surprising, as our clinical experience suggests that most staffing targets in hospitals are set by examining case mix or similar patient acuity tools.

Our results differ slightly from earlier studies. Mark[15] identified that perceptions of staffing were influenced by case mix, growth in hospital admissions, number of beds on the unit, and patient acuity. Nursing characteristics such as education and experience were not associated with perceptions of staffing adequacy. However, the current and earlier studies differ in their time points for staffing adequacy measurement, the availability of hospital characteristics, and a hospital versus unit-level measure of CMI.

The relationship observed between inadequate assistive personnel and overall staffing adequacy is intriguing and important. From a policy perspective, initiatives to legislate staffing ratios are focused primarily on patient-to-nurse ratios, and rarely consider the ratio of patients to assistive personnel. Yet in this multisite study, units with inadequate assistive personnel reported more staffing inadequacy. Failure to control for differences in the staffing of assistive personnel may conceal important relationships between overall nurse staffing and patient outcomes. Such analyses

TABLE 2. Pearson Correlation Matrix Among Unit-level Variables (N = 92 Nursing Units)

	1	2	3	4	5	6
Perception of staff adequacy	1					
HPPD	0.115	1				
Nurse-reported patient load, last shift	−0.384**	−0.276**	1			
CMI	0.030	0.314**	−0.348**	1		
Unexpected rise in patient volume and/or acuity	−0.288**	−0.127	0.184	−0.127	1	
Inadequate number of assistive personnel	−0.426**	−0.219*	0.149	0.056	0.612**	1

*P < 0.05; **P < 0.01.
CMI indicates case mix index; HPPD, hours per patient day.

TABLE 3. Variables Associated With 3 Measures of Nurse Staffing (N = 92 Nursing Units)

Variables	Model 1 Nurse-perceived Adequacy	Model 2 Nurse-perceived Adequacy	Model 3 Nurse-perceived Adequacy	Model 4 Nurse-perceived Adequacy	Model 5 HPPD	Model 6 Nurse-reported Patient Load, Last Shift
	Beta (*P*)					
HPPD	0.251 (0.079)	0.363 (0.051)	0.330 (0.083)	0.131 (0.414)	—	—
CMI		−0.111 (0.434)	−0.112 (0.433)	−0.073 (0.553)	0.332 (0.000)	−0.294 (0.004)
Nursing education ≥ BSN			0.119 (0.419)	0.210 (0.099)	0.179 (0.073)	−0.035 (0.750)
Unexpected rise in patient volume and acuity				−0.141 (0.376)	−0.017 (0.896)	0.126 (0.372)
Inadequate No. assistive personnel				−0.497 (0.002)	−0.145 (0.252)	0.299 (0.035)
Adjusted R^2 (*P* value)	0.105 (0.044)	0.041 (0.242)	0.036 (0.275)	0.338 (0.000)	0.574 (0.000)	0.468 (0.000)

Analysis included a dummy variable for study hospitals to control for its effect.
CMI indicates case mix index; HPPD, hours per patient day.

may lead to an overemphasis on RN staffing to address quality of care problems.

Our results inform the discussions regarding the optimal measure of nurse staffing for quality of care studies. We recommend researchers consider their research questions and conceptual framework before selecting a nurse staffing measure. For example, nurse-reported staffing adequacy does not seem to be associated with CMI, but rather with unit-based working conditions, such as inadequate assistive personnel. This measure may be more desirable for intervention research targeted on performance improvement where patient outcomes are not considered. Conversely, HPPD and nurse-reported patient workload are less associated with working conditions and have a higher association with CMI. Researchers conducting outcomes studies where patient severity of illness data are not available may wish to consider these measures, as higher HPPD generally reflects higher CMI and therefore higher resource utilization.

Reasonable arguments could be made to reconsider HPPD as a primary measure of nurse staffing for quality of care studies. Although HPPD can be calculated from available data sources, this measure suffers from inadequate consideration of actual nursing care required for hospitalized patients. Nor does HPPD address completely the use of non-nursing assistive personnel. It is more accurate, however, than using an HPPD measure restricted solely to RNs, which can be calculated from administrative data sets on national samples. Moreover, measures using HPPD require noteworthy assumptions for calculation, and comparison across personnel classes (RNs, Licensed Practical Nurses, aides) is challenging. The issues of staffing adequacy and in particular, the sufficiency of assistive personnel are not captured easily in administrative data. However, these important factors can be measured through questionnaires to nursing personnel. In contrast, data collection from personnel surveys suffers from cost, response rate, and logistical challenges.

Our study is limited by the cross-sectional design, which minimizes our ability to explicate causal pathways. In addition, the model fit statistics suggest that variables not captured in this study may explain more variation in nurse

staffing. Owing to the limited number of hospitals, we were not able to use robust methods to adjust standard errors for nurse clustering in hospitals. However, we did include hospital dummy variables in the regression models to minimize bias in our estimates.[25] CMI is an imperfect measure of severity of illness and the related demands on nursing care. However, we were able to collect this at the nursing unit, as opposed to the hospital-level. These limitations are presented alongside a multisite study with a robust array of unit-based measures of nurse staffing and important correlates of staffing.

Perceptual and empirical measures of nurse staffing are only modestly correlated. Perceived adequacy of nurse staffing is not associated with CMI, but rather with nursing unit characteristics, such as the availability of nursing personnel. In contrast, both administratively derived HPPD and nurse-reported patient workloads on the last shift are associated with CMI. Researchers conducting quality of care studies should choose nurse staffing measures not by availability, but by the conceptual framework and research questions of the study.

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